ANNUAL FISH POPULATION
AND
ANGLER USE AND SPORT FISH HARVEST SURVEYS
ON
LAKE FRANCIS CASE, SOUTH DAKOTA, 2004

by

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PREFACE

Information collected during 2004 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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EXECUTIVE SUMMARY

This report includes annual fish population and angler use and harvest data, from 2000 through 2004, for Lake Francis Case (LFC), South Dakota. These surveys, their results and interpretation, are major strategy and evaluation tools for planning efforts outlined in the Missouri River Fisheries Program Strategic Plan. Results and discussion presented pertain to changes in fish community and population characteristics, sport fishing use and harvest, and evaluation of management activities and regulations.

Walleye catch per unit of effort (CPUE; No./min.), during 2004 spring-spawning-run electrofishing near Chamberlain, decreased from 2003 and was the lowest of the five-year period. Walleye electrofishing CPUE at the face of Ft. Randall Dam decreased from 2003.

Fall gill netting collected seventeen fish species. Walleye CPUE (No./net night), in 2004, decreased over that observed in 2003 and is at a five-year low. Sauger CPUE increased from the 2003 value. Channel catfish CPUE decreased from the 2003 value. Mean white bass CPUE in 2004 declined from 2003. Smallmouth bass mean CPUE in 2004 decreased from the 2003 value while yellow perch CPUE increased from the 2003 value and is at a five-year high.

Sixteen species of age-0 fishes or small littoral prey species were collected by seining in 2004. Age-0 gizzard shad were most common in 2004 seine catches, accounting for 67% of the total catch, while age-0 white bass accounted for 15% of the total catch. Emerald shiners, johnny darter, river carpsucker, smallmouth bass, spottail shiners and yellow perch were also common in seine catches.

Walleye mean age, growth, and relative weight (Wr) in 2004 were all similar to previous year's values, while proportional stock density (PSD) increased, abundance decreased, and survival was similar to the 2003 estimate. All sauger population parameter values were within the five-year range. The number of smallmouth bass collected in fall netting surveys was inadequate to allow meaningful population parameter comparisons.

Anglers spent an estimated 659,184 hours fishing LFC, during the April-September 2004 daylight period, a decrease from the 710,078 hours estimated for 2003 and over 300,000 hours less than the high estimated for 1999. Total fish harvest in 2004 was estimated at 162,512 fish. Walleye dominated the harvest, with an estimated 113,813 fish harvested in the April-September 2004 survey period. Estimated mean length of harvested walleye was 40.7 cm (16.0 in). Channel catfish, white bass, sauger, and smallmouth bass were also common in the harvest. An overall catch rate (harvest and release rates combined) of just under 1.0 fish/angler-h was estimated for the April-September 2004 daylight period. Total catch, release, and harvest rates for walleye were 0.70 walleye/angler-h, 0.53 walleye/angler-h, and 0.17 walleye/angler-h, respectively. Approximately 75% of LFC anglers expressed some degree of satisfaction with their angling trip. Anglers from South Dakota and 22 other states, fishing LFC, generated a local economic impact estimated at approximately 8.2 million dollars, in 2004. Results from several questions regarding LFC angler attitudes and preferences are reported.

TABLE OF CONTENTS

Page

LIST OF TABLES

List of tables continued...

Table Page

List of tables continued...

Table

Page

LIST OF FIGURES

LIST OF APPENDICES

ANNUAL FISH POPULATION
AND
ANGLER USE AND SPORT FISH HARVEST SURVEYS
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INTRODUCTION

Lake Francis Case (LFC), a Missouri River mainstem reservoir, has provided more than 100,000 angler days of recreation annually since 1992 (Table 1). Overall, the river segments and reservoirs comprising the Missouri River system, in South Dakota, provide a large and diverse portion of the state's available fishing opportunity. The importance of this system to South Dakota anglers was documented in a 1992 Angler Use and Preference Survey (Mendelsohn 1994; Stone 1996a), in which 50 percent of the respondents listed the "Missouri River and its reservoirs" as their preferred fishing area. Recognizing the importance of the Missouri River, strategic planning efforts (SDGFP 1994) by the South Dakota Department of Game, Fish and Parks (SDGFP) have designated the Missouri River as a specific planning program within the overall planning effort.

Walleye, and to a lesser extent smallmouth bass, white bass and channel catfish, provide the majority of sport fishing opportunity available in this reservoir. Over the past 23 years, management of the walleye sport fishery has undergone several significant changes in response to changes in walleye population structure and angler use and harvest (Stone 1990; Stone et al. 1994; Stone and Sorensen 1999, 2001). Harvest regulations for walleye/sauger and their hybrids for LFC in 2004 included:

- daily and possession limits of 3 and 8 per angler, respectively.
- a minimum length limit of 381 mm (15 in.) for all months of the year except July and August.
- anglers are allowed only one walleye/sauger or hybrid per day longer than 457 mm (18 in.), year-round.
- anglers are not allowed to "cull" or "hi-grade" walleye/sauger or hybrids.
- anglers fishing through the ice in the lower half of the reservoir are required to keep the first three walleye/sauger or hybrids they catch and size restrictions do not apply.
- closed area: the area in the upper portion of the reservoir, between I-90 and the railroad bridge, referred to as the "dredge hole" is closed to fishing (except shore fishing on the Brule County side) during the months of January through April and December.

LFC anglers fishing in the late 1990s and early 2000s benefited from high walleye abundance resulting from conditions provided by unusually high water levels in 1995 and 1997. However, with water yield in the Missouri River Basin entering the fifth consecutive year of below normal conditions, past research (Stone 1997b) and observations would suggest that it will be unrealistic to expect to maintain fish population abundance at the levels observed in the mid-to-late 1990s. Walleye abundance has steadily decreased over the past four years due to persistent drought conditions.

Maintaining LFC as one of South Dakota's most productive fisheries resources requires that it be effectively managed to produce optimal recreational benefits, within the framework of protecting and maintaining the overall integrity of the aquatic community. The Missouri River Fisheries Program Strategic Plan (SDGFP 1994) documents the goal, objectives and strategies developed for management of this system. Annual acquisition and analysis of data describing the fish community and fish population parameters, in association with data describing angler use and sport fish harvest, is a primary strategy outlined in that plan. This work is required for evaluation of objectives and strategies outlined in that plan and as a prerequisite to effective development of future management strategies. This report describes data collected in 2004 from LFC and the discussion focuses on changes in fish populations and associated angler use and sport fish harvest since 2000.

Table 1. Angler use and sport fish harvest statistics from creel surveys conducted on Lake Francis Case since 1954. TL = total length.

Year	Fishing pressure (h)	Angler days	Mean trip length (h)	Total fish harvest (No.)	Walleye harvest (No.)	Total harvest rate (Fish/ angler-h)	Walleye harvest rate (Fish/ angler-h)	Mean walleye TL(mm) in harvest	Reference
1954	84,000	35,000	2.4	115,000	0	1.369	0.000	-	Shields (1955)
1955	119,000	41,000	2.9	105,000	190	0.882	0.002	-	Shields (1956)
1956	159,000	47,500	3.4	89,500	177	0.563	0.001	-	Shields (1957)
1960	425,000	78,500	5.3	114,310	1,386	0.269	0.003	-	Nelson (1961)
1981*	565,890	99,280	5.7	173,730	145,412	0.307	0.257	-	Miller (1984)
1982	557,570	101,375	5.5	136,150	110,554	0.244	0.198	-	Miller (1984)
1983	425,060	74,570	5.7	102,070	70,434	0.240	0.166	-	Unkenholz et al. (1984)
1984	433,640	86,730	5.0	259,070	242,431	0.597	0.559	-	Stone (1985)
1989	604,100	115,290	5.2	289,854	222,008	0.480	0.368	340	Stone and Wickstrom (1991a)
1990	383,711	81,641	4.7	117,155	64,596	0.305	0.169	368	Stone and Wickstrom (1991b)
1991	409,600	87,521	4.7	139,600	95,298	0.341	0.233	381	Stone and Wickstrom (1992)
1992#	640,215	127,215	5.0	267,105	217,841	0.417	0.339	386	Stone et al. (1994)
1993	589,153	115,520	5.1	126,231	95,425	0.214	0.161	386	Stone et al. (1994)
1994	695,371	131,202	5.3	220,386	174,775	0.317	0.251	386	Stone (1995)
1995	543,414	113,923	4.8	185,354	158,354	0.341	0.292	391	Stone (1996b)
1996	856,421	190,316	4.5	324,221	274,339	0.379	0.320	383	Stone (1997a)
1997	652,510	143,409	4.6	307,297	285,463	0.471	0.437	385	Stone (1998)
1998	961,343	204,324	4.7	397,535	339,889	0.413	0.354	396	Stone and Sorensen (1999)
1999	997,871	212,902	4.7	359,440	285,186	0.360	0.286	417	Stone and Sorensen (2000)
2000	809,806	149,964	5.4	248,234	196,795	0.306	0.243	412	Stone and Sorensen (2001)
2001	780,962	152,830	5.1	242,869	199,372	0.311	0.255	409	Stone and Sorensen (2002)
2002	714,510	148,856	4.8	215,275	178,666	0.301	0.250	405	Stone and Sorensen (2003)
2003	710,078	139,231	5.1	205,705	162,581	0.290	0.229	411	Sorensen (2004)
2004	659,184	134,527	4.9	162,512	113,813	0.247	0.173	407	This study

* Estimate projected from a creel survey for approximately 1/3 of reservoir.
\# Estimate was for May-August only.

OBJECTIVES

The objectives of the two main surveys discussed in this report are to provide information on or estimates of:

Annual Fish Population Surveys (Federal Aid Project 2102):

(1) species composition
(2) relative abundance
(3) condition
(4) age, growth, and 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

Fish tagging was also conducted to provide information on fish movement and angler exploitation.

Angler Use and Sport Fish Harvest Survey (Federal Aid Project 2109):

(1) recreational angling pressure
(2) angler catch, harvest, and release, by species
(3) angler catch, harvest and release rates, by species
(4) mean angler party size and mean length of an angler day
(5) annual direct economic impact of this sport fishery
(6) effects of regulations
(7) effects of stocking and other management activities
(8) angler demographics
(9) angler preference, satisfaction and attitudes

STUDY AREA

Lake Francis Case is located in south-central South Dakota (Figure 1). Historical, biological, chemical and physical parameters have been discussed in North Central Reservoir Investigation reports (Benson 1968; Gasaway 1970; Walburg 1977). Table 2 presents selected physical characteristics and management statistics for Lake Francis Case.

Water yield in the Missouri River system in 2004 was below normal and was the fifth consecutive year of below normal inflow after six years of above normal yield (Appendix 1; U.S. Army Corps of Engineers, unpublished data). During the spring of 2004, the elevation of LFC increased as was forecasted by the U.S. Army Corps of Engineers (USCOE). Reservoir elevation reached 413 m msl (1354.3 ft. msl) by mid-March and remained above this level until the annual fall draw-down began in late July. Appendix 1 presents monthly data on water released from Ft. Randall Dam.

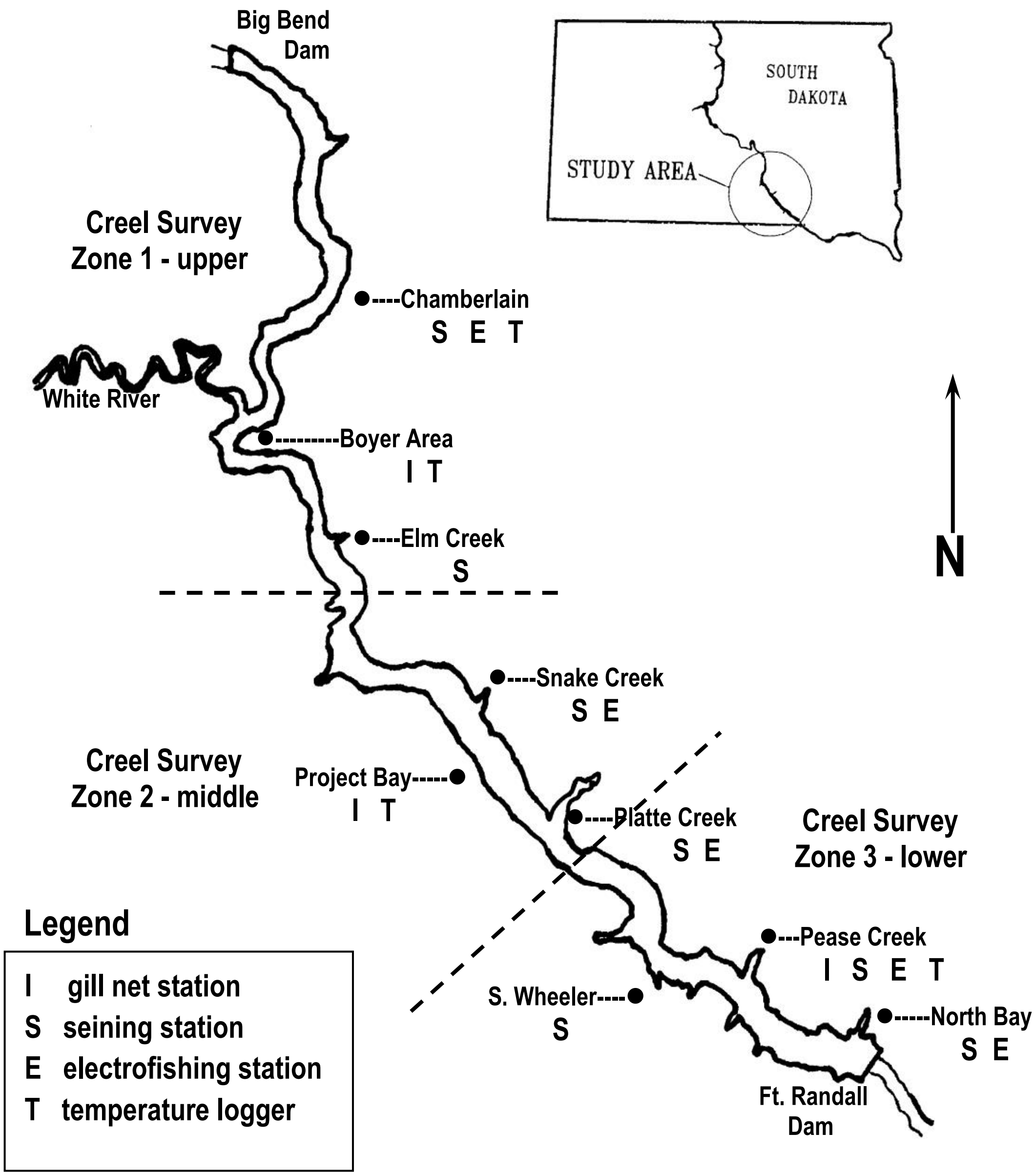

Figure 1. Lake Francis Case study area.

Table 2. Physical characteristics at base of flood control, management classification, and sampling times and depths for annual fish population surveys on Lake Francis Case.

	Lake Francis Case
Location:	From Pickstown to Ft. Thompson, SD
Surface Area (x 1000 ha):	32.0
Depth (m) - maximum: - mean:	42.6 15.2
Bottom:	Sand, gravel, shale and silt
Water source:	Missouri River and tributaries
Management classification:	Cool and warm water permanent
Electrofishing - walleye - smallmouth bass	April, May May, June
Gill net depths:	0-12 m (0-40 ft) 12-24 m (40-80 ft) 24-37 m (80-120 ft)
Number of gill nets:	27
Gill net date:	September
Seine date:	July

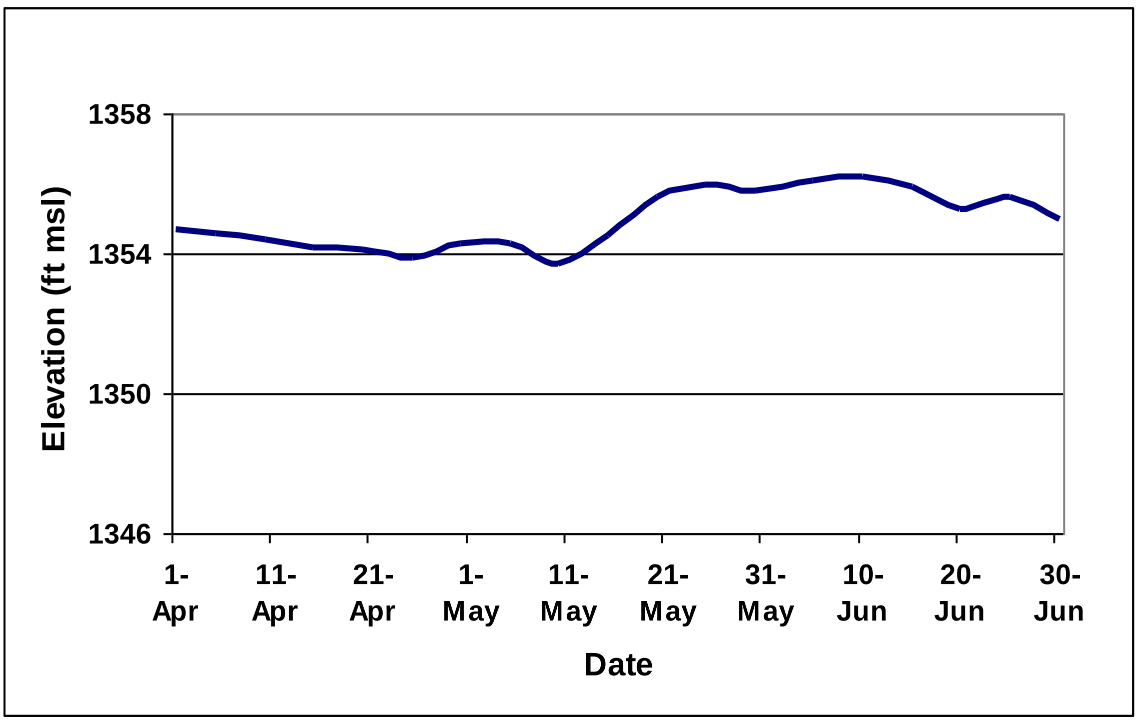

Figure 2. Spring 2004 Lake Francis Case reservoir elevation.

SAMPLING METHODS AND SCHEDULE

FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES

Data Collection

Gill nets, seines, and electrofishing were used to sample fish populations in LFC at locations identified in Figure 1. Three variable-mesh standard gill nets (Lott et al. 1994) were fished overnight, on the bottom, in one embayment and in each depth zone (where possible), at each station (Table 2). All fish species collected were identified, counted, measured for total length (TL; mm) and weighed (g). Scale samples and otoliths (100 per species per sampling location) were collected from walleye, sauger, smallmouth bass and white bass, where possible.

Pulsed-DC (60 pps, 6-8 amps) electrofishing, using a Smith Root GPP electrofishing boat, was used to collect walleye during April and smallmouth bass during May and June, for population monitoring (fish/min) and tagging studies. Nine and six 10-minute electrofishing runs were conducted at night near Chamberlain and on the face of Ft. Randall Dam, respectively, to collect walleye. Smallmouth bass were collected at five locations: Chamberlain, Big Bend Dam tailwater, Platte Creek, Pease Creek and near Ft. Randall Dam (Figure 1). Three, 30-minute electrofishing runs were conducted at each sampling location. All fish were measured for total length.

Nylon seines, previously described by Lott et al. (1994), 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; two on each side of the reservoir. All fish collected with seines were identified to species and counted. Walleye were measured for total length.

Water temperature data was collected with submersible HOBO Water Temp Pro temperature loggers. Loggers, configured to record temperature every two hours, were deployed at four locations (Figure 1) on the reservoir between March 31 and April 14, 2004 and retrieved between September 8 and September 14, 2004.

A list of common names, scientific names, and abbreviations of fish mentioned throughout this report is presented in Appendix 2.

Data Analysis

Relative abundance of fish species was expressed as mean catch per unit effort (CPUE) for standard gill net (No./net night), electrofishing (No./min.), and seine catches (No./haul). Age and growth analyses were completed for walleye, sauger and smallmouth bass. Scales and otoliths were aged according to standard techniques (DeVries and Frie 1996). Back-calculations for scale analysis were made with the computer program WINFIN (Francis 1999, 2000). Standard y-intercept values, suggested by Carlander (1982), were used for walleye (55 mm), sauger (55 mm), and smallmouth bass (35 mm). Age distributions from gill net catches were developed, for selected species, by aging approximately 100 fish randomly selected per sampling station (when available). Proportional stock density (PSD) and relative stock density (RSD) values for preferred- (RSD-P) and memorable- (RSD-M) length fish were calculated for channel catfish, sauger, smallmouth bass, walleye, white bass, and yellow perch (Anderson and Weithman 1978; Gabelhouse 1984). Length categories (Gabelhouse 1984) used to calculate PSD and RSD are listed in Table 3.

Table 3. Minimum lengths (mm) of length class designations (Gabelhouse 1984).

Species	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 weight (W_r; Anderson 1980), for stock-to-quality (S-Q), quality-to-preferred (Q-P), and preferred-length (P) fish (Table 3) was calculated using length designations established by Gablehouse (1984). Relative weight (W_r) values were generated using standard weight (W_s) equations developed for walleye (Murphy et al. 1990), sauger (Guy et al. 1990), smallmouth bass (Kolander and Willis 1991), channel catfish (Brown et al. 1995), yellow perch (Willis et al. 1991), and white bass (Brown and Murphy 1991). Standard weight equations used in this report are provided in Appendix 3. Mean W_r values were tested for differences among length-class designations using a one-way analysis of variance (SYSTAT, 1998). A mean W_r value for stock-length fish is reported when no significant differences were detected among length categories. Statistical significance was set at $P < 0.05$.

Length-weight regression equations were developed for walleye, sauger, and smallmouth bass using Systat 8.0 (SYSTAT 1998). The equations are presented in Appendix 4.

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 consecutive years of age-distribution data, from the gill net survey, were combined for analysis. Catch curves were analyzed to determine the age at which each species was 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.

ANGLER USE AND SPORT FISH HARVEST SURVEY

A bus route creel survey design (Soupir and Brown 2002; Jones and Robson 1991), first utilized in 2000 (Stone and Sorensen 2001), was conducted to estimate angler use and harvest on LFC. Prior to 2000, fishing pressure was estimated by either aerial counts of fishing boats and shore anglers (Schmidt 1975) or by ground counts of boat trailers and shore anglers (Stone and Sorensen 1999). A bus route design is a modified access survey typically used for fisheries with numerous access sites spread over a broad geographical region (Robson and Jones 1989; Jones et. al. 1990). For a more detailed description of the bus route theory and techniques see Robson and Jones (1989), Jones and Robson (1991) and Pollock et al. (1994). Estimates of angler catch, harvest, and release rates, along with information on mean party size, mean angler day length, and angler residency were collected by interviewing anglers. Total fish catch, harvest and release estimates were calculated by multiplying the pressure estimate (angler hours) by the estimated catch, harvest, or release rate (fish/angler-h). Despite the modification to the fishing pressure estimate technique, the survey design provides statistics comparable to those previously determined for LFC (Miller 1984; Unkenholz et al. 1984; Stone 1985; Stone and Wickstrom 1991a, 1991b, 1992; Stone et al. 1994; Stone 1995, 1996b, 1997, 1998; Stone and Sorensen 1999, 2000, 2001, 2002; Sorensen 2003).

Sampling was conducted from 1 April 2004 through 30 September 2004, for the daylight period (sunrise to sunset). Creel zones are identified in Figure 1.

ANGLER PREFERENCE AND ATTITUDE SURVEY

A series of questions were selected by SDGFP reservoir fisheries biologists and human dimensions staff to measure angler satisfaction, preferences, and attitudes on several management issues. Questions selected were those thought to have a direct relationship to current reservoir fisheries management.

Questions were asked of individual anglers by incorporating two different sets of questions into routine creel-survey-interview forms. One person, from each angling party, was asked one series of questions. The questions appeared on an alternating basis on creel survey interview forms, in an attempt to reduce duplication in subsequent interviews. Responses were encoded into a database for summary and analysis.

RESULTS

FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES

Species Composition and Relative Abundance

Results of spring electrofishing, conducted to monitor the timing and abundance of spawning walleye, are presented in Tables 4 - 6. Overall walleye electrofishing CPUE in 2004, near Chamberlain, was similar to values measured in previous years (Table 4). Sampling near Ft. Randall Dam, during 2004, yielded a CPUE within the range of the five-year period (Table 5).

Table 4. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Chamberlain, 2000-2004. Catch per unit effort (CPUE) values with the same letter code are not significantly different at the *P* = 0.05 level.

Year	Sampling time (min)	Number of fish	CPUE (fish/min)
2000	65	707	10.9 a
2001	83	777	9.4 a
2002	50	623	12.5 a
2003	70	628	9.0 a
2004	90	749	8.3 a

Table 5. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Ft. Randall Dam, 2000-2004. Catch per unit effort (CPUE) values with the same letter code are not significantly different at the *P* = 0.05 level.

Year	Total Sampling time (min)	Number of fish	CPUE (fish/min)
2000	80	183	2.3 a
2001	66	344	5.2 a
2002	120	445	3.7 a
2003	90	431	4.8 a
2004	60	245	4.1 a

Table 6. Electrofishing data, by location and date, for walleye from Lake Francis Case, 2004. Catch per unit effort (CPUE) values, by location, with the same letter code are not significantly different at the *P* = 0.05 level.

Location	Date	Water temp. (C)	Total Sampling time (min)	No. of fish	CPUE (fish/min)
Chamberlain	4/13/04	8.9	30	246	8.2 a
Chamberlain	4/19/04	11.8	30	184	6.1 a
Chamberlain	4/26/04	11.1	30	319	10.6 a
Ft. Randall Dam	4/20/04	8.7	30	131	4.4 a
Ft. Randall Dam	4/27/04	12.1	30	114	5.1 a

Catch-per-unit-effort of smallmouth bass, while not statistically different, decreased at four of the five sampling stations (Table 7). However, with the exception of the Big Bend Dam Tailwater, most smallmouth bass spring electrofishing CPUE’s were near the low end of the sampling range over the past three-to-five years (Table 7).

Table 7. Electrofishing catch of smallmouth bass during spring sampling, at five locations on Lake Francis Case, 2000-2004. Catch per unit effort (CPUE) values within sites with the same letter code are not significantly different at the *P* = 0.05 level.

Chamberlain			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2000	30	108	3.6 a
2001	45	45	1.0 a
2002	49	75	1.5 a
2003	45	122	2.7 a
2004	55	62	1.1 a
Big Bend Dam Tailwaters			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2001	60	49	0.8 a
2002	90	126	1.4 a
2003	60	112	1.9 a
2004	30	67	2.2 a
Platte Creek			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2000	90	67	0.7 a
2001	60	32	0.5 ab
2002	90	12	0.1 ab
2003	90	83	0.9 a
2004	45	30	0.7 ab
Pease Creek			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2000	45	27	0.6 a
2001	60	28	0.5 a
2002	90	50	0.6 a
2003	90	102	1.1 a
2004	55	24	0.4 a
Ft. Randall Dam			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2000	60	115	1.9 a
2001	60	76	1.3 a
2002	90	232	2.6 a
2003	90	175	1.9 a
2004	30	23	0.8 a

Fall gill-net sampling collected 17 species of fish from LFC in 2004 (Table 8). All species had been previously reported (Lott et al. 1994). Walleye have been the most common species in the gill net catch since re-initiation of this survey in 1981 (Michaletz et al. 1986; Lott et al. 1994), and comprised 34% of gill net catches in 2004, followed by sauger and channel catfish, which accounted for 19% and 17% of the catch, respectively. White bass, gizzard shad, common carp, freshwater drum, river carpsucker, yellow perch, goldeye and smallmouth bass were also common in gill-net catches during 2004.

Walleye CPUE in gill nets, in 2004, was similar to the 2003 value and significantly lower than other years in the five-year period (Table 8). This decrease in abundance can be attributed primarily to low walleye production and recruitment from 2001 through 2004.

Channel catfish CPUE in gill nets, in 2004, was similar to other years in the five-year period. Sauger and smallmouth bass CPUE for 2004 was similar to other years in the five-year period. Yellow perch CPUE was similar to all year in the five-year period except 2001. White bass CPUE was similar to other values in the five-year period but was significantly lower than 2001.

Sixteen species of age-0 fishes or small littoral species were collected by seining in 2004 (Table 9). All species had been previously reported for LFC (Lott et al. 1994). Age-0 gizzard shad comprised the majority of seine catches, as they have for the past five years, and accounted for 67% of the total seine catch. White bass and emerald shiners comprised 15 and 10 % of the total seine catch respectively. Spottail shiners, freshwater drum, johnny darters, yellow perch, river carpsucker, channel catfish, walleye, and smallmouth bass were also common in seine samples.

The age-0 walleye seining CPUE decreased for the third consecutive year to 0.3 fish/seine haul in 2004. Age-0 walleye collections in 2004 followed a normal LFC pattern, with 67% of the fish collected in the upper half of the reservoir. Walleye collected in seines, in mid-July, averaged 88.5 mm (Table 10).

Table 8. Mean gill net catch per lift (CPUE; No./net night), sampling stations combined, on Lake Francis Case, 2000-2004. SE is standard error. Trace (T) < 0.1.

Species	2000		2001		2002		2003		2004	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Black bullhead	0.2	0.1	0.0		0.0		0.0		0.0	
Channel catfish	4.1	0.5	4.4	0.5	5.6	0.6	5.6	0.9	4.4	0.8
Common carp	1.1	0.3	0.9	0.3	1.8	0.4	0.9	0.2	0.8	0.2
Emerald shiner	T	-	T	-	0.0		T	-	0.0	
Freshwater drum	1.2	0.3	1.1	0.3	0.7	0.2	0.3	0.1	0.8	0.3
Gizzard shad	4.3	3.6	12.0	3.8	1.8	0.8	1.1	0.7	0.8	0.3
Goldeye	2.0	0.7	2.2	0.9	1.0	0.4	1.2	0.4	1.5	0.6
Northern pike	0.1	0.1	T	-	T	-	0.0		0.0	
Rainbow trout	0.0		T	-	0.0		0.0		T	-
River carpsucker	0.2	0.1	0.2	0.1	0.3	0.2	0.1	0.1	0.5	0.2
Sauger	5.5	0.6	4.9	0.7	6.3	1.0	4.0	0.6	4.7	0.7
Shorthead redhorse	0.1	0.1	0.2	0.1	0.3	0.1	0.0		0.1	0.1
Shortnose gar	0.1	0.1	0.1	0.1	0.0		0.2	0.1	0.2	0.1
Shovelnose sturgeon	T	-	T	-	0.0		0.0		0.0	
Smallmouth bass	0.9	0.4	0.6	0.2	1.4	0.6	0.9	0.3	0.7	0.4
Smallmouth buffalo	T	-	0.0		T	-	0.1	0.1	T	-
Spottail shiner	T	-	T	-	T	-	0.2	0.2	0.1	0.1
Walleye	21.6	3.3	11.3	1.1	15.9	2.0	9.6	1.0	8.6	1.0
White bass	1.1	0.3	4.2	1.1	0.9	0.2	1.6	0.4	0.6	0.2
White crappie	0.1	0.1	0.7	0.3	0.1	0.1	0.1	0.1	T	-
Yellow perch	0.9	0.3	0.3	0.1	0.6	0.1	1.0	0.3	1.2	0.4

Table 9. Mean catch per seine haul (CPUE; No./haul), sampling stations combined, of age-0 fishes and small littoral species from Lake Francis Case, 2000-2004. SE is standard error. Trace (T) < 0.1

Species	2000		2001		2002		2003		2004	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Bigmouth buffalo	0.0		T	-	0.0		0.0		0.0	
Black bullhead	0.0		0.0		0.0		0.0		0.0	
Black crappie	T	-	T	-	0.0		0.0		0.0	
Channel catfish	T	-	0.2	0.2	0.0		0.0		0.5	0.3
Common carp	0.0		0.5	0.4	0.1	0.1	0.0		0.6	0.3
Common shiner	1.2	0.6	0.3	0.3	0.0		0.2	0.2	0.0	
Emerald shiner*	72.8	20.0	35.4	12.8	26.9	8.9	22.0	8.4	45.1	12.2
Fathead minnow*	0.1	0.1	1.7	1.0	T	-	0.1	0.1	0.0	
Freshwater drum	2.0	1.6	0.5	0.3	1.0	0.6	6.3	3.5	0.4	0.2
Gizzard shad	202.0	101.6	793.7	495.1	3659.1	1610.8	934.2	299.3	290.6	100.6
Goldeye	0.3	0.1	0.3	0.3	T	-	0.0		0.1	0.1
Johnny darter*	2.3	0.9	3.2	1.4	0.4	0.3	5.4	2.5	8.4	5.4
Largemouth bass	0.0		0.0		0.0		0.0		0.0	
North. redbelly dace	0.0		T	-	0.0		0.0		0.0	
Red shiner*	0.2	0.2	0.6	0.3	0.4	0.2	0.1	0.1	0.4	0.2
River carpsucker	T	-	0.2	0.2	0.3	0.1	0.1	0.1	5.4	1.8
Sauger	0.0		0.3	0.2	T	-	0.0		0.1	0.1
Shorthead redhorse	0.0		T	-	0.0		0.0		0.0	
Silvery minnow	0.2	0.1	0.0		0.0		0.1	0.1	0.0	
Smallmouth bass	1.3	0.4	1.5	0.7	1.8	0.7	1.3	0.4	2.6	0.7
Smallmouth buffalo	0.2	0.2	1.8	0.8	T	-	0.0		T	-
Spottail shiner*	10.8	7.7	33.4	12.5	3.3	1.3	11.5	2.7	6.8	2.5
Walleye	1.1	0.5	11.9	4.7	3.5	1.3	2.3	1.3	0.3	0.1
White bass	59.1	33.0	389.1	130.0	65.1	23.4	11.2	5.4	65.2	21.0
White crappie	0.0		0.2	0.1	0.0		0.0		0.0	
Yellow perch	18.7	5.5	41.2	25.7	10.0	4.6	3.6	1.4	5.8	2.3

- includes both age-0 and adults

Table 10. Number (No.), catch per unit effort (CPUE; No./haul), mean total length (TL) and length range for age-0 walleye collected by seines from Lake Francis Case, 2000 – 2004.

Year	No.	CPUE	Mean TL (mm)	Total length (mm) range
2000	30	1.1	67.5	58 - 83
2001	322	11.9	68.3	41 - 91
2002	95	3.5	80.0	63 - 109
2003	65	2.4	88.2	62-103
2004	9	0.3	88.5	85-92

Population Parameters for Walleye

Walleye growth, during 2003 (the last full year that growth could be calculated), was within the range of previous years for all age-classes (Table 11). Back-calculated length-at-age estimates are provided in Table 12. One concern with the use of minimum length limits is a reduction in growth rates resulting in "stockpiling" of fish just below the minimum length limit (Noble and Jones 1993). Current LFC length-at-age data suggests that stockpiling is not occurring. Mean walleye age in gill net samples, at 2.3 years, is similar to values generated for 2000-2003. Walleye from six year-classes were collected in the 2004 gill net survey (Table 13) and ranged in TL from 120-mm to 510-mm (Figure 3).

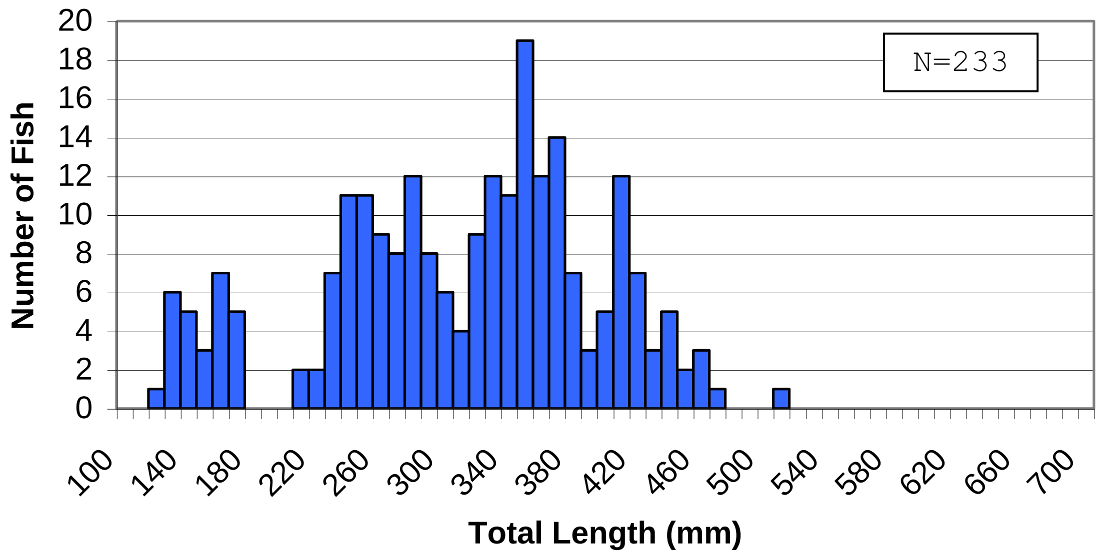

Figure 3. Length frequency of walleye collected with gill nets from Lake Francis Case, 2004. N = sample size.

Annual survival, for pooled 2003 and 2004 data, was estimated at 46% (Table 14), within the range of the five-year period. Relative weights for stock-quality (S-Q) length and quality-preferred (Q-P) length fish sampled in 2004 were similar to previous years (Table 15). Proportional stock density (PSD) values for 2003 and 2004 were similar and lower than values from 2000-2002 (Table 16).

Table 11. Mean annual growth increments (mm) of back-calculated total lengths, from scale analysis, for each year class of walleye collected with variable-mesh gill nets during September 2004 from Lake Francis Case. N = sample size.

Year Class	Age	N	Growth increment at age					
			1	2	3	4	5	6
2003	1	46	154					
2002	2	85	154	112				
2001	3	37	135	116	76			
2000	4	29	145	114	75	51		
1999	5	5	163	119	71	51	41	
1998	6	1	129	83	81	68	34	12
All classes			147	107	73	56	37	65
N		20 3	203	157	72	35	6	1

Table 12. Mean annual back-calculated total lengths (mm), from scale analysis for each year class of walleye collected with variable-mesh gill nets during September 2004 from Lake Francis Case. N = sample size.

Year Class	Age	N	Back-calculated length at age					
			1	2	3	4	5	6
2003	1	46	154					
2002	2	85	154	266				
2001	3	37	135	251	327			
2000	4	29	145	259	334	385		
1999	5	5	163	282	353	404	445	
1998	6	1	129	212	293	361	395	407
All classes			147	254	327	383	420	407
N		203	203	157	72	35	6	1

Table 13. Age distribution, from scale analysis, of walleye collected from Lake Francis Case with variable-mesh gill nets, 2000-2004. Mean age excludes age-0 fish.

Year	Age												
	0	1	2	3	4	5	6	7	8	9	10	11	Mean
2000	59	107	206	134	28	36	8	2	1	0	0	0	2.2
2001	16	77	112	54	34	3	4	1	0	0	0	0	2.3
2002	117	100	101	71	26	7	1	0	0	0	0	1	2.2
2003	27	93	59	46	19	4	3	3	0	0	0	1	2.1
2004	15	46	85	37	29	5	1	0	0	0	0	0	2.3

Table 14. Estimates of annual survival (S), annual mortality (A), and instantaneous mortality rates (Z) for age-1-and-older fish of selected species, from Lake Francis Case. Years indicate which years of annual gill net survey data were combined for analysis.

Species	Years	S	A	-z	R^2
Walleye	1999-2000	0.46	0.54	0.767	0.953
	2000-2001	0.43	0.57	0.846	0.911
	2001-2002	0.39	0.61	0.940	0.916
	2002-2003	0.47	0.53	0.755	0.955
	2003-2004	0.46	0.54	0.769	0.954
Sauger	1999-2000	0.34	0.66	1.078	0.887
	2000-2001	0.36	0.64	1.018	0.918
	2001-2002	0.31	0.69	1.166	0.839
	2002-2003	0.34	0.66	1.082	0.861
	2003-2004	0.52	0.48	0.652	0.821
Smallmouth bass	1999-2000	0.65	0.35	0.424	0.542
	2000-2001	0.49	0.51	0.723	0.565
	2001-2002	0.54	0.46	0.607	0.820
	2002-2003	0.45	0.55	0.788	0.853
	2003-2004	0.20	0.80	1.590	0.938

Table 15. Mean relative weight, by length category, for Lake Francis Case walleye, sauger, and smallmouth bass, collected in gill net catches in early September, 2000-2004. S-Q = stock-to-quality length, Q-P = quality-to-preferred length, P = preferred length. *N* = sample size.

Walleye				
Year	**S-Q**	**Q-P**	**P**	***N***
2000	83	82	78	482
2001	82	83	78	243
2002	83	81	86	274
2003	81	80	73	196
2004	83	82	77	185
Sauger				
Year	**S-Q**	**Q-P**	**P**	***N***
2000	74	72	69	146
2001	74	76	75	128
2002	76	73	73	119
2003	74	73	69	88
2004	74	74	73	124
Smallmouth bass				
Year	**S-Q**	**Q-P**	**P**	***N***
2000	118	111	109	23
2001	111	110	119	12
2002	111	107	101	29
2003	111	110	-	20
2004	112	105	-	15

Table 16. Walleye, sauger, and smallmouth bass proportional stock density (PSD) and relative stock density for preferred- and memorable-length fish (RSD-P and RSD-M, respectively), for Lake Francis Case gill net data, 2000-2004.

Species	2000	2001	2002	2003	2004
Walleye	37 (3,0)	34 (0,0)	34 (1,0)	24 (1,0)	27 (1,0)
Sauger	56 (21,0)	69 (17,0)	63 (20,0)	51 (18,0)	75 (11,0)
Smallmouth bass	61 (9,0)	50 (8,0)	35 (7,0)	25 (0,0)	33 (0,0)

Yearly total walleye abundance (CPUE), as indexed by fall gill netting, partitioned by selected age and size groups and plotted with total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA is presented in Figure 4. Two factors have been credited for the improvements in walleye abundance and age structure, that was observed through the mid-1990’s. First, walleye population parameter improvements were noted soon after sport-fishing-regulation changes were implemented in 1990 (Stone and Wickstrom 1991a). The population also positively responded to habitat/nutrient conditions provided by the high runoff into the Missouri River system during 1993–1997 (Stone 1997b). The general decline in overall walleye abundance beginning in 1996 through this current survey can be attributed to angler harvest coupled with declining productivity, as Missouri River water yield returned to more normal levels in 1998 and 1999, followed by five consecutive years of drought conditions. Walleye abundance in 2004 was similar to 2003 and lower than all other year’s abundance indices since 1985. The decrease in abundance can be attributed to poor nutrient conditions caused by reduced localized run off resulting in poor production and recruitment during 2001-2004. Following a sharp decrease in water elevation during the peak walleye egg incubation period in 2002, the Department of Game, Fish and Parks stocked 400,000 walleye fingerlings and 4 million walleye fry. There appeared to be a large walleye year class produced in 2002 and although origin of these age-0 fish could not be determined, their smaller-than-average size in fall gill net samples led to the assumption that a majority of these fish were a result of stocking efforts. Unfortunately, the strong 2002 year class did not translate into a strong age-1 or age-2 year class in 2003 and 2004 and a significant portion of these fish were lost from the population (Table 13).

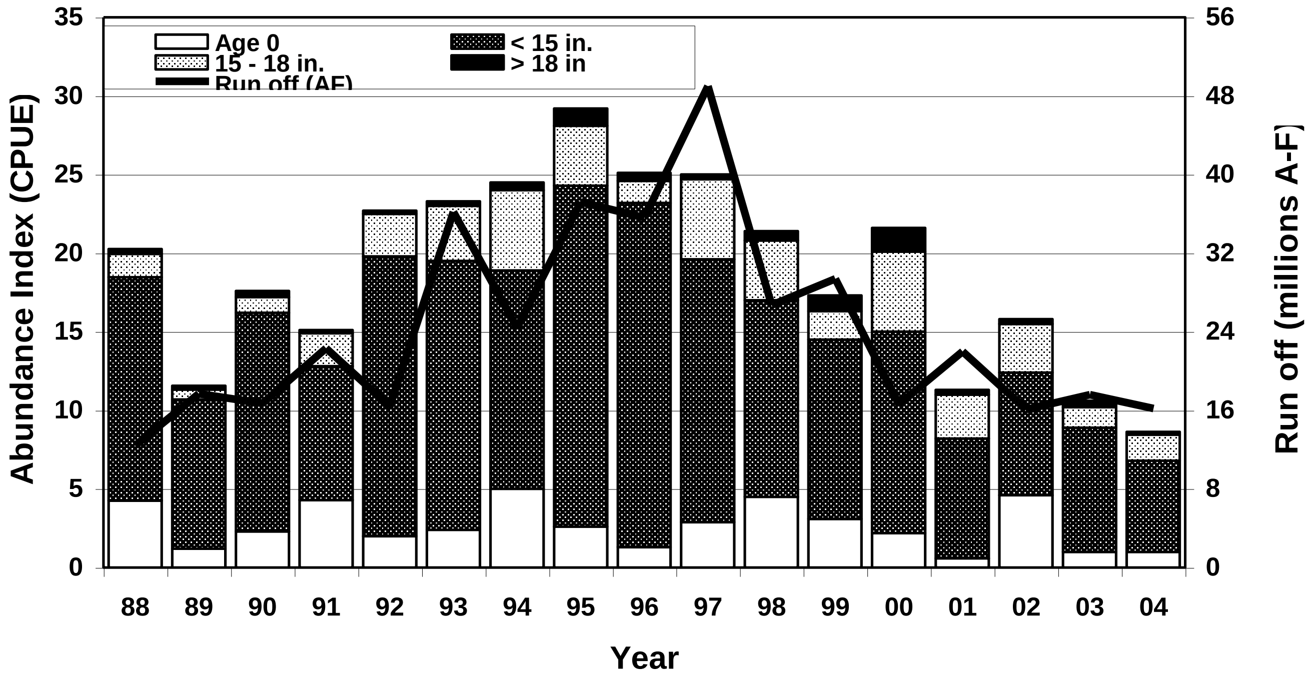

Figure 4. Lake Francis Case total walleye abundance (No. per net night) partitioned by walleye age and length groups and plotted against total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA. 1988-2004.

Population Parameters for Sauger

The 2004 Sauger abundance index in LFC, at a mean CPUE of 4.7 fish/net night, increased from 2003, and was similar to other years in the five-year reporting period (Table 8). Lengths of sauger sampled in the 2004 gill net survey ranged from 160 mm to 420 mm TL (Figure 5). Sauger growth increments and back-calculated length-at-age during 2003 (the last full year that growth could be calculated) are presented in Tables 17 and 18. Mean sauger W_r values, for the various length categories are within the five-year range (Table 15).

Four year classes of sauger were sampled by gill nets in 2004 (Table 19). The mean age of 1.8 years is within the range of the five-year period (Table 19). The 2002 and 2003 year classes comprise a majority of the current adult sauger population, with indications that 2004 was a year of low reproduction. Annual sauger survival for the 2003-2004 pooled data increased to 52% (Table 14). Sauger PSD for the 2004 sample, at 75, was the highest value of the five-year period and was related to good recruitment of the 2002 year class of sauger (Table 16).

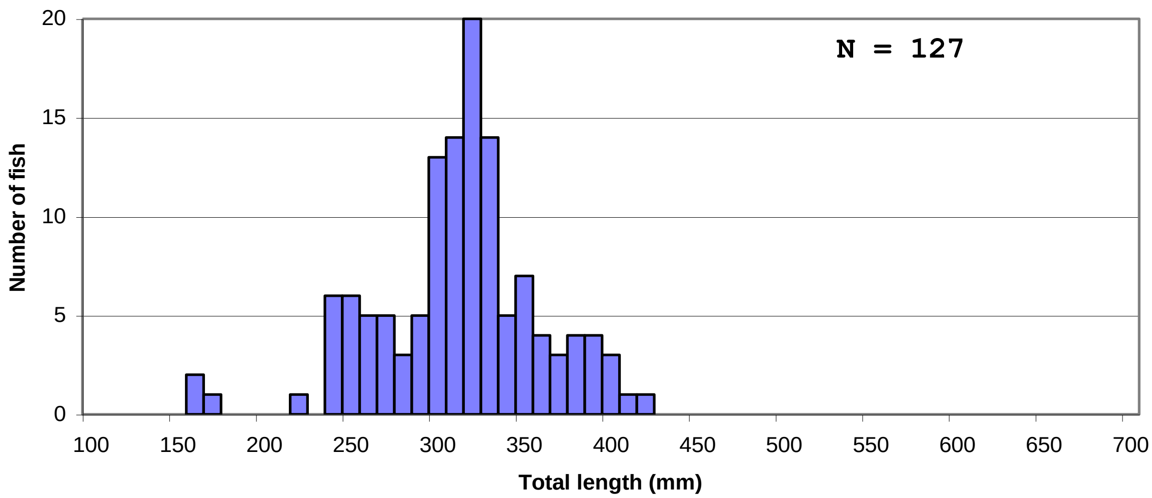

Figure 5. Length frequency of sauger collected with gill nets from Lake Francis Case, 2004. N = sample size.

Table 17. Mean annual growth increments (mm) of back-calculated total lengths for each year class of sauger collected with variable-mesh gill nets during September 2004 from Lake Francis Case. N = sample size.

Year class	Age	N	Growth increment at age			
			1	2	3	4
2003	1	28	189			
2002	2	79	187	95		
2001	3	12	182	110	55	
2000	4	4	201	100	60	34
All classes			190	102	62	41
N		123	123	95	16	4

Table 18. Mean back-calculated total lengths (mm) for each year class of sauger collected with variable-mesh gill nets during September 2004 from Lake Francis Case. N = sample size.

Year class	Age	N	Back-calculated length at age			
			1	2	3	4
2003	1	28	189			
2002	2	79	187	282		
2001	3	12	182	292	347	
2000	4	4	201	301	361	395
All classes			190	292	354	395
N		123	123	95	16	4

Table 19. Age distribution, from scale analysis, of sauger collected from Lake Francis Case with variable-mesh gill nets, 2000-2004. Mean age excludes age-0 fish.

	Age						
Year	**0**	**1**	**2**	**3**	**4**	**5**	**Mean**
2000	3	66	48	17	14	1	1.9
2001	4	53	56	18	0	1	1.8
2002	49	37	58	20	2	1	1.9
2003	5	46	14	20	8	0	1.9
2004	0	28	79	12	4	0	1.8

Population Parameters for Smallmouth Bass

Smallmouth bass CPUE for the 2004 gill net survey (Table 8) was similar to other years in the 2000-2004 period. Smallmouth bass CPUE in 2004 electrofishing samples (Table 7), were also similar to 2003 values. Annual growth increments and back-calculated lengths of smallmouth bass from LFC during 2003 (the last full year that growth could be calculated) are presented in Tables 20 and 21. Small sample size prevents meaningful growth comparisons with previous year's data from being made. Smallmouth bass condition remains excellent, as W_r values for all length categories sampled in the gill net survey were above 100 (Table 15).

Table 20. Mean annual increments (mm) of back-calculated total lengths for each year class of smallmouth bass collected with variable-mesh gill nets during September 2004 from Lake Francis Case. N = sample size.

Year class	Age	N	Growth increment at age		
			1	**2**	**3**
2003	1	11	114		
2002	2	3	99	124	
2001	3	1	77	50	74
All classes			97	118	26
N		15	15	4	1

Table 21. Mean back-calculated total lengths (mm) for each year class of smallmouth bass collected with variable-mesh gill nets during September 2004 from Lake Francis Case. N = sample size.

Year class	Age	N	Back-calculated length at age		
			1	**2**	**3**
2003	1	11	114		
2002	2	3	99	223	
2001	3	1	77	127	201
All classes			97	175	201
N		15	15	4	1

Three year classes were represented in the 2004 gill net sample, with a mean age of 1.3 years (Table 22). Smallmouth bass PSD for the gill net sample increased from 25 in 2003 to 33 in 2004 (Table 16). Annual survival, for pooled 2003 and 2004 gill net data, was 20 %, the lowest of the five-year period (Table 14). Lengths of fish sampled by spring electrofishing ranged from 100 mm to 400 mm TL, while those collected by fall gill nets ranged from 90 mm to 340 mm TL (Figure 6).

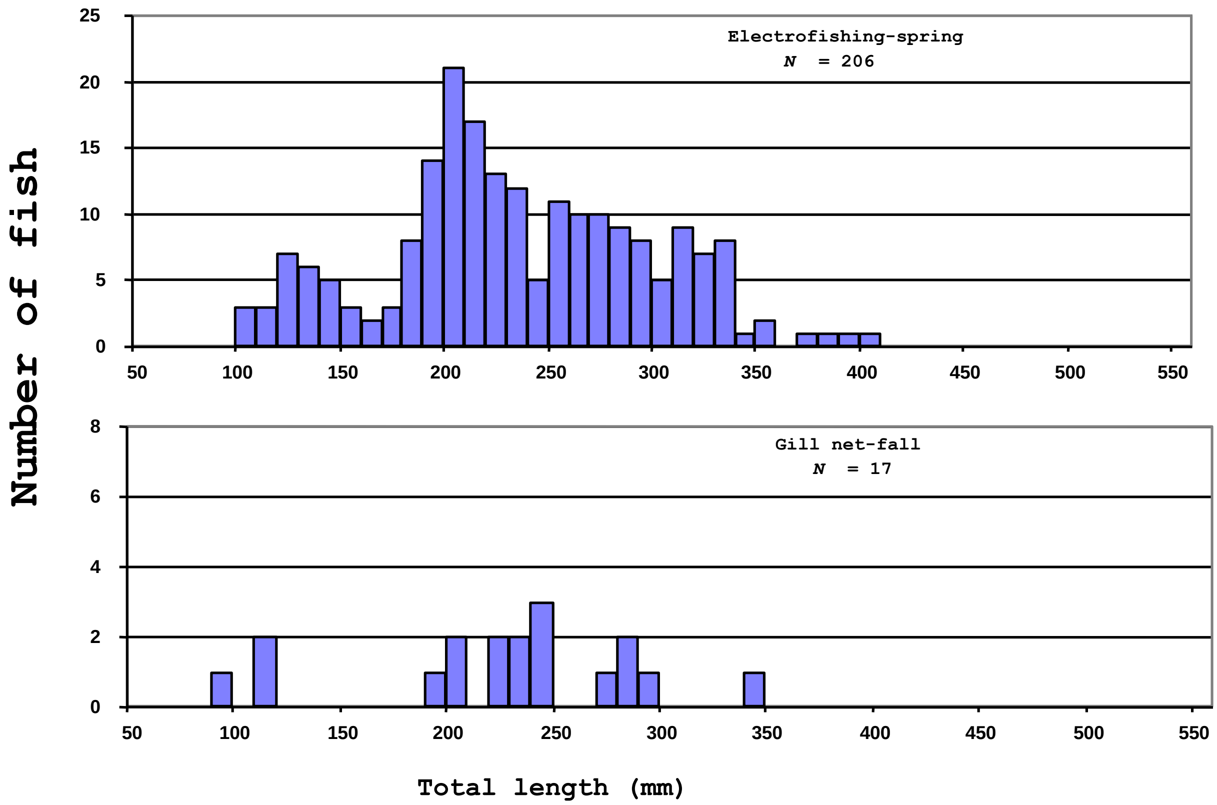

Figure 6. Length frequencies of smallmouth bass collected by spring electrofishing and fall gill netting from Lake Francis Case, 2004. *N* = sample size

Table 22. Age distribution, from scale analysis, of smallmouth bass collected from Lake Francis Case with variable-mesh gill nets, 2000-2004. Mean age excludes age-0 fish.

	Age							
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**Mean**
2000	0	5	13	6	0	0	0	2.0
2001	0	4	4	3	1	0	0	2.1
2002	0	22	11	3	0	0	1	1.6
2003	0	13	7	0	0	0	0	1.4
2004	3	11	3	1	0	0	0	1.3

Population Parameters for Channel Catfish

Channel catfish gill net CPUE in 2004 (Table 8) was similar to all years in the five-year period. Channel catfish ranging from 200 mm to 590 mm TL (Figure 7) were collected in the 2004 gill net survey. Back-calculated lengths of channel catfish from LFC during 2003 (the last full year that growth could be calculated) are presented in Table 23. Channel catfish PSD, RSD and mean W_r values are presented in Appendix 5.

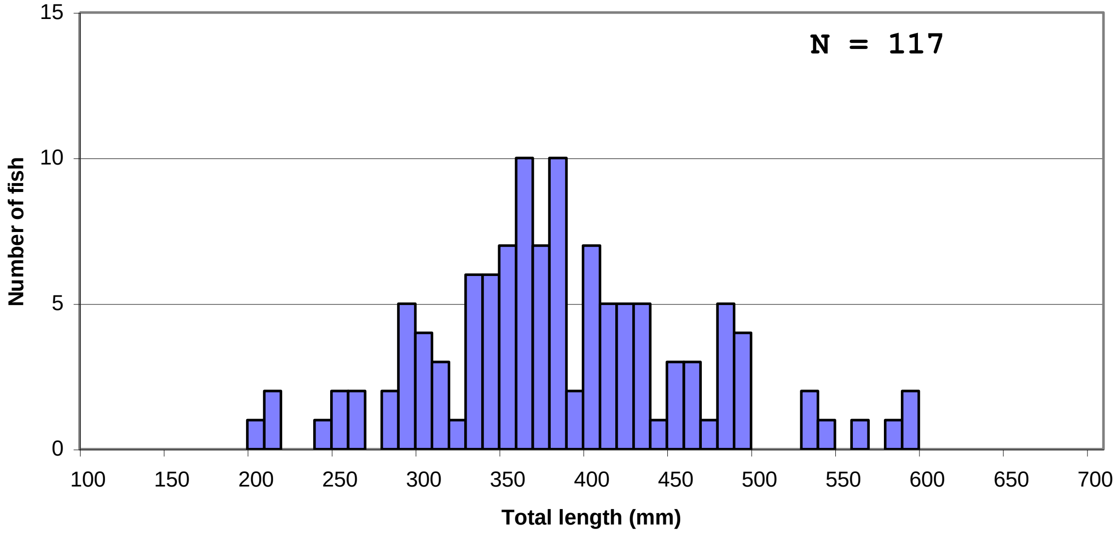

Figure 7. Length frequency of channel catfish collected with gill nets from Lake Francis Case, 2004. N = sample size.

Table 23. Mean annual back-calculated total lengths (mm) for each year class of channel catfish collected from Lake Francis Case in 2004. *N* = sample size.

Year Class	*Age*	*N*	Back-calculation age													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
2003	1	0														
2002	2	4	62	175												
2001	3	8	66	149	223											
2000	4	8	64	161	245	284										
1999	5	10	67	116	216	281	313									
1998	6	21	77	149	235	296	326	344								
1997	7	24	71	137	228	288	327	352	370							
1996	8	16	76	151	240	282	326	355	374	390						
1995	9	9	73	136	220	285	316	349	375	395	411					
1994	10	7	78	160	227	281	332	361	384	400	418	438				
1993	11	4	78	155	194	252	287	352	379	410	440	458	475			
1992	12	3	79	133	203	251	321	374	406	428	449	476	492	509		
1991	13	2	86	143	214	255	311	335	383	408	432	456	481	505	521	
1990	14	2	94	126	214	245	270	310	350	382	413	437	461	493	517	541
All classes			75	145	222	273	313	348	378	402	427	453	477	502	519	541
N		118	118	114	106	98	88	67	43	27	18	11	7	4	2	2

Paddlefish Monitoring

Efforts to monitor the LFC paddlefish population were initiated on 17 May 2004. Collection efforts occurred over three days near the mouth of the White River, and resulted in 23 paddlefish being transported to American Creek Fisheries Station at Chamberlain for artificial propagation efforts and 24 paddlefish being coded wire tagged and released near the mouth of the White River. After spawning, all surviving paddlefish were coded-wire-tagged (CWT) and released (Table 24).

Table 24. Statistics on paddlefish collected from Lake Francis Case, 2004. CWT = coded wire tag.

Fish number	Date tagged	Tagging/release location	Eye-fork length (mm)	Weight (kg)	Sex	Previous tag	
						Jaw (No.)	CWT (Y/N)
1	5/17/04	White River Confluence	724	5.9	M	-	Y
2	5/17/04	White River Confluence	826	9.0	M	-	N
3	5/17/04	White River Confluence	865	10.1	M	-	Y
4	5/17/04	White River Confluence	1032	24.5	F	-	Y
5	5/17/04	White River Confluence	984	12.9	M	-	Y
6	5/17/04	White River Confluence	869	8.9	M	-	Y
7	5/17/04	White River Confluence	1039	12.6	M	-	N
8	5/17/04	White River Confluence	854	8.8	M	-	Y
9	5/17/04	White River Confluence	807	7.3	M	-	Y
10	5/17/04	White River Confluence	853	8.2	M	-	Y
11	5/17/04	White River Confluence	814	7.5	M	-	Y
12	5/17/04	White River Confluence	866	9.6	M	-	Y
13	5/17/04	White River Confluence	899	10.0	M	-	Y
14	5/17/04	White River Confluence	860	8.6	M	-	Y
15	5/18/04	White River Confluence	832	7.9	M	-	Y
16	5/18/04	White River Confluence	922	11.6	M	-	Y
17	5/18/04	White River Confluence	1170	32.7	M	-	N
18	5/18/04	White River Confluence	758	5.3	M	-	Y
19	5/19/04	White River Confluence	759	5.8	M	-	Y
20	5/19/04	White River Confluence	970	20.9	F	-	N
21	5/19/04	White River Confluence	789	7.6	M	-	Y
22	5/19/04	White River Confluence	870	8.8	M	-	Y
23	5/19/04	White River Confluence	930	13.0	M	-	Y
24	5/19/04	White River Confluence	917	11.2	M	-	N
25	5/17/04	Chamberlain	892	10.0	M	-	Y
26	5/17/04	Chamberlain	996	14.5	M	-	N
27	5/17/04	Chamberlain	910	11.9	M	-	N
28	5/17/04	Chamberlain	1167	27.1	M	-	N
29	5/17/04	Chamberlain	1159	15.6	M	-	N
30	5/17/04	Chamberlain	922	9.6	M	-	N
31	5/17/04	Chamberlain	941	12.4	M	-	Y
32	5/17/04	Chamberlain	862	9.0	M	-	Y
33	5/17/04	Chamberlain	897	9.3	M	-	Y
34	5/17/04	Chamberlain	875	9.1	M	-	Y
35	5/17/04	Chamberlain	926	13.5	M	-	N
36	5/18/04	Chamberlain	931	9.9	M	-	N
37	5/18/04	Chamberlain	1086	20.0	M	-	N
38	5/18/04	Chamberlain	934	11.5	M	-	N
39	5/18/04	Chamberlain	892	9.9	M	-	N
40	5/19/04	Chamberlain	1132	29.9	M	-	N
41	5/19/04	Chamberlain	1082	27.7	F	-	N
42	5/19/04	Chamberlain	871	9.0	M	-	Y

Water Temperature Monitoring

Due to equipment malfunctions and the loss of one temperature logger, data was only available from the Pease Creek sampling station in 2004 (Figure 8). Water temperatures warmed rapidly, reaching 25 C by July. Overall, the 2004 Pease Creek water temperature profile was similar to the profile from recent years (Stone 1997a, 1998; Stone and Sorensen 1999, 2000, 2003; Sorensen 2004).

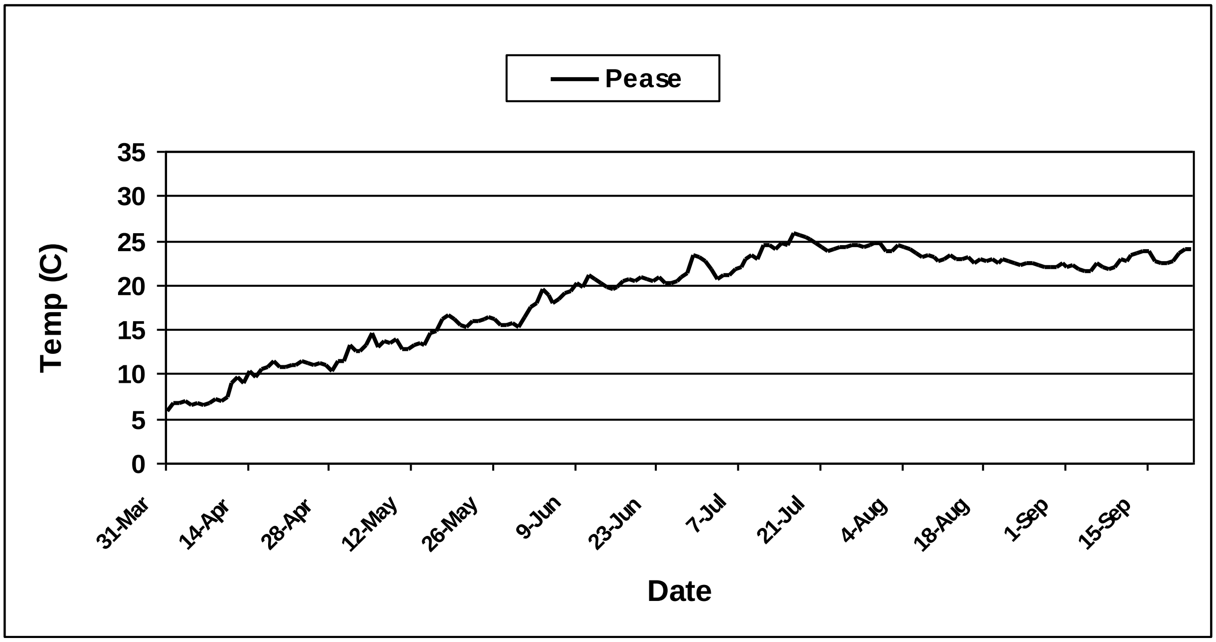

Figure 8. Water temperature in Lake Francis Case at Pease Creek, 2004.

ANGLER USE AND SPORT FISH HARVEST SURVEY

Fishing Pressure

Lake Francis Case anglers spent an estimated 659,184 hours (+/- 62,981 h, 95% CI) fishing during the April through September, 2004 creel survey period (Table 25). This estimate is similar to the 710,078 hours estimated for the same period in 2003 but lower than that estimated during the 1998-2001 period (Table 1).

Table 25. Estimated total fishing pressure (angler hours), by month and zone, on Lake Francis Case, April-September 2004 (+/- 95% confidence interval).

Zone	Apr	May	Jun	Jul	Aug	Sep	Total
1 - upper	59,321 (26,366)	63,703 (22,266)	88,929 (25,293)	48,214 (20,070)	27,388 (11,577)	14,632 (6,240)	253,811 (41,173)
2 - middle	15,421 (7,566)	48,391 (23,516)	51,121 (14,831)	24,656 (5,967)	13,351 (3,994)	5,491 (4,474)	233,668 (49,514)
3 - lower	2,155 (1,087)	27,931 (13,863)	63,627 (12,002)	61,256 (15,021)	29,316 (7,104)	14,280 (6,707)	222,599 (39,366)
Total	76,897 (27,452)	140,025 (35,227)	203,677 (31,682)	134,126 (25,769)	70,056 (14,158)	34,403 (10,195)	659,184 (62,981)

Estimated fishing pressure for the entire reservoir averaged 18.7 angler-h/ha (Table 26). The upper portion of the reservoir (Figure 1) received the heaviest pressure at 20.6 angler-h/ha. The middle and lower portions of the reservoir received equal use at 17.3 angler-h/ha each (Table 26). Peak fishing pressure occurred in May and June, a typical LFC pattern (Table 25, Figure 9).

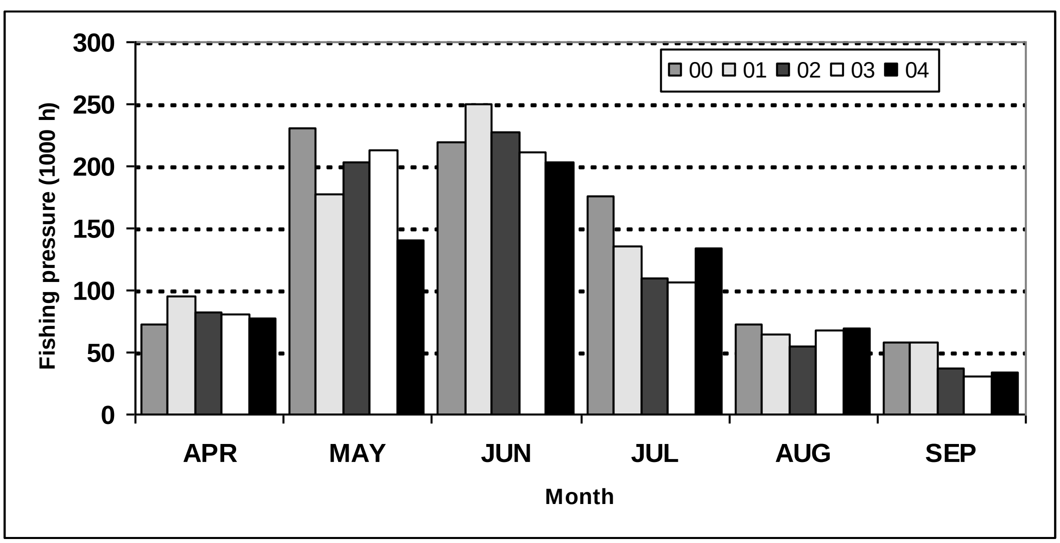

Figure 9. Estimated fishing pressure, by month, on Lake Francis Case, 2000-2004.

Table 26. Estimated total angler hours, for boat anglers, shore anglers, and angling methods combined, by zone, for Lake Francis Case, April-September, 2004.

	Boat			Shore			Combined		
Zone	**Total angler hours**	**%**	**No. h/ha**	**Total angler hours**	**%**	**No. h/ha**	**Total Angler hours**	**%**	**No. h/ha**
1 - upper	272,059	44	18.6	30,129	80	2.1	302,188	46	20.6
2 - middle	155,647	25	17.0	2,783	7	0.3	158,430	24	17.3
3 - lower	193,796	31	16.9	4,770	13	0.4	198,566	30	17.3
Tot/Avg	621,502	100	17.6	37,682	100	1.1	659,184	100	18.7

Fish Harvest

Anglers fishing LFC, during the April-September 2004 period, harvested an estimated 162,512 fish (+/- 28,354 fish, 95% CI); all species, fishing methods and zones combined, including an estimated walleye harvest of 113,813 fish (+/- 17,766 fish, 95% CI; Table 27). Seventeen species of fish were observed in the 2004 harvest, with walleye accounting for 70% of the total number harvested (Table 27). White bass, channel catfish, and sauger accounted for 13.9%, 7.7% and 1.7% of the 2004 estimated total harvest, respectively. The harvest estimate for walleye decreased from 162,581 in 2003 to 113,813 in 2004 (Sorensen 2004). This decrease in walleye harvest can be partially attributed to decreases in both fishing use and walleye catch rates. Estimated sauger harvest, at 2,722 fish, was below the ten-year average of 5,893 and can be attributed to diminishing 1999 and 2000 sauger year-classes and low reproduction and recruitment during 2001-2003. Increases in estimated harvest from 2003 (Sorensen 2004) to 2004 were noted for white bass, smallmouth bass and channel catfish. White bass abundance and harvest continued to rebound from a die-off of the adult population that occurred in 1998 (Stone and Sorensen 1999). High recruitment of the 2001 white bass year-class followed by moderate recruitment of the 2002 white bass year-class (Stone and Sorensen 2002, 2003) contributed to an increase in the 2004 white bass harvest, with indications that 2004 was a moderate reproductive year for white bass (Table 9). Smallmouth bass harvest increased from 6,232 in 2003 to 8,781 in 2004 (Sorensen 2004, this survey). Moderate recruitment in 2002, 2003 (Stone and Sorensen 2003; Sorensen 2004) and 2004 suggests that smallmouth bass harvest may increase in future years.

Table 27. Estimated total fish harvest, by month, for anglers fishing Lake Francis Case, April-September, 2004 (+/- 95% confidence interval).

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	16,131 (7,451)	264 (197)	395 (345)	334 (430)	959 (1,782)	35 (79)	30 (60)	234 (493)	18,383 (8,301)
May	29,410 (8,289)	715 (486)	2,502 (1,419)	1,114 (1,150)	8,605 (280)	0 (-)	0 (-)	120 (180)	42,466 (14,494)
June	28,816 (8,031)	361 (303)	1,091 (667)	2,947 (1,812)	9,210 (28,362)	0 (-)	0 (-)	447 (568)	42,872 (17,398)
July	26,755 (9,392)	1,210 (842)	2,446 (1,504)	3,108 (1,373)	3,292 (2,269)	0 (-)	0 (-)	230 (333)	37,041 (12,572)
August	11,383 (6,182)	151 (143)	254 (209)	4,363 (2,860)	242 (354)	0 (-)	0 (-)	1,053 (1,038)	17,446 (7,309)
September	1,318 (716)	20 (39)	2,092 (3,104)	605 (1,215)	211 (285)	0 (-)	29 (63)	29 (61)	4,304 (3,285)
Total	113,813 (17,766)	2,722 (1,048)	8,781 (3,811)	12,470 (4,041)	22,518 (28,513)	35 (79)	59 (88)	2,115 (3,285)	162,512 (28,354)

*OTH includes black crappie, common carp, flathead catfish, freshwater drum, goldeye, largemouth bass, rainbow trout, white crappie and yellow bullhead.

Estimated fish harvest during 2004, by survey zone (see Figure 1 for zone identification), followed a typical LFC pattern (Stone 1995; Stone et al. 1994; Stone and Wickstrom 1992). Anglers who fished the upper portion of the reservoir accounted for 63 % of the harvest, followed by the lower and middle zones with 20 and 17 % of the harvest, respectively (Table 28). Walleye, sauger, channel catfish, and white bass harvest in 2004 was highest in the upper zone, while smallmouth bass harvest was highest in the lower zone of the reservoir (Table 28).

Table 28. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2004 (+/- 95% confidence interval).

Zone	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
1 - upper	69,374 (15,313)	1,814 (888)	2,488 (1,183)	6,208 (2,590)	20,895 (28,504)	35 (79)	0 (-)	684 (1,108)	101,500 (26,018)
2 - middle	22,714 (6,239)	411 (214)	1,647 (793)	1,972 (1,072)	840 (430)	0 (-)	59 (88)	251 (314)	27,895 (6,993)
3 - lower	21,724 (6,498)	497 (514)	4,645 (3,534)	4,289 (2,910)	783 (587)	0 (-)	0 (-)	1,179 (1,066)	33,117 (8,838)
Total	113,813 (17,766)	2,722 (1,048)	8,781 (3,811)	12,470 (4,041)	22,518 (28,513)	35 (79)	59 (88)	2,115 (3,285)	162,512 (28,354)

*OTH includes black crappie, common carp, flathead catfish, freshwater drum, goldeye, largemouth bass, rainbow trout, white crappie and yellow bullhead.

Estimated total fish harvest (Table 27) peaked in June during 2004, while walleye harvest was similar in May, June and July (Figure 10), typical of the normal LFC pattern, where pressure and harvest peak in June (Stone 1995; Stone et al. 1994). Changes in walleye harvest regulations, initiated in 1990 and modified in 1999 and 2004, continue to maintain the walleye size structure at a level that allows sufficient numbers of legal-sized fish to be available for harvest during the period of the year that size limit regulations are in effect.

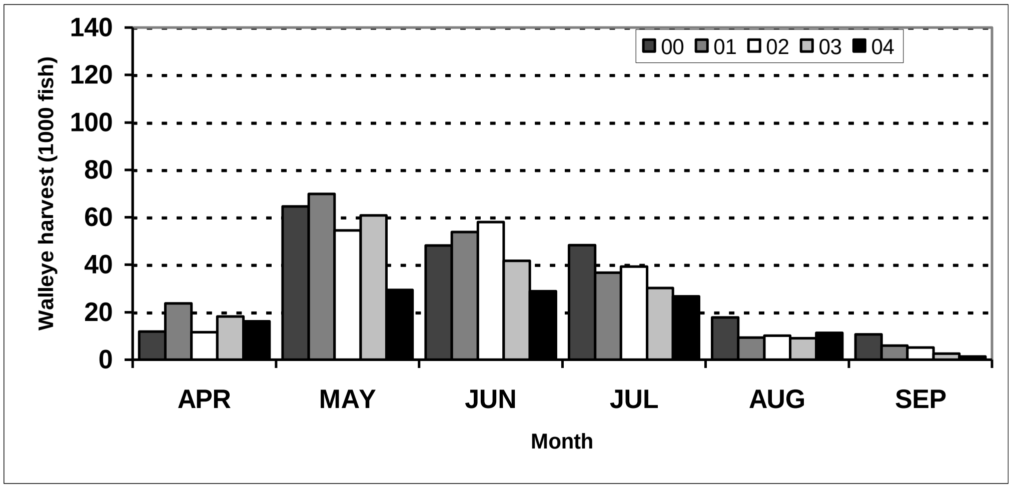

Figure 10. Estimated total walleye harvest, by month, for anglers fishing Lake Francis Case, 2000-2004.

Monthly length frequencies of angler-caught walleye (Figure 11), reflect the impact of the September-June 381-mm (15 inch) minimum-length limit. During April through June and September of 2004, very few walleye under 381 mm were harvested (illegal), while in July and August, fish under 381 mm were common in the walleye harvest. However, mean size of walleye harvested, by month, remained near or above 381 mm (minimum length limit) during all months (Figure 11). Overall, mean length of walleye harvested by sport anglers has been considerably higher since the 1990 changes in walleye sport fishing regulations were implemented (Table 1). Table 29 provides statistics on the percentage of angling parties that caught a daily limit of walleye/sauger. The percentage of angling parties harvesting a limit was 9% in 2004, similar to the previous four years, despite the daily limit being reduced to three fish in 2004.

Monthly length frequencies, of angler-caught smallmouth bass are presented in Figure 12.

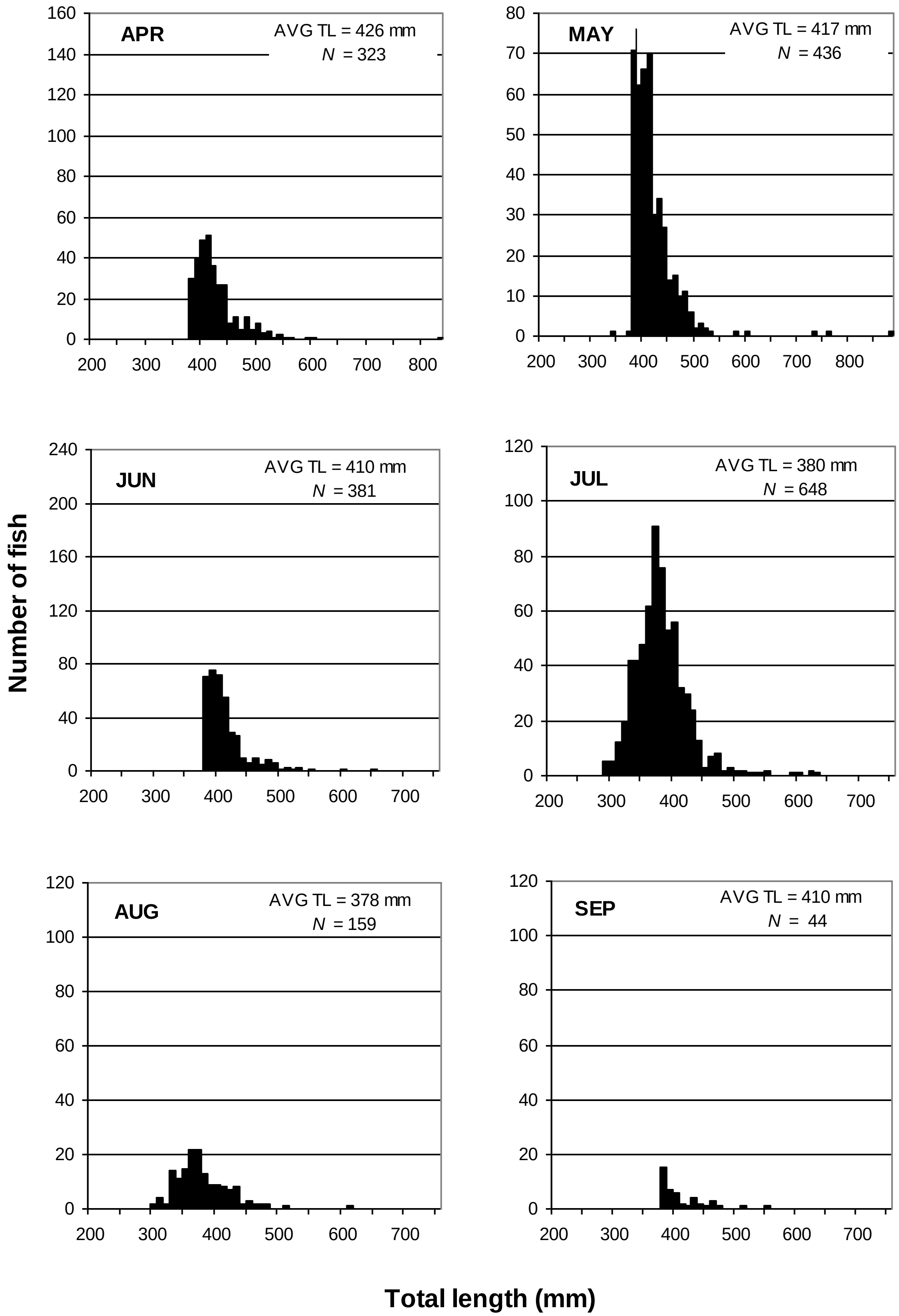

Figure 11. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2004. N = sample size.

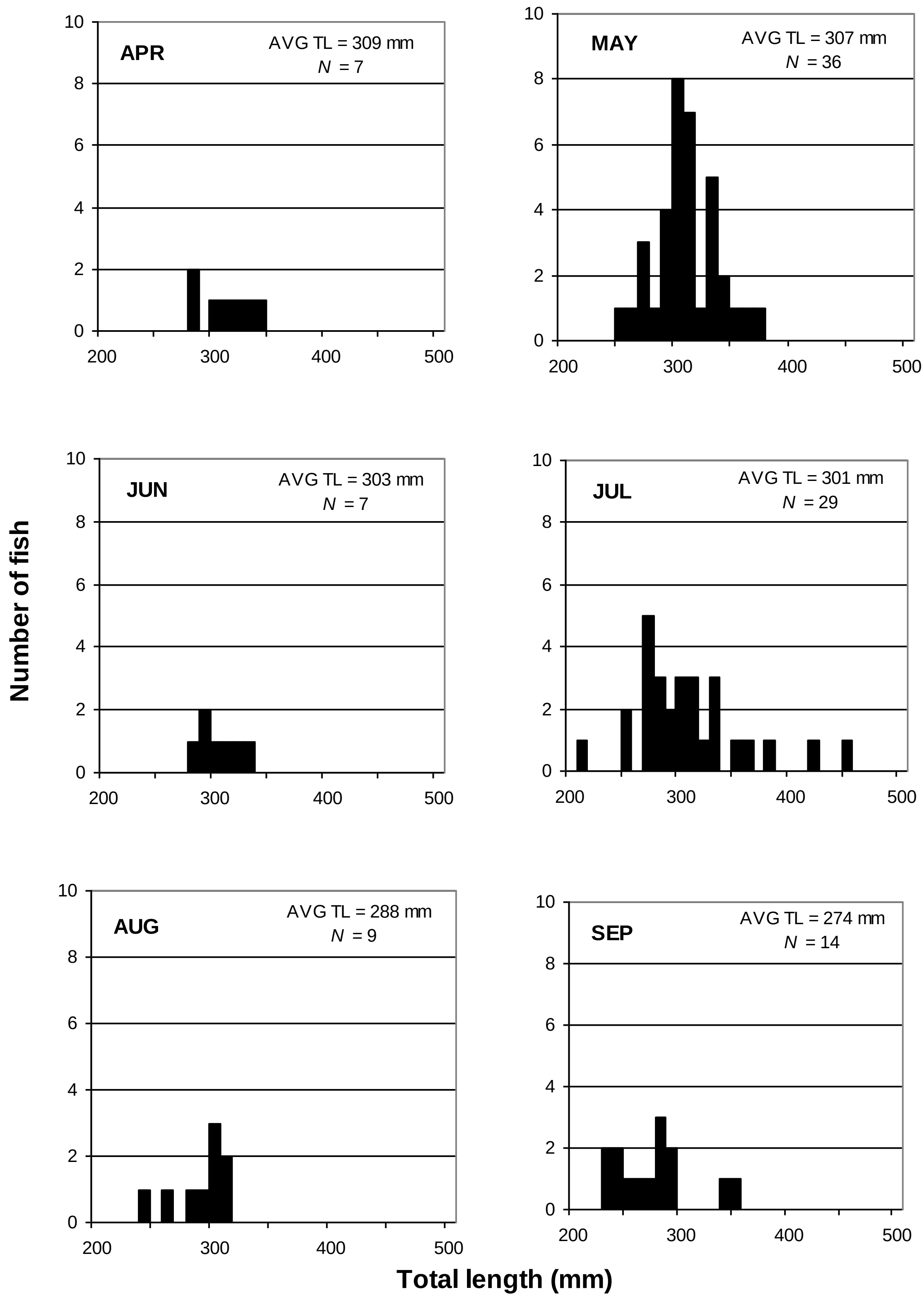

Figure 12. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2004. N = sample size.

Table 29. Percent of angling parties harvesting a limit of walleye-sauger/angler, at least three walleye-sauger/angler, at least two walleye-sauger/angler, etc., from Lake Francis Case, 2000-2004.

Party success walleye-sauger/angler	2000	2001	2002	2003	2004*
Limit (4)	8	8	8	8	
3.0 - 3.9	9	6	6	6	9
2.0 - 2.9	12	10	10	10	7
1.0 - 1.9	19	18	18	19	18
0.1 - 0.9	15	16	16	17	17
0	37	42	42	38	49

* The daily limit for walleye/sauger was 3 in 2004

Fish Caught and Released

Catch and release, either mandated by length-limit regulations or voluntary, has become an important component of the LFC sport fishery. Table 30 presents estimates of the number of fish released by month. For each species listed in Table 30, the number of fish estimated to have been caught and released exceeded harvest estimates (Table 27). While the estimate of released fish is based on the angler's ability to recall what they released and may be biased up or down, it does provide trend data and gives a good indication of the magnitude of fish being released. The overall number of fish estimated to have been released by LFC anglers in 2004 was 478,934, a decrease from the 2003 estimate of 610,158 fish (Sorensen 2004).

Table 30. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2004.

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	27,445	260	1,413	719	962	74	0	1,122	31,995
May	95,789	1,421	14,009	1,104	14,935	45	363	4,567	132,233
June	168,415	1,566	9,257	6,321	20,269	64	368	7,039	213,299
July	36,511	520	4,084	7,443	4,004	25	555	8,447	61,589
August	13,786	325	2,039	5,433	2,763	0	525	3,432	28,303
September	6,632	111	932	855	1,671	0	221	1,093	11,515
Total	348,578	4,203	31,733	21,875	44,604	208	2,032	25,701	478,934

* OTH includes black bullhead, black crappie, bigmouth buffalo, bluegill, common carp, flathead catfish, freshwater drum, goldeye, river carpsucker, shorthead redhorse, shortnose gar, shovelnose sturgeon, smallmouth buffalo, and white crappie.

Harvest, Release and Catch Rates

Mean harvest rate (species, type of fishing, and zones combined) for LFC, during 2004, was 0.25 fish/angler-h (Table 31), within the range observed during previous surveys (Table 1). An excellent overall catch rate (the 2004 harvest rate plus estimated release rate of 0.73 fish/angler-h) of 0.97 fish/angler-hour was estimated for the April through September 2004 daylight period (Table 32). Mean catch rates were highest during May and June while the mean harvest rate was highest during May (Table 32).

The mean walleye harvest rate was 0.17 walleye/angler-h (Table 33) for the April–September daytime period. Walleye harvest rates during July and August, when there is no minimum length restriction, were similar to other months in the survey period. When harvest rate for walleye was combined with release rate, an overall catch rate of 0.70 walleye/angler-h was estimated (Table 33). This value is more than double the rate of 0.30 fish/angler-h that is considered by most biologists to be indicative of an excellent walleye fishery (Colby et al. 1979).

Catch and harvest rates for smallmouth bass, during 2004, are presented in Table 34. Smallmouth bass harvest and catch rate estimates for 2004 were similar to 2003 (Sorensen 2004).

Table 31. Estimated harvest rate, release rate and catch rate, by species (+/- 95% confidence interval), for anglers fishing Lake Francis Case, 2004.

Species	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
Walleye	0.173 (0.042)	0.529 (0.125)	0.702 (0.163)
Sauger	0.004 (0.002)	0.006 (0.003)	0.012 (0.004)
Smallmouth bass	0.013 (0.007)	0.048 (0.010)	0.062 (0.015)
Channel catfish	0.019 (0.007)	0.033 (0.010)	0.052 (0.014)
White bass	0.034 (0.045)	0.068 (0.024)	0.102 (0.079)
Northern pike	0.000 (-)	0.000 (-)	0.000 (-)
Yellow perch	0.000 (-)	0.003 (0.001)	0.003 (0.001)
Other*	0.002 (-)	0.040 (-)	0.040 (-)
Species combined	0.247 (0.065)	0.727 (0.158)	0.973 (0.218)

* Other includes black bullhead, black crappie, bigmouth buffalo, bluegill, common carp, flathead catfish, freshwater drum, goldeye, largemouth bass, rainbow trout, river carpsucker, shorthead redhorse, shortnose gar, shovelnose sturgeon, smallmouth buffalo, and white crappie.

Table 32. Estimated harvest rate, release rate, and catch rate for all species combined (+/- 95% confidence interval), by month, for anglers fishing Lake Francis Case, 2004.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.239 (0.187)	0.416 (0.313)	0.655 (0.494)
May	0.303 (0.199)	0.944 (0.483)	1.248 (0.678)
June	0.211 (0.113)	1.047 (0.398)	1.258 (0.498)
July	0.276 (0.132)	0.459 (0.170)	0.735 (0.287)
August	0.249 (0.142)	0.404 (0.186)	0.653 (0.310)
September	0.125 (0.099)	0.335 (0.259)	0.460 (0.293)
Combined	0.247 (0.065)	0.727 (0.158)	0.973 (0.218)

Table 33. Estimated harvest rate, release rate, and catch rate of walleye (+/- 95% confidence interval), by month, for anglers fishing Lake Francis Case, 2004.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.210 (0.170)	0.357 (0.285)	0.567 (0.449)
May	0.210 (0.119)	0.684 (0.370)	0.894 (0.483)
June	0.142 (0.065)	0.827 (0.326)	0.968 (0.387)
July	0.200 (0.091)	0.272 (0.112)	0.472 (0.194)
August	0.163 (0.105)	0.197 (0.095)	0.359 (0.188)
September	0.038 (0.026)	0.193 (0.166)	0.231 (0.181)
Combined	0.173 (0.042)	0.529 (0.125)	0.702 (0.163)

Table 34. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 95% confidence interval), by month, for anglers fishing Lake Francis Case, 2004.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.006 (-)	0.018 (0.016)	0.024 (0.012)
May	0.018 (0.013)	0.100 (0.060)	0.118 (0.070)
June	0.005 (0.004)	0.045 (0.017)	0.051 (0.018)
July	0.018 (0.021)	0.030 (-)	0.049 (0.020)
August	0.004 (0.003)	0.029 (0.017)	0.033 (0.018)
September	0.061 (0.091)	0.027 (0.025)	0.088 (0.097)
Combined	0.013 (0.007)	0.048 (0.010)	0.062 (0.015)

Angler Demographics and Economics

Thirty three percent of anglers contacted on LFC during 2004 were non-residents, similar to values estimated for the previous five years (Stone and Sorensen 2000, 2001, 2002, 2003; Sorensen 2004). Non-resident anglers from 22 states were contacted during 2004, (Table 35) with Iowa, Nebraska and Minnesota anglers accounting for the majority of non-resident angler contacts. Figure 14 provides information on the county of residence of South Dakota anglers who fished LFC in 2004. Over 85% of the resident LFC anglers in 2004 came from counties in the southeastern ¼ of the state (Figure 13).

Table 35. Percentage of non-resident anglers who fished Lake Francis Case, 2000-2004, by state of residence, expressed as percent of total non-residents.

State	2000	2001	2002	2003	2004
Iowa	42.2	42.9	42.4	46.0	42.0
Nebraska	38.1	38.6	36.6	39.5	36.2
Minnesota	11.3	10.3	14.0	9.1	13.9
Colorado	1.3	0.8	1.3	1.6	1.2
Wisconsin	0.6	1.4	1.3	0.3	0.5
Kansas	-	0.5	0.8	0.3	0.7
Missouri	1.3	1.4	0.8	1.2	0.4
Illinois	0.9	0.4	0.3	0.2	0.7
North Dakota	0.4	0.7	0.3	0.3	0.5
Florida	0.6	0.3	0.2	0.5	0.2
Montana	0.2	0.3	0.2	-	0.5
Wyoming	0.1	0.8	0.2	0.2	0.7
California	0.6	0.4	-	0.3	-
Other*	2.2	1.2	1.6	0.5	2.5

*Other includes: Arizona, Kentucky, Louisiana, Michigan, Nevada, New York, Ohio, Oregon, Pennsylvania, and Texas

Mean angler trip length (boat and shore combined) on LFC was 4.9 hours (Table 1), for the April-September, 2004 daylight period. The average angling party consisted of approximately 2.2 individuals in 2004 and anglers traveling at least 100 miles (one-way), to fish LFC, accounted for about 53 % of all trips (Table 36). A majority of anglers fishing Lake Francis Case in 2004 targeted walleye, similar to the past four years (Table 37).

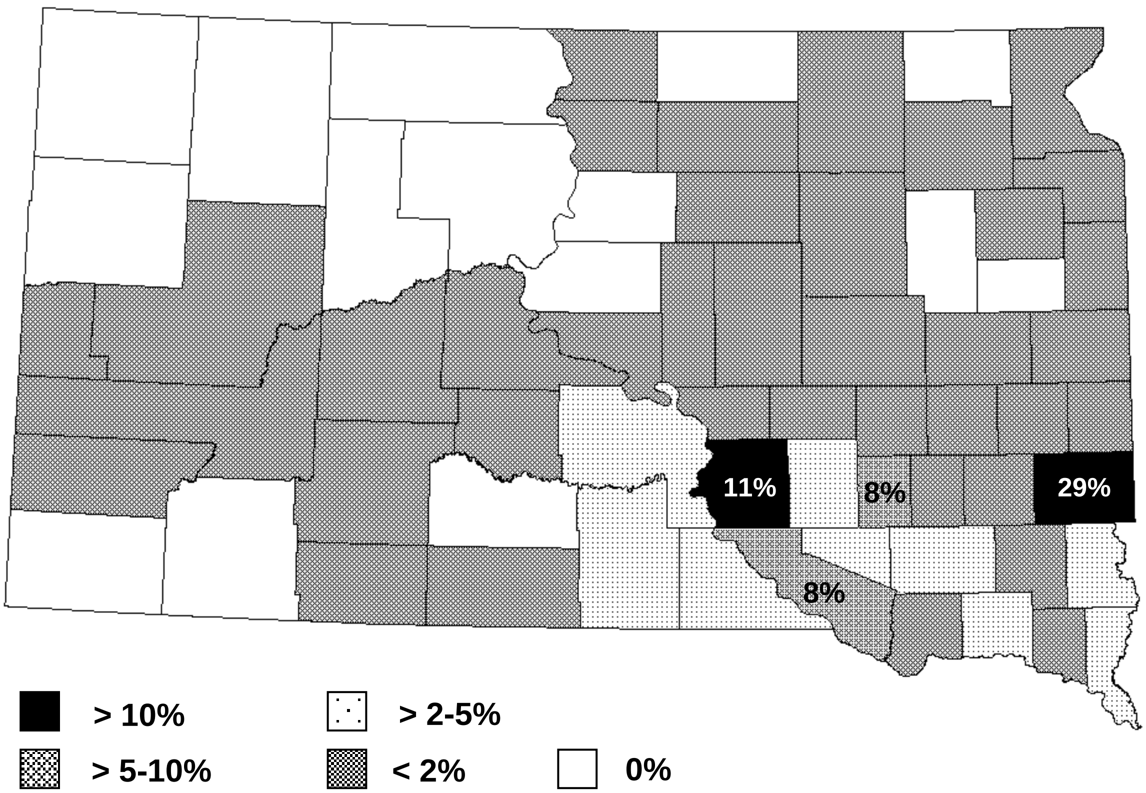

Figure 13. County of residence for resident anglers fishing Lake Francis Case in 2004. Percentage of total resident anglers is shown for the top four represented counties.

The 2004 LFC fishery had an estimated economic impact of nearly 8.2 million dollars to local economies, based on approximately 134,500 angling trips. This estimate is based on an average expenditure of $61/trip for angling in South Dakota (U.S. Dept. of Interior, Fish and Wildlife Service, and U.S. Dept. of Commerce, Bureau of Census 2002).

Table 36. Percentage of anglers traveling specified distances, one way, to fish Lake Francis Case during 2000-2004.

Distance (miles)	2000	2001	2002	2003	2004
<25	13.7	10.7	12.1	11.2	13.3
25-50	7.2	17.4	17.8	7.6	17.0
51-100	17.4	19.3	13.4	15.9	16.2
101-200	39.8	37.1	38.7	43.1	37.1
200+	21.8	15.5	18.0	22.2	16.4

Table 37. Target species of Lake Francis Case anglers, during 2000-2004, expressed as percentage of total angling trips.

Target species	2000	2001	2002	2003	2004
Walleye	93.4	97.0	93.5	94.6	94.6
Anything	4.1	0.2	3.8	3.6	2.2
Smallmouth bass	1.9	1.6	1.7	1.2	1.1
Other	0.6	1.2	1.0	0.6	2.1

ANGLER PREFERENCE AND ATTITUDE SURVEY

Angler attitudes about fishing and their preferences concerning management options are important components of a total fishery. Historically, fisheries biologists have primarily focused efforts on understanding biological aspects of fish populations and monitoring sport fish harvest and use. Recently, biologists have realized the necessity and value of understanding angler attitudes, level of satisfaction, and preferences. Consequently, more attitude, preference and satisfaction data has been collected in recent years.

The following results build on angler preference and attitude survey data collected previously from Lake Francis Case (Stone et.al. 1993; Stone 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004).

Angling Trip Satisfaction

How anglers feel about their fishing experience is important when evaluating the success of fishery management efforts. Angler responses help evaluate if current management practices and regulations are providing a fishery that meets angler needs and expectations. Overall, 75% of LFC anglers expressed some degree of satisfaction with their days fishing in 2004 versus approximately 21% who expressed some degree of dissatisfaction (Table 38). The 75% satisfaction rating falls within the range of previous surveys (Stone and Sorensen 2001, 2002, 2003; Sorensen 2004) and exceeds the Missouri River Fisheries Program management objective of 70 % (SDGFP, unpublished document).

Table 38. Response of 2004 Lake Francis Case anglers, by month, to the question: “Considering all factors, how satisfied are you with your fishing trip today?” 1 = Very Satisfied, 2 = Moderately satisfied, 3 = Slightly satisfied, 4 = Neutral, 5 = Slightly dissatisfied, 6 = Moderately dissatisfied, 7 = Very dissatisfied, N.O. = No opinion. Median excludes those with no opinion.

Month	Satisfied →			Neut.	←		Dissatisfied			
	1	2	3	4	5	6	7	N.O.	Total	Median
Apr	44	65	24	4	4	8	4	4	157	2
May	64	63	31	4	14	10	6	2	194	2
Jun	71	41	26	2	23	13	5	1	182	2
Jul	58	53	19	5	19	10	7	3	174	3
Aug	13	20	22	4	9	7	9	2	86	3
Sep	2	15	16	4	3	20	8	2	70	4
Total	252	257	138	23	72	68	39	14	863	3
Percent	29.2	29.8	16.0	2.7	8.3	7.9	4.5	1.6	100	-
Combined	75.0			2.7	20.7			1.6	100	-

Angler satisfaction is directly correlated to the number of walleye harvested per angler (Table 39). These results follow the pattern documented in previous surveys (Stone 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004) showing a decrease in satisfaction and a corresponding increase in dissatisfaction as the number of walleye harvested per angler decreases. However, over 63% of the anglers who did not harvest a walleye still indicated that they were satisfied with their fishing trip. These results follow the suggestion of other studies (Mendelsohn 1994, McPhillips 1989, Kinman and Hoyt 1984) that harvesting fish ranked below other components of a successful fishing trip (i.e. fun, relaxation, etc.). While these results do indicate a relationship between number of walleye harvested and trip satisfaction, they should not be interpreted as a direct relationship, other factors, such as weather or angler type (Gigliotti 1996) may affect catch and harvest rates, and in turn, influence the question response.

Table 39. Responses of 2004 Lake Francis Case anglers to the question: “Considering all factors, how satisfied are you with your fishing trip today?” by number of walleye harvested. Responses are grouped as satisfied, dissatisfied and neutral/no-opinion based on the more detailed breakdowns defined in Table 38.

No. walleye harvested/ angler	Satisfied		Dissatisfied		Neutral/No-Opinion	
	No.	Percent	No.	Percent	No.	Percent
3	83	98.8	1	1.2	0	0.0
2 – 2.9	59	92.2	3	4.7	2	3.1
1 – 1.9	141	89.9	12	7.6	4	2.5
0.1 – 0.9	106	74.1	34	23.8	3	2.1
0	268	63.1	129	30.4	28	6.6
Total	657	75.3	179	20.5	37	4.2

With current management regulations requiring the mandatory release of certain sizes of walleye/sauger, coupled with the voluntary release of a significant number of fish by LFC anglers, how anglers feel about their fishing trip, based on the total number of walleye/sauger caught versus harvested, may also be important. Table 40 provides angler satisfaction data categorized by the average number of walleye caught per angler. Similar to results presented in Table 39, over 60% of anglers questioned were still satisfied with their fishing trip despite catching no walleye (Table 40). Over 85% of anglers who caught at least 4 to 7.9 walleye/angler indicated they were satisfied with their trip (Table 40).

Table 40. Responses of 2004 Lake Francis Case anglers to the question: “Considering all factors, how satisfied are you with your fishing trip today?” by the average number of walleye caught per angler. Responses are grouped as satisfied, dissatisfied and neutral/no-opinion, based on the more detailed breakdowns defined in Table 38.

No. WAE Caught/ angler	Satisfied		Dissatisfied		Neutral/No-opinion	
	No.	Percent	No.	Percent	No.	Percent
16 or >	13	92.9	0	0.0	1	7.1
12-15.9	25	100.0	0	0.0	0	0.0
8-11.9	59	93.7	4	6.3	0	0.0
4-7.9	143	86.7	18	10.9	4	2.4
>0-3.9	275	71.2	97	25.2	14	3.6
0	142	64.5	60	27.3	18	8.2
Total	657	75.3	179	20.5	37	4.2

Zebra mussels were recently discovered in the Missouri River below Gavins Point and Ft. Randall Dams. In an effort to increase angler awareness to the presence of this aquatic nuisance species, anglers participating in the 2004 angler use and harvest survey were asked if they knew zebra mussels had been recently found below Ft. Randall and Gavins Point Dams. Overall, 57% of anglers interviewed stated they knew zebra mussels had been discovered in the Missouri River system in South Dakota (Table 41). A higher percentage of interviewed anglers in August and September stated that they knew zebra mussels had been discovered in the Missouri River system in South Dakota, than during other months surveyed (Table 41). These findings contrast with those from Lake Sharpe, another Missouri River mainstem impoundment, where a higher percentage of angers interviewed in April and May were aware of zebra mussels being discovered in South Dakota (Lott et. al., 2006).

Table 41. Responses of 2004 Lake Francis Case anglers to the question: “Do you know that zebra mussels were recently found below Fort Randall and Gavins Point Dams, on the Missouri River in South Dakota, and can easily be transported to other waters?” Responses are shown as percentages of total number of responses. N = number of responses.

	Month						
	April	May	June	July	August	September	Total
N	153	183	180	172	86	66	840
Yes (%)	49	59	46	55	80	79	57
No (%)	51	41	54	45	20	21	43

Competitive angling events have increased in popularity in recent years, especially on Lake Francis Case. In an effort to determine the level of participation in fishing tournaments by Lake Francis Case anglers and angler attitudes toward tournaments, anglers participating in the 2004 angler use and harvest survey were asked questions concerning these issues. When asked whether or not they had participated in a tournament held on Lake Francis Case within the past twelve months, 15% of those interviewed indicated they had (Table 42).

Table 42. Responses of 2004 Lake Francis Case anglers to the question: "Within the last 12 months, how many fishing tournaments have you participated in on Lake Francis Case?" Responses are presented as percentage of total responses. N = number of responses.

Number of Tournaments Participated in	N	Percent
0	748	85
1	62	7
2	33	4
3	21	2
4	8	1
>4	13	1

When anglers were asked how they felt about the number of tournaments held on Lake Francis Case each year, 39% of respondents had no opinion on the issue, suggesting tournaments are not an important issue for this portion of the angling public (Table 43). However, when "no opinion" responses were removed from the analysis, 78% of anglers believed there were too many tournaments on Lake Francis Case. In addition, 21% believed there was about the right number, and 1% believed there were too few tournaments held on Lake Francis Case (Table 43).

Table 43. Responses of 2004 Lake Francis Case Anglers to the question: "In General, how do you feel about the number of fishing tournaments held on Lake Francis Case each year?" N = number of responses.

Response	N	Percent
	Including "No Opinion" Responses	
Too Many	419	47
About the Right Number	116	13
Too Few	6	1
No Opinion	344	39
	Excluding "No Opinion" Responses	
Too Many	419	78
About the Right Number	116	21
Too Few	6	1

DISCUSSION

Lake Francis Case, supporting one of South Dakota's most important walleye fisheries, continues to attract anglers from across the upper Midwest. Walleye, ranked the favorite species by 69% of respondents to a 1992 survey of South Dakota anglers (Mendelsohn 1994), continued to remain the target species of most LFC anglers. Since a peak in total walleye abundance in 1995, the LFC walleye population has generally declined in abundance. That decline has been attributed, in part, to angler harvest coupled with continuing drought conditions in the Missouri River basin, limiting walleye reproduction and recruitment. From 1996 through 2001, the estimated LFC walleye harvest was near or exceeded 200,000 fish, peaking at over 339,000 in 1998. This harvest, combined with low recruitment in 2000-2003 began to impact the number of legal-size walleye available for harvest beginning in 2003. A significant portion of the initially abundant 2002 LFC walleye year class did not recruit to age 1, so the expected downturn in population abundance may be longer in duration than previously thought. Walleye growth rates in 2004 remained similar to the 2002 and 2003 values and were probably maintained by moderate gizzard shad reproduction. Walleye growth rates will need to be watched closely in future surveys as the walleye population responds to modifications in size limit regulations and fluctuations in gizzard shad abundance. Walleye condition, as indexed by W_r, has remained unchanged since the initial 1990 regulation changes, despite variability in walleye and gizzard shad abundance over that same time period.

Water yield in the Missouri River system ranged between two extremes during the decade of the 1990's; from the drought of the late 1980's and early 1990's to the record water yield measured in 1997. These extremes in water yield undoubtedly played a significant role in shaping the fish populations of LFC. While changes to walleye management regulations in 1990 were given much of the credit for restructuring the LFC walleye population, resulting in the outstanding fishing that occurred throughout the latter half of the 1990's, the high water yield in the mid-1990's played a role that cannot be overlooked (Stone and Lott 2002). While walleye population abundance, size structure, and growth were showing positive trends in the early 1990's, when drought conditions still existed, the high walleye abundance levels reached in 1997 and 1998 were probably the result of improved habitat and nutrient conditions created by high water yield in 1995 and 1997 (Stone 1997b). As water yield in the Missouri River basin returned to normal or below normal levels, it was unrealistic to expect that the high walleye abundance of the mid-1990's could be maintained. Water yield in the Missouri River Basin has been below normal for the past five years. Persistent drought conditions have resulted in poor reproduction and recruitment causing a steady decline in walleye abundance since 1998.

Modifications to walleye sport fishing regulations in 2004, combined with decreasing walleye abundance, have reduced walleye harvest rates as well as overall harvest to sustainable levels. Improvements in walleye population structure, as a result of length limit regulations, is reflected in the 407 mm (16.0 in.) mean length of walleye harvested over the past five years, versus the 385 mm (15.2 in.) average the previous eleven years, and the 343 mm (13.5 in.) average estimated in 1989. However, despite a decline in overall walleye population abundance the past several years, a high proportion of anglers are still attaining the daily creel limit of three walleye during certain periods of the year. In this regard, the daily creel limit remains an important factor in the regulation of the fishery and distribution of the walleye harvest, at least during years of high walleye abundance or harvest. Survey results also suggests that while most LFC anglers are satisfied with their overall fishing trip experience, they can be less satisfied (based on trip rating) with the numbers and sizes of fish that they caught (Stone and Sorensen 2002, 2003; Sorensen 2004).

Smallmouth bass, which in previous years had ranked second in the sport fishery in terms of total fish caught (harvest and released), remain an important component in angler catches. Initially introduced as an alternative species that could direct fishing pressure away from walleye, they are now the target species of a small portion of LFC anglers. Smallmouth bass abundance, as measured by spring electrofishing CPUE, decreased in 2004 after two consecutive years of increasing abundance linked to a moderate 2002 smallmouth bass year class. Fair smallmouth bass reproduction also occurred in 2004. Because of the importance of smallmouth bass to the overall LFC sport fishery, it is hoped that good recruitment of the 2004 smallmouth bass year class will increase smallmouth abundance. In a 1992 survey of South Dakota anglers (Mendelsohn 1994) smallmouth bass were ranked in the top half of 14 species listed as most favorite by over 65% of the respondents. Channel catfish, white bass and sauger populations have maintained adequate abundance in recent years to support additional harvest.

Results from these surveys document the contribution and importance of the LFC fishery to the overall angling opportunities provided by the Missouri River system in South Dakota. Lake Francis Case continues to meet or exceed the objective of providing 100,000 angler days of recreation annually, as established in the Missouri River Fisheries Program Strategic Plan (SDGFP 1994). However, with declining walleye abundance and the return of Missouri River basin water yield to normal or below normal conditions, the near future of the LFC sport fishery is somewhat uncertain. While overall walleye abundance in LFC has decreased, the current population structure should support a sport fishery in 2005. However, anglers fishing Lake Francis Case in 2005 should expect lower walleye harvest rates than those experienced in 2004. A conservative walleye harvest in 2005 is needed to lessen the degree of reduction in fishery quality that anglers may begin seeing in 2005. High angler catch rates combined with reduced overall walleye abundance and continuing drought conditions in the basin, will continue to have an effect on the Lake Francis Case walleye population in the near future.

Prey fish abundance remains an additional area of concern. The LFC walleye population relies heavily on annual production of age-0 gizzard shad as prey. A missing year class of shad could greatly impact the growth and condition of LFC walleye. Continued monitoring of fish populations and associated sport fisheries through annual surveys is essential to allow fisheries managers the ability to monitor and react to changing conditions in fish populations, angler demographics and expectations, and reservoir operation.

Factors that will shape the future of this walleye fishery over the next several years include:

1) As discussed previously, history suggests that this walleye fishery is not capable of sustaining the harvest that occurred during 1996-2001, partially attributed to the unusually high water yield in the Missouri River Basin in the mid-late 1990s. If water yield in the basin remains at or below normal, it is expected that walleye abundance will remain low and that the population cannot sustain the high harvest that has occurred in the past. Walleye harvest from LFC will need to be conservative when walleye abundance is low.

2) Reproduction and recruitment of gizzard shad, emerald and spottail shiners, and yellow perch is essential for good growth of major sport fish species. These species provide the majority of fish prey species in the reservoir.

3) Initial results from the 2002 gill net survey suggested that moderate-to-high walleye production occurred. However, these fish did not materialize as a strong age-1 year class in 2003 as a majority of them were lost from the population. Therefore, the downturn in overall walleye abundance will last longer than initially thought due to low reproduction and recruitment during 2000-2004 and will impact Lake Francis Case anglers at least until 2007, and possibly longer, if there is not moderate-to-high walleye recruitment in 2005.

RECOMMENDATIONS

1. Continue and strive to improve reservoir fish population and creel surveys, as described in this report, on an annual basis. These surveys are essential for providing basic information on fish population abundance, reproduction and recruitment, growth and condition, survival and mortality, and sport fish use and harvest. Also, these surveys provide evaluation of progress towards objectives outlined in the Missouri River Fisheries Program Strategic Plan.

2. Revise and update the 1997 Lake Francis Case Fisheries Management Plan, with species specific goals, objectives, and management philosophies for walleye, smallmouth bass and paddlefish.

3. Continue public education efforts focusing on increasing angler awareness and compliance with recent walleye fishing regulation changes and the responsible use and harvest of LFC fisheries resources.

4. Continue annual review and evaluation of sport fishing regulations and their effectiveness.

5. Continue to incorporate angler attitude and preference questions in routine creel survey sampling. This technique provides valuable information with very little additional expense.

6. Continue standardized spring smallmouth bass electrofishing sampling. This technique is providing a more reliable long-term data set than fall gill netting.

7. Future research projects that need to be considered and developed include:
   - a study to evaluate LFC smallmouth bass distribution and movement related to the annual fall draw-down of the reservoir.
   - a study to document LFC gizzard shad life history with special emphasis on spawning and over wintering habitat.
   - working with researchers at South Dakota State University to continue studies to evaluate the effects of inter-basin transfer of nutrients, zooplankton and fish between South Dakota Missouri River reservoirs on fish population status.

8. Increase public awareness of aquatic nuisance species and the threat they pose to waters of the Missouri River system in South Dakota.

9. Continue to document threatened and endangered fish observations and locations.

10. Develop standardized sampling techniques to index annual reservoir productivity.

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Appendix 1. Monthly water volume (1000's acre-feet) released through (power) or over (spill) Ft. Randall Dam, 2000-2004.

Month	2000		2001		2002		2003		2004	
	Power	Spill	Power	Spill	Power	Spill	Power	Spill	Power	Spill
Jan	1,172	0	681	0	672	0	792	0	896	0
Feb	745	0	615	0	594	0	611	0	609	0
Mar	1,205	0	591	0	976	0	931	0	638	0
Apr	1,540	0	208	0	1,204	0	1,355	0	1,186	0
May	1,796	0	783	0	1,266	0	1,464	0	1,580	0
Jun	1,842	0	1,051	0	1,432	0	1,453	0	1,585	0
Jul	1,834	0	1,250	0	1,619	0	1,494	0	1,561	0
Aug	1,765	9	1,566	0	1,773	0	1,504	0	1,494	0
Sep	1,852	12	1,548	0	1,807	0	1,671	0	1,365	0
Oct	1,872	0	1,620	0	1,808	0	1,664	0	738	0
Nov	1,569	0	1,455	0	1,363	0	1,205	0	460	0
Dec	848	0	672	0	662	0	725	0	687	0
Total	18,040	21	12,040	0	15,176	0	14,869	0	12,799	0

Appendix 2. Common and scientific names of fishes mentioned in this report.

Common name	Scientific name	Abbreviation
Bigmouth buffalo	*Ictiobus cyprinellus*	BIB
Black bullhead	*Ameiurus melas*	BLB
Black crappie	*Pomoxis nigromaculatus*	BLC
Bluegill	*Lepomis macrochirus*	BGL
Brown trout	*Salmo trutta*	BNT
Channel catfish	*Ictalurus punctatus*	CCF
Common carp	*Cyprinus carpio*	CAP
Common shiner	*Notropis cornutus*	CMS
Emerald shiner	*Notropis atherinoides*	EMS
Fathead minnow	*Pimephales promelas*	FHM
Flathead catfish	*Pylodictis olivaris*	FCF
Freshwater drum	*Aplodinotus grunniens*	FRD
Gizzard shad	*Dorosoma cepedianum*	GIS
Goldeye	*Hiodon alosoides*	GOE
Johnny darter	*Etheostoma nigrum*	JOD
Largemouth bass	*Micropterus salmoides*	LMB
Northern pike	*Esox lucius*	NOP
Northern redbelly dace	*Phoxinus eos*	NRD
Paddlefish	*Polyodon spathula*	PAH
Rainbow trout	*Oncorhynchus mykiss*	RBT
Red shiner	*Notropis lutrensis*	RES
River carpsucker	*Carpiodes carpio*	CPS
Sauger	*Sander canadense*	SAR
Shorthead redhorse	*Moxostoma macrolepidotum*	SHR
Shortnose gar	*Lepisosteus platostomus*	SNG
Shovelnose sturgeon	*Scaphirynchus platorynchus*	SNS
Silvery minnow	*Hybognathus nuchalis*	SIM
Smallmouth bass	*Micropterus dolomieu*i	SMB
Smallmouth buffalo	*Ictiobus bubalus*	SAB
Spottail shiner	*Notropis hudsonius*	SPS
Walleye	*Sander vitreum*	WAE
White bass	*Morone chrysops*	WHB
White crappie	*Pomoxis annularis*	WHC
Yellow perch	*Perca flavescens*	YEP

Appendix 3. 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 = 3.180*LogTL-5.453
Sauger	LogWs = 3.187*LogTL-5.492
Smallmouth bass	LogWs = 3.200*LogTL-5.329
Channel catfish	LogWs = 3.294*LogTL-5.800
Yellow perch	LogWs = 3.230*LogTL-5.386
White bass	LogWs = 3.081*LogTL-5.066

Appendix 4. Total length (TL;mm) - weight (WT;g) regression equations for walleye, sauger, and smallmouth bass from Lake Francis Case, and mean total lengths and weights. Logarithms are to the base 10. *N* = sample size. Mean (X) total lengths and weights do not include age-0 fish.

Species	**Year**	***N***	**Equation**	**R^2**	**X TL (mm)**	**X WT (gm)**
Walleye	2000	523	LogWT=3.133LogTL-5.417	0.99	355	428
	2001	288	LogWT=3.209LogTL-5.613	0.99	335	357
	2002	306	LogWT=3.095LogTL-5.326	0.99	340	369
	2003	230	LogWT=3.160LogTL-5.498	0.97	324	324
	2004	206	LogWT=3.153LogTL-5.469	0.99	336	352
Sauger	2000	146	LogWT=3.063LogTL-5.322	0.98	323	267
	2001	128	LogWT=3.240LogTL-5.751	0.98	320	257
	2002	120	LogWT=3.044LogTL-5.267	0.98	322	256
	2003	88	LogWT=3.101LogTL-5.417	0.97	310	240
	2004	124	LogWT=3.122LogTL-5.463	0.94	320	244
SM bass	2000	23	LogWT=3.074LogTL-4.966	0.98	292	453
	2001	12	LogWT=3.277LogTL-5.463	0.99	258	400
	2002	30	LogWT=3.104LogTL-5.061	0.99	258	309
	2003	20	LogWT=3.171LogTL-5.216	0.99	248	264
	2004	18	LogWT=3.044LogTL-4.914	0.98	249	259

Appendix 5. Channel catfish, white bass, and yellow perch proportional stock density (PSD), relative stock density of preferred and memorable length fish (RSD-P and RSD-M, respectively), and relative weight (W_r), for 2000-2004, for fish collected from Lake Francis Case. *N* = sample size.

Species	**2000**				**2001**				**2002**				**2003**				**2004**			
	PSD	**RSD**		W_r	**PSD**	**RSD**		W_r	**PSD**	**RSD**		W_r	**PSD**	**RSD**		W_r	**PSD**	**RSD**		W_r
		P	**M**			**P**	**M**			**P**	**M**			**P**	**M**			**P**	**M**	
Channel catfish	44	1	0	76	27	4	0	79	35	1	0	76	26	1	0	78	36	0	0	76
N =	101				109				139				141				118			
White bass	90	86	24	107	91	91	27	104	100	50	42	99	95	85	32	106	100	83	25	101
N =	21				33				12				39				15			
Yellow perch	35	0	0	82	50	50	0	86	11	0	0	78	13	0	0	76	5	0	0	80
N =	17				6				9				16				32			