ANNUAL FISH POPULATION AND ANGLER USE AND SPORT FISH HARVEST SURVEYS ON LAKE FRANCIS CASE, SOUTH DAKOTA, 2011-2013

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by

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PREFACE

Information collected during 2011, 2012, and 2013 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 2009 through 2013, for Lake Francis Case (LFC), South Dakota. These surveys, their results and interpretations, are strategy and evaluation tools for planning efforts outlined in the Missouri River Fisheries Program Strategic Plan. Results and discussions presented pertain to changes in fish community and population characteristics, sport fish use and harvest, and evaluation of management activities and regulations.

Walleye catch per unit effort (CPUE; No./min.), during 2013 spring-spawning-run electrofishing near Chamberlain, was similar to 2009 and 2010. Walleye electrofishing CPUE at the face of Ft. Randall Dam during 2013 was similar to all other values in the five-year period.

Fall gill netting collected seventeen fish species. Walleye CPUE (No./net night) decreased from 2011 to 2013. Sauger CPUE increased from 2011 to 2012 before decreasing in 2013. Channel catfish CPUE in 2011 was at a 5-year low before increasing in 2012 and 2013. White Bass CPUE decreased during 2012 after reaching a 5-year high in 2011. Smallmouth bass and yellow perch CPUE reached 5-year highs during 2011 and decreased in 2012 and 2013.

Nineteen species of age-0 fishes or small littoral prey species were collected by seining in 2013. Gizzard shad were most common in 2013 seine catches, accounting for 67% of the total catch, while yellow perch, white bass, freshwater drum, emerald shiners, and smallmouth bass accounted for 10%, 9%, 3%, 3%, and 2% of the total catch, respectively. Johnny darters, walleye, and western silvery minnows were also common in seine catches.

Walleye survival increased from 2011 to 2013 and mean age was similar among years. Relative weight (*Wr*) was similar for the 5-year period and proportional size distribution (PSD) decreased from 2011 to 2013. Overall walleye abundance has steadily decreased from 2010 to 2013. Walleye growth in 2013 decreased from 2012 and 2011. Sauger gill net CPUE increased in 2011 and 2012 before decreasing in 2013. Sauger PSD increased in 2012 from 2011 before decreasing in 2013 and survival increased from 2011 to 2013. Sauger mean age increased during 2013 while growth was similar among years. Smallmouth bass gill net CPUE decreased from 2011 to 2013. Smallmouth bass PSD and survival decreased from 2011 to 2013. Smallmouth bass mean age increased in 2013.

Anglers spent an estimated 736,121 hours fishing LFC, during the April-September 2013 daylight period, an increase from the 616,337 hours estimated for 2012. Total fish harvest in 2013 was estimated at 297,664 fish, similar to the estimate in 2011 of 302,347. Walleye were most abundant in the harvest, with an estimated 235,608 harvested in the April-September 2013 survey period, similar to the 248,773 walleye estimate in 2011. Estimated mean length of harvested walleye from 2011-2013 was 417, 411, and 413 cm, respectively. Sauger, white bass, channel catfish, smallmouth bass, northern pike, and yellow perch were also common in the harvest. An overall catch rate (harvest and release rates combined) of 1.59 fish/angler-h was estimated for the April-September 2013 daylight period. Total catch, release, and harvest rates for walleye were 1.25 walleye/angler-h, 0.93 walleye/angler-h, and 0.32 walleye/angler-h, respectively. Approximately 83%, 78%, and 73% of LFC anglers expressed some degree of satisfaction with their angling trip in 2011-2013, respectively. Anglers from South Dakota and 24 other states and 2 Canadian provinces, fishing LFC in 2013, generated a local economic impact estimated at approximately $13.2 million. This estimate is up slightly from 2011 and 2012 when anglers from 21 and 18 states generated a local economic impact estimated at $11.1 and $11.2 million, respectively. Results from several questions regarding LFC angler attitudes and preferences are reported.

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ANGLER USE AND SPORT FISH HARVEST SURVEYS
ON
LAKE FRANCIS CASE, SOUTH DAKOTA, 2011-2013

INTRODUCTION

Lake Francis Case (LFC), a Missouri River mainstem reservoir, has provided more than 100,000 angler days annually since 1992 (Table 1). 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 opportunities. The importance of this system to South Dakota anglers was documented in a 2010 Resident Fishing Activity, Harvest and Angler Opinion Survey (Gigliotti, 2011), in which 50 percent of the respondents reported as having fished the Missouri River and its reservoirs. 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 30 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; Sorensen and Knecht 2006). Harvest regulations for walleye/sauger and their hybrids for LFC in 2011 through 2013 included:

- daily and possession limits of 4 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 508 mm (20 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 four 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 unusually high water levels in 1995 and 1997. Water yield in the Missouri River Basin was below normal for the 2000-2007 period. Following eight consecutive years of drought, water yield in the basin returned to above average condition in 2008 through 2011. Record water yield of 60 million-acre-feet (MAF) occurred in 2011. Water yield decreased to below normal levels during 2012 after four consecutive years of above average run-off. Past research (Stone 1997b) suggests that it is unrealistic to expect fish population abundance at levels observed in the mid-to-late 1990s during low run-off conditions. Walleye abundance steadily decreased from 1995 to 2004 due to persistent drought conditions. Increases in overall walleye abundance have been documented during 2005 and 2006 followed by a sharp decrease in 2007. Walleye abundance increased in 2009-2011 before decreasing during 2012 and falling to a record low in 2013.

Maintaining LFC as one of South Dakota's most productive fisheries 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 goals, 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 the strategic plan and as a prerequisite to effective development of future management strategies. This report describes data collected in 2011, 2012, and 2013 from LFC and the discussion focuses on changes in fish populations and associated angler use and sport fish harvest since 2009.

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/h)	Walleye harvest rate (Fish/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 (1996)
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)

Table 1 continued

Year	Fishing pressure (h)	Angler days	Mean trip length (h)	Total fish harvest (No.)	Walleye harvest (No.)	Total harvest rate (Fish/h)	Walleye harvest rate (Fish/h)	Mean walleye TL(mm) in harvest	Reference
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	Sorensen and Knecht (2006)
2005	554,440	113,151	4.9	168,882	102,693	0.305	0.185	404	Sorensen and Knecht (2007)
2006	639,335	122,949	5.2	254,195	202,437	0.398	0.317	410	Sorensen and Knecht (2008)
2007	562,447	115,968	4.9	154,622	105,506	0.275	0.188	409	Sorensen and Knecht (2009)
2008	553,822	128,497	4.3	139,346	86,352	0.252	0.156	394	Sorensen and Knecht (2010a)
2009	587,786	138,302	4.3	189,985	143,383	0.323	0.244	398	Sorensen and Knecht (2010b)
2010	480,884	112,094	4.3	136,457	102,973	0.284	0.214	411	Sorensen and Knecht (2013)
2011	633,536	143,698	4.4	302,347	248,773	0.477	0.393	417	This Study
2012	616,337	145,363	4.2	265,290	195,859	0.430	0.318	411	This Study
2013	736,121	170,794	4.3	297,664	235,608	0.404	0.320	413	This Study

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

OBJECTIVES

The objectives of 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

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.

Record setting water yield (60 MAF) occurred in the Missouri River system in 2011, the fourth consecutive year of above average run-off in the basin (Appendix 1; U.S. Army Corps of Engineers, unpublished data). Run-off during 2012 was below average (25.2 MAF), while 2013 experienced average water yield. During the springs of 2011-2013, the elevation of LFC increased, exceeding elevation 413 m msl (1354.3 ft. msl) by mid-March and remained at or above this level until early September when the U.S. Army Corps of Engineers (USCOE) began the annual fall draw-down (Figure 2). Appendix 1 presents monthly data on water released through Ft. Randall Dam.

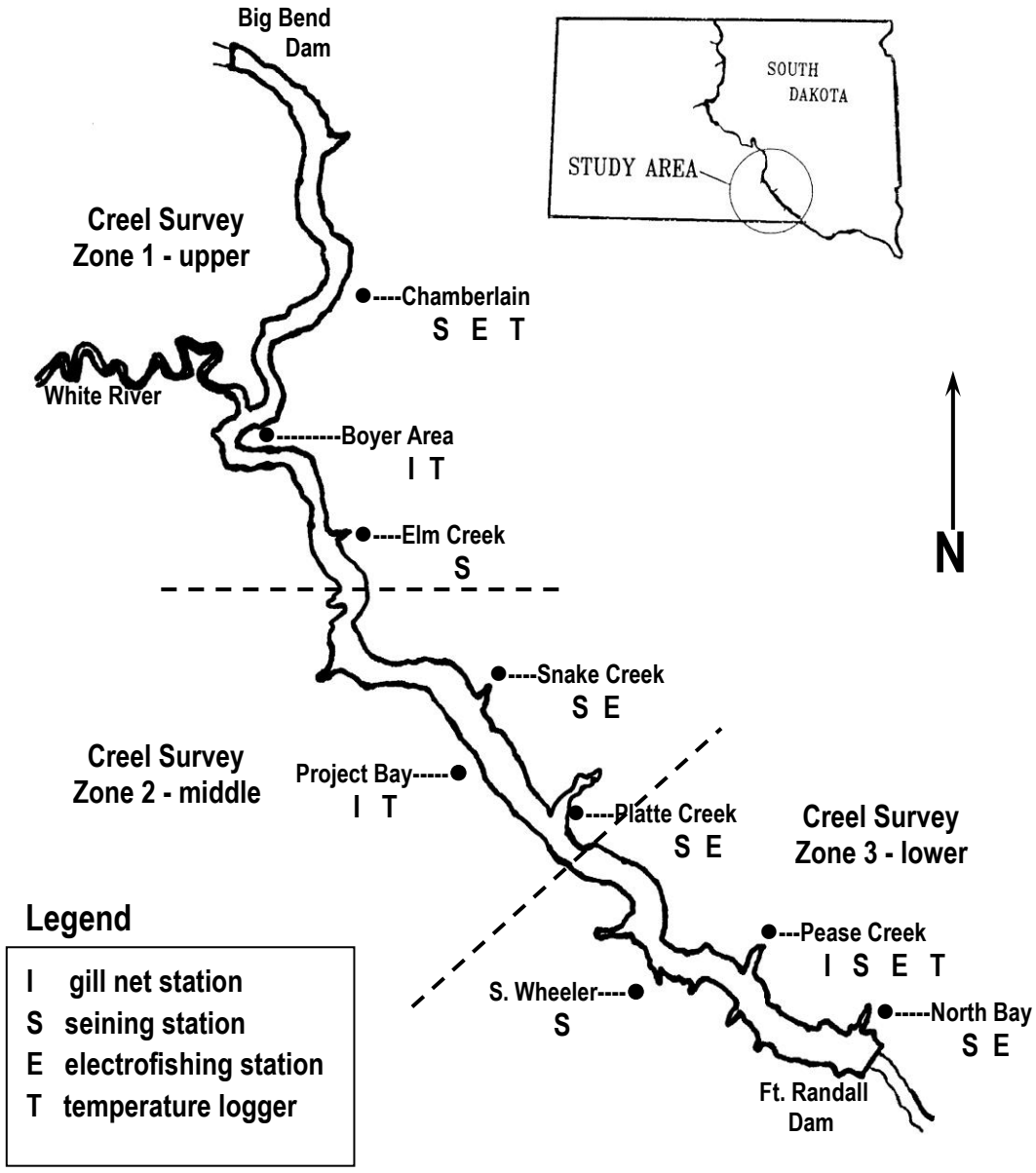

Figure 1. Lake Francis Case study area.

Table 2. Physical characteristics at base of flood control, management classification, 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, October 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

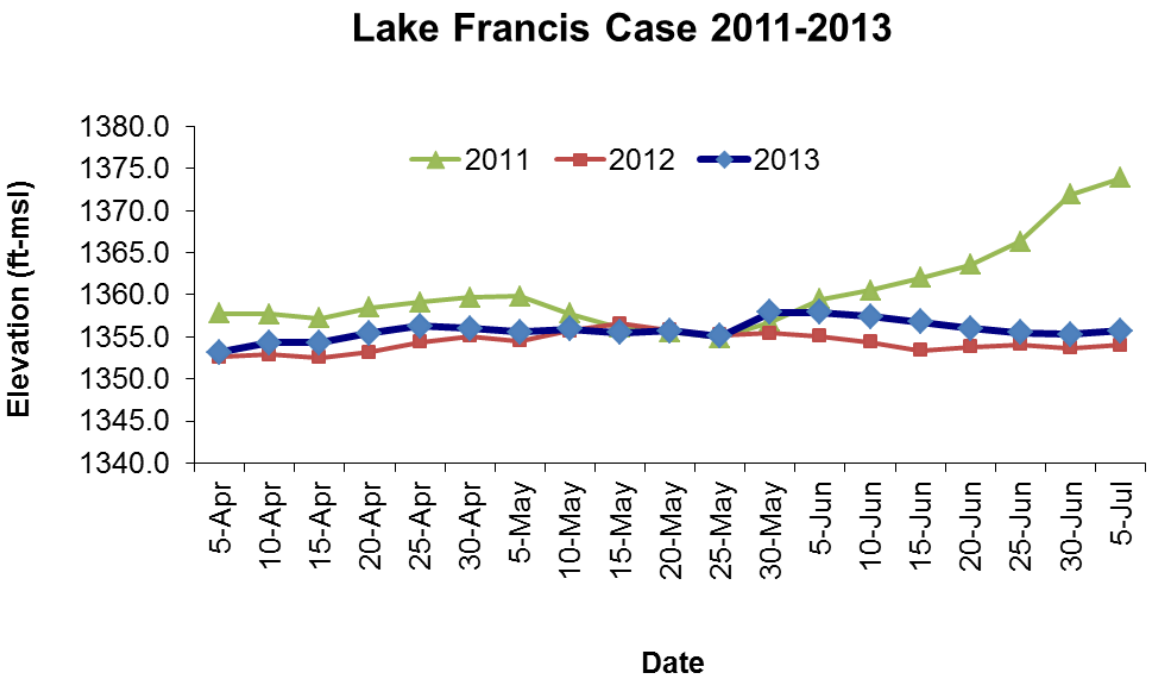

Figure 2. Spring 2011-2013 Lake Francis Case reservoir elevation.

SAMPLING METHODS AND SCHEDULE

FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES

Data Collection

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

Pulsed-DC (60 pps, 6-8 amps) electrofishing, using a Smith-Root GPP electrofishing boat, was used to collect adult walleye in April, smallmouth bass in May and June, and age-0 walleye in October, for population monitoring. Nine and six 10-minute electrofishing runs were conducted at night near Chamberlain and on the face of Ft. Randall Dam, respectively, to collect adult 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. Age-0 walleye were collected at three locations: Chamberlain, Snake Creek, and Fort Randall Dam (Figure 1). Six, 10-minute electrofishing runs were conducted at each sampling location. All fish were measured.

Nylon shoreline 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. All walleye were measured.

Water temperature data was collected with submersible HOBO Water Temp Pro temperature loggers. Loggers, configured to record temperature every two hours, were deployed each spring at four locations (Figure 1) on the reservoir during April and retrieved in October.

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), 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 usingWINFIN (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 size distribution (PSD) and proportional size distribution (PSD) values for preferred- (PSD-P) and memorable- (PSD-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 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 1993), 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 and alpha values were set at $P = 0.02$.

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 (Jones and Robson 1991; Soupir and Brown 2002), 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, 1996, 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b).

Surveying was conducted from 1 April through 30 September each year, 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 direct implications for 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

Species Composition and Relative Abundance

Overall walleye electrofishing CPUE in 2013, near Chamberlain, was similar to values measured in 2009 and 2010 (Table 4). Sampling near Ft. Randall Dam, during 2013, yielded a CPUE of 3.1 walleye/minute, a low for the period (Table 5). Sampling was not conducted during 2011 and 2012. Walleye electrofishing CPUE near Chamberlain peaked on 30 April 2013 and was similar to the 22 April 2013 sampling date but significantly different than the 15 April 2013 sampling date (Table 6). Electrofishing CPUE near Ft. Randall Dam was significantly higher for the 29 April 2013 sampling date compared to the 21 April 2013 sampling date (Table 6).

Table 4. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Chamberlain, 2009-2013. Catch per unit effort (CPUE) values with the same letter are not significantly different at the $P = 0.2$ level.

Year	Sampling time (min)	Number of fish	CPUE (fish/min)
2009	61	972	15.9 b
2010	55	990	18.2 b
2013	60	932	18.3 b

Table 5. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Ft. Randall Dam, 2008-2013. Catch per unit effort (CPUE) values with the same letter code are not significantly different at the $P = 0.2$ level.

Year	Total Sampling time (min)	Number of fish	CPUE (fish/min)
2008	60	260	4.3 a
2009	60	332	5.5 a
2010	62	362	5.8 a
2013	60	188	3.1 a

Table 6. Electrofishing data, by location and date, for walleye from Lake Francis Case, 2013. Catch per unit effort (CPUE) values, by location, with the same letter code are not significantly different at the $P = 0.2$ level.

Location	Date	Water temp. (C)	Total Sampling time (min)	No. of fish	CPUE (fish/min)
Chamberlain	4/15/13	2.3	30	220	7.3 a
Chamberlain	4/22/13	4.5	15	324	21.6 b
Chamberlain	4/29/13	8.5	15	388	25.9 b
Ft. Randall Dam	4/21/13	3.2	30	35	1.2 a
Ft. Randall Dam	4/30/13	5.3	30	153	5.1 b

Catch-per-unit-effort of smallmouth bass in 2009 through 2013 remained consistent and was similar among years for all sampling locations with the exception of the Platte Creek sampling location (Table 7). A significant decrease in smallmouth bass CPUE was observed at the Platte Creek sampling station in 2010.

Table 7. Electrofishing catch of smallmouth bass during spring sampling, at five locations on Lake Francis Case, 2009-2013. Catch per unit effort (CPUE) values within sites with the same letter code are not significantly different at the $P = 0.2$ level.

Big Bend Dam Tailwater			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2009	45	32	0.7 a
2010	45	95	2.1 a
2011	45	30	0.7 a
2012	45	82	1.8 a
2013	45	82	1.8 a
Chamberlain			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2009	45	104	2.3 a
2010	30	59	2.0 a
2011	45	129	2.9 a
2012	45	234	5.2 a
2013	45	106	2.4 a
Platte Creek			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2009	45	63	1.4 a
2010	45	15	0.3 b
2011	45	27	0.6 ab
2012	45	64	1.4 a
2013	45	47	1.0 ab
Pease Creek			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2009	45	76	1.7 a
2010	45	44	1.0 a
2011	45	40	0.9 a
2012	50	81	1.6 a
2013	45	17	0.4 a
Ft. Randall Dam			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2009	45	53	1.2 a
2010	45	112	2.5 a
2011	45	109	2.4 a
2012	45	119	2.6 a
2013	40	63	1.6 a

Fall gill-net sampling collected 17 species of fish from LFC in 2013 (Table 8). All species had been previously reported (Lott et al. 1994). Walleye have been the most common species in gill net catches since re-initiation of this survey in 1981 (Michaletz et al. 1986; Lott et al. 1994), and comprised 24% of gill net catches in 2013, followed by sauger, channel catfish, gizzard shad, common carp, and white bass which accounted for 21%, 12%, 9%, 5%, and 2% of the catch, respectively. Freshwater drum, goldeye, smallmouth bass, and white crappie were also common in gill-net catches during 2013.

Walleye gill net CPUE for 2011 was 17.5 walleye/net and decreased during 2012 (12.2 walleye/net) and was at an all-time low of 6.9 walleye/net during 2013 (Table 8). The strong 2005 and 2006 year classes comprise a bulk of the angler harvest. High walleye reproduction occurred during 2012 while low walleye production occurred in 2013.

Channel catfish gill net CPUE for 2011-2013 was 2.6, 3.8, and 3.4 fish/net, respectively, similar to the last five-years. Sauger gill net CPUE increased in 2011 and 2012 to 7.5 and 8.0 sauger/net, respectively before decreasing to 6.1 fish/net in 2013. Smallmouth bass gill net CPUE for 2011 remained at 0.9 smallmouth bass/net and decreased in 2012 and 2013 to 0.6 and 0.3 fish/net, respectively. Yellow perch gill net CPUE decreased from 4.9 yellow perch/net in 2010 to 4.0 yellow perch/net in 2011 before decreasing to 1.6 and 0.5 fish/net in 2012 and 2013, respectively. A 2011 white bass gill net CPUE of 1.8 white bass/net was the highest in the last five years. White bass CPUE decreased to 0.5 fish/net in 2012 and 2013.

Twenty-two species of age-0 fishes or small littoral species were collected by seining in 2011, with twenty species being collected in 2012 and 2013 (Table 9). All species had been previously reported for LFC (Lott et al. 1994). Age-0 gizzard shad were most abundant in seine catches making up 67%, 84%, and 37% of the total seine catch in 2011-2013, respectively. Age-0 white bass comprised 9%, 4%, and 26% percent of the total seine catch during 2011-2013, respectively. Yellow perch, emerald shiners, freshwater drum, and fathead minnows were common in seine catches.

The 2011 age-0 walleye seining CPUE of 4.1 fish/ haul was the high for the five-year period, and decreased to 1.9 and 1.3 fish/ haul in 2012 and 2013, respectively. Age-0 walleye were collected at all sampling locations in 2011. Age-0 walleye were collected at 4 of 7 sampling locations in 2012 and all sampling locations except Snake Creek during 2013. A majority of age-0 walleye are usually collected in the upper half of the reservoir, however, during 2011, 78% of all age-0 walleye collected in seines were sampled in the lower portion of the reservoir. During 2012 and 2013, most age-0 walleye were sampled in the upper portion of the reservoir. During 2011-2013, 110, 67, and 39 age-0 walleye were collected by seines in mid-July, respectively. Age-0 walleye averaged 59.0, 84.6, and 72.5 mm TL in 2011-2013 respectively (Table 10).

Table 8. Mean gill net CPUE; (No./net), sampling stations combined, on Lake Francis Case, 2009-2013. SE is standard error. Trace (T) < 0.05.

Species	2009		2010		2011		2012		2013	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Black bullhead	0.0	-	0.4	0.2	0.1	0.1	0.0	-	0.0	-
Channel catfish	5.0	0.7	4.2	0.7	2.6	0.5	3.8	0.5	3.4	0.6
Common carp	1.0	0.3	0.9	0.3	1.1	0.3	1.9	0.5	1.4	0.4
Emerald shiner	0.0	-	0.0	-	0.0	-	0.0	-	0.0	-
Freshwater drum	1.1	0.2	1.2	0.4	1.4	0.3	1.1	0.3	1.6	0.3
Gizzard shad	5.2	2.2	7.2	2.6	1.6	0.5	2.4	0.7	2.7	1.0
Goldeye	1.3	0.6	0.9	0.3	1.9	0.6	2.0	0.7	3.4	1.1
Northern pike	0.1	0.1	0.7	0.4	0.4	0.1	0.4	0.2	0.1	0.1
Rainbow trout	0.0	-	0.0	-	0.0	-	0.0	-	0.0	-
River carpsucker	0.2	0.1	0.3	0.1	0.1	0.1	0.1	0.1	T	-
Sauger	2.3	0.5	5.2	1.4	7.5	1.4	8.0	0.9	6.1	0.8
Shorthead redhorse	0.1	0.1	0.4	0.2	0.3	0.1	0.2	0.1	0.3	0.1
Shortnose gar	T	-	0.5	0.3	0.7	0.2	0.4	0.2	0.2	0.1
Shovelnose sturgeon	T	-	0.0	-	0.1	0.2	0.0	-	0.2	0.1
Smallmouth bass	0.6	0.2	0.9	0.3	0.9	0.5	0.6	0.2	0.3	0.1
Smallmouth buffalo	0.1	0.1	T	-	0.0	-	T	-	T	-
Spottail shiner	T	-	0.3	0.1	T	-	0.0	-	0.0	-
Walleye	12.0	1.4	18.9	3.4	17.4	3.1	12.3	1.4	7.0	0.8
White bass	0.7	0.2	0.4	0.3	1.8	1.1	0.5	0.1	0.5	0.2
White crappie	0.4	0.3	4.6	3.3	1.1	0.4	1.3	0.5	1.0	0.4
Yellow perch	1.0	0.3	4.9	1.4	4.0	1.2	1.6	0.4	0.5	0.2

Table 9. Mean seine haul CPUE; (No./haul), sampling stations combined, of age-0 fishes and small littoral species from Lake Francis Case, 2009-2013. SE is standard error. Trace (T) < 0.05

Species	2009		2010		2011		2012		2013	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Bigmouth buffalo	0.3	0.2	0.2	0.1	0.7	0.3	0.0	-	0.1	0.1
Black bullhead	0.0	-	34.1	24.4	0.0	-	0.0	-	0.0	-
Black crappie	T	-	0.0	-	4.2	1.6	0.2	0.1	T	-
Channel catfish	0.0	-	0.0	-	0.0	-	0.3	0.2	0.0	-
Common carp	0.1	0.1	0.3	0.1	1.4	0.9	0.0	-	0.1	0.1
Common shiner	0.6	0.3	0.0	-	0.0	-	0.0	-	0.0	-
Emerald shiner*	44.1	14.0	54.4	12.4	17.9	8.5	36.4	16.3	2.6	0.9
Fathead minnow*	0.1	0.1	11.6	5.8	65.5	28.7	0.4	0.4	0.1	0.1
Freshwater drum	0.1	0.1	0.0	-	2.4	2.2	33.9	15.4	3.1	1.5
Gizzard shad	158.8	66.2	785.2	219.2	146.4	99.4	888.1	440.6	56.3	22.7
Goldeye	1.7	1.7	12.1	8.1	0.2	0.2	T	-	0.3	0.1
Johnny darter*	0.4	0.1	0.2	0.1	0.2	0.1	0.2	0.1	1.4	0.5
Largemouth bass	0.0	-	0.0	-	T	-	0.0	-	T	-
North. Redbelly dace	T	-	0.2	0.2	0.2	0.2	0.0	-	0.0	-
Red shiner*	T	-	1.4	0.9	0.0	-	0.8	0.5	0.0	-
River carpsucker	0.4	0.2	0.0	-	0.8	0.5	1.2	0.5	0.2	0.2
Sauger	0.0	-	T	-	0.2	0.1	0.3	0.1	0.2	0.2
Shorthead redhorse	0.0	-	0.0	-	0.1	0.1	0.3	0.3	T	-
Silvery minnow	0.0	-	T	-	5.5	4.4	1.2	0.7	0.0	-
Smallmouth bass	2.4	0.7	7.5	5.1	0.8	0.4	2.7	0.7	1.8	0.6
Smallmouth buffalo	0.1	0.1	0.0	-	0.3	0.2	1.0	0.3	0.3	0.2
Spottail shiner*	6.8	4.8	10.2	5.3	18.7	5.0	12.2	5.0	0.5	0.2
Walleye	1.2	0.6	0.6	0.5	4.1	1.9	1.9	1.3	1.3	0.6
White bass	6.0	2.5	1109.0	499.9	100.2	28.4	42.0	12.7	9.4	0.6
White crappie	T	-	2.4	1.3	0.5	0.3	T	-	0.1	0.1
Yellow perch	2.8	1.1	11.5	4.1	22.9	9.3	3.7	1.3	10.8	4.5

*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, 2009 – 2013.

Year	No.	CPUE	Mean TL (mm)	Total length (mm) range
2009	28	1.0	74.6	53-103
2010	14	0.5	90.0	68-97
2011	110	4.1	59.0	33-83
2012	67	1.9	84.6	58-104
2013	39	1.3	72.5	45-93

Population Parameters for Walleye

Beginning in 2003, otoliths were collected from walleye during the September gill netting survey. Mean length-at-age-at-capture shows Lake Francis Case walleye typically reach the minimum legal length (381 mm; table 11) at age 3. Mean annual growth increments for walleye indicate that growth improved during the 2008-2013 time period (Table 12). Mean walleye age in 2013 was 2.4 years, similar to previous years but down from 3.2 years in 2009, which was influenced by the very large 2005 year-class (Table 13). Walleye from ten year-classes were collected in the 2011 and 2013 gill net survey, while 12 year-classes were sampled during the 2012 gill net survey (Table 13) and ranged in TL from 110-mm to 620-mm (Figure 3).

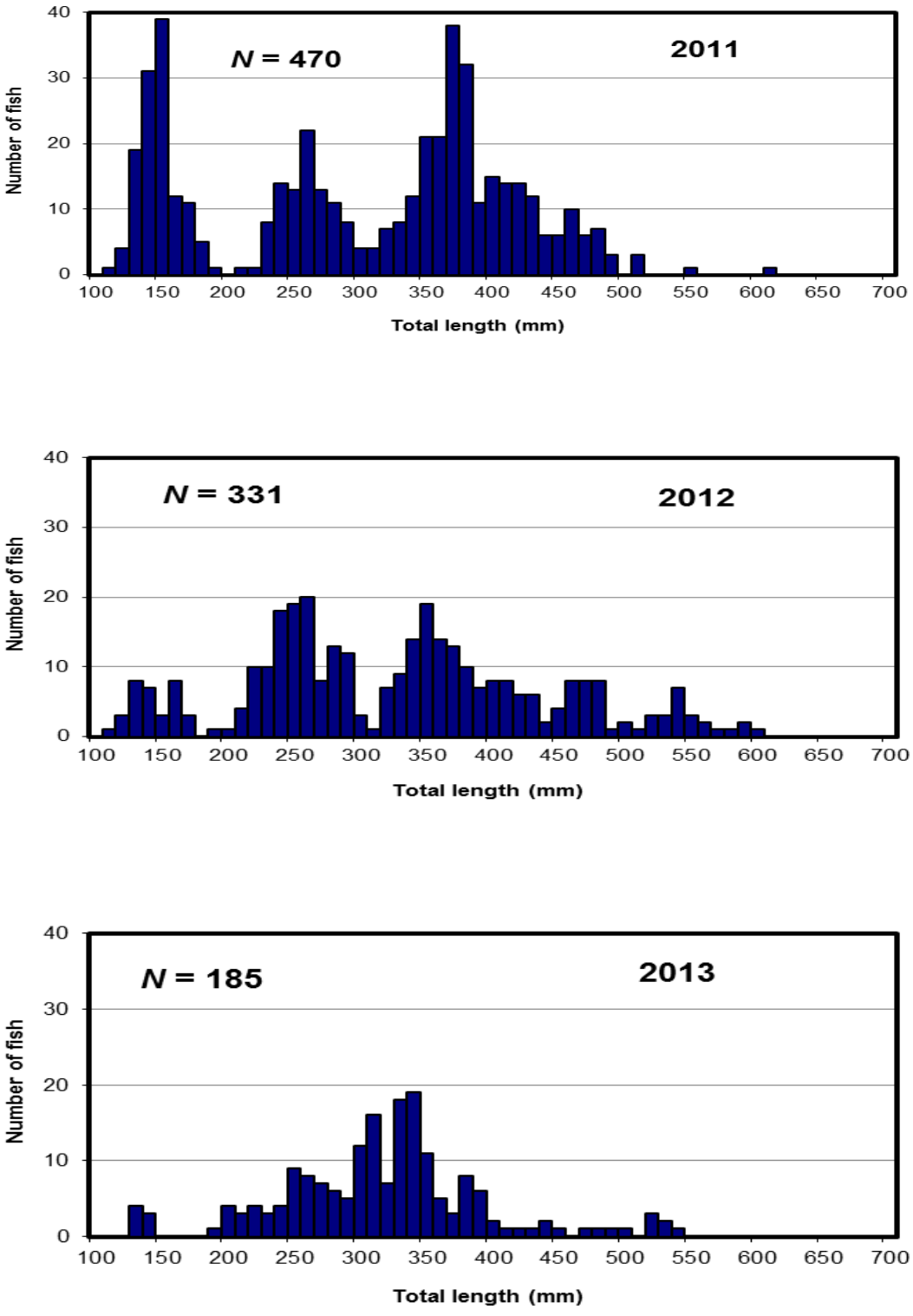

Figure 3. Length frequency of walleye collected with gill nets from Lake Francis Case, 2011-2013. *N* = sample size.

Annual survival for pooled 2012 and 2013 data was estimated at 64% (Table 14), similar to the five-year period. Relative weights for stock-quality (S-Q), quality-preferred (Q-P), and preferred (P) length fish sampled in 2013 were similar to values measured over the past five years with the exception of preferred length fish which decreased to a five-year low (Table 15). Walleye proportional size distribution (PSD) for 2013 decreased to 20, a low for the five-year period, while PSD-P was 4 (Table 16).

Table 11. Mean length-at-age-at-capture (mm) for walleye, as determined by otoliths, collected in the standard September gill net survey, 2009-2013, Lake Francis Case, South Dakota. *N*=sample size

Year		Length at age at capture (mm)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2009	**Mean**	236	316	368	393	417	427	562		453	543	641		
	N	41	44	70	122	10	4	1	0	2	2	1	0	0
	SE	4.9	6.9	3.0	2.8	12.2	17.4	NA		24.7	128.0	NA		
2010	**Mean**	273	358	413	437	442	455	493		481				524
	N	165	79	35	68	56	6	2	0	2	0	0	0	1
	SE	1.5	4.5	6.2	4.4	5.0	16.9	7.0		24.5				NA
2011	**Mean**	268	369	417	446	458	462	449		482		615		
	N	97	156	41	11	10	25	1	0	1	0	1	0	0
	SE	3.2	2.2	5.2	8.8	13.1	5.9	NA		NA		NA		
2012	**Mean**	257	349	398	479	475	474	512	516	466	546		480	
	N	113	75	48	10	5	7	26	8	1	2	0	1	0
	SE	2.2	3.0	4.1	13.7	10.8	10.9	9.9	19.7	NA	47.0		NA	
2013	**Mean**	231	312	376	431	468	535	529	520				504	
	N	21	107	31	8	2	3	1	1	0	0	0	1	0
	SE	4.7	3.2	5.5	18.8	63.0	3.7	NA	NA				NA	
Mean of means		253	341	394	437	452	471	509	518	471	545	628	492	524

Table 12. Mean annual growth increments for walleye collected in the standard September gill net survey on Lake Francis Case, South Dakota for 2008-2009, 2009-2010, 2010-2011, 2011-2012, and 2012-2013 as determined by aging otoliths.

Year	Growth increment added during period (mm)									
	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11
2008-2009	82	59	36	1	--	80	--	--	30	101
2009-2010	122	97	69	49	38	66	--	--	--	--
2010-2011	96	59	33	21	20	-	-	-	-	-
2011-2012	81	29	62	29	16	50	67	-	64	-
2012-2013	55	27	33	-	60	55	8	-	-	-

Table 13. Age distribution, from otolith analysis, of walleye collected from Lake Francis Case with variable-mesh gill nets, 2009-2013. Mean age excludes age-0 fish.

	Age														
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
2009	4	41	44	70	122	10	4	1	0	2	2	1	0	0	3.2
2010	90	165	79	35	68	56	6	2	0	2	0	0	0	1	2.6
2011	90	97	156	41	11	10	25	1	0	1	0	1	0	0	2.3
2012	30	113	75	48	10	5	7	26	8	1	2	0	1	0	2.7
2013	7	21	107	31	8	2	3	1	1	0	0	0	1	0	2.4

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	2008-2009	0.61	0.39	0.495	0.796
	2009-2010	0.59	0.41	0.524	0.893
	2010-2011	0.59	0.41	0.534	0.919
	2011-2012	0.61	0.39	0.493	0.922
	2012-2013	0.64	0.36	0.448	0.795
Sauger	2008-2009	0.57	0.43	0.572	0.808
	2009-2010	0.45	0.55	0.795	0.998
	2010-2011	0.59	0.42	0.868	0.930
	2011-2012	0.62	0.38	0.493	0.922
	2012-2013	0.62	0.38	0.475	0.771
Smallmouth bass	2008-2009	0.42	0.58	0.874	0.690
	2009-2010	0.49	0.51	0.870	0.714
	2010-2011	0.49	0.51	0.708	0.806
	2011-2012	0.48	0.52	0.742	0.845
	2012-2013	0.47	0.53	0.763	0.770

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, 2009-2013. 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***
2009	81	79	75	271
2010	84	93	79	402
2011	83	83	83	321
2012	82	83	81	253
2013	82	80	74	158
Sauger				
Year	**S-Q**	**Q-P**	**P**	***N***
2009	77	76	78	51
2010	81	82	85	110
2011	75	78	77	196
2012	75	75	72	196
2013	74	74	70	163
Smallmouth bass				
Year	**S-Q**	**Q-P**	**P**	***N***
2009	107	103	101	17
2010	103	108	-	17
2011	115	105	108	21
2012	106	110	106	16
2013	100	92	-	5

Table 16. Walleye, sauger, and smallmouth bass proportional size distribution (PSD) and proportional size distribution for preferred- and memorable-length fish (PSD-P and PSD-M, respectively) for Lake Francis Case gill net data, 2009-2013.

Species	2009	2010	2011	2012	2013
Walleye	46 (1,1)	47 (1,0)	44 (2,0)	40 (10,0)	20 (4,0)
Sauger	82 (26,0)	38 (16,0)	70 (27,1)	74 (35,0)	65 (16,0)
Smallmouth bass	71 (6,0)	12 (0,0)	76 (19,5)	50 (31,0)	40 (0,0)

Walleye population improvements were noted soon after sport-fishing-regulation changes were implemented in 1990 (Stone and Wickstrom 1991a; Figure 4). 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 2004 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 eight consecutive years of drought conditions. Poor nutrient conditions caused by reduced localized run-off resulted in poor production and recruitment during 2001-2004. Following a sharp decline 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. Walleye abundance increased to levels similar to the early 2000's during 2005 and 2006, but remains well below abundance levels experienced in the late 1990's. Walleye abundance in 2010 increased from 2009. Walleye produced in 2005, 2006 have comprised a majority of the Lake Francis Case walleye population during the latter part of the 2000s. High water yield in the basin during 2010, and record yield in 2011 created conditions favorable for fish production. Lake Francis Case walleye produced large year classes in 2010 and 2011 followed by moderate and poor production in 2012 and 2013, respectively. Water yield in the basin during 2012 was below average while 2013 run-off was average.

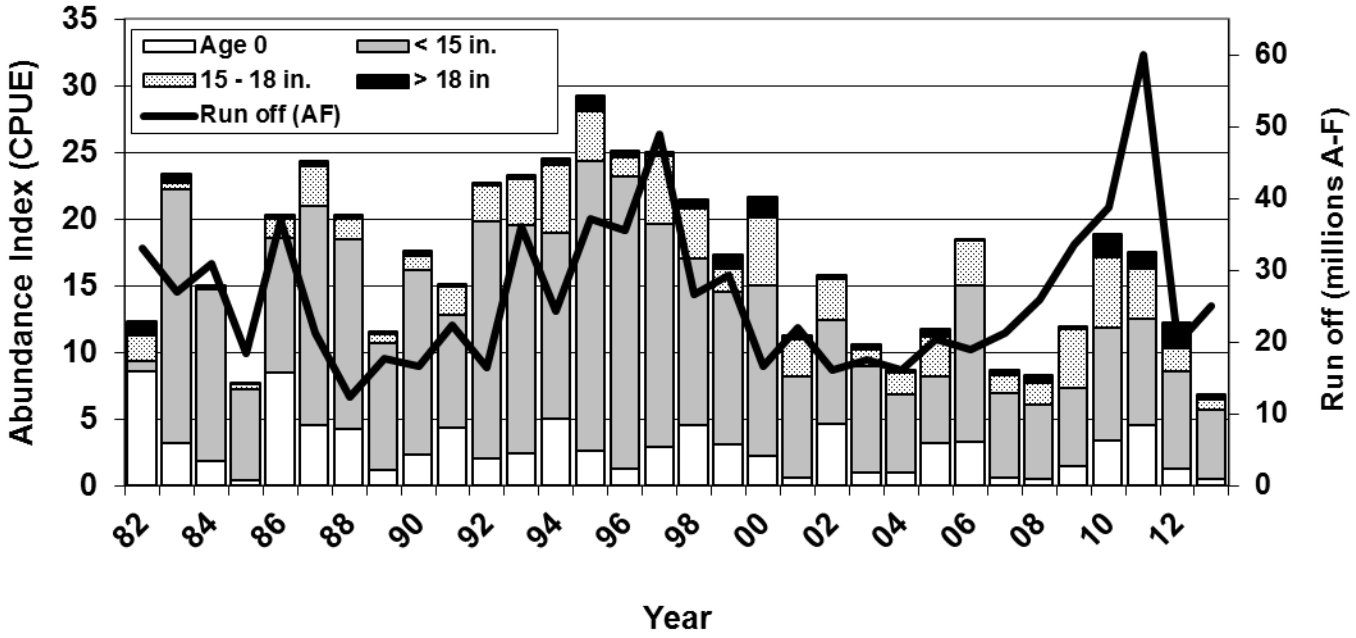

Figure 4. Lake Francis Case walleye abundance (No. per net) partitioned by age and length groups and plotted against total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA. 1988-2013.

Population Parameters for Sauger

Lake Francis Case sauger abundance index has been above normal since 2010. Sauger abundance peaked in 2012 at 8.0 fish/net night before decreasing to 6.1 fish/net night in 2013 (Table 8). Lengths of sauger sampled in the 2013 gill net survey ranged from 130 mm to 490 mm TL (Figure 5). Sauger average length-at-age-at-capture indicates that LFC sauger typically surpass 381 mm at three years of age (Table 17). Sauger up to age 5 were collected in the 2013 gill net survey (Table 17). Sauger growth for the 2012-2013 period decreased from that measured in previous years (Table 18). Mean sauger condition, for the various length categories during 2013 was similar to other years (Table 15).

Six year classes of sauger were collected by gill nets in 2013 (Table 19). The mean age of 2.4 years is a high for the five-year period (Table 19). The strong 2009 and a moderate 2010 sauger year class comprise a majority of the current adult sauger population. Annual sauger survival for 2011-2012 and 2012-2013 pooled data increased to 62%, a high for the five-year period (Table 14). Sauger PSD decreased during 2013 to 65 while PSD-P decreased to 16 (Table 16).

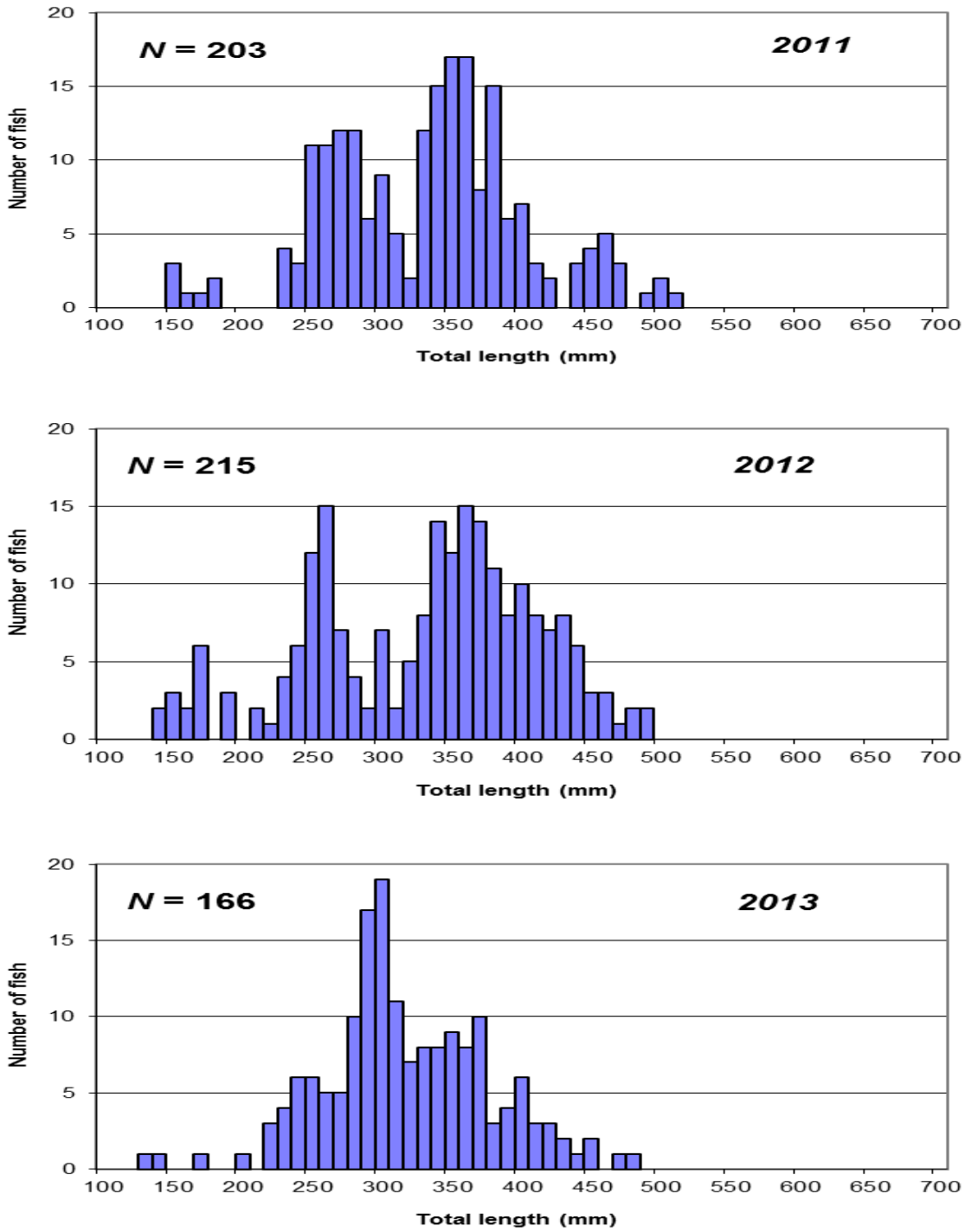

Figure 5. Length frequency of sauger collected with gill nets from Lake Francis Case, 2011-2013. *N* = sample size.

Table 17. Mean length-at-age-at-capture (mm) for sauger, as determined by otoliths, collected in standard September gill net survey, 2009-2013, Lake Francis Case, South Dakota. *N* = sample size.

Year		Length at age at capture (mm)											
		1	2	3	4	5	6	7	8	9	10	11	12
2009	**Mean**	288	348	375	400								
	N	12	28	8	3	0	0	0	0	0	0	0	0
	SE	5.3	6.4	8.3	19.4								
2010	**Mean**	288	388	443	433	430							
	N	74	9	8	5	1	0	0	0	0	0	0	0
	SE	2.7	7.8	11.5	24.1	NA							
2011	**Mean**	277	362	450	468	459	473						
	N	73	101	8	9	2	3	0	0	0	0	0	0
	SE	3.0	2.6	6.6	10.1	13.5	17.7						
2012	**Mean**	267	361	405	458	455	439						464
	N	61	68	58	4	2	4	0	0	0	0	0	1
	SE	3.6	3.9	4.0	13.3	21.5	28.7						NA
2013	**Mean**	237	300	371	403	432							
	N	16	86	36	20	1	0	0	0	0	0	0	0
	SE	6.3	3.0	4.8	10.1	NA							
Mean of means		271	352	409	432	444	456						464

Table 18. Mean annual growth increments for sauger collected in standard September gill net survey, Lake Francis Case, South Dakota, for 2008-2009, 2009-2010, 2010-2011, 2011-2012, and 2012-2013 periods, as determined by aging otoliths.

Year	Growth increment added during period (mm)					
	1-2	2-3	3-4	4-5	5-6	6-7
2008-2009	83	37	20	--	--	--
2009-2010	100	95	58	30	--	--
2010-2011	74	62	25	26	43	--
2011-2012	84	43	8	--	--	--
2012-2013	33	10	--	--	--	--

Table 19. Age distribution, from otolith analysis, of sauger collected from Lake Francis Case with variable-mesh gill nets, 2009-2013. Mean age excludes age-0 fish.

	Age													
Year	0	1	2	3	4	5	6	7	8	9	10	11	12	Mean
2009	5	12	28	8	3	0	0	0	0	0	0	0	0	2.0
2010	43	74	9	8	5	1	0	0	0	0	0	0	0	1.5
2011	7	73	101	8	9	2	3	0	0	0	0	0	0	1.9
2012	13	61	68	58	4	2	4	0	0	0	0	0	1	2.2
2013	2	16	86	36	20	1	0	0	0	0	0	0	0	2.4

Population Parameters for Smallmouth Bass

Smallmouth bass gill net CPUE peaked in 2010 and 2011 at 0.9 fish/net night (Table 8). Gill net CPUE for smallmouth bass decreased in 2012 and 2013 to 0.6 and 0.3 fish/net night, respectively (Table 8). All but one sampling location exhibited a decrease in smallmouth bass CPUE in 2013 electrofishing samples (Table 7). Smallmouth bass CPUE at the Big Bend Dam sampling location remained constant. Chamberlain, Platte Creek, and Fort Randall Dam sampling locations experienced five-year high smallmouth bass electrofishing CPUE in 2012 (Table 7). Lake Francis Case smallmouth bass typically surpass 300 mm in length at age 3 (Table 20). Smallmouth bass growth decreased during 2013 for age 1 to 3 smallmouth bass (Table 20). Smallmouth bass condition for stock-quality size smallmouth bass remains excellent, as W_r values from fish in the gill net survey were above 100 for all length categories for the five-year period with the exception of the Q-P length fish in 2013 (Table 15).

Table 20. Mean length-at-age-at-capture (mm) for smallmouth bass, as determined by scales collected by spring night electrofishing, 2009-2013, Lake Francis Case, South Dakota. N=sample size.

Year		Length at age at capture (mm)							
		1	2	3	4	5	6	7	8
2009	**Mean**	104	201	297	339	382			
	N	13	136	106	34	2	0	0	0
	SE	4.5	2.2	3.2	5.2	2.0			
2010	**Mean**	112	177	284	343	400	416	430	
	N	29	69	153	32	5	2	1	0
	SE	20.9	2.8	2.5	4.8	3.4	22.5	NA	
2011	**Mean**	119	217	282	362	396	422	437	472
	N	25	159	69	28	11	7	3	1
	SE	3.9	1.9	4.4	6.6	9.5	7.2	19.1	NA
2012	**Mean**	126	198	280	316	392	417		
	N	43	158	134	35	13	2	0	0
	SE	3.1	3.0	3.5	6.0	9.2	10.0		
2013	**Mean**	127	183	234	316	345	403	416	440
	N	10	55	144	73	15	3	2	1
	SE	6.2	5.1	4.7	5.4	11.9	40.7	44.0	NA
Mean of means		118	195	276	335	363	414	428	456

Table 21. Mean annual growth increments for smallmouth bass collected by spring night electrofishing, Lake Francis Case, South Dakota, for 2008-2009, 2009-2010, 2010-2011, 2011-2012, and 2012-2013 periods, as determined by aging scales.

Year	Growth increment added during period (mm)						
	1-2	2-3	3-4	4-5	5-6	6-7	7-8
2008-2009	96	95	43	42	-	-	-
2009-2010	66	107	60	57	15	16	-
2010-2011	97	65	80	35	26	16	35
2011-2012	84	77	24	77	40	-	-
2012-2013	55	52	83	28	59	13	24

Eight year-classes were present in the 2013 electrofishing sample, with a mean age of 3.2 years (Table 22). Age-3 and 4 smallmouth bass accounted for the majority of the fish in the sample. Smallmouth bass PSD for the gill net sample decreased to 40 in 2013 (Table 16). Smallmouth bass production in 2011 was above average. Annual survival, for pooled 2012 and 2013 gill net data was 47%, similar to other years in the five-year period (Table 14). Lengths of fish collected by spring electrofishing ranged from 80 mm to 460 mm TL, while those collected by fall gill nets ranged from 100 mm to 320 mm TL (Figure 6).

Table 22. Age distribution, from scale analysis, of smallmouth bass collected from Lake Francis Case by spring night electrofishing 2009-2013. Mean age excludes age-0 fish.

	Age								
Year	1	2	3	4	5	6	7	8	Mean
2009	13	136	106	34	2	0	0	0	2.6
2010	29	69	153	32	5	2	1	0	2.7
2011	25	159	69	28	11	7	3	1	2.6
2012	43	158	134	35	13	2	0	0	2.5
2013	10	55	144	73	15	3	2	1	3.2

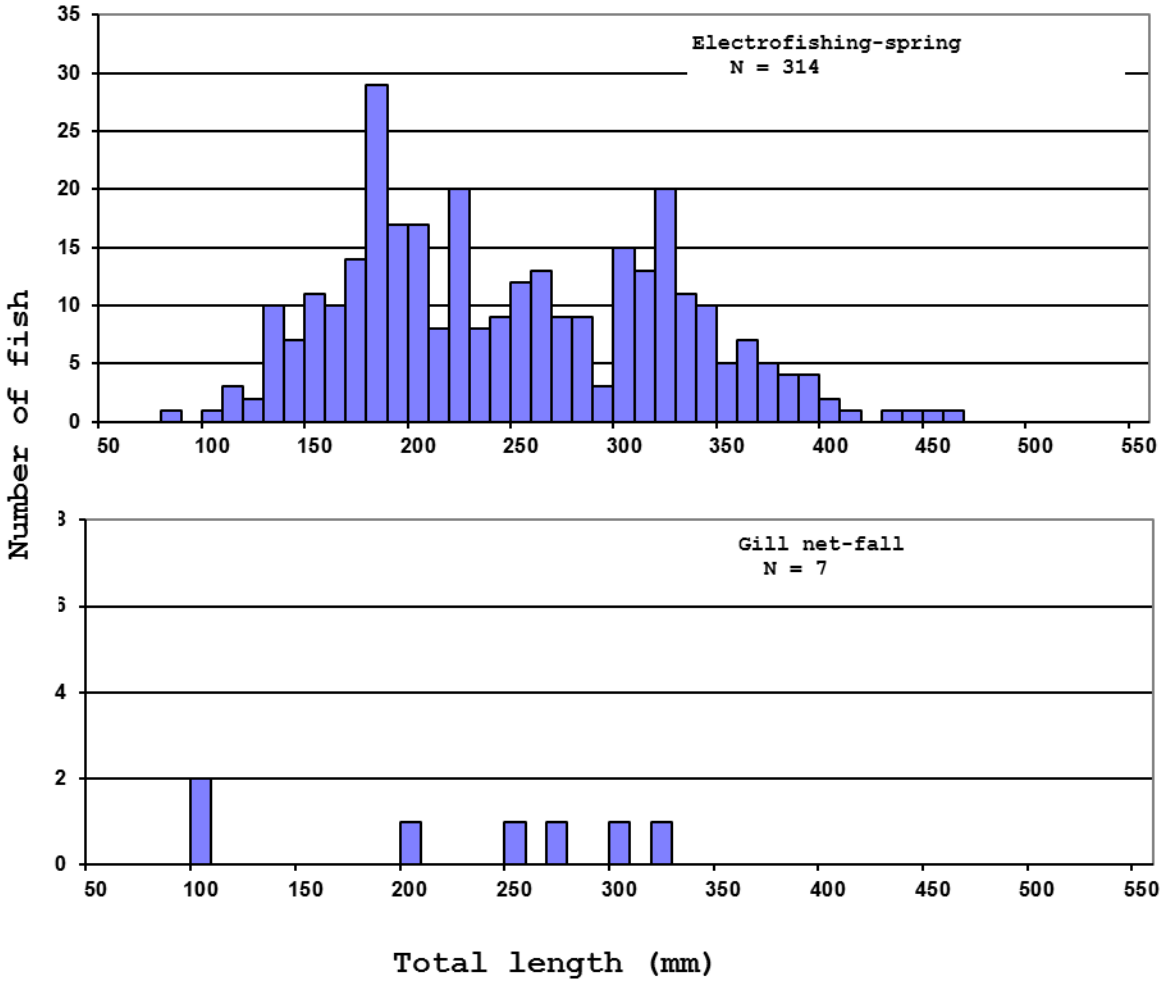

Figure 6. Length frequencies of smallmouth bass collected by spring electrofishing and fall gill netting from Lake Francis Case, 2013. *N* = sample size

Population Parameters for Channel Catfish

Channel catfish gill net CPUE decreased to a five-year low in 2011 before increasing to 3.8 and 3.4 fish/net in 2012 and 2013 respectively (Table 8). Channel catfish ranging from 170 mm to 570 mm TL were collected in the 2013 gill net survey (Figure 7). Mean annual back-calculated total length for 2010, the last year channel catfish were aged shows LFC channel catfish typically reach 381 mm in length at age six (Table 23). Channel catfish PSD, PSD-P and mean W_r values are presented in Appendix 5.

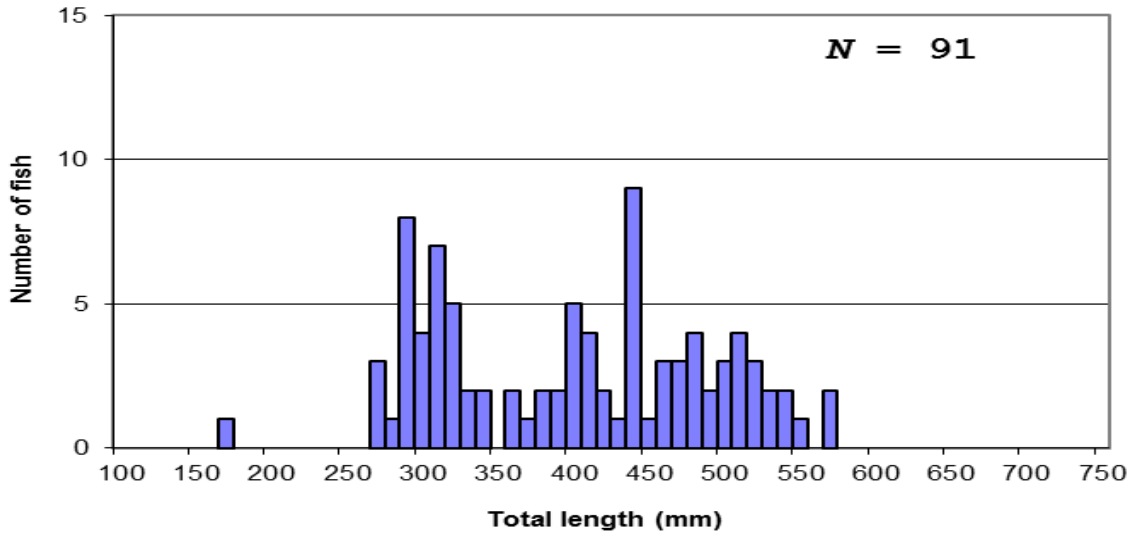

Figure 7. Length frequency of channel catfish collected with gill nets from Lake Francis Case, 2013. *N* = sample size.

Table 23. Mean annual back-calculated total lengths (mm) for each year class of channel catfish collected with variable-mesh gill nets during September 2011 from Lake Francis Case. *N* = sample size.

Year Class	Age	*N*	Back-calculation Age														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2009	2	5	73	188													
2008	3	8	71	153	274												
2007	4	10	75	128	218	299											
2006	5	6	79	140	217	286	355										
2005	6	5	83	143	228	302	360	397									
2004	7	6	85	147	241	313	362	413	444								
2003	8	6	89	132	254	319	365	398	426	468							
2002	9	10	92	146	260	321	361	403	427	460	488						
2001	10	6	85	155	243	314	348	379	409	435	459	481					
2000	11	3	93	147	232	308	347	372	401	428	462	496	516				
1999	12	3	91	137	247	320	354	385	404	425	445	461	482	500			
1998	13	2	84	116	185	246	304	327	355	384	419	445	474	503	554		
1997	14	1	74	112	188	252	309	322	328	353	379	398	423	442	474	486	
1996	15	1	102	159	253	274	289	318	368	389	404	447	461	476	497	504	533
All Classes			84	143	234	296	341	371	396	418	437	455	471	480	508	495	533
N		71	59	91	62	45	30	24	22	19	18	17	9	28	-	38	-

Water Temperature Monitoring

Water temperatures warmed rapidly, nearing 25 degrees C by early July, similar to previous years (Figure 8). The 2013 American Creek Fisheries Station water temperature profile rarely exceeded 25 degrees C, which differs from recent years (Sorensen and Knecht 2006, 2007, 2008, 2009, 2010).

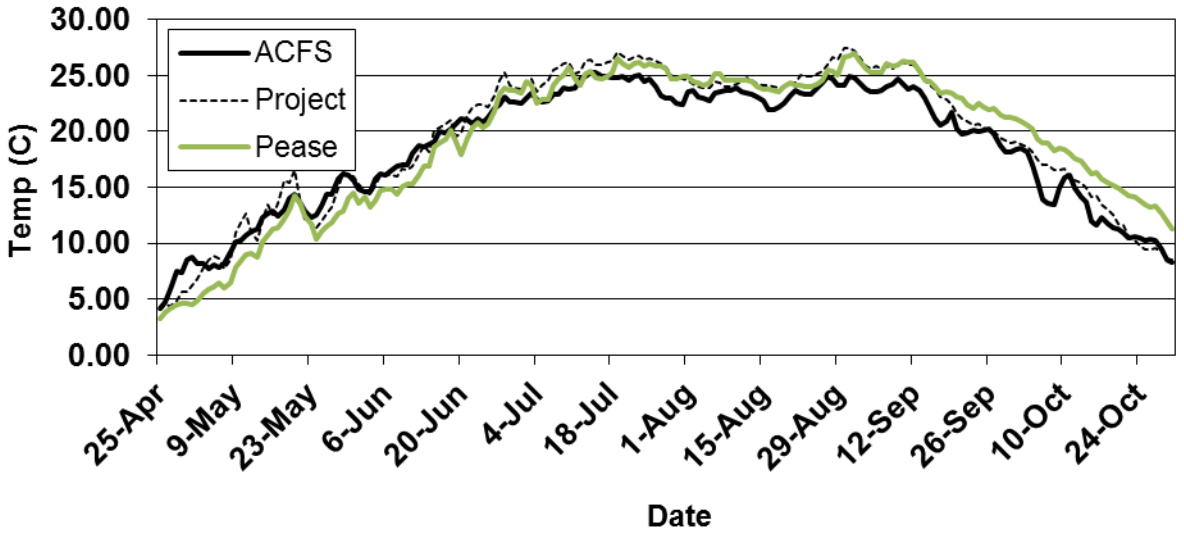

Figure 8. Water temperature in Lake Francis Case at American Creek Fisheries Station (ACFS), Pease Creek (Pease) and Project Bay (Project), 2013

ANGLER USE AND SPORT FISH HARVEST SURVEY

Fishing Pressure

Lake Francis Case anglers spent an estimated 736,121 hours (+/- 32,345 hours, 80% CI) fishing during the April through September, 2013 creel survey period (Table 24). This estimate is higher than the 616,337 and 633,535 hours estimated for the same period in 2012 and 2011 respectively (Table 1).

Table 24. Estimated total fishing pressure (hours), by month and zone, on Lake Francis Case, April-September, 2011 (+/- 80% confidence interval).

Zone	Apr	May	Jun	Jul	Aug	Sep	Total
1 - upper	36,119 (12,079)	70,319 (26,378)	75,297 (23,249)	24,075 (8,894)	25,239 (4,427)	21,905 (7,422)	252,954 (39,191)
2 - middle	3,063 (638)	61,957 (17,854)	56,548 (15,755)	19,269 (3,995)	25,506 (3,619)	19,658 (6,961)	186,000 (25,400)
3 - lower	350 (354)	23,535 (8,960)	54,330 (10,049)	49,686 (9,689)	52,287 (13,176)	14,395 (6,477)	194,581 (17,281)
Total	39,532 (12,112)	155,810 (33,088)	186,175 (29,828)	93,029 (13,745)	103,031 (14,363)	55,958 (12,062)	633,536 (51,691)

Table 25. Estimated total fishing pressure (hours), by month and zone, on Lake Francis Case, April-September, 2012 (+/- 80% confidence interval).

Zone	Apr	May	Jun	Jul	Aug	Sep	Total
1 - upper	49,364 (7,890)	56,841 (12,848)	26,018 (5,663)	21,148 (5,900)	39,143 (26,375)	17,320 (4,000)	209,833 (31,716)
2 - middle	10,571 (4,406)	66,035 (21,770)	67,288 (10,787)	29,497 (5,826)	12,288 (2,911)	10,502 (2,723)	196,181 (25,681)
3 - lower	3,914 (1,389)	37,540 (7,646)	78,665 (14,873)	43,169 (6,321)	26,993 (4,227)	20,043 (3,498)	210,323 (18,752)
Total	63,847 (9,143)	160,416 (26,410)	171,970 (19,226)	93,814 (10,427)	78,424 (26,870)	47,865 (5,971)	616,337 (44,912)

Table 26. Estimated total fishing pressure (hours), by month and zone, on Lake Francis Case, April-September, 2013 (+/- 80% confidence interval).

Zone	Apr	May	Jun	Jul	Aug	Sep	Total
1 - upper	58,994 (16,719)	67,138 (12,191)	31,063 (5,382)	29,838 (6,446)	21,873 (5,689)	9,848 (3,656)	218,754 (23,332)
2 - middle	9,757 (8,434)	65,900 (10,011)	76,003 (13,859)	51,001 (17,396)	14,647 (2,670)	11,642 (5,480)	228,949 (26,517)
3 - lower	4,349 (1,774)	32,779 (12,338)	87,966 (12,672)	104,900 (23,909)	40,369 (7,420)	18,055 (3,332)	288,418 (30,883)
Total	73,101 (18,809)	165,817 (20,026)	195,032 (19,535)	185,738 (30,262)	76,889 (9,723)	39,545 (7,382)	736,121 (46,918)

Estimated fishing pressure for the entire reservoir averaged 20.9 hours/ha during 2013, an increase over previous years (Table 25). The lower and middle portions of the reservoir (Figure 1) received the heaviest pressure at 25.1 and 25.0 angler-h/ha, respectively (Table 25). The upper portion of the reservoir received 14.9 angler-h/ha during 2013 (Table 25). Peak fishing pressure occurred in May and June, a typical LFC pattern (Table 24, Figure 9).

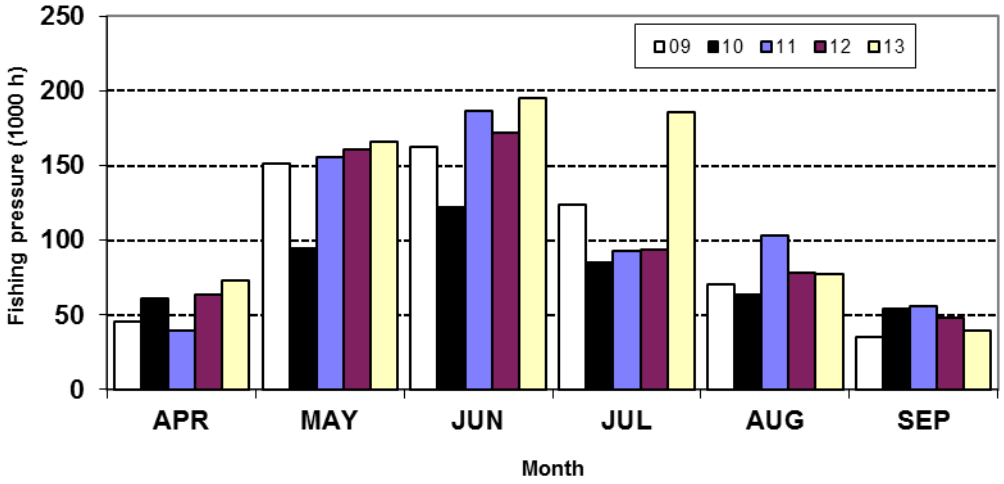

Figure 9. Estimated fishing pressure, by month, on Lake Francis Case, 2009-2013.

Table 27. Estimated total hours, for boat anglers, shore anglers, and angling methods combined, by zone, for Lake Francis Case, April-September, 2011.

	Boat			Shore			Combined		
Zone	Hours	%	No. h/ha	Hours	%	No. h/ha	Hours	%	No. h/ha
1 - upper	227,528	38	15.5	25,426	78	1.7	252,954	34	14.3
2 - middle	181,370	30	19.8	4,630	14	0.5	186,000	32	21.4
3 - lower	191,867	32	16.7	2,715	8	0.2	194,582	34	18.3
Tot/Ave	600,765	100	17.0	32,771	100	0.9	633,536	100	17.5

Table 28. Estimated total hours, for boat anglers, shore anglers, and angling methods combined, by zone, for Lake Francis Case, April-September, 2012.

	Boat			Shore			Combined		
Zone	Hours	%	No. h/ha	Hours	%	No. h/ha	Hours	%	No. h/ha
1 - upper	179,454	31	12.3	30,379	84	2.1	209,833	34	14.3
2 - middle	193,239	33	21.1	2,941	8	0.3	196,181	32	21.4
3 - lower	207,444	36	18.1	2,880	8	0.3	210,323	34	18.3
Tot/Ave	580,137	100	16.4	36,200	100	1.0	616,337	100	17.5

Table 29. Estimated total hours, for boat anglers, shore anglers, and angling methods combined, by zone, for Lake Francis Case, April-September, 2013.

	Boat			Shore			Combined		
Zone	Hours	%	No. h/ha	Hours	%	No. h/ha	Hours	%	No. h/ha
1 - upper	189,259	27	12.9	29,495	80	2.0	218,754	30	14.9
2 - middle	224,626	32	24.5	4,323	12	0.5	228,949	31	25.0
3 - lower	285,481	41	24.9	2,938	8	0.3	288,418	39	25.1
Tot/Ave	699,366	100	19.8	36,756	100	1.0	736,121	100	20.9

Fish Harvest

Anglers fishing LFC, during the April-September 2013 period, harvested an estimated 297,664 fish (+/- 26,338 fish, 80% CI); all species, fishing methods and zones combined, including an estimated walleye harvest of 235,608 fish (+/- 22,313 fish, 80% CI; Table 26). Fifteen species of fish were observed in the 2013 harvest, with walleye accounting for 79% of the total number harvested (Table 26). Sauger, white bass, channel catfish, and smallmouth bass accounted for 6.1%, 4.9%, 4.5%, and 3.1% of the 2013 estimated total harvest, respectively. Estimated sauger harvest in 2013 was 18,252 fish, similar to 2012 but an increase over

the 2011 harvest estimate (Table 26). Sauger production from 2009-2011 currently supports a bulk of the sauger harvest. Harvest estimates for channel catfish increased during 2012 and 2013 (Table 26). The 2013 white bass harvest estimate of 14,440 fish was similar to the 2012 estimate, and a decrease from the 2011 estimate of 26,918 fish (Sorensen and Knecht, 2010b; Table 26). Higher that average white bass production occurred in 2010 (Table 9). Smallmouth bass harvest decreased in 2013 from the 2011 and 2012 estimates (Sorensen and Knecht 2010b).

Table 30. Estimated total fish harvest, by month, for anglers fishing Lake Francis Case, April-September, 2011 (+/- 80% confidence interval).

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	10,807 (4,627)	301 (80)	0 (-)	219 (162)	0 (-)	64 (47)	17 (20)	369 (356)	11,777 (4,799)
May	63,075 (17,431)	1,182 (414)	3,979 (1,776)	658 (449)	1,929 (1,526)	303 (201)	459 (291)	136 (160)	71,723 (19,997)
June	66,759 (19,658)	1,351 (563)	1,083 (409)	685 (501)	9,277 (4,611)	13 (19)	531 (379)	86 (108)	79,787 (22,927)
July	56,696 (6,847)	586 (218)	1,703 (889)	255 (145)	11,557 (8,495)	139 (110)	326 (184)	258 (380)	71,520 (12,808)
August	37,637 (7,187)	1,205 (498)	3,006 (2,295)	1,475 (1,166)	3,514 (2,227)	93 (94)	1,262 (500)	581 (468)	48,774 (8,966)
September	13,799 (5,718)	154 (99)	994 (834)	1,793 (805)	641 (224)	142 (114)	454 (173)	788 (360)	18,767 (8,866)
Total	248,773 (29,033)	4,779 (894)	10,765 (3,174)	5,085 (1,584)	26,918 (10,038)	755 (277)	3,051 (737)	2,221 (1,347)	302,347 (35,660)

*OTH includes black bullhead, black crappie, bluegill, chinook salmon, common carp, freshwater drum, goldeye, green sunfish, largemouth bass, smallmouth buffalo and white crappie.

Table 31. Estimated total fish harvest, by month, for anglers fishing Lake Francis Case, April-September, 2012 (+/- 80% confidence interval).

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	17,046 (3,138)	1,688 (712)	2,244 (953)	296 (170)	309 (351)	390 (209)	0 (-)	329 (217)	22,303 (2,949)
May	53,674 (12,436)	7,457 (2,381)	5,976 (2,156)	1,093 (870)	6,390 (4,343)	455 (171)	744 (319)	2,408 (2,278)	78,196 (15,839)
June	51,800 (9,564)	5,775 (1,240)	1,967 (748)	1,640 (705)	4,033 (1,337)	407 (201)	763 (314)	785 (730)	67,170 (10,872)
July	32,013 (6,169)	509 (196)	530 (276)	2,200 (527)	1,756 (828)	45 (32)	509 (196)	1,608 (1,154)	39,001 (7,396)
August	33,203 (16,197)	1,131 (559)	2,275 (1,367)	3,459 (2,686)	3,150 (1,844)	243 (263)	336 (253)	1,385 (1,177)	45,183 (21,296)
September	8,122 (2,291)	986 (404)	627 (275)	3,249 (1,279)	260 (215)	42 (43)	40 (60)	110 (129)	13,438 (3,315)
Total	195,859 (23,698)	17,547 (2,868)	13,620 (2,852)	11,937 (3,227)	15,898 (4,991)	1,581 (431)	2,223 (607)	6,628 (3,940)	265,290 (29,949)

*OTH includes black bullhead, black crappie, blue catfish, bluegill, chinook salmon, flathead catfish, freshwater drum, goldeye, green sunfish, paddlefish, rainbow trout, shortnose gar, and white crappie.

Table 32. Estimated total fish harvest, by month, for anglers fishing Lake Francis Case, April-September, 2013 (+/- 80% confidence interval).

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	26,133 (7,381)	2,634 (1,475)	24 (24)	618 (464)	73 (91)	10 (16)	0 (-)	34 (35)	29,526 (8,159)
May	55,509 (7,619)	8,749 (1,861)	4,027 (1,523)	770 (405)	4,487 (211)	489 (362)	117 (86)	1,261 (1,079)	75,407 (12,380)
June	50,413 (8,876)	4,782 (1,115)	2,932 (1,127)	2,403 (960)	4,012 (1,810)	410 (276)	137 (73)	2,388 (1,930)	67,477 (9,861)
July	85,176 (16,682)	1,504 (493)	1,076 (414)	2,170 (742)	4,193 (1,752)	368 (274)	233 (218)	1,014 (631)	95,733 (18,418)
August	14,998 (5,237)	336 (301)	902 (526)	3,029 (1,286)	692 (296)	11 (14)	14 (14)	176 (156)	20,159 (5,552)
September	3,380 (908)	247 (170)	243 (216)	4,410 (2,206)	983 (532)	0 (-)	48 (36)	51 (65)	9,363 (2,566)
Total	235,608 (22,313)	18,252 (2,691)	9,204 (2,021)	13,399 (2,893)	14,440 (2,602)	1,289 (532)	548 (249)	4,923 (2,534)	297,664 (26,338)

*OTH includes black crappie, bluegill, common carp, freshwater drum, goldeye, largemouth bass, paddlefish, and white crappie.

Estimated fish harvest during 2011, by survey zone (see Figure 1 for zone identification), resulted in anglers who fished the upper portion of the reservoir accounting for 53% of the harvest, followed by the middle and lower zones with 26 % and 21% of the harvest, respectively (Table 27). During 2013, each zone of the reservoir accounted for approximately one-third of the estimated fish harvest (Table 27). Walleye, sauger, smallmouth bass, channel catfish, and white bass harvest in 2011 was highest in the upper zone of the reservoir (Table 27).

Table 33. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2011 (+/- 80% confidence interval).

Zone	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
1 - upper	125,039 (25,732)	2,438 (641)	4,389 (2,491)	3,340 (1,409)	23,274 (9,999)	108 (63)	991 (351)	1,769 (1,096)	161,347 (32,481)
2 - middle	54,008 (8,817)	1,798 (388)	2,394 (1,027)	1,373 (690)	2,135 (591)	357 (206)	489 (212)	189 (229)	62,745 (9,855)
3 - lower	69,727 (10,149)	543 (488)	3,981 (1,677)	372 (214)	1,508 (655)	290 (174)	1,571 (612)	263 (179)	78,256 (10,930)
Total	248,773 (29,033)	4,779 (894)	10,765 (3,174)	5,085 (1,584)	26,918 (10,038)	755 (277)	3,051 (737)	2,221 (1,347)	302,347 (35,660)

*OTH includes black bullhead, black crappie, bluegill, chinook salmon, common carp, freshwater drum, goldeye, green sunfish, largemouth bass, smallmouth buffalo and white crappie.

Table 34. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2012 (+/- 80% confidence interval).

Zone	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
1 - upper	73,866 (18,005)	6,829 (1,423)	3,202 (1,577)	7,781 (2,999)	11,247 (4,803)	756 (294)	139 (71)	2,402 (1,695)	106,222 (23,370)
2 - middle	59,194 (12,129)	9,219 (2,439)	3,118 (1,018)	2,631 (984)	2,155 (556)	448 (178)	951 (388)	2,723 (2,088)	80,440 (15,128)
3 - lower	62,799 (9,503)	1,499 (500)	7,299 (2,148)	1,525 (671)	2,496 (1,235)	378 (259)	1,133 (462)	1,499 (1,156)	78,628 (11,045)
Total	195,859 (23,698)	17,547 (2,868)	13,620 (2,852)	11,937 (3,227)	15,898 (4,991)	1,581 (431)	2,223 (607)	6,628 (4,371)	265,290 (29,949)

*OTH includes black bullhead, black crappie, blue catfish, bluegill, chinook salmon, flathead catfish, freshwater drum, goldeye, green sunfish, paddlefish, rainbow trout, shortnose gar, and white crappie.

Table 35. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2013 (+/- 80% confidence interval).

Zone	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
1 - upper	76,066 (10,675)	9,195 (2,186)	2,176 (1,070)	7,150 (2,331)	6,189 (534)	249 (169)	85 (58)	1,916 (1,721)	103,027 (14,946)
2 - middle	75,429 (11,478)	7,230 (1,378)	3,276 (745)	3,402 (1,094)	3,866 (1,258)	446 (336)	250 (102)	1,958 (1,379)	95,856 (13,645)
3 - lower	84,113 (15,880)	1,827 (753)	3,752 (1,544)	2,847 (1,319)	4,385 (2,214)	594 (376)	214 (219)	1,049 (744)	98,781 (16,857)
Total	235,608 (22,313)	18,252 (2,691)	9,204 (2,021)	13,399 (2,893)	14,440 (2,602)	1,289 (532)	548 (249)	4,923 (2,534)	297,664 (26,338)

*OTH includes black crappie, bluegill, common carp, freshwater drum, goldeye, largemouth bass, paddlefish, and white crappie.

Estimated total fish harvest peaked in June during 2011, but peaked in May and July during 2012 and 2013 respectively (Table 26). Walleye harvest estimates followed the same pattern as total harvest (Figure 10) (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.

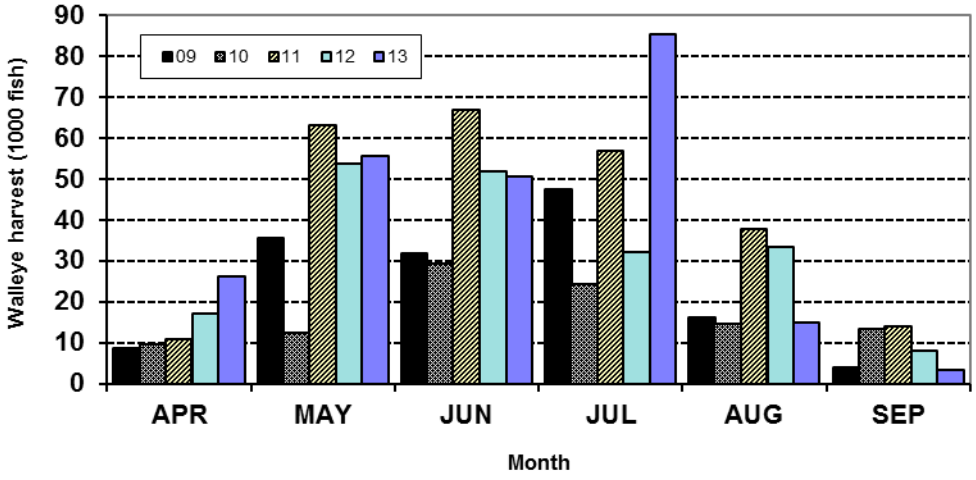

Figure 10. Estimated total walleye harvest, by month, for anglers fishing Lake Francis Case, 2009-2013.

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, very few walleye under 381-mm are harvested (illegal), while in July and August, fish under 381-mm are common in the walleye harvest. Mean size of walleye harvested by month during 2011-2013 remained above 381-mm (minimum length limit) during all months, including July and August when the minimum length restriction is not in effect with the exception of August 2012 and 2013 (Figure 11). Overall, mean length of walleye harvested by anglers has been considerably higher since the 1990 changes in walleye sport fishing regulations were implemented (Table 1). The percentage of angling parties harvesting a walleye limit was 16% in 2011, an increase over previous years (Table 28). The percentage of angling parties harvesting a walleye limit during 2012 and 2013 was 10% each year, a decrease from the 16% measured in 2011. The average length of harvested smallmouth bass exceeded 300-mm during all months of the April-September creel survey period (Figure 14, 15, 16).

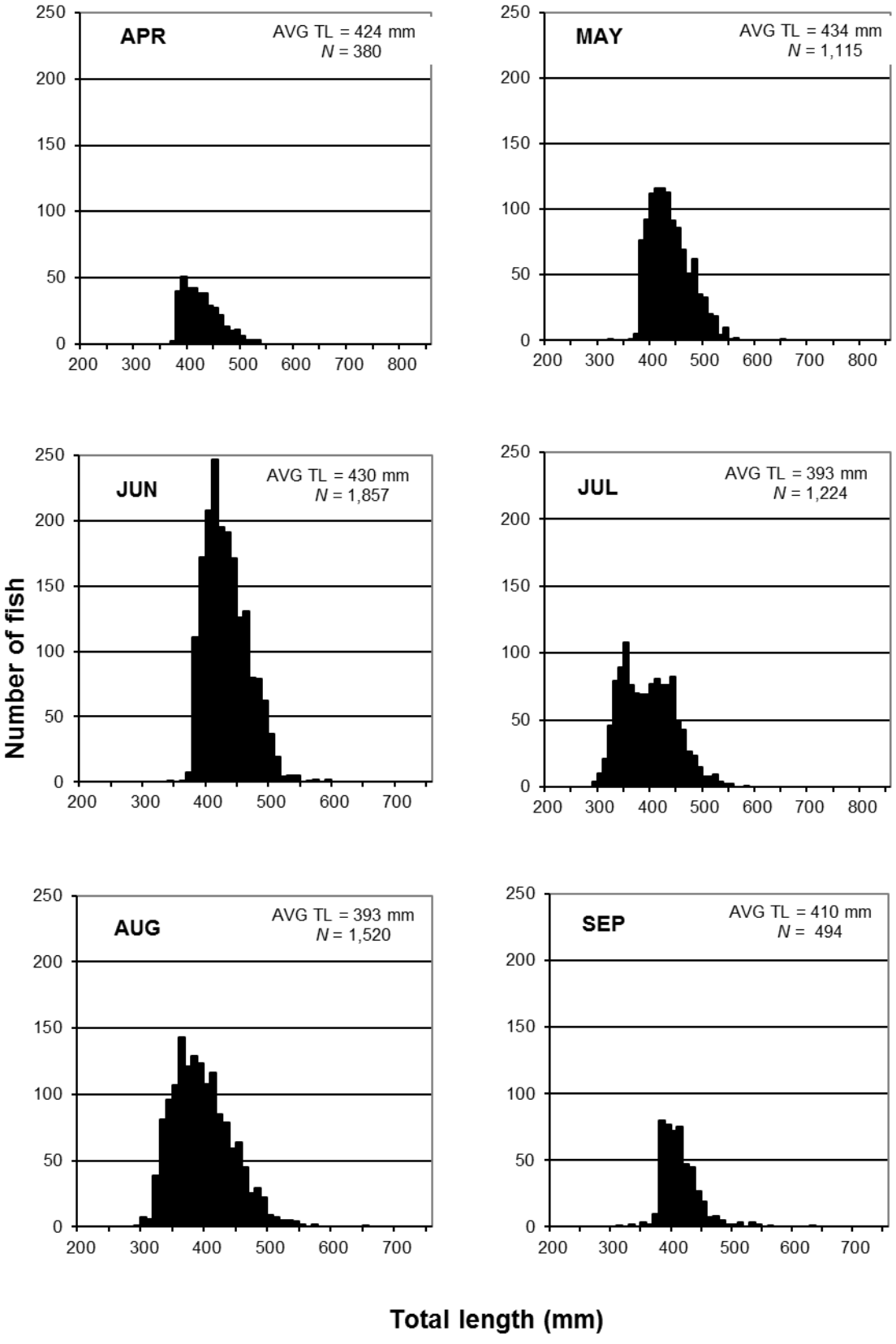

Figure 11. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2011. *N* = sample size.

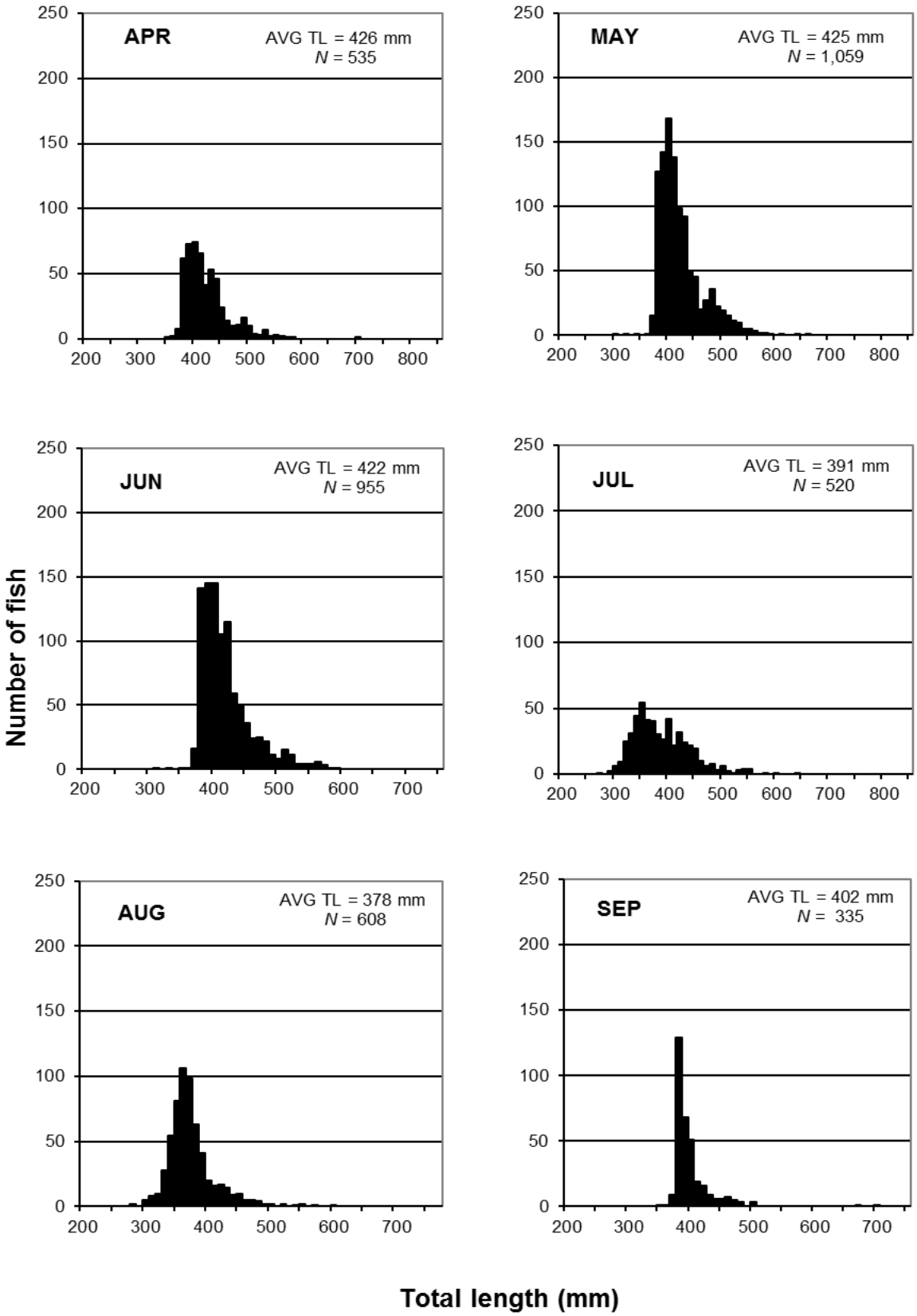

Figure 12. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2012. *N* = sample size.

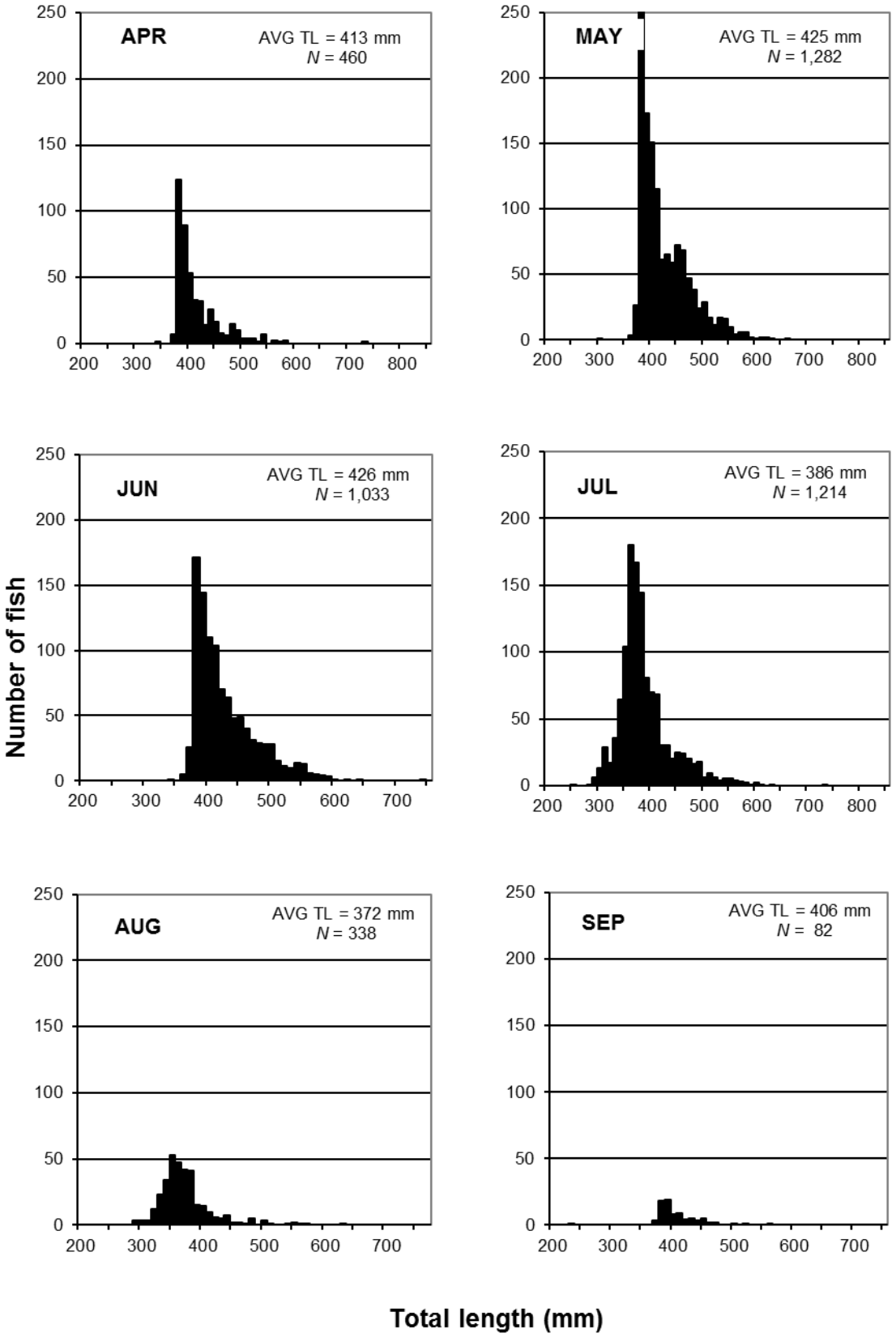

Figure 13. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2013. *N* = sample size.

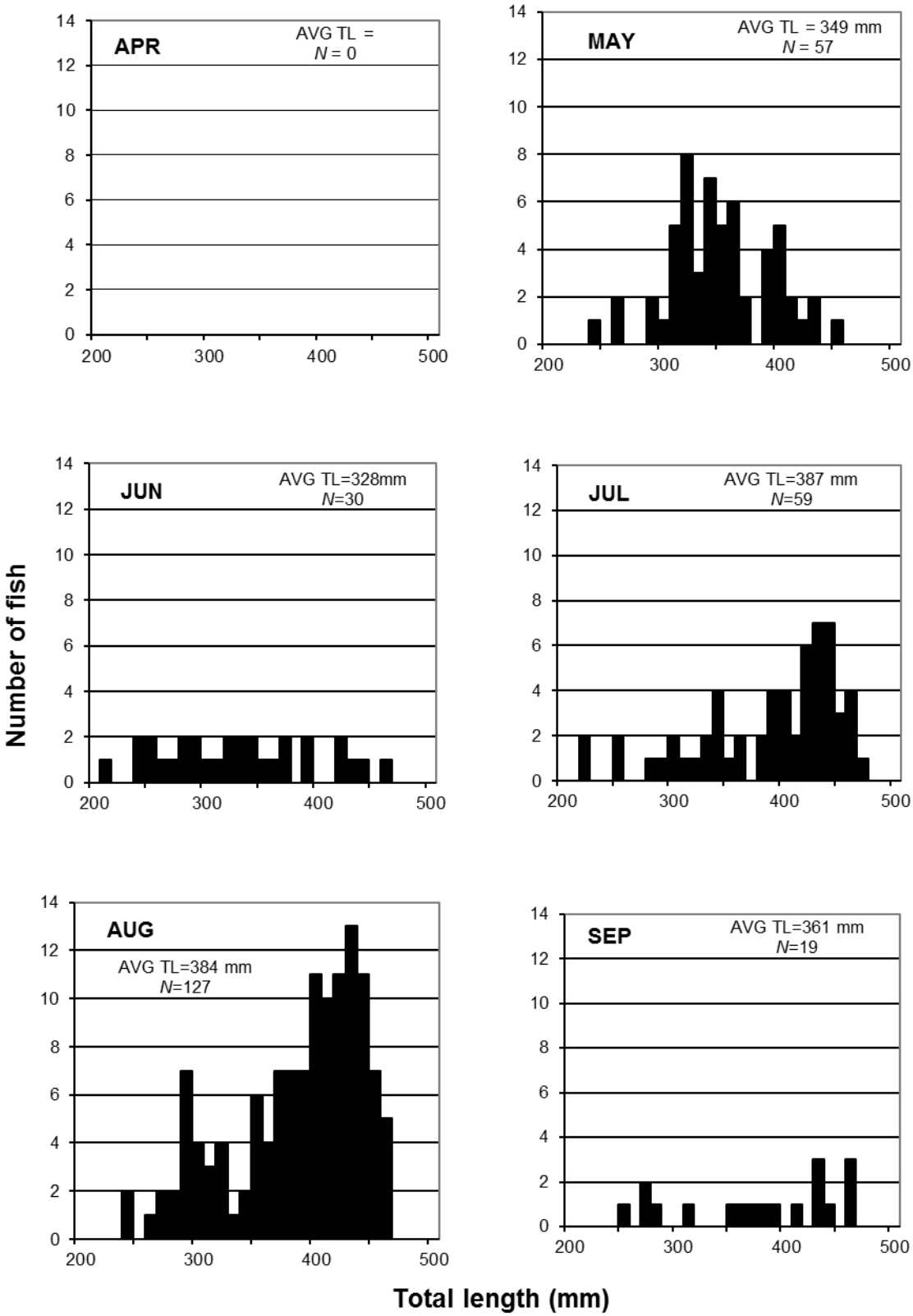

Figure 14. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2011. *N* = sample size.

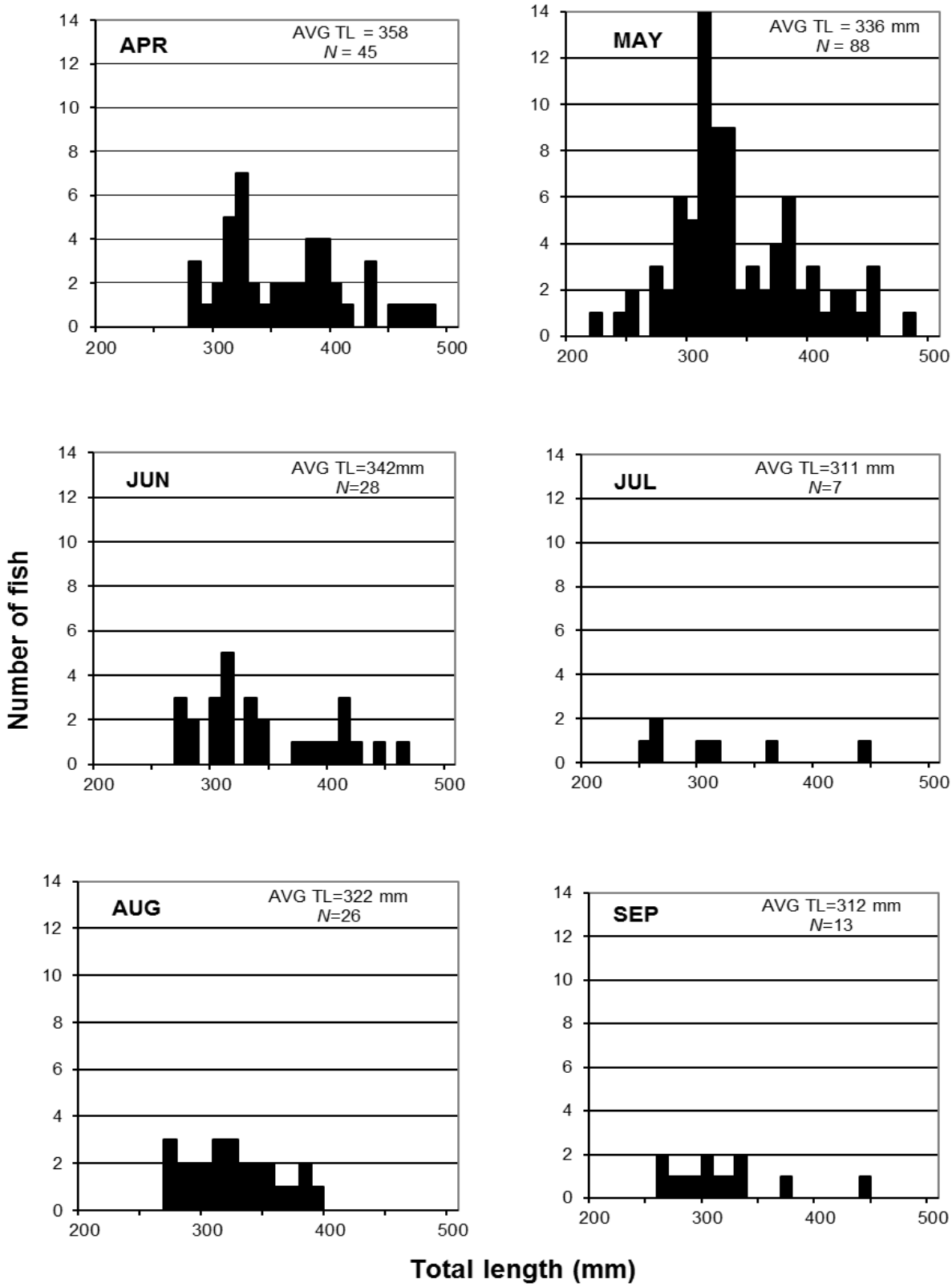

Figure 15. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2012. *N* = sample size.

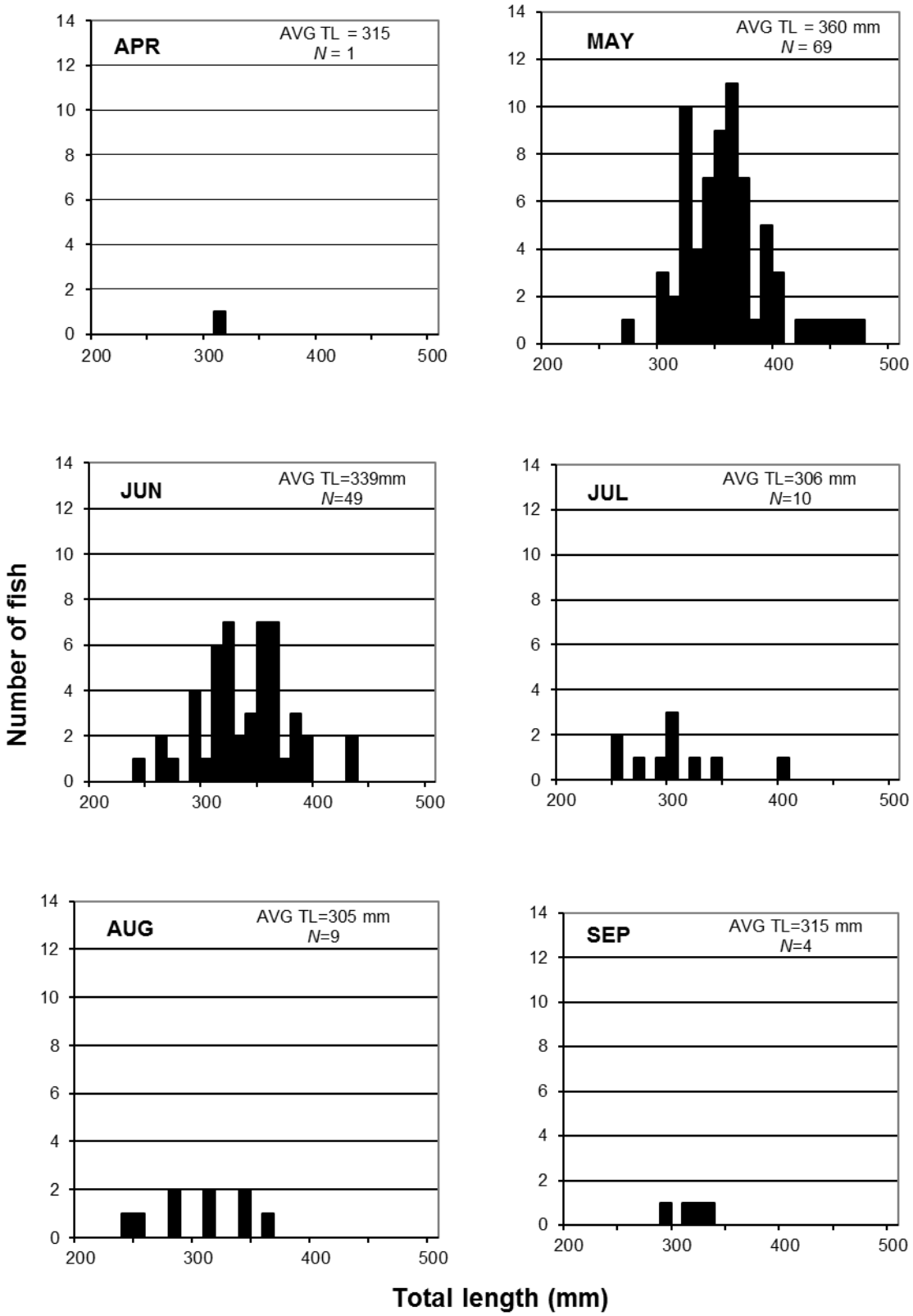

Figure 16. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2013. *N* = sample size.

Table 36. 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, 2009-2013.

Party success walleye-sauger/angler	2009	2010	2011	2012	2013
0	43	52	34	37	39
0.1-0.9	57	48	66	63	61
1.0-1.9	42	32	53	48	49
2.0-2.9	26	18	37	31	33
3.0-3.9	15	11	27	19	20
4	7	6	16	10	10

Fish Caught and Released

Catch and release, either mandated by length-limit regulations or voluntary, is an important component of the LFC sport fishery. For each species listed in Table 29 the number of fish estimated to have been caught and released exceeded harvest estimates (Table 26). While estimates of released fish are 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 2011 was 777,068, an increase from the 2010 estimate of 222,915 fish, but lower than the 2013 estimate of 873,478 fish (Table 39) (Sorensen and Knecht 2010b).

Table 37. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2011.

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	18,734	1,567	20	206	295	61	115	863	21,861
May	150,589	1,533	19,508	775	7,759	2,298	1,478	3,222	187,162
June	189,515	895	21,301	809	18,759	1,000	1,683	5,527	239,489
July	128,599	801	8,796	1,212	7,916	164	2,692	5,402	155,582
August	67,791	111	10,237	4,201	6,256	616	8,361	5,718	103,291
September	46,214	1,155	8,210	1,639	4,935	306	3,512	3,712	69,683
Total	601,442	6,061	68,073	8,841	45,920	4,444	17,842	24,445	777,068

* OTH includes bigmouth buffalo, black bullhead, black crappie, bluegill, Chinook salmon, common carp, freshwater drum, goldeye, largemouth bass, paddlefish, river carpsucker, rock bass, shortnose gar, shovelnose sturgeon, smallmouth buffalo, and white crappie.

Table 38. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2012.

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	72,992	6,668	10,944	496	1,920	1,182	66	884	95,252
May	186,944	9,736	37,431	1,443	15,165	1,657	2,543	3,937	258,856
June	175,660	4,863	30,206	3,833	11,957	1,770	4,686	10,844	243,819
July	45,678	278	2,153	9,858	5,497	312	3,051	8,501	75,328
August	56,836	332	5,988	7,038	4,088	309	2,352	6,850	83,793
September	39,498	580	3,646	2,080	1,971	376	2,157	2,832	53,140
Total	577,609	22,456	90,369	24,747	40,598	5,605	14,854	33,951	810,189

* OTH includes bigmouth buffalo, black bullhead, black crappie, bluegill, chinook salmon, common carp, flathead catfish, freshwater drum, goldeye, green sunfish, largemouth bass, paddlefish, pumpkinseed, river carpsucker, rock bass, shorthead redhorse, shortnose gar, shovelnose sturgeon, smallmouth buffalo, and white crappie.

Table 39. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2013.

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	100,322	2,658	73	209	212	137	0	120	103,731
May	149,683	15,768	7,081	1,268	7,523	1,103	273	1,640	184,339
June	213,611	10,655	20,017	3,497	8,293	880	429	7,280	264,662
July	191,055	2,049	11,517	15,042	13,811	808	835	20,913	256,030
August	16,292	127	6,199	5,794	6,289	308	221	4,725	39,955
September	15,121	257	1,405	2,438	3,285	110	281	1,865	24,762
Total	686,084	31,514	46,291	28,248	39,412	3,345	2,039	36,545	873,478

* OTH includes bigmouth buffalo, black crappie, bluegill, common carp, flathead catfish, freshwater drum, gizzard shad, goldeye, largemouth bass, paddlefish, river carpsucker, rock bass, shorthead redhorse, shortnose gar, smallmouth buffalo, and white crappie.

Harvest, Release and Catch Rates

Mean harvest rate (species, type of fishing, and zones combined) for LFC, in 2011-2013, was 0.48, 0.43, and 0.4 fish/angler-h respectively (Table 30), an increase from previous surveys (Table 1). An overall catch rate (estimated harvest rate plus estimated release rate) of 1.7, 1.75, and 1.59 fish/angler-hour was estimated for the April through September 2011-2013 daylight period, respectively (Table 31). Mean catch and harvest rates were highest during July in both 2011 and 2013 (Table 31). April, 2012 provided the highest catch rate during the 2012 survey period while August provided the highest harvest rate during 2012.

The mean walleye harvest rate was 0.39, 0.32, and 0.32 walleye/angler-h (Table 32) for the 2011-2013 April–September daytime period, respectively. Walleye harvest rates were highest in July during 2011 and 2012, and highest in August during 2013 when there is no minimum length restriction. When the harvest rate for walleye was combined with the release rate, an overall catch rate of 1.34, 1.26, and 1.25 walleye/angler-h was estimated for 2011-1013 respectively (Table 32). These values are higher than 0.30 fish/angler-h that is considered by most biologists to be indicative of an excellent walleye fishery (Colby et al. 1979).

Smallmouth bass harvest rate estimates for 2011-2013 were 0.017, 0.022, and 0.013 fish/angler-h respectively (Table 33). The August 2011 harvest rate estimate was highest for that year, with May producing the highest estimate during 2012 and 2013 (Table 33). Smallmouth Bass catch rate estimates for 2011-2013 were 0.124, 0.169, and 0.075 fish/angler-h respectively.

Table 40. Estimated harvest rate, release rate and catch rate, by species (+/- 80% confidence interval), for anglers fishing Lake Francis Case, 2011.

Species	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
Walleye	0.393 (0.092)	0.949 (0.224)	1.342 (0.258)
Sauger	0.008 (0.002)	0.010 (0.004)	0.017 (0.005)
Smallmouth bass	0.017 (0.006)	0.107 (0.031)	0.124 (0.036)
Channel catfish	0.008 (0.004)	0.014 (0.005)	0.022 (0.007)
White bass	0.043 (0.019)	0.073 (0.023)	0.115 (0.038)
Northern pike	0.001 (0.001)	0.007 (0.002)	0.008 (0.002)
Yellow perch	0.008 (0.002)	0.010 (0.004)	0.017 (0.005)
Other*	0.003 (0.002)	0.039 (0.012)	0.042 (0.014)
Species combined	0.477 (0.111)	1.227 (0.275)	1.704 (0.325)

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

Table 41. Estimated harvest rate, release rate and catch rate, by species (+/- 80% confidence interval), for anglers fishing Lake Francis Case, 2012.

Species	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
Walleye	0.318 (0.057)	0.937 (0.173)	1.255 (0.223)
Sauger	0.029 (0.006)	0.036 (0.012)	0.065 (0.016)
Smallmouth bass	0.022 (0.005)	0.147 (0.033)	0.169 (0.035)
Channel catfish	0.019 (0.006)	0.040 (0.012)	0.060 (0.017)
White bass	0.026 (0.009)	0.066 (0.017)	0.092 (0.025)
Northern pike	0.003 (0.001)	0.009 (0.002)	0.012 (0.002)
Yellow perch	0.004 (0.001)	0.024 (0.006)	0.028 (0.006)
Other*	0.011 (0.007)	0.055 (0.018)	0.066 (0.022)
Species combined	0.430 (0.074)	1.315 (0.221)	1.745 (0.290)

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

Table 42. Estimated harvest rate, release rate and catch rate, by species (+/- 80% confidence interval), for anglers fishing Lake Francis Case, 2013.

Species	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
Walleye	0.340 (0.048)	0.932 (0.139)	1.252 (0.183)
Sauger	0.025 (0.005)	0.043 (0.009)	0.068 (0.013)
Smallmouth bass	0.013 (0.003)	0.063 (0.016)	0.075 (0.017)
Channel catfish	0.018 (0.004)	0.038 (0.009)	0.057 (0.011)
White bass	0.020 (0.004)	0.054 (0.018)	0.073 (0.022)
Northern pike	0.002 (0.001)	0.005 (0.001)	0.006 (0.001)
Yellow perch	0.001 (0.001)	0.003 (0.001)	0.004 (0.001)
Other*	0.007 (0.004)	0.050 (0.017)	0.057 (0.019)
Species combined	0.404 (0.058)	1.187 (0.172)	1.591 (0.22)

* Other includes bigmouth buffalo, black crappie, bluegill, common carp, flathead catfish, freshwater drum, gizzard shad, goldeye, largemouth bass, paddlefish, shorthead redhorse, shortnose gar, smallmouth buffalo, and white crappie.

Table 43. Estimated harvest rate, release rate, and catch rate for all species combined (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2011.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.298 (0.225)	0.553 (0.336)	0.851 (0.554)
May	0.460 (0.305)	1.201 (0.757)	1.662 (0.667)
June	0.429(0.199)	1.286 (0.575)	1.715 (0.774)
July	0.769 (0.281)	1.672 (0.486)	2.441 (0.754)
August	0.473 (0.156)	1.003 (0.327)	1.476 (0.481)
September	0.335 (0.253)	1.245 (0.773)	1.581 (1.556)
Combined	0.477 (0.111)	1.227 (0.275)	1.704 (0.325)

Table 44. Estimated harvest rate, release rate, and catch rate for all species combined (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2012.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.349 (0.090)	1.492 (0.538)	1.841 (0.621)
May	0.488 (0.189)	1.614 (0.634)	1.101 (0.812)
June	0.391 (0.107)	1.418 (0.357)	1.808 (0.456)
July	0.416 (0.140)	0.803 (0.236)	1.219 (0.366)
August	0.576 (0.346)	1.069 (0.752)	1.645 (1.089)
September	0.281 (0.110)	1.110 (0.356)	1.391 (0.457)
Combined	0.430 (0.074)	1.315 (0.221)	1.745 (0.290)

Table 45. Estimated harvest rate, release rate, and catch rate for all species combined (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2013.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.404 (0.214)	1.419 (0.721)	1.823 (0.928)
May	0.455 (0.120)	1.112 (0.299)	1.567 (0.415)
June	0.346 (0.084)	1.357 (0.310)	1.703 (0.387)
July	0.515 (0.172)	1.378 (0.484)	1.894 (0.650)
August	0.262 (0.099)	0.520 (0.169)	0.782 (0.255)
September	0.237 (0.099)	0.626 (0.260)	0.863 (0.345)
Combined	0.404 (0.058)	1.187 (0.172)	1.591 (0.227)

Table 46. Estimated harvest rate, release rate, and catch rate of walleye (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2011.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.273 (0.214)	0.474 (0.298)	0.747 (0.505)
May	0.405 (0.274)	0.967 (0.662)	1.371 (0.567)
June	0.359 (0.171)	1.018 (0.457)	1.377 (0.627)
July	0.609 (0.148)	1.382 (0.354)	1.992 (0.493)
August	0.365 (0.124)	0.658 (0.228)	1.023 (0.347)
September	0.247 (0.174)	0.826 (0.538)	1.073 (0.707)
Combined	0.393 (0.092)	0.949 (0.224)	1.342 (0.258)

Table 47. Estimated harvest rate, release rate, and catch rate of walleye (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2012.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.267 (0.079)	1.143 (0.460)	1.410 (0.534)
May	0.335 (0.136)	1.165 (0.500)	1.500 (0.616)
June	0.301 (0.092)	1.022 (0.266)	1.323 (0.352)
July	0.341 (0.109)	0.487 (0.170)	0.828 (0.274)
August	0.423 (0.263)	0.725 (0.578)	1.148 (0.831)
September	0.170 (0.075)	0.825 (0.308)	0.995 (0.379)
Combined	0.318 (0.057)	0.937 (0.173)	1.255 (0.223)

Table 48. Estimated harvest rate, release rate, and catch rate of walleye (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2013.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.358 (0.196)	1.372 (0.698)	1.730 (0.886)
May	0.335 (0.082)	0.903 (0.249)	1.238 (0.327)
June	0.259 (0.067)	1.095 (0.258)	1.354 (0.316)
July	0.459 (0.156)	1.029 (0.364)	1.487 (0.516)
August	0.195 (0.086)	0.212 (0.077)	0.407 (0.159)
September	0.086 (0.033)	0.382 (0.164)	0.468 (0.192)
Combined	0.320 (0.048)	0.932 (0.139)	1.252 (0.183)

Table 49. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2011.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.000 (0.000)	0.001 (0.000)	0.005 (0.000)
May	0.026 (0.018)	0.125 (0.060)	0.151 (0.077)
June	0.006 (0.004)	0.114 (0.076)	0.120 (0.078)
July	0.018 (0.012)	0.095 (0.055)	0.113 (0.065)
August	0.029 (0.025)	0.099 (0.065)	0.129 (0.090)
September	0.018 (0.017)	0.147 (0.126)	0.165 (0.136)
Combined	0.017 (0.006)	0.107 (0.031)	0.124 (0.036)

Table 50. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2012.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.035 (0.011)	0.171 (0.123)	0.207 (0.125)
May	0.037 (0.017)	0.233 (0.081)	0.271 (0.093)
June	0.011 (0.005)	0.176 (0.077)	0.187 (0.077)
July	0.006 (0.003)	0.023 (0.016)	0.029 (0.015)
August	0.029 (0.021)	0.076 (0.057)	0.105 (0.068)
September	0.013 (0.006)	0.076 (0.022)	0.089 (0.025)
Combined	0.022 (0.005)	0.147 (0.033)	0.169 (0.035)

Table 51. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2013.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.000 (0.001)	0.001 (0.001)	0.001 (0.002)
May	0.024 (0.011)	0.043 (0.020)	0.067 (0.025)
June	0.015 (0.007)	0.103 (0.049)	0.118 (0.050)
July	0.006 (0.003)	0.062 (0.020)	0.068 (0.021)
August	0.012 (0.011)	0.081 (0.049)	0.092 (0.058)
September	0.006 (0.006)	0.036 (0.017)	0.042 (0.019)
Combined	0.013 (0.003)	0.063 (0.016)	0.075 (0.017)

Angler Demographics and Economics

Thirty-three percent of anglers contacted on LFC in 2013 were non-residents, similar to 32% measured in 2012 and an increase from 25% measured in 2011 (Sorensen and Knecht 2007, 2008, 2009, 2010a, 2010b). Non-resident anglers from 24 states and two Canadian Provinces were contacted in 2013, (Table 34) with Iowa, Nebraska and Minnesota anglers accounting for the majority of non-resident angler contacts. Eighty-seven percent of resident LFC anglers in 2013 came from counties in the southeastern ¼ of the state, similar to previous years (Figure 13).

Table 52. Percentage of non-resident anglers who fished Lake Francis Case, 2009-2013, by state of residence, expressed as percent of total non-residents.

State	2009	2010	2011	2012	2013
Iowa	42.5	44.0	45.3	42.8	38.8
Nebraska	39.1	36.3	37.9	40.6	39.7
Minnesota	12.7	11.9	8.6	9.1	11.3
Colorado	0.7	1.6	1.4	0.4	0.3
Wisconsin	0.2	1.2	0.6	1.4	1.2
Kansas	0.7	1.4	1.0	1.0	0.6
Missouri	0.2	0.7	0.8	0.6	0.9
Illinois	-	0.2	0.4	0.2	1.1
North Dakota	-	0.5	0.4	0.4	0.2
Florida	0.2	0.2	0.2	0.2	0.5
Montana	-	0.2	0.4	0.4	0.5
Wyoming	1.2	0.5	-	1.6	0.5
California	-	0.5	0.6	-	0.2
Other*	2.5	0.8	2.4	1.3	4.2

*Other includes: Alabama, Alaska, Alberta, Arizona, Arkansas, Hawaii, Idaho, Indiana, Maryland, Massachusetts, Michigan, Mississippi, New Mexico, Ohio, Oklahoma, Ontario, Oregon, Tennessee, Texas, Vermont and Washington.

Mean angler trip length (boat and shore combined) on LFC was 4.4, 4.2, and 4.3 hours (Table 1), for the April-September, 2011-2013 daylight period, respectively. The average angling party consisted of approximately 2.3 individuals in 2011 and 2012 and 2.4 individuals in 2013. Anglers traveling at least 100 miles (one-way) to fish LFC, accounted for 66% of all trips in 2013, similar to values from 2012 and 2011 (Table 35). A majority of anglers fishing Lake Francis Case in 2011-2013 targeted walleye, similar to past years (Table 36).

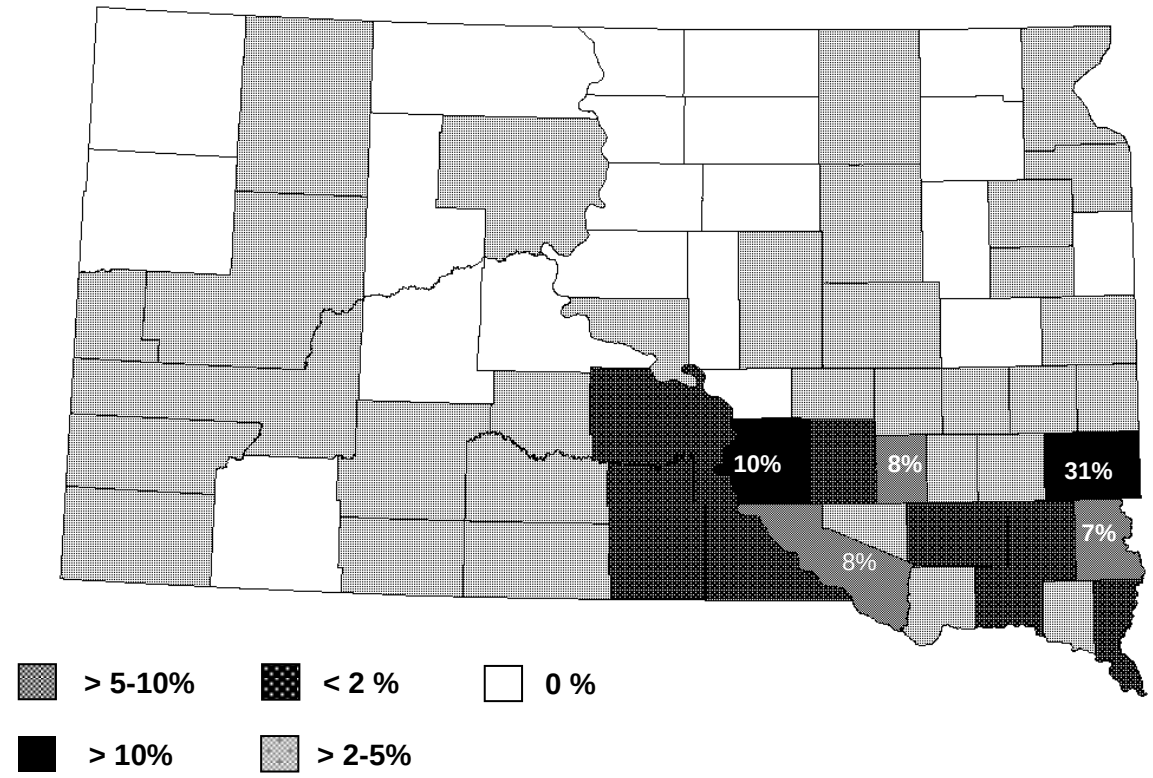

Figure 17. County of residence for resident anglers fishing Lake Francis Case in 2013. Percentage of total resident anglers is shown for the top four represented counties.

The 2013 LFC fishery had an estimated economic impact of nearly $13.2 million to local economies, based on approximately 170,794 angling trips, compared to $11.1 million (143,698 angling trips) in 2011, and $11.2 million (145,363 angling trips) in 2012. This estimate is based on an average expenditure of $77/trip for angling in South Dakota (U.S. Dept. of Interior, Fish and Wildlife Service, and U.S. Dept. of Commerce, Bureau of Census 2006).

Table 53. Percentage of anglers traveling specified distances, one way, to fish Lake Francis Case during 2009-2013.

Distance (miles)	2009	2010	2011	2012	2013
<25	15.9	13.4	15.1	14.1	13.2
25-50	16.9	17.2	17.3	16.8	16.8
51-100	15.3	17.4	16.5	16.9	17.6
101-200	40.2	37.5	38.3	36.1	34.8
201+	11.7	14.5	12.8	16.2	17.7

Table 54. Target species of Lake Francis Case anglers, during 2009-2013, expressed as a percentage of total angling trips.

Target species	2009	2010	2011	2012	2013
Walleye	85.4	81.4	86.2	83.0	84.7
Anything	6.5	8.7	6.2	7.2	6.0
Smallmouth bass	2.0	2.3	1.7	2.1	3.7
Other	6.1	7.6	5.9	7.7	5.6

ANGLER PREFERENCE AND ATTITUDE SURVEY

Angler attitudes about fishing and their preferences concerning management options are important components of a fishery. Historically, fisheries biologists have focused efforts on understanding biological aspects of fish populations and monitoring sport fish harvest and use. 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; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b).

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, 83%, 78%, and 73% of LFC anglers expressed some degree of satisfaction with their days fishing in 2011-2013 versus approximately 12%, 17%, and 20% who expressed some degree of dissatisfaction, respectively (Table 37). The satisfaction ratings fall within the range of previous surveys (Sorensen and Knecht 2007, 2008, 2009, 2010a, 2010b) and exceeds the Missouri River Fisheries Program management objective of 70% (SDGFP, unpublished document).

Table 55. Responses of 2011 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.

	Satisfied →			Neut.	← Dissatisfied					
Month	1	2	3	4	5	6	7	N.O.	Total	Median
Apr	34	30	15	11	9	3	5	0	107	3
May	75	48	19	9	7	8	7	0	173	2
Jun	117	64	36	7	22	10	5	0	261	2
Jul	63	43	12	3	6	3	1	0	131	2
Aug	85	69	33	6	19	6	3	0	221	2
Sep	46	31	16	5	6	4	2	0	110	2
Total	420	285	131	41	69	34	23	0	1,003	2
Percent	41.9	28.4	13.1	4.1	6.9	3.4	2.3	0.0	100	-
Combined	83.3			4.1	12.6			0.0	100	-

Table 56. Responses of 2012 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.

	Satisfied →			Neut.	← Dissatisfied					
Month	1	2	3	4	5	6	7	N.O.	Total	Median
Apr	42	36	9	6	9	4	6	0	112	3
May	84	44	27	4	15	7	7	0	188	2
Jun	72	53	38	9	7	4	11	0	194	2
Jul	22	31	26	7	12	5	10	0	113	2
Aug	21	30	17	9	9	5	7	0	98	2
Sep	34	23	21	4	10	3	4	0	99	2
Total	275	217	138	39	62	28	45	0	804	2
Percent	34.2	27.0	17.2	4.9	7.7	3.5	5.6	0.0	100	-
Combined	78.4			4.9	16.8			0.0	100	-

Table 57. Responses of 2013 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.

	Satisfied →			Neut.	← Dissatisfied					
Month	1	2	3	4	5	6	7	N.O.	Total	Median
Apr	45	15	11	7	5	4	9	0	96	3
May	102	52	30	16	15	5	8	0	228	2
Jun	92	59	43	14	11	6	18	0	243	2
Jul	83	38	37	14	14	4	9	0	199	2
Aug	16	15	25	16	12	14	36	0	134	2
Sep	20	20	26	2	12	6	13	0	99	2
Total	358	199	172	69	69	39	93	0	999	2
Percent	35.8	19.9	17.2	6.9	6.9	3.9	9.3	0.0	100	-
Combined	73.0			6.9	20.1			0.0	100	-

Angler satisfaction increases as the number of walleye harvested per angler increases (Table 38). These results follow the pattern documented in previous surveys (Stone 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b) showing a decrease in satisfaction and a corresponding increase in dissatisfaction as the number of walleye harvested per angler decreases. However, 68%, 63%, and 52% of anglers from 2011-2013, respectively, who did not harvest a walleye still indicated that they were satisfied with their fishing trip (Table 38). 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 angler response.

Table 58. Responses of 2011 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 37.

No. walleye harvested/ angler	Satisfied		Dissatisfied		Neutral/No-Opinion	
	No.	Percent	No.	Percent	No.	Percent
4	177	98.8	1	0.6	1	0.6
3 -- 3.9	107	98.2	0	-	2	1.8
2 – 2.9	110	96.5	1	0.9	3	2.6
1 – 1.9	146	86.9	17	10.1	5	3.0
0.1 – 0.9	99	77.3	22	17.2	7	5.5
0	224	67.5	85	25.6	23	6.9
Total	863	83.8	126	12.2	41	4.0

Table 59. Responses of 2012 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 37.

No. walleye harvested/ angler	Satisfied		Dissatisfied		Neutral/No-Opinion	
	No.	Percent	No.	Percent	No.	Percent
4	77	95.1	2	2.5	2	2.5
3 -- 3.9	66	95.7	0	-	3	4.3
2 – 2.9	90	93.8	4	4.2	2	2.1
1 – 1.9	123	86.6	15	10.6	4	2.8
0.1 – 0.9	90	73.2	27	22.0	6	4.9
0	184	62.8	87	29.7	22	7.5
Total	630	78.4	135	16.8	39	4.9

Table 60. Responses of 2013 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 37.

No. walleye harvested/ angler	Satisfied		Dissatisfied		Neutral/No-Opinion	
	No.	Percent	No.	Percent	No.	Percent
4	101	96.2	1	1.0	3	2.8
3 -- 3.9	93	95.9	1	1.0	3	3.1
2 – 2.9	117	90.7	5	3.9	7	5.4
1 – 1.9	126	80.3	20	12.7	11	7.0
0.1 – 0.9	91	72.8	24	19.2	10	8.0
0	201	52.1	150	38.9	35	9.1
Total	729	73.0	201	20.1	69	6.9

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. About 66%, 61%, and 47% of anglers questioned during 2011-2013, respectively, were still satisfied with their fishing trip despite catching no walleye (Table 39). Eighty-nine percent of anglers interviewed in 2011 and 2012, and 85% interviewed during 2013 who caught at least 4 to 7.9 walleye/angler indicated they were satisfied with their trip (Table 39).

Table 61. Responses of 2011 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 37.

No. WAE Caught/ angler	Satisfied		Dissatisfied		Neutral/No-opinion	
	No.	Percent	No.	Percent	No.	Percent
16 or >	73	98.6	0	-	1	1.4
12-15.9	63	95.5	3	4.5	0	-
8-11.9	129	94.9	5	3.7	2	1.5
4-7.9	181	88.7	16	7.8	7	3.4
>0-3.9	274	78.5	57	16.3	18	5.2
0	116	65.5	47	26.6	14	7.9
Total	836	83.1	128	12.7	42	4.2

Table 62. Responses of 2012 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 37.

No. WAE Caught/ angler	Satisfied		Dissatisfied		Neutral/No-opinion	
	No.	Percent	No.	Percent	No.	Percent
16 or >	63	92.6	4	5.9	1	1.5
12-15.9	26	83.9	5	16.1	0	-
8-11.9	85	92.4	5	5.4	2	2.2
4-7.9	141	88.7	12	7.5	6	3.8
>0-3.9	235	73.2	72	22.4	14	4.4
0	80	60.6	37	28.0	15	11.4
Total	630	78.5	135	16.8	38	4.7

Table 63. Responses of 2013 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 37.

No. WAE Caught/ angler	Satisfied		Dissatisfied		Neutral/No-opinion	
	No.	Percent	No.	Percent	No.	Percent
16 or >	64	92.8	1	1.4	4	5.8
12-15.9	43	81.1	7	13.2	3	5.7
8-11.9	118	90.8	5	3.8	7	5.4
4-7.9	184	85.2	18	8.3	14	6.5
>0-3.9	241	68.9	88	25.1	21	6.0
0	89	46.8	82	43.2	19	10.0
Total	739	73.3	201	19.9	68	6.7

Angler Preference and Attitude Survey: Competitive Angling Events

Competitive angling events have increased in popularity 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 competitive angling events, anglers participating in the 2011 angler use and harvest survey were asked questions concerning these events. When asked whether or not they had participated in a tournament held on Lake Francis Case within the past twelve months, 17% of those interviewed during 2011 indicated they had (Table 40). Survey results concerning tournament participation in 2011 were consistent with previous survey results (Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b).

Table 64. Responses of Lake Francis Case anglers to the question: "Within the last 12 months, how many fishing tournaments have you participated in on Lake Francis Case?", 2007-2011. Responses are presented as percentage of total responses. *N* = number of responses.

	2007		2008		2009		2010		2011	
No. of Tournaments Participated in	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**	**N**	**Percent**
0	486	86.5	504	82.6	619	82.3	546	80.9	828	83.4
1	76	13.5	106	17.3	133	17.6	128	19.0	165	16.6
2	32	5.7	42	6.8	67	8.8	58	8.6	76	7.6
3	22	3.9	23	3.7	39	5.1	29	4.3	31	3.1
4	13	2.3	16	2.6	17	2.2	15	2.2	20	2.0
>4	8	1.4	10	1.6	7	0.9	8	1.2	13	1.3

The majority of competitive angling events on Lake Francis Case occur during the April-June period. This also encompasses the months with highest overall angler use. Crowding at access facilities where such events are being held is a concern. To help understand the significance of such user conflicts, anglers were asked if they have ever not used an access site because a tournament was being held there. Overall, 74 percent of interviewed anglers during 2011 indicated they had not avoided an access site because a tournament was being held there, suggesting that crowding at access sites due to tournament use may not be occurring at this time (Table 41). Due to the early start times of many fishing tournaments, other anglers may not be aware that a fishing tournament is being held at the access site they choose to use and may just view the access site as being generally crowded. However, with twenty-six percent of anglers being displaced by competitive angling events, this issue should be carefully monitored in the future (Table 41).

Table 65. Responses of Lake Francis Case anglers to the question: "Did you ever decide not to use an access site on Lake Francis Case because a tournament was being held there?" Responses are presented as number of responses and percentage of total responses by year.

	Response		
Year	Yes	No	No Opinion
2007	150 (26.3)	411 (73.0)	1 (0.2)
2008	167 (27.4)	445 (72.6)	1 (0.2)
2009	154 (20.4)	598 (79.3)	2 (0.3)
2010	152 (22.5)	522 (77.3)	1 (0.2)
2011	254 (25.6)	734 (73.9)	5 (0.5)

When anglers were asked how they felt about the number of tournaments held on Lake Francis Case each year, 42% of 2011 respondents had no opinion on the issue, suggesting tournaments are not an important issue for this portion of the angling public (Table 42). However, when "no opinion" responses were removed from the analysis, 52% of anglers believed there were too many tournaments on Lake Francis Case (Table 42). In addition, 47% believed there was about the right number, and 2% believed that there were too few tournaments held on Lake Francis Case annually (Table 42).

Table 66. Responses of 2011 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	299	30.1
About the Right Number	269	27.1
Too Few	11	1.1
No Opinion	414	41.7
	Excluding "No Opinion" Responses	
Too Many	299	51.6
About the Right Number	269	46.5
Too Few	11	1.9

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), remains the target species of most LFC anglers. Since ~~a~~ peak ~~in total~~ walleye abundance in 1995, the LFC walleye population generally declined in abundance until 2005. 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 was longer in duration than initially expected. Water yield in the Missouri River basin began to recover in 2005 following nine years of below normal water yield. Walleye abundance increased during 2005 and 2006 due to the presence of consecutive strong year classes. In spite of strong 2005 and 2006 walleye year classes, overall abundance declined in 2007 and 2008 to levels similar to 2003 and 2004 due to poor walleye production in 2007 and 2008 coupled with angler harvest. Poor production and recruitment commonly follows years with excellent walleye production, such as 2005 and 2006. Moderate walleye production in 2009 and excellent production in 2010 and 2011 led to increases in abundance. Moderate walleye production occurred in 2012. Continued presence of strong 2005 and 2006 year classes has led to an increase in abundance of larger walleye in the population. Lake Francis Case walleye typically reach harvestable size at about three years of age. Walleye growth rates increased during 2005, but decreased in 2006 and 2007 due to the presence of two large year classes of walleye in the population. Walleye growth rates recovered during 2008-2013 and remain stable. Walleye growth rates need to be monitored closely 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 stable 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 early 2000's through 2013; from the drought conditions experienced between 2000 and 2008 to the record run-off recorded in 2011. These extremes in water yield undoubtedly played a significant role in shaping the fish populations of LFC. While walleye population abundance, size structure, and growth showed negative trends in the early 2000's, when drought conditions existed, walleye abundance levels trended upward as water yield increased and created favorable habitat and nutrient conditions. Following record run-off in 2011, the Missouri River basin returned to below average water yield in 2012 and 2013 resulting in decreasing walleye abundance. Under such conditions, it is unrealistic to expect to maintain high walleye abundances such as those of the mid-1990's. Localized runoff events in the spring of 2010 and 2011 provided conditions favorable to fish production resulting in two consecutive strong walleye year classes. Moderate walleye production occurred in 2009 and 2012.

The large 2005 and 2006 walleye year-classes translated into an increase in abundance of harvestable sized walleye from 2009-2012. Improvements in walleye population structure, as a result of length limit regulations, is reflected in the 411-mm (16.2 in.) mean length of walleye harvested during 2013, versus the 343-mm (13.5 in.) average estimated in 1989 (Stone 1995). Abundance of harvestable size walleye decreased from 2011 through 2013 as the large 2005 and 2006 walleye year classes move through and out of the population. With recent increases in overall walleye population abundance, a high proportion of anglers are attaining the daily creel limit of four 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 low walleye abundance or high harvest. Survey results also suggest 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 caught (Stone and Sorensen 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b).

Smallmouth bass, which in previous years has 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 was similar for all sampling locations among years with the exception of the Platte Creek sampling location where abundance increased during 2012 before decreasing in 2013. The 2009 smallmouth bass year class comprises a majority of the current Lake Francis Case smallmouth bass population. Excellent smallmouth bass production occurred in 2010 with moderate production in 2012. Smallmouth bass are targeted by a small group of Lake Francis Case anglers and continue to gain

popularity. 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. Sauger continue to increasingly contribute to the harvest. Sauger harvest increased in 2012 and again in 2013 as moderate to strong sauger year-classes from 2009-2011 begin to contribute to the sport harvest. White bass contribution to sport fish harvest has decreased from 2011 to 2013 as angler harvest of the large 2010 year class takes its toll. High white bass production during 2010 and 2011 was followed by moderate production in 2012 and poor production in 2013. The white bass population has a well distributed size structure and is capable of providing additional recreational opportunity. Channel catfish have maintained adequate abundance in recent years to support additional harvest, while the average size channel catfish in netting surveys continues to exceed 406 mm in length. Channel catfish growth has remained good with fish surpassing 406 mm by age 7.

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). Overall walleye abundance in LFC increased during 2010 due to a strong walleye year class produced that year. Excellent production in 2011 resulted in only a slight drop in overall abundance in 2011 before decreasing abundance occurred during 2012 and 2013. Walleye growth has been variable in recent years but has stabilized near the long term average for Lake Francis Case. Walleye growth should be closely monitored in future years. Anglers fishing Lake Francis Case in 2014 should expect lower catches of harvestable sized walleye as the large 2005 and 2006 walleye year classes decrease in abundance. Increased catches of sub-legal-length walleye should occur due to the large 2010 and 2011 year classes. Run-off conditions and weather patterns favorable for walleye production and recruitment are needed to ensure improvements in overall walleye abundance.

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.

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Appendix 1. Monthly water volume (1000's acre-feet) released through (power) or over (spill) Ft. Randall Dam, 2009-2013.

Month	2009		2010		2011		2012		2013	
	Power	Spill	Power	Spill	Power	Spill	Power	Spill	Power	Spill
Jan	672	0	870	0	1,062	0	1,237	0	741	0
Feb	335	0	644	0	878	0	1,076	0	611	0
Mar	664	0	420	0	927	0	1,298	0	1,014	0
Apr	756	0	743	0	1,620	28	1,392	0	901	0
May	1,011	0	1,402	0	1,962	1,543	1,564	0	965	0
Jun	1,337	0	1,119	0	1,533	6,474	1,771	0	1,122	0
Jul	1,498	0	1,952	0	1,404	8,193	1,994	0	1,380	0
Aug	1,571	0	2,414	101	1,461	6,716	2,244	0	1,455	0
Sep	1,710	0	2,346	322	1,465	3,298	2,045	0	1,801	0
Oct	1,598	0	2,193	702	1,578	834	2,117	0	1,587	0
Nov	935	0	2,276	339	1,476	832	1,818	0	1,433	0
Dec	881	0	1,401	0	1,428	199	873	0	853	0
Total	12,968	0	17,780	1,464	16,794	28,089	19,429	0	13,863	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*	COS
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	*Scaphirhynchus platorynchus*	SNS
Silvery minnow	*Hybognathus argyritis*	SIM
Smallmouth bass	*Micropterus dolomieu*i	SMB
Smallmouth buffalo	*Ictiobus bubalus*	SAB
Spottail shiner	*Notropis hudsonius*	SPS
Walleye	*Sander vitreus*	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	2009	323	LogWT=3.114LogTL-5.383	0.99	341	386
	2010	509	LogWT=3.286LogTL-5.778	0.99	361	500
	2011	470	LogWT=3.227LogTL-5.656	0.99	369	474
	2012	330	LogWT=3.094LogTL-5.318	0.98	373	527
	2013	185	LogWT=3.049LogTL-5.215	0.99	340	359
Sauger	2009	60	LogWT=3.126LogTL-5.453	0.99	310	266
	2010	141	LogWT=3.207LogTL-5.629	0.99	306	266
	2011	203	LogWT=3.229LogTL-5.715	0.98	345	339
	2012	212	LogWT=3.043LogTL-5.264	0.96	358	356
	2013	166	LogWT=3.113LogTL-5.441	0.98	333	279
SM Bass	2009	17	LogWT=3.057LogTL-4.965	0.99	278	350
	2010	24	LogWT=3.270LogTL-5.482	0.99	232	190
	2011	25	LogWT=3.169LogTL-5.233	0.96	310	521
	2012	16	LogWT=3.250LogTL-5.424	0.99	288	424
	2013	7	LogWT=3.127LogTL-5.169	0.99	223	212

Appendix 5. Channel catfish, white bass, and yellow perch proportional size distribution (PSD), proportional size distribution of preferred and memorable length fish (PSD-P and PSD-M, respectively), and relative weight (W_r), for 2009-2013, for fish collected from Lake Francis Case. *N* = sample size.

Species	2009				2010				2011				2012				2013			
	PSD	PSD		W_r	PSD	PSD		W_r	PSD	PSD		W_r	PSD	PSD		W_r	PSD	PSD		W_r
		P	M			P	M			P	M			P	M			P	M	
Channel catfish	35	0	0	84	59	0	0	82	63	2	0	85	43	1	0	84	53	0	0	85
N =	135				114				67				77				87			
White bass	100	86	7	97	0	0	0	69	100	79	43	95	100	50	25	118	100	89	22	98
N =	19				8				14				4				9			
Yellow perch	25	0	0	90	25	2	0	83	25	1	0	84	28	5	0	84	8	8	0	83
N =	28				131				108				39				12			