

**SOUTH**

**DAKOTA**

A large, stylized graphic of a fish, where the body of the fish is formed by the word "FISHHERIES" in a bold, blocky, sans-serif font. The fish is oriented horizontally, facing right. The letters are thick and black. The tail of the fish is a simple black triangle. To the right of the fish's head, there are several small, empty circles of varying sizes, arranged in a descending line, resembling bubbles or a thought bubble trail.

**FISHHERIES**

**ANNUAL FISH POPULATION  
AND  
ANGLER USE AND SPORT FISH HARVEST SURVEYS  
ON  
LAKE FRANCIS CASE, SOUTH DAKOTA, 2009**

**South Dakota  
Department of  
Game, Fish and Parks  
Wildlife Division  
Joe Foss Building  
Pierre, South Dakota 57501-3182**

**Annual Report  
No. 10-13**

ANNUAL FISH POPULATION  
AND  
ANGLER USE AND SPORT FISH HARVEST SURVEYS  
ON  
LAKE FRANCIS CASE, SOUTH DAKOTA, 2009

by

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## PREFACE

Information collected during 2009 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 2005 through 2009, for Lake Francis Case (LFC), South Dakota. These surveys, their results and interpretation, are major strategy and evaluation tools for planning efforts outlined in the Missouri River Fisheries Program Strategic Plan. Results and discussion presented pertain to changes in fish community and population characteristics, sport fishing use and harvest, and evaluation of management activities and regulations.

Walleye catch per unit of effort (CPUE; No./min.), during 2009 spring-spawning-run electrofishing near Chamberlain, was similar to 2008. Walleye electrofishing CPUE at the face of Ft. Randall Dam increased from 2008 and was similar to other values in the five-year period.

Fall gill netting collected eighteen fish species. Walleye and Sauger CPUE (No./net night) in 2009 both increased from 2008. Channel catfish CPUE in 2009 was similar to that observed in 2008. Mean white bass CPUE in 2009 was similar to that observed in 2008. Smallmouth bass CPUE during 2009 increased from 2008. Yellow perch mean CPUE in 2009 increased from 2008.

Twenty species of age-0 fishes or small littoral prey species were collected by seining in 2009. Age-0 gizzard shad were most common in 2009 seine catches, accounting for 70% of the total catch, while emerald shiners, spottail shiners, and white bass accounted for 20%, 3% and 3% of the total catch respectively. Common shiner, goldeye, johnny darter, river carpsucker, smallmouth bass, walleye, and yellow perch were also common in seine catches.

Walleye survival decreased in 2009 while mean age remained similar to 2008. Relative weight (Wr) during 2009 remained similar to 2008 while proportional size distribution (PSD) increased. Overall walleye abundance during 2009 increased from 2008. Walleye growth during 2009 increased from 2008. Sauger gill net CPUE in 2009 increased from 2008. Sauger PSD in 2009 decreased from 2008 while survival increased during 2009. Sauger mean age decreased during 2009 while growth increased from 2008 values. Smallmouth bass gill net CPUE in 2009 increased from 2008. Smallmouth bass PSD and survival both decreased during 2009. Smallmouth bass mean age and growth both decreased during 2009.

Anglers spent an estimated 587,786 hours fishing LFC, during the April-September 2009 daylight period, similar to the 553,822 hours estimated for 2008 and over 400,000 hours less than the high estimated for 1999. Total fish harvest in 2009 was estimated at 189,985 fish. Walleye dominated the harvest, with an estimated 143,383 fish harvested in the April-September 2009 survey period. Estimated mean length of harvested walleye was 39.8 cm (15.7 in). White bass, sauger, channel catfish, and smallmouth bass were also common in the harvest. An overall catch rate (harvest and release rates combined) of 1.1 fish/angler-h was estimated for the April-September 2009 daylight period. Total catch, release, and harvest rates for walleye were 0.81 walleye/angler-h, 0.57 walleye/angler-h, and 0.24 walleye/angler-h, respectively. Approximately 70% of LFC anglers expressed some degree of satisfaction with their angling trip. Anglers from South Dakota and 18 other states, fishing LFC, generated a local economic impact estimated at approximately 10.6 million dollars in 2009. Results from several questions regarding LFC angler attitudes and preferences are reported.

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# **ANNUAL FISH POPULATION AND ANGLER USE AND SPORT FISH HARVEST SURVEYS ON LAKE FRANCIS CASE, SOUTH DAKOTA, 2009**

## **INTRODUCTION**

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

Walleye, and to a lesser extent smallmouth bass, white bass and channel catfish, provide the majority of sport fishing opportunity available in this reservoir. Over the past 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 2009 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 conditions provided by unusually high water levels in 1995 and 1997. Water yield in the Missouri River Basin was below normal for the 2000-2007 periods. Water yield in the basin returned to above average condition in 2008 and 2009 following eight consecutive years of drought. Past research (Stone 1997b) and observations would suggest that it is unrealistic to expect to maintain fish population abundance at the 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 in 2008 was similar to 2007, but increased for 2009.

Maintaining LFC as one of South Dakota's most productive fisheries resources requires that it be effectively managed to produce optimal recreational benefits, within the framework of protecting and maintaining the overall integrity of the aquatic community. The Missouri River Fisheries Program Strategic Plan (SDGFP 1994) documents the goal, objectives and strategies developed for management of this system. Annual acquisition and analysis of data describing the fish community and fish population parameters, in association with data describing angler use and sport fish harvest, is a primary strategy outlined in that plan. This work is required for evaluation of objectives and strategies outlined in the strategic plan and as a prerequisite to effective development of future management strategies. This report describes data collected in 2009 from LFC and the discussion focuses on changes in fish populations and associated angler use and sport fish harvest since 2005.

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

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

Table 1 continued

Year	Fishing pressure (h)	Angler days	Mean trip length (h)	Total fish harvest (No.)	Walleye harvest (No.)	Total harvest rate (Fish/angler-h)	Walleye harvest rate (Fish/angler-h)	Mean walleye TL(mm) in harvest	Reference
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 (2010)
2009	587,786	138,302	4.3	189,985	143,383	0.323	0.244	398	This Study

\* Estimate projected from a creel survey for approximately 1/3 of reservoir.

# Estimate was for May-August only.

## OBJECTIVES

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

### Annual Fish Population Surveys (Federal Aid Project 2102):

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

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

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

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

## STUDY AREA

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

Water yield in the Missouri River system in 2009 returned to above normal levels (Appendix 1; U.S. Army Corps of Engineers, unpublished data). During the spring of 2009, the elevation of LFC increased as was forecasted by the U.S. Army Corps of Engineers (USCOE). Reservoir elevation reached 413 m msl (1354.3 ft. msl) by early March and remained at or above this level until early October when the annual fall draw-down began. Appendix 1 presents monthly data on water released through Ft. Randall Dam.

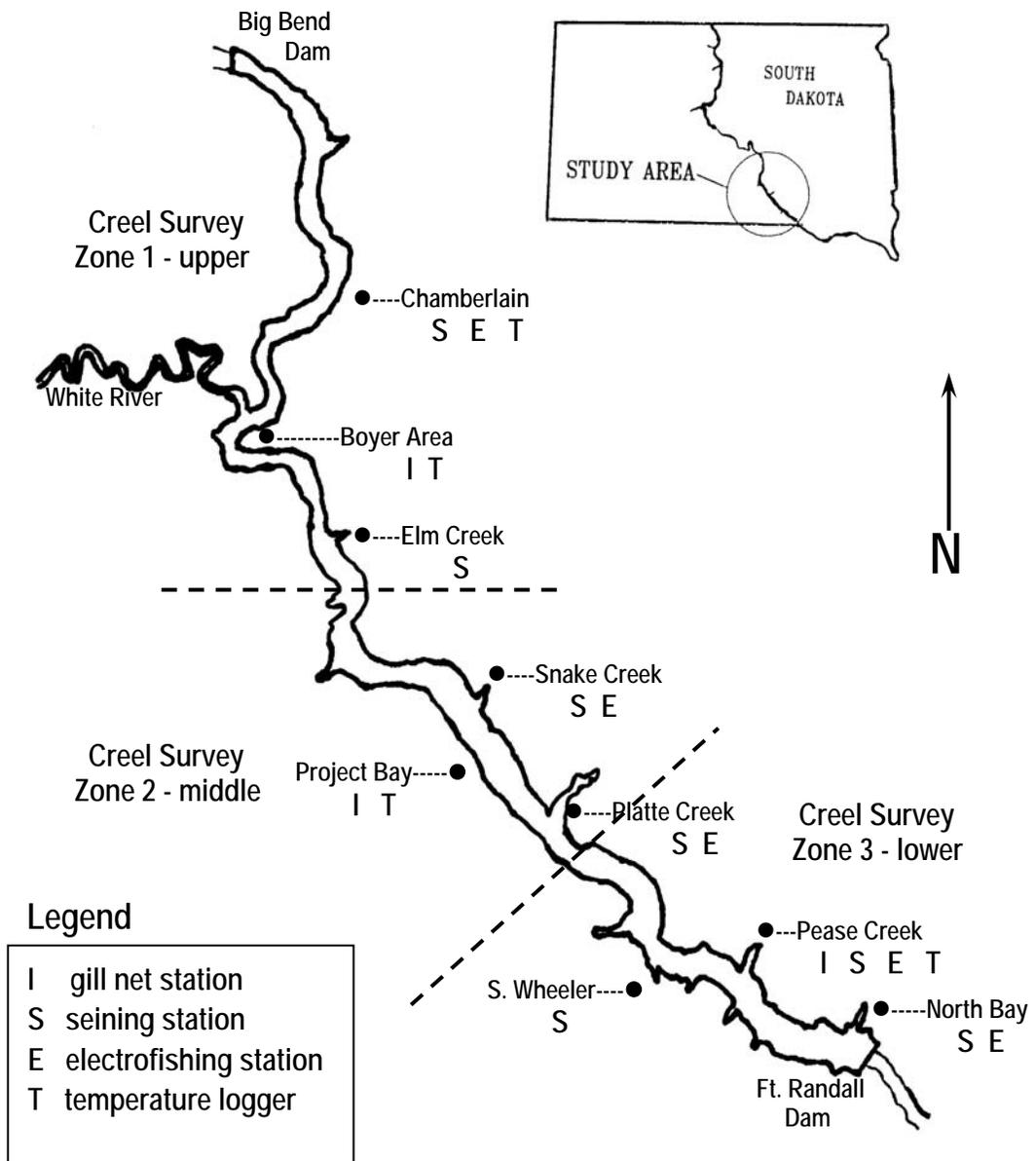


Figure 1. Lake Francis Case study area.

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

	<b>Lake Francis Case</b>
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

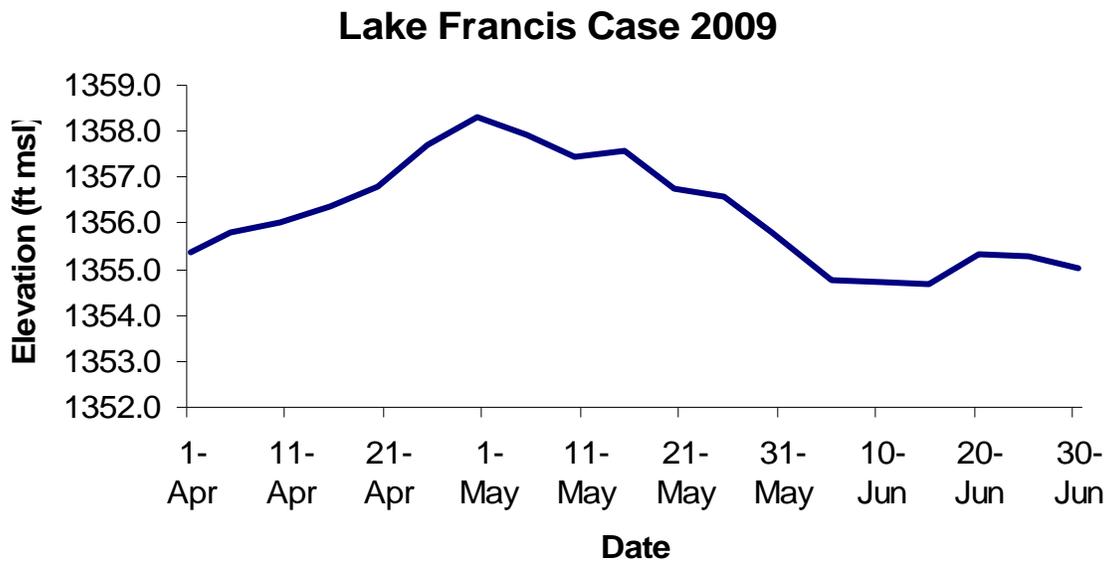


Figure 2. Spring 2009 Lake Francis Case reservoir elevation.

## **SAMPLING METHODS AND SCHEDULE**

### **FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES**

#### **Data Collection**

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

Pulsed-DC (60 pps, 6-8 amps) electrofishing, using a Smith Root GPP electrofishing boat, was used to collect adult walleye during April, smallmouth bass during May and June, and age-0 walleye during October, for population monitoring (fish/min) and tagging studies. Nine and six 10-minute electrofishing runs were conducted at night near Chamberlain and on the face of Ft. Randall Dam, respectively, to collect 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 for total length.

Nylon seines, previously described by Lott et al. (1994), were used to collect age-0 fishes and small littoral species. A quarter-arc seine haul was accomplished by methods described in Martin et al. (1981). Four seine hauls were made at each sampling station; two on each side of the reservoir. All fish collected with seines were identified to species and counted. Walleye were measured for total length.

Water temperature data was collected with submersible HOBO Water Temp Pro temperature loggers. Loggers, configured to record temperature every two hours, were deployed at four locations (Figure 1) on the reservoir April 9, 2009 and retrieved September 21, 2009.

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

#### **Data Analysis**

Relative abundance of fish species was expressed as mean catch per unit effort (CPUE) for standard gill net (No./net night), electrofishing (No./min.), and seine catches (No./haul). Age and growth analyses were completed for walleye, sauger and smallmouth bass. Scales and otoliths were aged according to standard techniques (DeVries and Frie 1996). Back-calculations for scale analysis were made with the computer program WINFIN (Francis 1999, 2000). Standard y-intercept values, suggested by Carlander (1982), were used for walleye (55 mm), sauger (55 mm), and smallmouth bass (35 mm). Age distributions from gill net catches were developed for selected species by aging approximately 100 fish randomly selected per sampling station (when available). Proportional size distribution (PSD) and proportional size distribution 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 PSDs are listed in Table 3.

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

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

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

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

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

## **ANGLER USE AND SPORT FISH HARVEST SURVEY**

A bus route creel survey design (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, 1996b, 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010).

Sampling was conducted from 1 April 2009 through 30 September 2009, for the daylight period (sunrise to sunset). Creel zones are identified in Figure 1.

## **ANGLER PREFERENCE AND ATTITUDE SURVEY**

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

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

## **RESULTS**

### **FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES**

#### **Species Composition and Relative Abundance**

Results of spring electrofishing, conducted to monitor timing and abundance of spawning walleye, are presented in Tables 4 - 6. Overall walleye electrofishing CPUE in 2009, near Chamberlain, was similar to values measured in 2008 (Table 4). Sampling near Ft. Randall Dam, during 2009, yielded a CPUE within the range of the five-year period (Table 5). Walleye electrofishing CPUEs near Chamberlain peaked on 27 April 2009 (Table 6). Electrofishing CPUEs near Ft. Randall Dam were similar for both sampling dates (Table 6).

Table 4. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Chamberlain, 2005-2009. Catch per unit effort (CPUE) values with the same letter code are not significantly different at the  $P = 0.2$  level.

<b>Year</b>	<b>Sampling time (min)</b>	<b>Number of fish</b>	<b>CPUE (fish/min)</b>
2005	75	773	10.3 a
2006	68	788	11.6 ab
2007	82	824	10.0 a
2008	54	893	16.5 b
2009	61	972	15.9 b

Table 5. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Ft. Randall Dam, 2005-2009. 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)
2005	60	360	6.0 a
2006	60	288	4.8 a
2007	64	404	6.3 a
2008	60	260	4.3a
2009	60	332	5.5 a

Table 6. Electrofishing data, by location and date, for walleye from Lake Francis Case, 2009. 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	4/13/09	6.4	30	340	11.3 a
Chamberlain	4/20/09	8.7	16	302	18.9 b
Chamberlain	4/27/09	9.6	15	330	22.0 b
Ft. Randall Dam	4/21/09	7.0	30	133	4.4 a
Ft. Randall Dam	4/28/09	7.1	30	199	6.6 b

Catch-per-unit-effort of smallmouth bass during 2009 was similar to those measured previously for all sampling stations (Table 7). Although not statistically significant, decreases in smallmouth bass CPUE were observed at all sampling stations with the exception of Ft. Randall Dam. Smallmouth bass CPUE of 2.1 fish/min. was the highest of the five-year period for the Ft. Randall Dam sampling station (Table 7).

Table 7. Electrofishing catch of smallmouth bass during spring sampling, at five locations on Lake Francis Case, 2005-2009. Catch per unit effort (CPUE) values within sites with the same letter code are not significantly different at the  $P = 0.2$  level.

<b>Big Bend Dam Tailwater</b>			
<b>Year</b>	<b>Sampling time (min)</b>	<b>Number of fish</b>	<b>Fish/min</b>
2005	60	55	0.9 a
2006	45	65	1.4 a
2007	45	33	0.9 a
2008	45	26	0.6 a
2009	45	32	0.7 a
<b>Chamberlain</b>			
<b>Year</b>	<b>Sampling time (min)</b>	<b>Number of fish</b>	<b>Fish/min</b>
2005	60	67	1.1 a
2006	47	102	2.2 a
2007	36	95	2.6 a
2008	30	47	1.6 a
2009	45	104	2.3 a
<b>Platte Creek</b>			
<b>Year</b>	<b>Sampling time (min)</b>	<b>Number of fish</b>	<b>Fish/min</b>
2005	60	59	1.0 a
2006	45	62	1.4 a
2007	60	55	0.9 ab
2008	45	21	0.5 b
2009	45	63	1.4 a
<b>Pease Creek</b>			
<b>Year</b>	<b>Sampling time (min)</b>	<b>Number of fish</b>	<b>Fish/min</b>
2005	45	71	1.6 a
2006	45	61	1.4 a
2007	45	79	1.8 a
2008	45	61	1.4 a
2009	45	76	1.7 a
<b>Ft. Randall Dam</b>			
<b>Year</b>	<b>Sampling time (min)</b>	<b>Number of fish</b>	<b>Fish/min</b>
2005	60	62	1.0 a
2006	45	66	1.5 ab
2007	45	44	1.0 a
2008	30	64	2.1 b
2009	45	53	1.2 ab

Fall gill-net sampling collected 18 species of fish from LFC in 2009 (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 38% of gill net catches in 2009, followed by gizzard shad, channel catfish, sauger, and goldeye which accounted for 17%, 16%, 7% and 4% of the catch, respectively. Common carp, freshwater drum, smallmouth bass, white bass, white crappie and yellow perch were also common in gill-net catches during 2009.

Walleye gill net CPUE for 2009 was 12.0 walleye/net. Walleye gill net CPUE was higher than 2008 and similar to the 2005 value (Table 8). An increase in abundance was anticipated as fish resulting from high production of walleye in 2005 and 2006 begin to recruit to the population.

Channel catfish gill net CPUE, of 5.0 fish/net in 2009 was similar to other years of the five-year period. Sauger gill net CPUE increased in 2009 to 2.3 sauger/net and remains near the low for the five-year period. Smallmouth bass gill net CPUE for 2009 increased to 0.6 smallmouth bass/net, within the range of the five-year period. Yellow perch gill net CPUE increased to 1.0 yellow perch/net in 2009, within the range of the five-year period. A 2009 white bass gill net CPUE of 0.7 white bass/net was within the range for the five-year period.

Twenty species of age-0 fishes or small littoral species were collected by seining in 2009 (Table 9). All species had been previously reported for LFC (Lott et al. 1994). Age-0 gizzard shad dominated the seine catches, as they have for the previous five years, making up 70% of the total seine catch. Emerald shiners, spottail shiners and white bass comprised 20, 3 and 3 percent of the total seine catch, respectively. Common shiners, goldeye, johnny darters, river carpsuckers, smallmouth bass, walleye and yellow perch were also common in seine samples.

The 2009 age-0 walleye seining CPUE of 1.2 fish/seine haul was the high for the five-year period. Age-0 walleye were collected at the North Point, Platte Creek, Snake Creek, Elm Creek and American Creek sampling locations in 2009. A majority of age-0 walleye are usually collected in the upper half of the reservoir. Thirty-three age-0 walleye were collected by seines in mid-July, 2009 and averaged 74.6 mm (Table 10).

Table 8. Mean gill net catch per lift (CPUE; No./net night), sampling stations combined, on Lake Francis Case, 2005-2009. SE is standard error. Trace (T) < 0.1.

Species	2005		2006		2007		2008		2009	
	CPUE	SE								
Black bullhead	0.0		0.0		0.0		0.0		0.0	
Channel catfish	4.1	0.5	5.7	0.7	5.7	0.8	5.6	0.9	5.0	0.7
Common carp	0.9	0.2	1.7	0.4	1.8	0.5	1.6	0.4	1.0	0.3
Emerald shiner	0.0		T	-	0.0		0.0		0.0	
Freshwater drum	1.3	0.4	1.1	0.3	0.8	0.2	0.8	0.2	1.1	0.2
Gizzard shad	2.8	1.2	17.1	9.2	4.0	1.4	2.0	0.9	5.2	2.2
Goldeye	1.5	0.5	3.1	1.2	1.6	0.5	0.3	0.1	1.3	0.6
Northern pike	T	-	0.0		0.0		0.0		0.1	0.1
Rainbow trout	0.0		0.0		0.0		0.0		0.0	
River carpsucker	0.1	0.1	0.4	0.2	0.2	0.1	0.1	0.1	0.2	0.1
Sauger	3.3	0.4	3.9	0.6	2.7	0.8	1.4	0.3	2.3	0.5
Shorthead redhorse	T	-	T	-	0.1	0.1	T	-	0.1	0.1
Shortnose gar	0.1	0.1	0.2	0.2	0.4	0.3	0.6	0.5	T	-
Shovelnose sturgeon	0.0		0.0		0.0		0.0		T	-
Smallmouth bass	0.7	0.3	0.9	0.2	0.3	0.1	0.3	0.2	0.6	0.2
Smallmouth buffalo	0.1	0.1	0.1	0.1	T	-	T	-	0.1	0.1
Spottail shiner	T	-	T	-	0.0		T	-	T	-
Walleye	11.7	1.7	18.4	1.8	8.7	1.2	8.3	1.2	12.0	1.4
White bass	3.0	0.8	1.3	0.4	1.1	0.3	0.5	0.2	0.7	0.2
White crappie	0.0		0.1	0.1	2.0	1.6	0.1	0.1	0.4	0.3
Yellow perch	2.4	0.7	0.8	0.2	0.3	0.1	0.6	0.2	1.0	0.3

Table 9. Mean catch per seine haul (CPUE; No./haul), sampling stations combined, of age-0 fishes and small littoral species from Lake Francis Case, 2005-2009. SE is standard error. Trace (T) < 0.1

Species	2005		2006		2007		2008		2009	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Bigmouth buffalo	T	-	0.0		T	-	0.1	0.1	0.3	0.2
Black bullhead	0.0		0.0		0.0		0.0		0.0	
Black crappie	0.0		0.0		0.0		0.0		T	-
Channel catfish	0.2	0.1	0.1	0.1	0.3	0.2	0.4	0.3	0.0	
Common carp	0.1	0.1	0.0		0.3	0.1	0.1	0.1	0.1	0.1
Common shiner	0.0		0.0		0.0		0.0		0.6	0.3
Emerald shiner*	17.8	3.3	80.3	53.4	24.1	11.2	54.3	15.7	44.1	14.0
Fathead minnow*	0.0		T	-	0.1	0.1	0.0		0.1	0.1
Freshwater drum	8.9	2.6	1.9	0.8	16.5	8.8	17.3	8.3	0.1	0.1
Gizzard shad	332.8	116.8	241.7	105.2	437.4	124.2	700.3	320.4	158.8	66.2
Goldeye	2.5	1.5	T	-	0.0		0.0		1.7	1.7
Johnny darter*	0.1	0.1	0.1	0.1	0.2	0.1	1.6	1.2	0.4	0.1
Largemouth bass	0.0		0.0		T	-	0.1	0.1	0.0	
North. Redbelly dace	0.0		0.0		0.0		0.0		T	-
Red shiner*	0.2	0.2	0.3	0.1	0.6	0.3	0.3	0.1	T	-
River carpsucker	T	-	0.0		0.1	0.1	T	-	0.4	0.2
Sauger	0.1	0.1	0.1	0.1	0.1	0.1	T	-	0.0	
Shorthead redhorse	0.0		0.0		0.0		T	-	0.0	
Silvery minnow	0.0		0.0		0.0		0.0		0.0	
Smallmouth bass	2.6	0.5	0.7	0.2	1.6	0.6	1.7	0.5	2.4	0.7
Smallmouth buffalo	T	-	0.0		T	-	T	-	0.1	0.1
Spottail shiner*	6.5	1.9	9.5	3.0	1.7	0.5	2.9	0.9	6.8	4.8
Walleye	0.8	0.3	0.9	0.4	1.0	0.3	0.6	0.3	1.2	0.6
White bass	38.7	16.1	3.1	1.0	14.6	7.0	92.4	40.1	6.0	2.5
White crappie	0.0		0.0		0.0		0.0		T	-
Yellow perch	1.7	0.6	1.8	0.9	0.7	0.4	8.6	3.1	2.8	1.1

\*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, 2005 – 2009.

Year	No.	CPUE	Mean TL (mm)	Total length (mm) range
2005	21	0.8	102.3	85-116
2006	26	1.0	86.5	62-108
2007	27	1.0	86.8	64-117
2008	21	0.8	64.9	52-75
2009	28	1.0	74.6	53-103

### Population Parameters for Walleye

Beginning in 2003, otoliths were removed from walleye collected during the September gill netting survey. Mean length-at-age-at-capture for each age group is listed in Table 11. Mean length-at-age-at-capture shows Lake Francis Case walleye typically reach the minimum legal length (381 mm) at age 3 suggesting that the large 2005 year class should have reached legal length in 2008. Mean annual growth increments for walleye indicates that growth decrease observed during the 2005-2007 period, possibly a result of large 2005 and 2006 year classes present in the population, improved during the 2008-2009 time period (Table 12). Mean walleye age in gill net samples, at 3.2 years, is the highest measured for the 2005-2009 time period (Table 13). Walleye from eleven year-classes were collected in the 2009 gill net survey (Table 13) and ranged in TL from 100-mm to 640-mm (Figure 3).

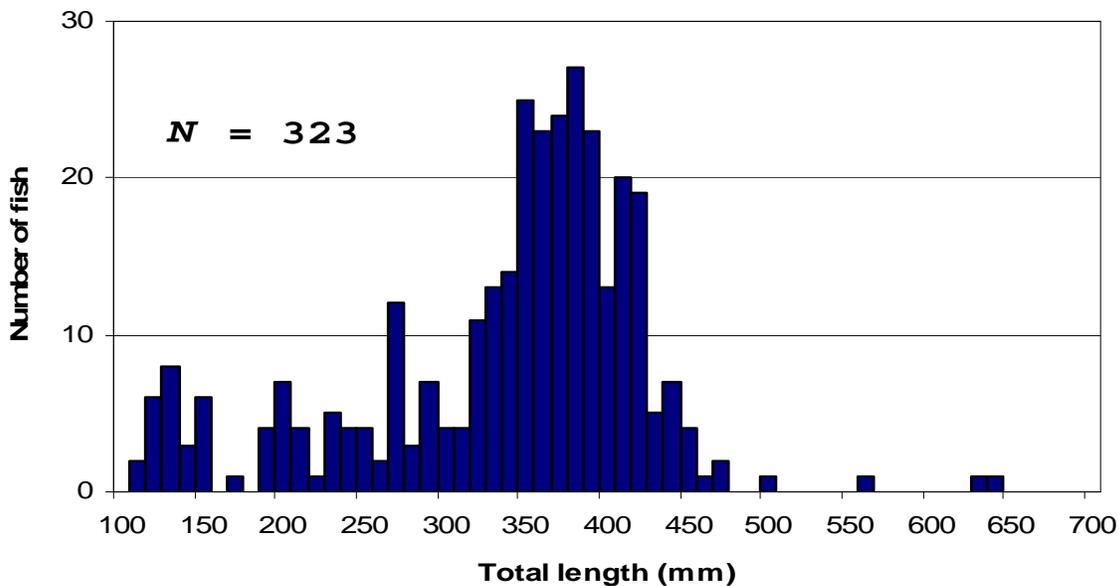


Figure 3. Length frequency of walleye collected with gill nets from Lake Francis Case, 2009. N = sample size.

Annual survival, for pooled 2008 and 2009 data, was estimated at 61% (Table 14), within the range of the five-year period. Relative weights for stock-quality (S-Q) length, quality-preferred (Q-P), and preferred length fish sampled in 2009 were similar to values measured over the past five years (Table 15). Walleye proportional size distribution (PSD) for 2009 increased to 46 while PSD-P increased to 1 (Table 16).

Table 11. Mean length-at-age-at-capture (mm) for walleye, as determined by aging otoliths, collected in the standard September gill net survey, 2005-2009, 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	
2005	Mean	298	374	413	455	447	477						
	N	80	82	40	12	5	7	0	0	0	0	0	0
	SE	2.0	2.2	4.4	8.2	11.1	15.2						
2006	Mean	257	350	394	433	444	454	477	469	573			
	N	168	103	58	17	5	4	5	3	1	0	0	0
	SE	2.7	8.0	14.8	26.4	67.5	107.9	127.5	98.8	NA			
2007	Mean	247	312	382	418	445	471	467	501		542		522
	N	36	110	33	15	7	4	2	2	0	1	0	2
	SE	6.6	3.0	4.1	9.4	8.8	17.6	20.5	19.5		NA		33.5
2008	Mean	237	309	357	416	453	482	445	488	513	540		
	N	23	44	101	21	11	6	1	3	4	1	0	0
	SE	4.6	3.1	2.9	8.2	12.0	13.5	NA	13.8	32.1	NA		
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
	SE	4.9	6.9	3.0	2.8	12.2	17.4	NA		24.7	128.0	NA	
<b>Mean of means</b>		254	332	383	423	441	462	488	486	513	542	641	522

Table 12. Mean annual growth increments for walleye collected in the standard September gill net survey on Lake Francis Case, South Dakota for 2004-2005, 2005-2006, 2006-2007, 2007-2008 and 2008-2009 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
2004-2005	108	66	70	29	39	--	--	--	--	--
2005-2006	94	42	38	14	0	13	0	104	--	--
2006-2007	55	32	24	12	27	13	24	--	0	--
2007-2008	62	45	34	35	37	--	21	12	--	--
2008-2009	82	59	36	1	--	80	--	--	30	101

Table 13. Age distribution, from otolith analysis, of walleye collected from Lake Francis Case with variable-mesh gill nets, 2005-2009. Mean age excludes age-0 fish.

Year	Age													
	0	1	2	3	4	5	6	7	8	9	10	11	12	Mean
2005	6	80	82	40	12	5	7	0	0	0	0	0	0	2.1
2006	1	168	103	58	17	5	4	5	3	1	0	0	0	2.0
2007	10	36	110	33	15	7	4	2	2	0	1	0	2	2.5
2008	14	23	44	101	21	11	6	1	3	4	1	0	0	3.1
2009	4	41	44	70	122	10	4	1	0	2	2	1	0	3.2

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 <sup>2</sup>
Walleye	2004-2005	0.54	0.46	0.621	0.905
	2005-2006	0.51	0.49	0.668	0.976
	2006-2007	0.59	0.41	0.531	0.892
	2007-2008	0.65	0.35	0.434	0.858
	2008-2009	0.61	0.39	0.495	0.796
Sauger	2004-2005	0.38	0.62	0.977	0.812
	2005-2006	0.43	0.57	0.837	0.759
	2006-2007	0.48	0.52	0.739	0.963
	2007-2008	0.43	0.57	0.595	0.849
	2008-2009	0.57	0.43	0.572	0.808
Smallmouth bass	2004-2005	0.36	0.64	1.010	0.862
	2005-2006	0.67	0.33	0.400	0.429
	2006-2007	0.88	0.12	0.125	0.307
	2007-2008	0.86	0.14	0.298	0.153
	2008-2009	0.57	0.43	0.565	0.313

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, 2005-2009. S-Q = stock-to-quality length, Q-P = quality-to-preferred length, P = preferred length. *N* = sample size.

<b>Walleye</b>				
<b>Year</b>	<b>S-Q</b>	<b>Q-P</b>	<b>P</b>	<b>N</b>
2005	84	84	77	229
2006	80	76	80	317
2007	79	75	73	196
2008	84	81	80	196
2009	81	79	75	271
<b>Sauger</b>				
<b>Year</b>	<b>S-Q</b>	<b>Q-P</b>	<b>P</b>	<b>N</b>
2005	82	75	75	83
2006	78	71	68	102
2007	74	73	68	70
2008	68	74	67	37
2009	77	76	78	51
<b>Smallmouth bass</b>				
<b>Year</b>	<b>S-Q</b>	<b>Q-P</b>	<b>P</b>	<b>N</b>
2005	118	108	110	14
2006	102	92	92	20
2007	93	98	-	7
2008	117	99	91	8
2009	107	103	101	17

Table 16. Walleye, sauger, and smallmouth bass proportional size distribution (PSD) and relative stock density for preferred- and memorable-length fish (PSD-P and PSD-M, respectively) for Lake Francis Case gill net data, 2005-2009.

<b>Species</b>	<b>2005</b>	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
Walleye	42 (1,0)	29 (1,0)	29 (2,0)	31 (0,0)	46 (1,1)
Sauger	95 (41,0)	62 (30,0)	87 (1,0)	84 (27,0)	82 (26,0)
Smallmouth bass	64 (14,0)	50 (10,0)	71 (0,0)	88 (13,0)	71 (6,0)

Yearly total walleye abundance (CPUE), as indexed by fall gill netting, partitioned by selected age and size groups and plotted with total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA is presented in Figure 4. Walleye population parameter improvements were noted soon after sport-fishing-regulation changes were implemented in 1990 (Stone and Wickstrom 1991a). The population also positively responded to habitat/nutrient conditions provided by the high runoff into the Missouri River system during 1993–1997 (Stone 1997b). The general decline in overall walleye abundance beginning in 1996 through 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 runoff resulted in poor production and recruitment during 2001-2004. Following a sharp decrease in water elevation during the peak walleye egg incubation period in 2002, the Department of Game, Fish and Parks stocked 400,000 walleye fingerlings and 4 million walleye fry. There appeared to be a large

walleye year class produced in 2002 and although origin of these age-0 fish could not be determined, their smaller-than-average size in fall gill net samples led to the assumption that a majority of these fish were a result of stocking efforts. Unfortunately, the strong 2002 year class did not translate into a strong age-1 or age-2 year class in 2003 and 2004 and a significant portion of these fish were lost from the population. 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 2009 increased from 2008. Walleye produced in 2005 and 2006 currently comprise a majority of the Lake Francis Case walleye population.

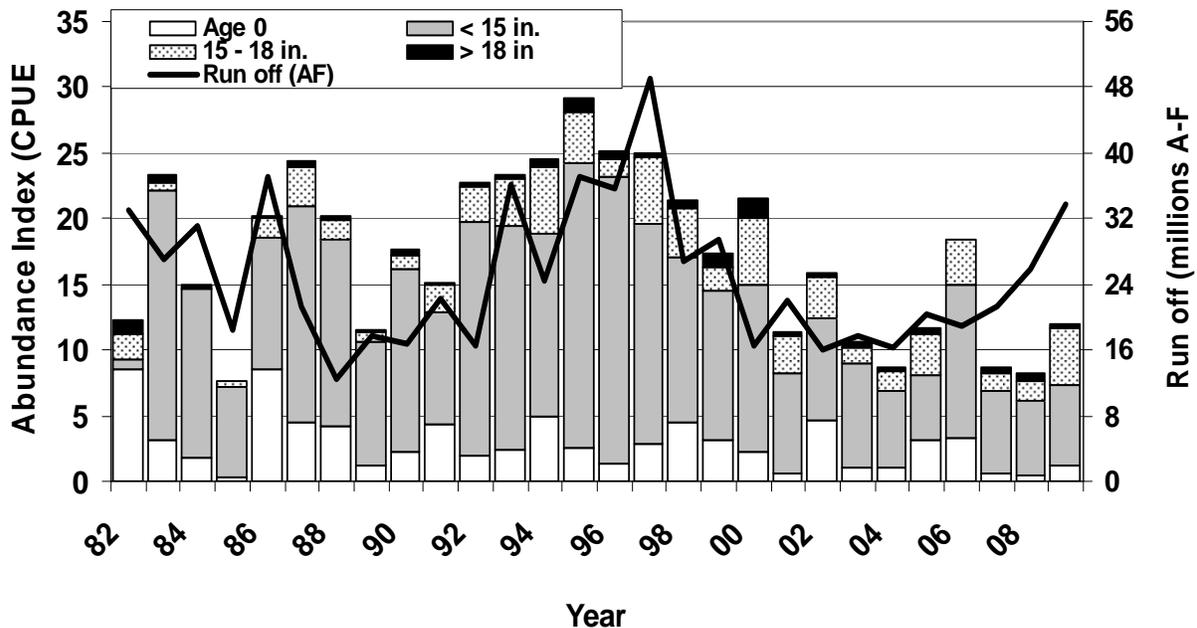


Figure 4. Lake Francis Case total walleye abundance (No. per net night) partitioned by walleye age and length groups and plotted against total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA. 1988-2009.

### Population Parameters for Sauger

The 2009 Lake Francis Case sauger abundance index, at a mean CPUE of 2.3 fish/net night increased from 2008 (Table 8). Lengths of sauger sampled in the 2009 gill net survey ranged from 120 mm to 420 mm TL (Figure 5). Sauger average length-at-age-at-capture indicates that LFC sauger typically surpass 381mm at 3 years of age (Table 17). Sauger up to age four were sampled in the 2009 gill net survey (Table 17). Sauger growth for the 2008-2009 period increased from that measured during 2007-2008, but remains below average for older age sauger (Table 18). Mean sauger  $W_t$  values, for the various length categories increased during 2009 (Table 15).

Five year classes of sauger were sampled by gill nets in 2009 (Table 19). The mean age of 2.0 years is the lowest for the five-year period (Table 19). The 2007 year class comprises a majority of the current adult sauger population. The strong 2005 sauger year class has diminished. However, 2009 appears to be a year of high sauger production. Annual sauger survival for 2008-2009 pooled data increased to 57%, a high for the five-year period (Table 14). Sauger PSD during 2009 was 82 while PSD-P was 26 (Table 16).

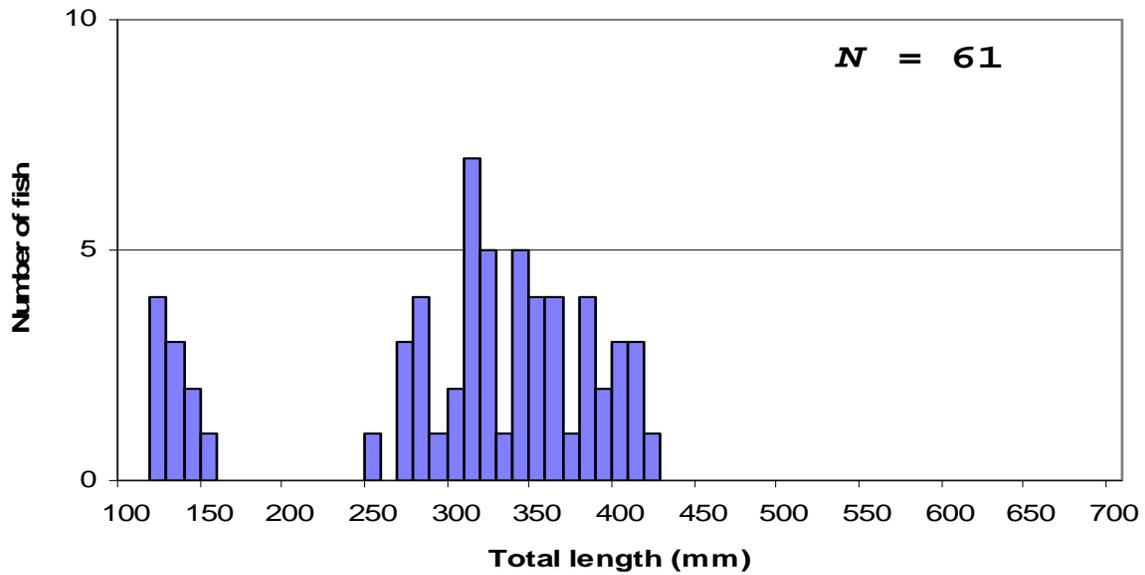


Figure 5. Length frequency of sauger collected with gill nets from Lake Francis Case, 2009.  
*N* = sample size.

Table 17. Mean length-at-age-at-capture (mm) for sauger, as determined by aging otoliths, collected in the standard September gill net survey, 2005-2009, Lake Francis Case, South Dakota.  
*N* = sample size.

Year		Length at age at capture (mm)						
		1	2	3	4	5	6	7
2005	Mean	306	352	392	396	426	439	
	N	9	31	32	3	1	1	0
	SE	2.2	6.4	4.5	24.5	NA	NA	
2006	Mean	285	362	393	428		442	
	N	55	8	19	17	0	2	0
	SE	3.6	5.3	5.7	8.3		35.0	
2007	Mean	317	357	386	454	414		461
	N	11	43	2	2	4	0	1
	SE	16.4	4.8	49.5	35.5	11.0		NA
2008	Mean	265	338	380	403		416	
	N	8	15	10	2	0	2	0
	SE	11.1	3.3	8.6	2.0		16.0	
2009	Mean	288	348	375	400			
	N	12	28	8	3	0	0	0
	SE	5.3	6.4	8.3	19.4			
<b>Mean of means</b>		289	352	385	416	420	432	461

Table 18. Mean annual growth increments for sauger collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2004-2005, 2005-2006, 2006-2007, 2007-2008 and 2008-2009 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
<b>2004-2005</b>	80	67	34	27	46	0
<b>2005-2006</b>	74	41	37	0	16	0
<b>2006-2007</b>	72	24	61	0	0	19
<b>2007-2008</b>	21	23	17	0	2	0
<b>2008-2009</b>	83	37	20	--	--	--

Table 19. Age distribution, from otolith analysis, of sauger collected from Lake Francis Case with variable-mesh gill nets, 2005-2009. Mean age excludes age-0 fish.

Year	Age								
	0	1	2	3	4	5	6	7	Mean
2005	2	9	31	32	3	1	1	0	2.5
2006	0	55	8	19	17	0	2	0	2.1
2007	2	11	43	2	2	4	0	1	2.2
2008	0	8	15	10	2	0	2	0	2.4
2009	5	12	28	8	3	0	0	0	2.0

### Population Parameters for Smallmouth Bass

Smallmouth bass CPUE for the 2009 gill net survey (Table 8) increased to 0.6 fish/net night, within the range for the 2005-2009 sampling period. Smallmouth bass CPUE in 2009 electrofishing samples (Table 7) increased at all sampling locations with the exception of Ft. Randall Dam. Mean length-at-age-at capture data for LFC smallmouth bass for the 2005-2009 period are presented in Table 20. Lake Francis Case smallmouth bass typically surpass 300 mm in length at age 2. Smallmouth bass growth decreased during 2009 for all age classes (Table 20). Smallmouth bass condition for stock-quality size smallmouth bass remains excellent, as  $W_t$  values from fish in the gill net survey were above 100 for all length categories (Table 15).  $W_t$  values for stock-quality, quality-preferred, and preferred length smallmouth bass was 107, 103, and 101 respectively during 2009 (Table 15).

Table 20. Mean length-at-age-at-capture (mm) for smallmouth bass, as determined by aging otoliths collected in the standard September gill net survey, 2005-2009, Lake Francis Case, South Dakota. N=sample size.

Year		Length at age at capture (mm)			
		1	2	3	
2005	Mean	232	317	374	
	N	4	9	1	0
	SE	5.5	7.2	NA	
2006	Mean	235	302	307	
	N	7	9	4	0
	SE	6.1	9.4	35.2	
2007	Mean	251	330	307	
	N	2	2	3	0
	SE	6.5	1.5	20.3	
2008	Mean		311	352	400
	N	0	8	1	1
	SE		30.1	NA	NA
2009	Mean	191	296	300	
	N	3	13	1	0
	SE	7.7	7.1	NA	
<b>Mean of means</b>		227	311	328	400

Table 21. Mean annual growth increments for smallmouth bass collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2004-2005, 2005-2006, 2006-2007, 2007-2008 and 2008-2009 periods, as determined by aging otoliths.

Year	Growth increment added during period (mm)		
	1-2	2-3	3-4
2004-2005	87	68	0
2005-2006	70	0	0
2006-2007	95	5	0
2007-2008	60	22	93
2008-2009	--	11	--

Three year classes were represented in the 2009 gill net sample, with a mean age of 1.9 years (Table 22). Smallmouth bass PSD for the gill net sample decreased from 88 in 2008 to 71 in 2009 (Table 16). Age-2 smallmouth bass accounted for a majority of the fish in the sample with little evidence of recruitment during 2008 and 2009. Annual survival, for pooled 2008 and 2009 gill net data was 57%, near the low for the five-year period (Table 14). Lengths of fish sampled by spring electrofishing ranged from 60mm to 380 mm TL, while those collected by fall gill nets ranged from 180 mm to 350 mm TL (Figure 6).

Table 22. Age distribution, from otolith analysis, of smallmouth bass collected from Lake Francis Case with variable-mesh gill nets, 2005-2009. Mean age excludes age-0 fish.

Year	Age					Mean
	0	1	2	3	4	
2005	4	4	9	1	0	1.8
2006	0	7	9	4	0	1.9
2007	1	2	2	3	0	2.1
2008	0	0	8	1	1	2.3
2009	0	3	13	1	0	1.9

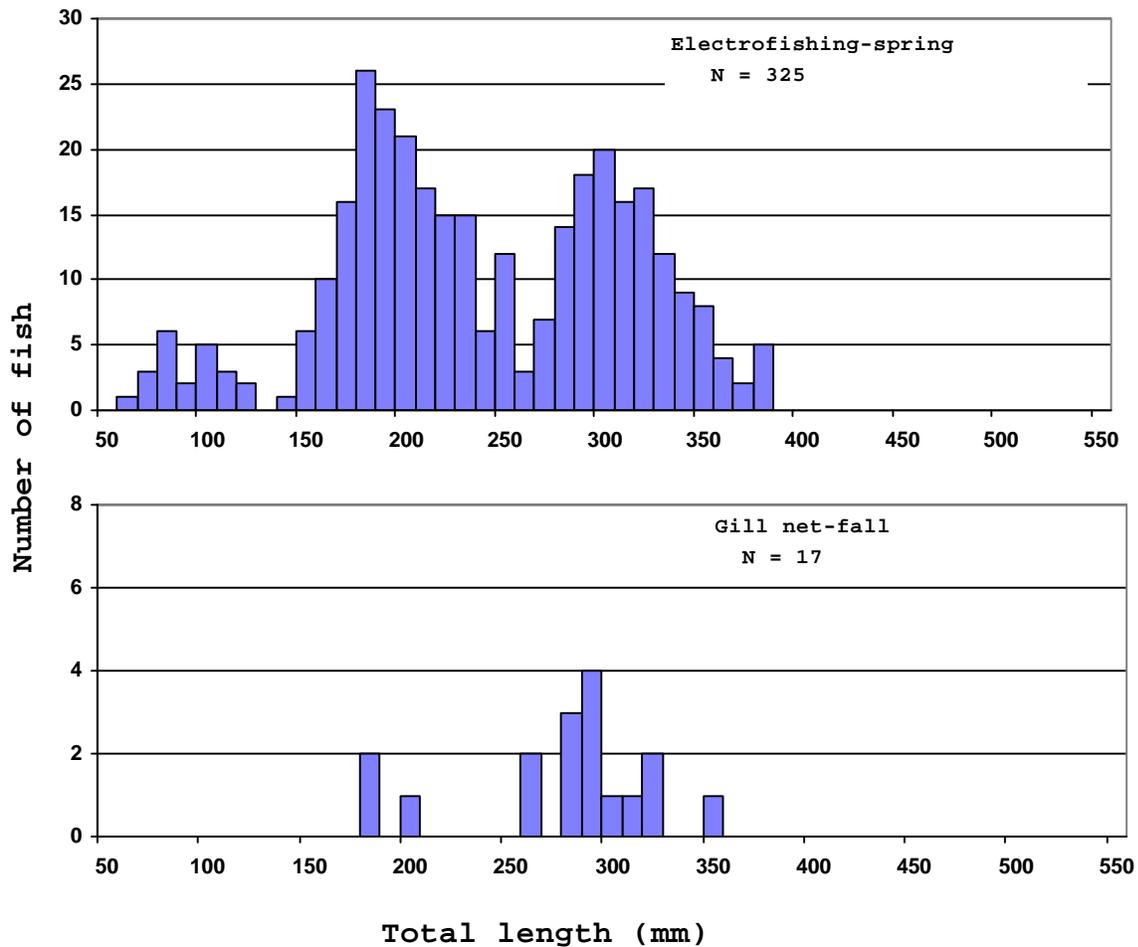


Figure 6. Length frequencies of smallmouth bass collected by spring electrofishing and fall gill netting from Lake Francis Case, 2009. *N* = sample size

## Population Parameters for Channel Catfish

Channel catfish 2009 gill net CPUE at 5.0 fish/net (Table 8) was similar to previous years in the five-year period. Channel catfish ranging from 200mm to 600 mm TL (Figure 7) were collected in the 2009 gill net survey. Mean annual back-calculated total length for 2009 showed similar growth to that seen in 2007, the last time back-calculated total lengths were calculated (Table 23). Channel catfish PSD, PSD and mean  $W_r$  values are presented in Appendix 5.

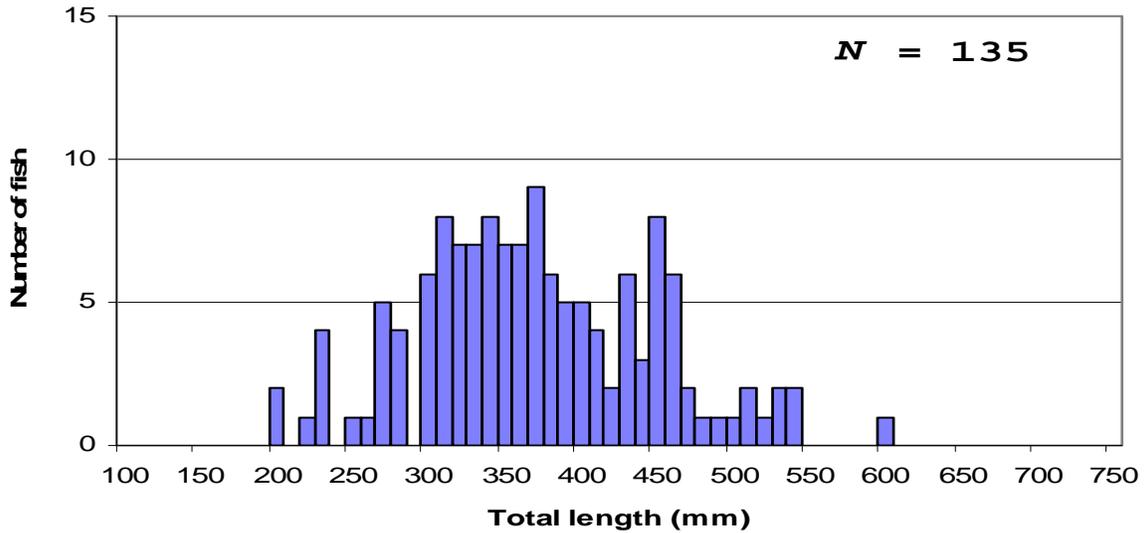


Figure 7. Length frequency of channel catfish collected with gill nets from Lake Francis Case, 2009.  $N$  = sample size.

Table 23. Mean annual back-calculated total lengths (mm) for each year class of channel catfish collected with variable-mesh gill nets during September 2009 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
2007	2	6	67	168												
2006	3	19	80	152	232											
2005	4	30	80	162	249	305										
2004	5	10	88	171	233	292	339									
2003	6	20	87	137	238	283	324	360								
2002	7	15	92	147	226	298	334	369	397							
2001	8	6	96	156	235	279	319	349	380	406						
2000	9	3	89	161	207	279	319	352	374	403	425					
1999	10	9	100	159	240	292	317	337	372	396	418	434				
1998	11	5	95	186	253	299	341	368	389	417	441	459	482			
1997	12	4	97	171	234	295	339	366	389	410	437	460	483	505		
1996	13	3	87	139	182	246	299	330	355	379	396	430	454	468	488	
1995	14	1	101	164	235	320	348	398	426	440	447	468	475	490	504	518
All classes			89	160	230	290	328	359	385	407	427	450	474	488	496	518
$N$		131	70	71	60	38	31	26	22	20	23	23	14	8	22	

### Water Temperature Monitoring

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

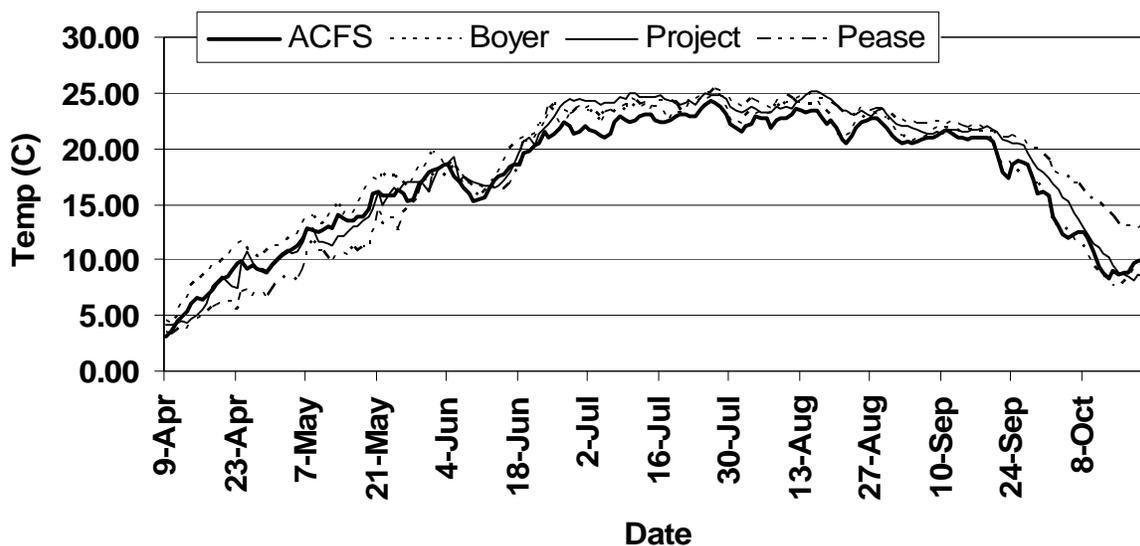


Figure 8. Water temperature in Lake Francis Case at American Creek Fisheries Station, Boyer, Pease Creek and Project Bay, 2009

## ANGLER USE AND SPORT FISH HARVEST SURVEY

### Fishing Pressure

Lake Francis Case anglers spent an estimated 587,786 hours (+/- 40,606 h, 80% CI) fishing during the April through September, 2009 creel survey period (Table 24). This estimate is similar to the 553,823 hours estimated for the same period in 2008 and significantly lower than that estimated during the 1998-2001 period (Table 1).

Table 24. Estimated total fishing pressure (angler hours), by month and zone, on Lake Francis Case, April-September, 2009 (+/- 80% confidence interval).

Zone	Apr	May	Jun	Jul	Aug	Sep	Total
1 - upper	31,057 (12,792)	60,971 (13,550)	33,128 (9,104)	27,840 (9,152)	12,904 (2,293)	9,554 (2,153)	175,454 (22,886)
2 - middle	10,831 (5,374)	44,557 (13,041)	60,807 (10,999)	37,005 (6,601)	19,386 (3,897)	7,451 (3,834)	180,037 (19,834)
3 - lower	3,468 (1,510)	45,592 (9,001)	68,660 (12,993)	58,501 (9,275)	38,187 (6,949)	17,886 (6,210)	232,295 (20,615)
Total	45,356 (13,957)	151,120 (20,850)	162,595 (19,305)	123,346 (14,606)	70,477 (8,291)	34,891 (7,609)	587,786 (36,636)

Estimated fishing pressure for the entire reservoir averaged 16.7 angler-h/ha (Table 25). The lower portion of the reservoir (Figure 1) received the heaviest pressure at 20.2 angler-h/ha (Table 25). The middle and upper portions of the reservoir received 19.6 and 12.0 angler-h/ha, respectively (Table 25). Peak fishing pressure occurred in May and June, a typical LFC pattern (Table 24, Figure 9).

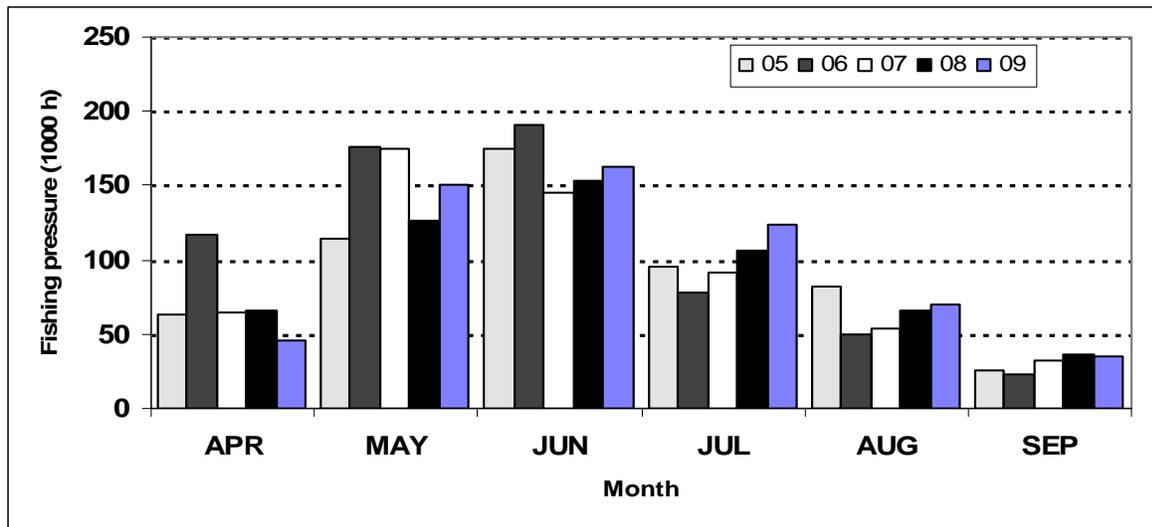


Figure 9. Estimated fishing pressure, by month, on Lake Francis Case, 2005-2009.

Table 25. Estimated total angler hours, for boat anglers, shore anglers, and angling methods combined, by zone, for Lake Francis Case, April-September, 2009.

Zone	Boat			Shore			Combined		
	Total angler hours	%	No. h/ha	Total angler hours	%	No. h/ha	Total Angler hours	%	No. h/ha
1 - upper	151,784	27	10.4	23,670	77	1.6	175,454	30	12.0
2 - middle	175,823	32	19.2	4,214	14	0.5	180,037	31	19.6
3 - lower	229,670	41	20.0	2,625	9	0.2	232,295	39	20.2
Tot/Ave	557,277	100	15.8	30,509	100	0.9	587,786	100	16.7

### Fish Harvest

Anglers fishing LFC, during the April-September 2009 period, harvested an estimated 189,985 fish (+/- 17,465 fish, 80% CI); all species, fishing methods and zones combined, including an estimated walleye harvest of 143,383 fish (+/- 12,724 fish, 80% CI; Table 26). Eighteen species of fish were observed in the 2009 harvest, with walleye accounting for 75% of the total number harvested (Table 26). White bass, sauger, channel catfish and smallmouth bass accounted for 11.4%, 3.9%, 3.8% and 3.3% of the 2009 estimated total harvest, respectively. Estimated sauger harvest in 2009 was 7,438 fish, a significant increase over the 2008 harvest estimate (Table 26). Sauger production from 2005 and 2007 currently supports a bulk of the sauger harvest. Harvest estimates for channel catfish and smallmouth bass decreased for 2009 (Table 26). The 2009 white bass harvest estimate of 21,733 fish was similar to the 2008 estimate of 24,129 fish (Sorensen and Knecht, 2010; Table 26). Good white bass production in 2004 and 2005 has supported a bulk of the white bass harvest for the past couple of years (Table 9). Smallmouth bass harvest decreased from 11,360 in 2008 to 6,830 in 2009 (Sorensen and Knecht 2010). Poor smallmouth bass recruitment since 2004 has resulted in a decrease in harvestable sized smallmouth bass (Sorensen 2004; Sorensen and Knecht 2006).

Table 26. Estimated total fish harvest, by month, for anglers fishing Lake Francis Case, April-September, 2009 (+/- 80% confidence interval).

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	8,632 (3,264)	1,172 (601)	98 (79)	573 (238)	550 (622)	114 (101)	0 (-)	0 (-)	11,138 (3,961)
May	35,622 (7,794)	4,192 (2,065)	3,378 (1,911)	311 (169)	1,295 (2,947)	262 (164)	105 (97)	320 (264)	45,484 (10,459)
June	31,717 (5,076)	871 (332)	1,593 (604)	625 (313)	5,596 (3,824)	46 (40)	28 (43)	842 (859)	41,317 (7,106)
July	47,386 (7,390)	761 (431)	1,302 (1,087)	2,655 (990)	6,989 (3,504)	110 (85)	153 (105)	636 (518)	59,993 (10,373)
August	16,232 (2,660)	284 (228)	381 (268)	2,280 (694)	6,060 (2,677)	0 (-)	140 (86)	410 (442)	25,787 (3,964)
September	3,793 (1,745)	159 (88)	78 (64)	735 (391)	1,243 (771)	0 (-)	14 (17)	243 (392)	6,266 (2,482)
Total	143,383 (12,724)	7,438 (2,232)	6,830 (2,298)	7,179 (1,342)	21,733 (6,613)	532 (215)	440 (173)	2,450 (1,884)	189,985 (17,465)

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

Estimated fish harvest during 2009, by survey zone (see Figure 1 for zone identification), resulted in anglers who fished the upper portion of the reservoir accounting for 37% of the harvest, followed by the lower and middle zones with 33 % and 30% of the harvest respectively (Table 27). Walleye and smallmouth bass harvest in 2009 was highest in the lower zone, while sauger, white bass and channel catfish harvest was highest in the upper zone of the reservoir (Table 27).

Table 27. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2009 (+/- 80% confidence interval).

Zone	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
1 - upper	46,219 (8,582)	5,894 (2,170)	426 (149)	4,280 (959)	12,724 (5,926)	102 (77)	84 (46)	933 (856)	70,663 (12,945)
2 - middle	45,648 (5,911)	889 (280)	2,350 (1,816)	2,215 (850)	5,289 (2,322)	307 (162)	177 (114)	677 (573)	57,553 (7,401)
3 - lower	51,516 (7,301)	655 (438)	4,054 (1,401)	684 (397)	3,719 (1,795)	122 (118)	179 (123)	1,607 (771)	61,769 (9,093)
Total	143,383 (12,724)	7,438 (2,232)	6,830 (2,298)	7,179 (1,342)	21,733 (6,613)	532 (215)	440 (173)	2,450 (1,884)	189,985 (17,465)

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

Estimated total fish harvest (Table 26) peaked in July during 2009. Walleye harvest also peaked in July (Figure 10), not typical of LFC, where pressure and harvest is normally highest in May and June (Stone 1995; Stone et al. 1994). Changes in walleye harvest regulations, initiated in 1990 and modified in 1999 and 2004, continue to maintain the walleye size structure at a level that allows sufficient numbers of legal-sized fish to be available for harvest during the period of the year that size limit regulations are in effect.

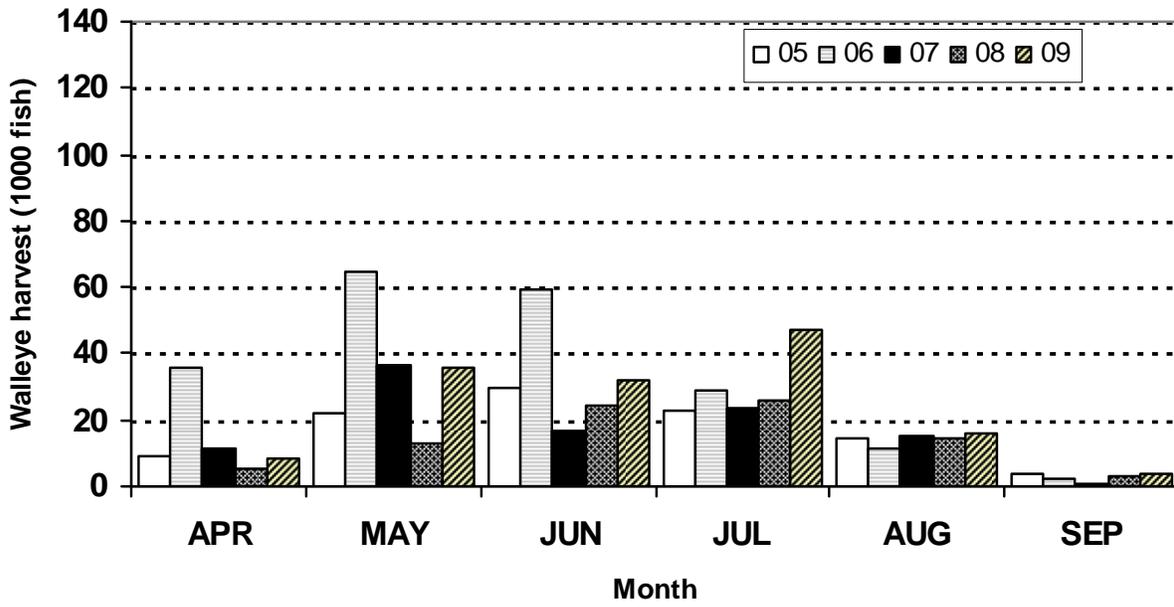


Figure 10. Estimated total walleye harvest, by month, for anglers fishing Lake Francis Case, 2005-2009.

Monthly length frequencies of angler-caught walleye (Figure 11) reflect the impact of the September-June 381-mm (15 inch) minimum-length limit. During April through June and September of 2009, very few walleye under 381 mm were harvested (illegal), while in July and August, fish under 381 mm were common in the walleye harvest. Mean size of walleye harvested by month remained near or above 381 mm (minimum length limit) during all months except July and August when the minimum length restriction is not in effect (Figure 11). Overall, mean length of walleye harvested by sport anglers has been considerably higher since the 1990 changes in walleye sport fishing regulations were implemented (Table 1). Table 28 provides statistics on the percentage of angling parties that caught a daily limit of walleye/sauger. The percentage of angling parties harvesting a limit was 7% in 2008 (Table 28), a significant increase from 3% measured in 2008.

Monthly length frequencies of angler-caught smallmouth bass are presented in Figure 12. For all months except August of the April-September creel survey period, the average length of harvested smallmouth bass was near or exceeded 300 mm.

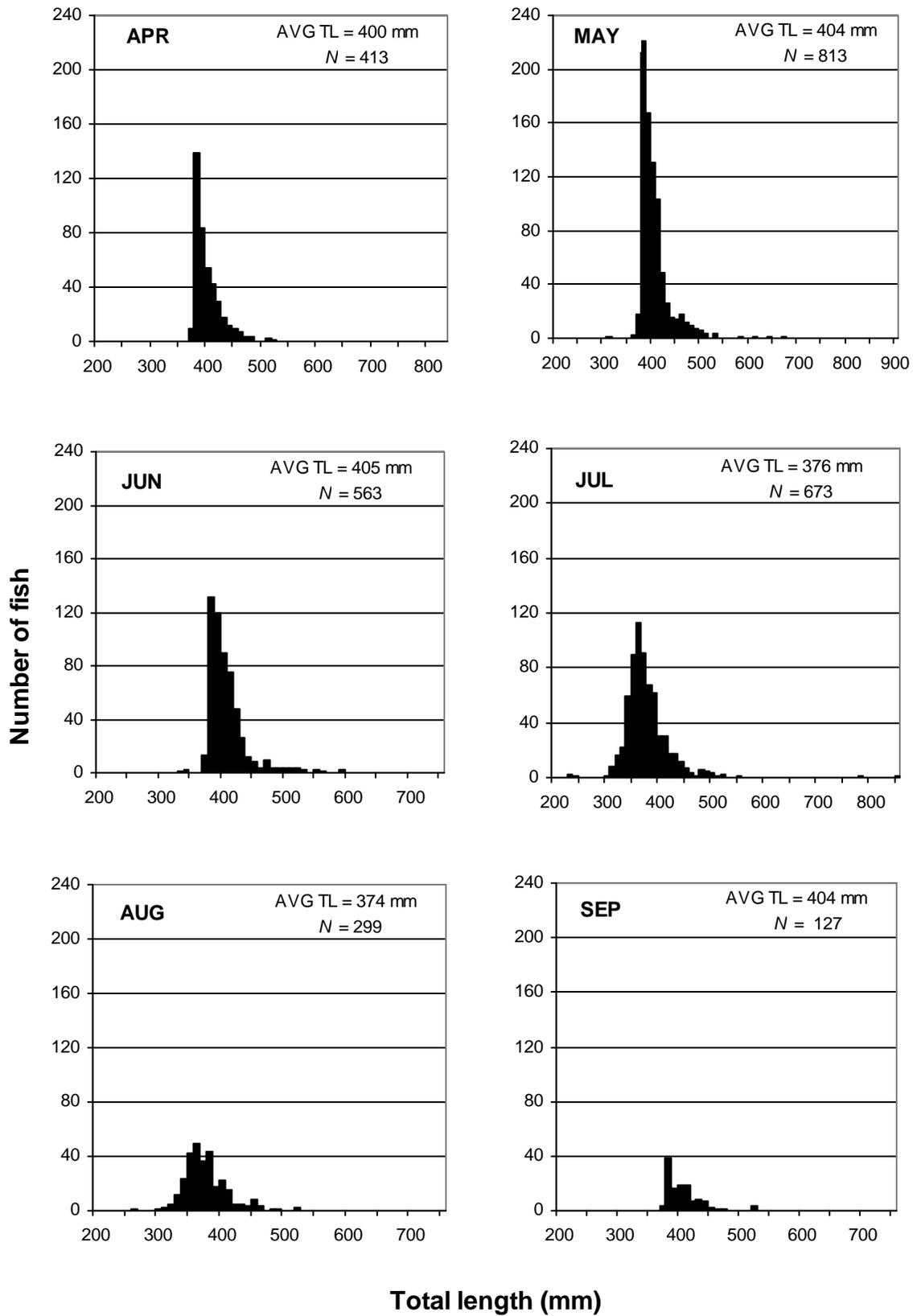


Figure 11. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2009. N = sample size.

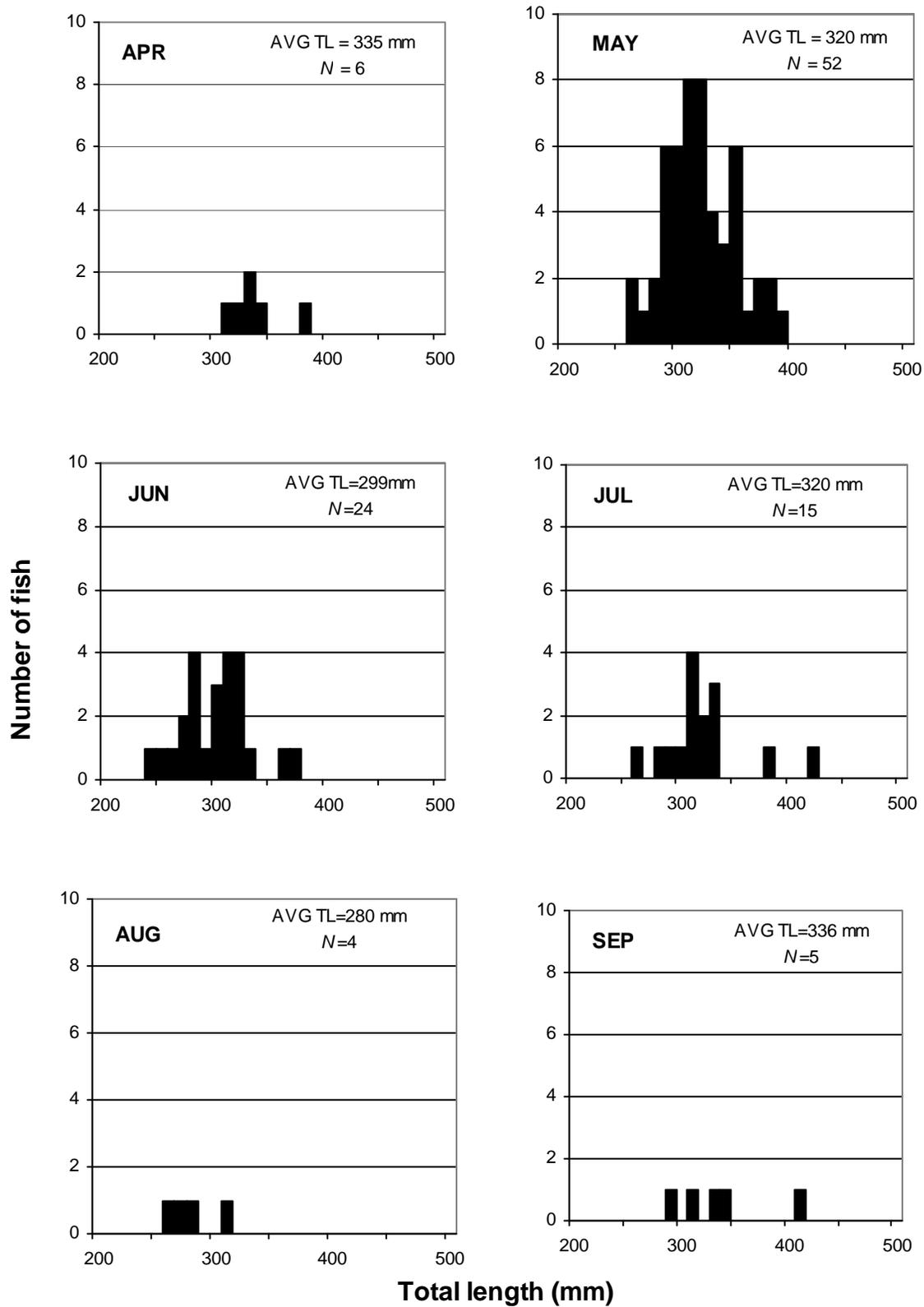


Figure 12. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2009. N = sample size.

Table 28. 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, 2005-2009.

Party success walleye-sauger/angler	2005*	2006	2007	2008	2009
Limit (4)		11	3	3	7
3.0 - 3.9	9	10	5	4	8
2.0 - 2.9	8	13	9	10	11
1.0 - 1.9	15	20	16	15	16
0.1 - 0.9	18	15	16	17	15
0	50	31	50	51	43

\* The daily limit for walleye/sauger was 3 in 2005

### Fish Caught and Released

Catch and release, either mandated by length-limit regulations or voluntary, has become an important component of the LFC sport fishery. Table 29 presents estimates of the number of fish released by month. For each species listed in Table 29, with the exception of sauger, the number of fish estimated to have been caught and released exceeded harvest estimates (Table 26). While the estimate of released fish is based on the angler's ability to recall what they released and may be biased up or down, it does provide trend data and gives a good indication of the magnitude of fish being released. The overall number of fish estimated to have been released by LFC anglers in 2009 was 436,083, similar to the 2008 estimate of 450,616 fish (Sorensen and Knecht 2010).

Table 29. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2009.

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	27,550	1,293	2,310	152	470	91	15	316	32,197
May	121,742	3,480	9,110	883	8,485	390	361	2,159	146,610
June	114,113	754	7,631	3,043	10,599	279	1,110	3,832	141,361
July	49,073	811	7,787	5,324	6,312	10	1,302	7,239	77,858
August	13,455	138	1,898	2,698	4,031	217	539	3,133	26,109
September	6,659	10	939	715	1,879	12	340	1,394	11,948
Total	332,592	6,485	29,675	12,814	31,775	1,000	3,667	18,075	436,083

\* OTH includes black bullhead, black crappie, bluegill, common carp, flathead catfish, freshwater drum, goldeye, green sunfish, largemouth bass, paddlefish, river carpsucker, shortnose gar, smallmouth buffalo and white crappie.

## Harvest, Release and Catch Rates

Mean harvest rate (species, type of fishing, and zones combined) for LFC, during 2009, was 0.32 fish/angler-h (Table 30), within the range of previous surveys (Table 1). An excellent overall catch rate (the 2009 harvest rate plus estimated release rate of 0.74 fish/angler-h) of 1.07 fish/angler-hour was estimated for the April through September 2009 daylight period (Table 31). Mean catch rates were highest during May while the mean harvest rate was highest during July (Table 31).

The mean walleye harvest rate was 0.24 walleye/angler-h (Table 32) for the 2009 April–September daytime period. Walleye harvest rates during July and August, when there is no minimum length restriction, remained higher than other months in the survey period with the exception of May. When the harvest rate for walleye was combined with the release rate, an overall catch rate of 0.81 walleye/angler-h was estimated (Table 32). This value is 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).

Catch and harvest rates for smallmouth bass, during 2009, are presented in Table 33. Smallmouth bass harvest and catch rate estimates for 2009 were similar to 2008 (Sorensen and Knecht 2010).

Table 30. Estimated harvest rate, release rate and catch rate, by species (+/- 80% confidence interval), for anglers fishing Lake Francis Case, 2009.

Species	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
Walleye	0.244 (0.038)	0.566 (0.107)	0.810 (0.143)
Sauger	0.013 (0.005)	0.011 (0.004)	0.024 (0.008)
Smallmouth bass	0.012 (0.004)	0.051 (0.014)	0.062 (0.015)
Channel catfish	0.012 (0.003)	0.022 (0.006)	0.034 (0.008)
White bass	0.037 (0.013)	0.054 (0.015)	0.091 (0.030)
Northern pike	0.001 (0.0004)	0.002 (0.001)	0.003 (0.001)
Yellow perch	0.001 (0.0003)	0.006 (0.001)	0.007 (0.002)
Other*	0.004 (0.003)	0.031 (0.010)	0.034 (0.012)
Species combined	0.323 (0.048)	0.742 (0.120)	1.065 (0.164)

\* Other includes black bullhead, black crappie, bluegill, common carp, flathead catfish, freshwater drum, goldeye, green sunfish, largemouth bass, paddlefish, rainbow trout, river carpsucker, shortnose gar, smallmouth buffalo and white crappie.

Table 31. Estimated harvest rate, release rate, and catch rate for all species combined (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2009.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.246 (0.218)	0.710 (0.776)	0.955 (0.991)
May	0.301 (0.100)	0.970 (0.286)	1.271 (0.379)
June	0.254(0.066)	0.869 (0.235)	1.124 (0.296)
July	0.486 (0.137)	0.631 (0.197)	1.118 (0.323)
August	0.366 (0.099)	0.371 (0.096)	0.736 (0.186)
September	0.180 (0.101)	0.342 (0.181)	0.522 (0.271)
Combined	0.323 (0.048)	0.742 (0.120)	1.065 (0.164)

Table 32. Estimated harvest rate, release rate, and catch rate of walleye (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2009.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.190 (0.229)	0.607 (0.902)	0.798 (1.130)
May	0.236 (0.079)	0.806 (0.243)	1.041 (0.317)
June	0.195 (0.047)	0.702 (0.192)	0.897 (0.236)
July	0.384 (0.104)	0.398 (0.135)	0.782 (0.233)
August	0.230 (0.063)	0.191 (0.056)	0.421 (0.116)
September	0.109 (0.066)	0.191 (0.120)	0.300 (0.178)
Combined	0.244 (0.038)	0.566 (0.107)	0.810 (0.143)

Table 33. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2009.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.002 (0.003)	0.051 (0.047)	0.053 (0.048)
May	0.022 (0.013)	0.060 (0.040)	0.083 (0.044)
June	0.010 (0.004)	0.047 (0.019)	0.057 (0.021)
July	0.011 (0.009)	0.063 (0.029)	0.074 (0.037)
August	0.005 (0.004)	0.027 (0.012)	0.032 (0.013)
September	0.002 (0.003)	0.027 (0.018)	0.029 (0.019)
Combined	0.012 (0.004)	0.051 (0.014)	0.062 (0.015)

## Angler Demographics and Economics

Twenty-seven percent of anglers contacted on LFC during 2009 were non-residents, similar to values estimated for the previous five years (Sorensen and Knecht 2006, 2007, 2008, 2009, 2010). Non-resident anglers from 18 states were contacted during 2009, (Table 34) with Iowa, Nebraska and Minnesota anglers accounting for the majority of non-resident angler contacts. Figure 13 provides information on the county of residence of South Dakota anglers who fished LFC in 2009. Nearly 90% of resident LFC anglers in 2009 came from counties in the southeastern ¼ of the state (Figure 13).

Table 34. Percentage of non-resident anglers who fished Lake Francis Case, 2005-2009, by state of residence, expressed as percent of total non-residents.

State	2005	2006	2007	2008	2009
Iowa	42.6	44.0	38.9	42.8	42.5
Nebraska	39.2	32.6	40.0	39.6	39.1
Minnesota	12.6	13.2	9.8	11.2	12.7
Colorado	0.7	1.2	1.1	1.1	0.7
Wisconsin	0.7	0.4	0.8	1.3	0.2
Kansas	1.1	0.4	0.8	0.5	0.7
Missouri	-	1.4	1.1	0.5	0.2
Illinois	-	0.6	0.5	-	-
North Dakota	-	0.4	1.4	0.3	-
Florida	0.2	0.6	0.3	0.5	0.2
Montana	-	0.4	0.3	-	-
Wyoming	0.9	1.6	1.9	0.3	1.2
California	-	0.8	-	-	-
Other*	2.0	2.4	3.1	1.9	2.5

\*Other includes: Alabama, Arkansas, Georgia, Idaho, Indiana, North Carolina, Pennsylvania, Texas, and Washington.

Mean angler trip length (boat and shore combined) on LFC was 4.3 hours (Table 1), for the April-September, 2009 daylight period. The average angling party consisted of approximately 2.2 individuals in 2009 and anglers traveling at least 100 miles (one-way) to fish LFC, accounted for about 52 % of all trips (Table 35). A majority of anglers fishing Lake Francis Case in 2009 targeted walleye, similar to the past four years (Table 36).

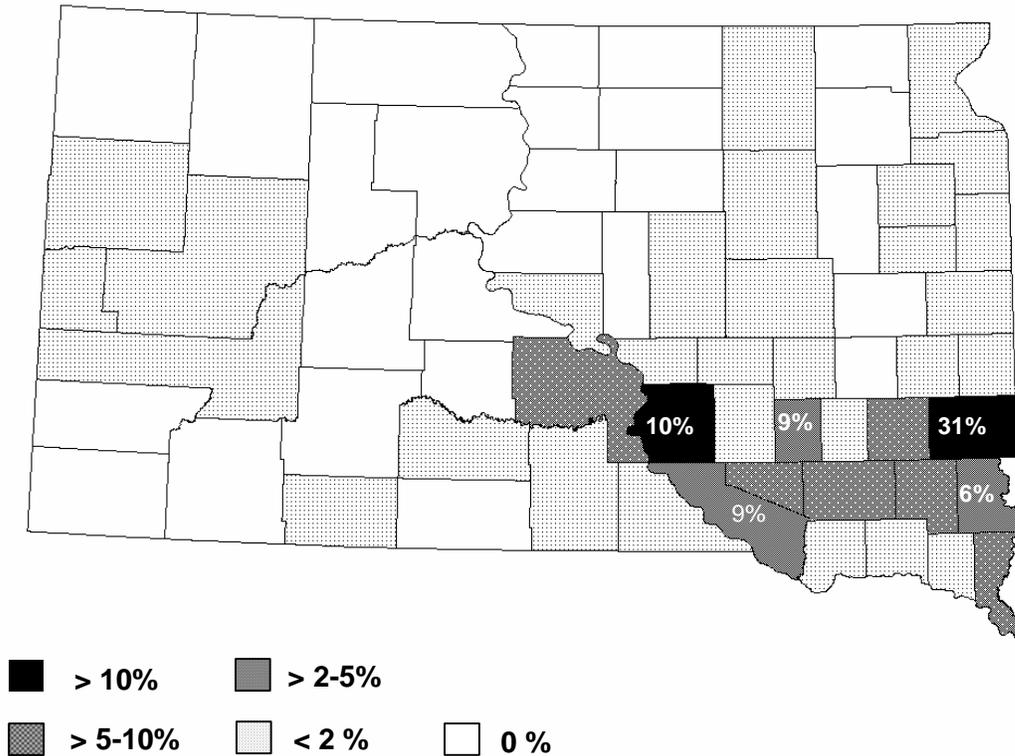


Figure 13. County of residence for resident anglers fishing Lake Francis Case in 2009. Percentage of total resident anglers is shown for the top five represented counties.

The 2009 LFC fishery had an estimated economic impact of nearly 10.6 million dollars to local economies, based on approximately 138,302 angling trips. 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 35. Percentage of anglers traveling specified distances, one way, to fish Lake Francis Case during 2005-2009.

Distance (miles)	2005	2006	2007	2008	2009
<25	12.2	11.0	15.9	15.0	15.9
25-50	16.5	17.7	16.2	17.2	16.9
51-100	15.5	15.6	15.8	17.3	15.3
101-200	39.8	40.7	35.6	36.9	40.2
201+	16.0	15.0	16.5	13.6	11.7

Table 36. Target species of Lake Francis Case anglers, during 2005-2009, expressed as a percentage of total angling trips.

Target species	2005	2006	2007	2008	2009
Walleye	90.9	95.6	92.0	89.3	85.4
Anything	4.6	1.6	5.1	6.4	6.5
Smallmouth bass	1.7	1.6	0.9	2.1	2.0
Other	2.8	1.2	2.0	2.2	6.1

## **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 primarily 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, 2010).

### **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, 70% of LFC anglers expressed some degree of satisfaction with their days fishing in 2009 versus approximately 22% who expressed some degree of dissatisfaction (Table 37). The 70% satisfaction rating falls within the range of previous surveys (Sorensen and Knecht 2006, 2007, 2008, 2009, 2010) and does meet the Missouri River Fisheries Program management objective of 70 % (SDGFP, unpublished document).

Table 37. Responses of 2009 Lake Francis Case anglers, by month, to the question: "Considering all factors, how satisfied are you with your fishing trip today?" 1 = Very Satisfied, 2 = Moderately satisfied, 3 = Slightly satisfied, 4 = Neutral, 5 = Slightly dissatisfied, 6 = Moderately dissatisfied, 7 = Very dissatisfied, N.O. = No opinion. Median excludes those with no opinion.

Month	Satisfied			Neut.	Dissatisfied			N.O.	Total	Median
	1	2	3	4	5	6	7			
Apr	50	41	8	6	14	2	3	1	125	2
May	67	29	36	13	22	6	9	1	183	3
Jun	57	30	26	10	19	7	8	2	159	3
Jul	40	36	23	9	14	7	6	1	136	3
Aug	10	28	15	11	10	6	6	0	86	3
Sep	6	17	11	8	15	3	5	1	66	4
Total	230	181	119	57	94	31	37	6	755	3
Percent	30.5	24.0	15.8	7.5	12.5	4.1	4.9	0.8	100	-
Combined	70.2			7.5	21.5			0.8	100	-

Angler satisfaction positively correlates to the number of walleye harvested per angler (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, 2010) showing a decrease in satisfaction and a corresponding increase in dissatisfaction as the number of walleye harvested per angler decreases. However, nearly 56% of the anglers 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 38. Responses of 2009 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	42	91.3	4	8.7	0	-
3 -- 3.9	60	90.9	5	7.6	1	1.5
2 – 2.9	77	88.5	6	6.9	4	4.6
1 – 1.9	83	75.5	14	12.7	13	11.8
0.1 – 0.9	82	71.9	26	22.8	6	5.3
0	184	55.8	107	32.4	39	11.8
Total	528	70.1	162	21.5	63	8.4

With current management regulations requiring the mandatory release of certain sizes of walleye/sauger, coupled with the voluntary release of a significant number of fish by LFC anglers, how anglers feel about their fishing trip, based on the total number of walleye/sauger caught versus harvested, may also be important. Table 39 provides angler satisfaction data categorized by the average number of walleye caught per angler. Similar to results presented in Table 38, about 50% of anglers questioned were still satisfied with their fishing trip despite catching no walleye (Table 39). Eighty percent of anglers who caught at least 4 to 7.9 walleye/angler indicated they were satisfied with their trip (Table 39).

Table 39. Responses of 2009 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 >	23	92.0	1	4.0	1	4.0
12-15.9	28	82.4	5	14.7	1	2.9
8-11.9	57	86.4	7	10.6	2	3.0
4-7.9	111	79.8	19	13.7	9	6.5
>0-3.9	228	69.9	69	21.2	29	8.9
0	81	49.7	61	37.4	21	12.9
Total	528	70.1	162	21.5	63	8.4

#### 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 2009 angler use and harvest survey were asked questions concerning these issues. When asked whether or not they had participated in a tournament held on Lake Francis Case within the past twelve months, nearly 18% of those interviewed during 2009 indicated they had (Table 40). Survey results concerning tournament participation in 2009 were consistent with previous survey results (Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010).

Table 40. 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?”, 2005-2009. Responses are presented as percentage of total responses. N = number of responses.

No. of Tournaments Participated in	2005		2006		2007		2008		2009	
	N	Percent								
0	705	83.5	664	77.2	486	86.5	504	82.6	619	82.3
1	85	10.1	112	13.0	44	7.8	64	10.5	66	8.8
2	26	3.1	35	4.1	10	1.8	19	3.1	28	3.7
3	9	1.1	21	2.4	9	1.6	7	1.1	22	2.9
4	8	0.9	8	1.0	5	0.9	6	1.0	10	1.3
>4	11	1.3	20	2.3	8	1.4	10	1.6	7	0.9

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. Angler participation in tournaments during this time frame may be different than other months of the survey period. The percentage of anglers participating in tournaments was higher during April and May than during other months of the survey period (Table 41) suggesting that tournament anglers represent a small portion of anglers using Lake Francis Case.

Table 41. Responses of 2009 Lake Francis Case anglers to the question: "Within the last 12 months, how many fishing tournaments have you participated in on Lake Francis Case?" Responses are presented as number of responses with percentage of total responses in parenthesis by month.

Month	Number of Tournaments Participated In						Total
	0	1	2	3	4	>4	
April	82 (68.3)	18 (15.0)	9 (7.5)	5 (4.2)	4 (3.3)	2 (1.7)	120
May	145 (78.8)	22 (12.0)	6 (3.3)	5 (2.7)	4 (2.2)	2 (1.1)	184
June	134 (86.5)	10 (6.5)	6 (3.9)	4 (2.6)	1 (0.6)	0 (0.0)	155
July	120 (88.2)	8 (5.9)	3 (2.2)	3 (2.2)	1 (0.7)	1 (0.7)	136
August	77 (87.5)	4 (4.5)	3 (3.4)	3 (3.4)	0 (0.0)	1 (1.1)	88
September	61 (88.4)	4 (5.8)	1 (1.4)	2 (2.9)	0 (0.0)	1 (1.4)	69
Total	619 (82.3)	66 (8.8)	28 (3.7)	22 (2.9)	10 (1.3)	7 (0.9)	752

When anglers were asked how they felt about the number of tournaments held on Lake Francis Case each year, 43% of 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, 53% of anglers believed there were too many tournaments on Lake Francis Case (Table 42). In addition, 43% believed there was about the right number, and 4% believed that there were too few tournaments held on Lake Francis Case annually (Table 42).

Table 42. Responses of 2009 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
<b>Including "No Opinion" Responses</b>		
Too Many	230	30.5
About the Right Number	187	24.8
Too Few	16	2.1
No Opinion	322	42.6
<b>Excluding "No Opinion" Responses</b>		
Too Many	230	53.1
About the Right Number	187	43.2
Too Few	16	3.7

With the popularity of competitive angling events, crowding at access facilities 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, 80 percent of interviewed anglers 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 43). 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 they may just view the access site as being generally crowded. However, with twenty percent of anglers being displaced by competitive angling events, this issue should be carefully monitored in the future (Table 43).

Table 43. Responses of 2009 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 by month and percentage of total responses.

Response			
Month	Yes	No	Total
Apr	23	97	120
May	36	147	183
Jun	31	126	157
Jul	36	101	137
Aug	14	74	88
Sep	14	55	69
Total	154	600	754
Percent	20.4	79.6	

## DISCUSSION

Lake Francis Case, supporting one of South Dakota’s most important walleye fisheries, continues to attract anglers from across the upper Midwest. Walleye, ranked the favorite species by 69% of respondents to a 1992 survey of South Dakota anglers (Mendelsohn 1994), continued to remain the target species of most LFC anglers. Since a peak in total walleye abundance in 1995, the LFC walleye population 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 previously expected. In 2005, water yield in the Missouri River basin began to recover 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 the continued presence of the 2005 and 2006 year classes led to increased abundance in 2009. Angler harvest has a significant effect on overall walleye abundance in Lake Francis Case. From 1996 through 2001, the estimated LFC walleye harvest was near or exceeded 200,000 fish, peaking at over 339,000 in 1998. This harvest, combined with low recruitment in 2000-2004 began to impact the number of legal-size walleye available for harvest beginning in 2003. Lake Francis Case walleye typically reach harvestable size at about three years of age. Walleye growth rates increased during 2005, but have decreased since 2005 due to the presence of two large year classes of walleye in the population. Walleye growth increased during 2008 and 2009. Walleye growth rates will need to be monitored closely in future surveys as the walleye population responds to modifications in size limit regulations and fluctuations in gizzard shad abundance. Walleye condition, as indexed by  $W_r$ , has remained unchanged since the initial 1990 regulation changes, despite variability in walleye and gizzard shad abundance over that same time period.

Water yield in the Missouri River system ranged between two extremes during the late 1990's to 2000's; from the record water yield measured in 1997 to drought conditions experienced between 2000 and 2008. These extremes in water yield undoubtedly played a significant role in shaping the fish populations of LFC. While changes to walleye management regulations in 1990 were given much of the credit for restructuring the LFC walleye population, resulting in the outstanding fishing that occurred throughout the latter half of the 1990's, the high water yield in the mid-1990's played a role that cannot be overlooked (Stone and Lott 2002). While walleye population abundance, size structure, and growth were showing positive trends in the early 1990's, when drought conditions still existed, the high walleye abundance levels reached in 1994 through 1998 were probably the result of improved habitat and nutrient conditions created by high water yield in 1995 and 1997 (Stone 1997b). As water yield in the Missouri River basin returned to normal and then below normal levels, it was unrealistic to expect that the high walleye abundance of the mid-1990's could be maintained. Water yield in the Missouri River Basin was below normal from 2000 through 2008. Persistent drought conditions resulted in poor reproduction and recruitment causing a steady decline in walleye abundance from 1998 through 2004. Localized runoff events in the spring of 2005 and 2006 provided conditions favorable to fish production resulting in two consecutive strong walleye year classes. Water yield in the Missouri River basin during 2009 was above normal, indicating a break in the drought cycle experience during the previous eight years. Good walleye production was measured as a result of this increased water yield.

Decreasing abundance of harvestable sized walleye has reduced walleye harvest rates as well as overall harvest to sustainable levels. Improvements in walleye population structure, as a result of length limit regulations, is reflected in the 398 mm (15.7 in.) mean length of walleye harvested during 2009, versus the 343 mm (13.5 in.) average estimated in 1989 (Stone 1995). Mean length of harvested walleye during 2009 was below 400 mm (15.7 in.) for the second consecutive year reflecting the decrease in abundance of older aged walleye in the population. However, despite a decline in overall walleye population abundance the past several years, a high proportion of anglers are still attaining the daily creel limit of 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 suggests that while most LFC anglers are satisfied with their overall fishing trip experience, they can be less satisfied (based on trip rating) with the numbers and sizes of fish caught (Stone and Sorensen 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010).

Smallmouth bass, which in previous years had ranked second in the sport fishery in terms of total fish caught (harvest and released), remain an important component in angler catches. Initially introduced as an alternative species that could direct fishing pressure away from walleye, they are now the target species of a small portion of LFC anglers. Smallmouth bass abundance, as measured by spring electrofishing CPUE, was similar to values observed during the 2008 survey for most sampling locations with the exception of the Ft. Randall Dam and Platte Creek sampling locations. The 2007 smallmouth bass year class comprises a majority of the current Lake Francis Case smallmouth bass population. 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. Along with smallmouth bass, sauger continue to contribute to the harvest. White bass significantly contributed to the 2009 sport fish harvest. The white bass population has a well distributed age and size structure and is capable of providing additional recreational opportunity. Channel catfish have maintained adequate abundance in recent years to support additional harvest.

Results from these surveys document the contribution and importance of the LFC fishery to the overall angling opportunities provided by the Missouri River system in South Dakota. Lake Francis Case continues to meet or exceed the objective of providing 100,000 angler days of recreation annually, as established in the Missouri River Fisheries Program Strategic Plan (SDGFP 1994). While overall walleye abundance in LFC increased during 2005 and 2006 due to strong year-classes produced during those years, decreasing overall abundance occurred in 2007 and 2008. Moderate walleye production once again spurred an increase in overall abundance during 2009. Walleye growth slowed from 2005 to 2008 prolonging the 2005 and 2006 year classes from entering the sport fish harvest. An increase in walleye growth was seen in 2009, possibly indicating better balance between predator and prey abundance in Lake Francis Case. Walleye growth should be closely monitored in future years. Anglers fishing Lake

Francis Case in 2010 should expect higher catches of harvestable sized walleye than those experienced in 2009. Improvements in overall catch rates are expected. A conservative walleye harvest in 2010 should lessen the degree of reduction in fishery quality. High angler catch rates combined with reduced overall walleye abundance will continue to have an effect on the Lake Francis Case walleye population in the near future. 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.

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

- 1) As discussed previously, history suggests that this walleye fishery is not capable of sustaining harvest near levels that occurred during 1996-2001, partially attributed to the unusually high water yield in the Missouri River Basin in the mid-late 1990s. As water yield in the basin returns to normal or above normal conditions, it is expected that walleye abundance will increase. However, the population cannot sustain the high harvest that has occurred in the past. Conservative annual walleye harvest from LFC will ensure quality fishing in the future.

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

- 3) The strong walleye year-classes produced in 2005 and 2006 currently support a bulk of the sport fish harvest. Conservative harvest of legal-sized walleye will lessen the effects of the poor reproduction and recruitment experienced during 2000-2004. Walleye production was low in 2008 and moderate in 2009.

## MANAGEMENT RECOMMENDATIONS

1. Continue and strive to improve reservoir fish population and creel surveys, as described in this report, on an annual basis. These surveys are essential for providing basic information on fish population abundance, reproduction and recruitment, growth and condition, survival and mortality, and sport fish use and harvest. Also, these surveys provide evaluation of progress towards objectives outlined in the Missouri River Fisheries Program Strategic Plan.
2. Revise and update the 1997 Lake Francis Case Fisheries Management Plan, with species specific goals, objectives, and management philosophies for walleye, smallmouth bass and paddlefish.
3. Continue public education efforts focusing on increasing angler awareness and compliance with current fishing regulations and the responsible use and harvest of LFC fisheries resources.
4. Continue annual review and evaluation of sport fishing regulations and their effectiveness.
5. Continue to incorporate angler attitude and preference questions in routine creel survey sampling. This technique provides valuable information with very little additional expense.
6. Continue standardized spring smallmouth bass electrofishing sampling. This technique is providing a more reliable long-term data set than fall gill netting.
7. Consider using fall age-0 nighttime electrofishing as an index to walleye year-class strength.
8. Future research projects that need to be considered and developed include:
  - a study to evaluate LFC smallmouth bass distribution and movement related to the annual fall draw-down of the reservoir.
  - a study to document LFC gizzard shad life history with special emphasis on spawning and over wintering habitat.
  - working with researchers at South Dakota State University to continue studies to evaluate the effects of inter-basin transfer of nutrients, zooplankton and fish between South Dakota Missouri River reservoirs on fish population status.
9. Monitor aquatic vegetation species diversity and track any changes while monitoring for exotic species introductions or spreading.
10. Increase public awareness of aquatic nuisance species and the threat they pose to waters of the Missouri River system in South Dakota.
11. Continue to document threatened and endangered fish observations and locations.
12. Develop standardized sampling techniques to index annual reservoir productivity.

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Appendix 1. Monthly water volume (1000's acre-feet) released through (power) or over (spill) Ft. Randall Dam, 2005-2009.

Month	2005		2006		2007		2008		2009	
	Power	Spill	Power	Spill	Power	Spill	Power	Spill	Power	Spill
Jan	754	0	526	0	778	0	724	0	672	0
Feb	342	0	647	0	536	0	537	0	335	0
Mar	817	0	712	0	253	0	407	0	664	0
Apr	958	0	681	0	408	0	711	0	756	0
May	1,156	0	1,063	0	471	0	610	0	1,011	0
Jun	982	0	1,399	0	922	0	395	0	1,337	0
Jul	1,279	0	1,599	0	1,298	0	961	0	1,498	0
Aug	1,420	0	1,816	0	1,254	0	1,349	0	1,571	0
Sep	1,439	0	1,564	0	1,187	0	1,167	0	1,710	0
Oct	638	0	764	0	706	0	950	0	1,598	0
Nov	553	0	588	0	470	0	399	0	935	0
Dec	763	0	651	0	658	0	780	0	881	0
Total	11,101	0	12,010	0	8,941	0	8,990	0	12,968	0

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

Common name	Scientific name	Abbreviation
Bigmouth buffalo	<i>Ictiobus cyprinellus</i>	BIB
Black bullhead	<i>Ameiurus melas</i>	BLB
Black crappie	<i>Pomoxis nigromaculatus</i>	BLC
Bluegill	<i>Lepomis macrochirus</i>	BGL
Brown trout	<i>Salmo trutta</i>	BNT
Channel catfish	<i>Ictalurus punctatus</i>	CCF
Common carp	<i>Cyprinus carpio</i>	CAP
Common shiner	<i>Notropis cornutus</i>	COS
Emerald shiner	<i>Notropis atherinoides</i>	EMS
Fathead minnow	<i>Pimephales promelas</i>	FHM
Flathead catfish	<i>Pylodictis olivaris</i>	FCF
Freshwater drum	<i>Aplodinotus grunniens</i>	FRD
Gizzard shad	<i>Dorosoma cepedianum</i>	GIS
Goldeye	<i>Hiodon alosoides</i>	GOE
Johnny darter	<i>Etheostoma nigrum</i>	JOD
Largemouth bass	<i>Micropterus salmoides</i>	LMB
Northern pike	<i>Esox lucius</i>	NOP
Northern redbelly dace	<i>Phoxinus eos</i>	NRD
Paddlefish	<i>Polyodon spathula</i>	PAH
Rainbow trout	<i>Oncorhynchus mykiss</i>	RBT
Red shiner	<i>Notropis lutrensis</i>	RES
River carpsucker	<i>Carpionodes carpio</i>	CPS
Sauger	<i>Sander canadense</i>	SAR
Shorthead redhorse	<i>Moxostoma macrolepidotum</i>	SHR
Shortnose gar	<i>Lepisosteus platostomus</i>	SNG
Shovelnose sturgeon	<i>Scaphirhynchus platyrhynchus</i>	SNS
Silvery minnow	<i>Hybognathus argyritis</i>	SIM
Smallmouth bass	<i>Micropterus dolomieu</i>	SMB
Smallmouth buffalo	<i>Ictiobus bubalus</i>	SAB
Spottail shiner	<i>Notropis hudsonius</i>	SPS
Walleye	<i>Sander vitreus</i>	WAE
White bass	<i>Morone chrysops</i>	WHB
White crappie	<i>Pomoxis annularis</i>	WHC
Yellow perch	<i>Perca flavescens</i>	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	$\text{Log}W_s = 3.180 * \text{Log}TL - 5.453$
Sauger	$\text{Log}W_s = 3.187 * \text{Log}TL - 5.492$
Smallmouth bass	$\text{Log}W_s = 3.200 * \text{Log}TL - 5.329$
Channel catfish	$\text{Log}W_s = 3.294 * \text{Log}TL - 5.800$
Yellow perch	$\text{Log}W_s = 3.230 * \text{Log}TL - 5.386$
White bass	$\text{Log}W_s = 3.081 * \text{Log}TL - 5.066$

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	<i>N</i>	Equation	R <sup>2</sup>	X TL (mm)	X WT (gm)
Walleye	2005	316	$\text{Log}WT = 3.244 \text{Log}TL - 5.693$	0.99	363	447
	2006	497	$\text{Log}WT = 3.045 \text{Log}TL - 5.217$	0.99	314	288
	2007	234	$\text{Log}WT = 3.122 \text{Log}TL - 5.420$	0.99	332	328
	2008	223	$\text{Log}WT = 3.120 \text{Log}TL - 5.384$	0.99	337	376
	2009	323	$\text{Log}WT = 3.114 \text{Log}TL - 5.383$	0.99	341	386
Sauger	2005	89	$\text{Log}WT = 3.076 \text{Log}TL - 5.333$	0.99	365	374
	2006	106	$\text{Log}WT = 2.916 \text{Log}TL - 4.952$	0.94	338	295
	2007	73	$\text{Log}WT = 2.994 \text{Log}TL - 5.152$	0.97	352	316
	2008	35	$\text{Log}WT = 2.691 \text{Log}TL - 4.365$	0.84	345	315
	2009	60	$\text{Log}WT = 3.126 \text{Log}TL - 5.453$	0.99	310	266
SM Bass	2005	18	$\text{Log}WT = 3.286 \text{Log}TL - 5.499$	0.99	297	453
	2006	23	$\text{Log}WT = 2.930 \text{Log}TL - 4.687$	0.99	280	328
	2007	9	$\text{Log}WT = 3.461 \text{Log}TL - 5.990$	0.99	255	309
	2008	8	$\text{Log}WT = 2.501 \text{Log}TL - 3.588$	0.96	311	450
	2009	17	$\text{Log}WT = 3.057 \text{Log}TL - 4.965$	0.99	278	350

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 2005-2009, for fish collected from Lake Francis Case.  $N$  = sample size.

Species	2005				2006				2007				2008				2009			
	PSD	PSD		$W_r$	PSD	PSD		$W_r$												
		P	M			P	M			P	M			P	M					
Channel catfish	46	2	0	78	40	2	0	80	52	1	0	77	37	1	0	82	35	0	0	84
$N =$	110				153				154				151				135			
White bass	22	22	36	99	100	29	18	95	96	85	24	95	100	90	30	90	100	86	7	97
$N =$	81				34				30				14				19			
Yellow perch	23	0	0	80	33	8	0	89	25	0	0	77	27	0	0	86	25	0	0	90
$N =$	66				22				9				15				28			