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ANNUAL FISH POPULATION AND ANGLER USE AND SPORT FISH HARVEST SURVEYS ON LAKE FRANCIS CASE, SOUTH DAKOTA, 2010

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Game, Fish and Parks**
**Wildlife Division
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ANNUAL FISH POPULATION
AND
ANGLER USE AND SPORT FISH HARVEST SURVEYS
ON
LAKE FRANCIS CASE, SOUTH DAKOTA, 2010

by

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PREFACE

Information collected during 2010 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 2006 through 2010, 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 fish use and harvest, and evaluation of management activities and regulations.

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

Fall gill netting collected eighteen fish species. Walleye and Sauger CPUE (No./net night) in 2010 increased from 2009. Channel catfish and white bass CPUE in 2010 decreased from that observed in 2009. Smallmouth bass and yellow perch CPUE during 2010 increased from 2009.

Eighteen species of age-0 fishes or small littoral prey species were collected by seining in 2010. Age-0 white bass were most common in 2010 seine catches, accounting for 54% of the total catch, while gizzard shad, emerald shiners, and black bullhead accounted for 39%, 3% and 2% of the total catch, respectively. Fathead minnow, goldeye, red shiner, smallmouth bass, spottail shiner, white crappie, and yellow perch were also common in seine catches.

Walleye survival and mean age decreased in 2010. Relative weight (*Wr*) and proportional size distribution (PSD) increased during 2010 from 2009. Overall walleye abundance during 2010 increased from 2009. Walleye growth in 2010 increased from 2009. Sauger gill net CPUE in 2010 increased from 2009. Sauger PSD and survival in 2010 decreased from 2009. Sauger mean age decreased during 2010 while growth increased from 2009 values. Smallmouth bass gill net CPUE in 2010 increased from 2009. Smallmouth bass PSD and survival decreased during 2010. Smallmouth bass mean age decreased while growth increased during 2010.

Anglers spent an estimated 480,884 hours fishing LFC, during the April-September 2010 daylight period, a decrease from the 587,786 hours estimated for 2009 and over 500,000 hours less than the high estimated for 1999. Total fish harvest in 2010 was estimated at 136,457 fish. Walleye dominated the harvest, with an estimated 102,973 harvested in the April-September 2010 survey period. Estimated mean length of harvested walleye was 41.1 cm (16.2 in). White bass, sauger, channel catfish, smallmouth bass, and yellow perch were also common in the harvest. An overall catch rate (harvest and release rates combined) of 0.75 fish/angler-h was estimated for the April-September 2010 daylight period. Total catch, release, and harvest rates for walleye were 0.49 walleye/angler-h, 0.27 walleye/angler-h, and 0.21 walleye/angler-h, respectively. Approximately 67% of LFC anglers expressed some degree of satisfaction with their angling trip. Anglers from South Dakota and 16 other states, fishing LFC, generated a local economic impact estimated at approximately 8.6 million dollars in 2010. Results from several questions regarding LFC angler attitudes and preferences are reported.

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INTRODUCTION

Lake Francis Case (LFC), a Missouri River mainstem reservoir, has provided more than 100,000 angler days annually since 1992 (Table 1). The river segments and reservoirs comprising the Missouri River system in South Dakota provide a large and diverse portion of the state's available fishing opportunities. The importance of this system to South Dakota anglers was documented in a 2010 Resident Fishing Activity, Harvest and Angler Opinion Survey (Gigliotti, 2011), in which 50 percent of the respondents reported as having fished the Missouri River and its reservoirs. Recognizing the importance of the Missouri River, strategic planning efforts (SDGFP 1994) by the South Dakota Department of Game, Fish and Parks (SDGFP) have designated the Missouri River as a specific planning program within the overall planning effort.

Walleye, and to a lesser extent smallmouth bass, white bass and channel catfish, provide the majority of sport fishing opportunity available in this reservoir. Over the past 30 years, management of the walleye sport fishery has undergone several significant changes in response to changes in walleye population structure and angler use and harvest (Stone 1990; Stone et al. 1994; Stone and Sorensen 1999, 2001; Sorensen and Knecht 2006). Harvest regulations for walleye/sauger and their hybrids for LFC in 2010 included:

- daily and possession limits of 4 and 8 per angler, respectively.
- a minimum length limit of 381 mm (15 in.) for all months of the year except July and August.
- anglers are allowed only one walleye/sauger or hybrid per day longer than 508 mm (20 in.), year-round.
- anglers are not allowed to "cull" or "hi-grade" walleye/sauger or hybrids.
- anglers fishing through the ice in the lower half of the reservoir are required to keep the first four walleye/sauger or hybrids they catch and size restrictions do not apply.
- closed area: the area in the upper portion of the reservoir, between I-90 and the railroad bridge, referred to as the "dredge hole" is closed to fishing (except shore fishing on the Brule County side) during the months of January through April and December.

LFC anglers fishing in the late 1990s and early 2000s benefited from high walleye abundance resulting from unusually high water levels in 1995 and 1997. Water yield in the Missouri River Basin was below normal for the 2000-2007 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) suggests that it is unrealistic to expect fish population abundance at levels observed in the mid-to-late 1990s during low run-off conditions. Walleye abundance steadily decreased from 1995 to 2004 due to persistent drought conditions. Increases in overall walleye abundance have been documented during 2005 and 2006 followed by a sharp decrease in 2007. Walleye abundance in 2008 was similar to 2007, but increased during 2009 and 2010.

Maintaining LFC as one of South Dakota's most productive fisheries requires that it be effectively managed to produce optimal recreational benefits, within the framework of protecting and maintaining the overall integrity of the aquatic community. The Missouri River Fisheries Program Strategic Plan (SDGFP 1994) documents the goals, objectives and strategies developed for management of this system. Annual acquisition and analysis of data describing the fish community and fish population parameters, in association with data describing angler use and sport fish harvest, is a primary strategy outlined in that plan. This work is required for evaluation of objectives and strategies outlined in the strategic plan and as a prerequisite to effective development of future management strategies. This report describes data collected in 2010 from LFC and the discussion focuses on changes in fish populations and associated angler use and sport fish harvest since 2006.

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 (1996)
1996	856,421	190,316	4.5	324,221	274,339	0.379	0.320	383	Stone (1997a)
1997	652,510	143,409	4.6	307,297	285,463	0.471	0.437	385	Stone (1998)
1998	961,343	204,324	4.7	397,535	339,889	0.413	0.354	396	Stone and Sorensen (1999)
1999	997,871	212,902	4.7	359,440	285,186	0.360	0.286	417	Stone and Sorensen (2000)
2000	809,806	149,964	5.4	248,234	196,795	0.306	0.243	412	Stone and Sorensen (2001)

Table 1 continued

Year	Fishing pressure (h)	Angler days	Mean trip length (h)	Total fish harvest (No.)	Walleye harvest (No.)	Total harvest rate (Fish/ 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 (2010a)
2009	587,786	138,302	4.3	189,985	143,383	0.323	0.244	398	Sorensen and Knecht (2010b)
2010	480,884	112,094	4.3	136,457	102,973	0.284	0.214	411	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

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 2010 remained above average for the second consecutive year (Appendix 1; U.S. Army Corps of Engineers, unpublished data). During the spring of 2010, the elevation of LFC increased quickly exceeding elevation 413 m msl (1354.3 ft. msl) by mid-March and remained at or above this level until early September when the U.S. Army Corps of Engineers (USCOE) began the annual fall draw-down (Figure 2). Appendix 1 presents monthly data on water released through Ft. Randall Dam.

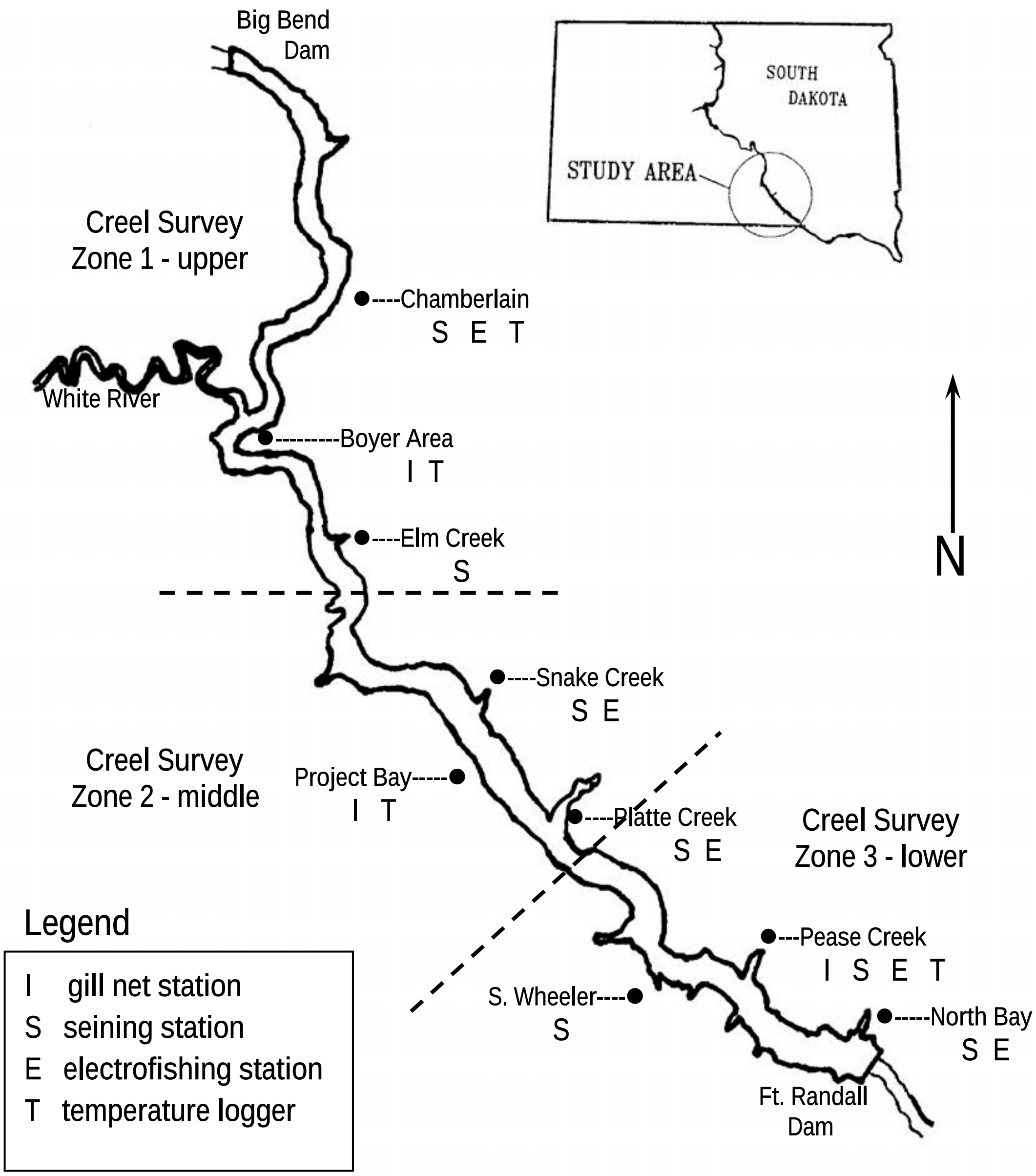

Figure 1. Lake Francis Case study area.

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

	Lake Francis Case
Location:	From Pickstown to Ft. Thompson, SD
Surface Area (x 1000 ha):	32.0
Depth (m) - maximum: - mean:	42.6 15.2
Bottom:	Sand, gravel, shale and silt
Water source:	Missouri River and tributaries
Management classification:	Cool and warm water permanent
Electrofishing - walleye - smallmouth bass	April, May, 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

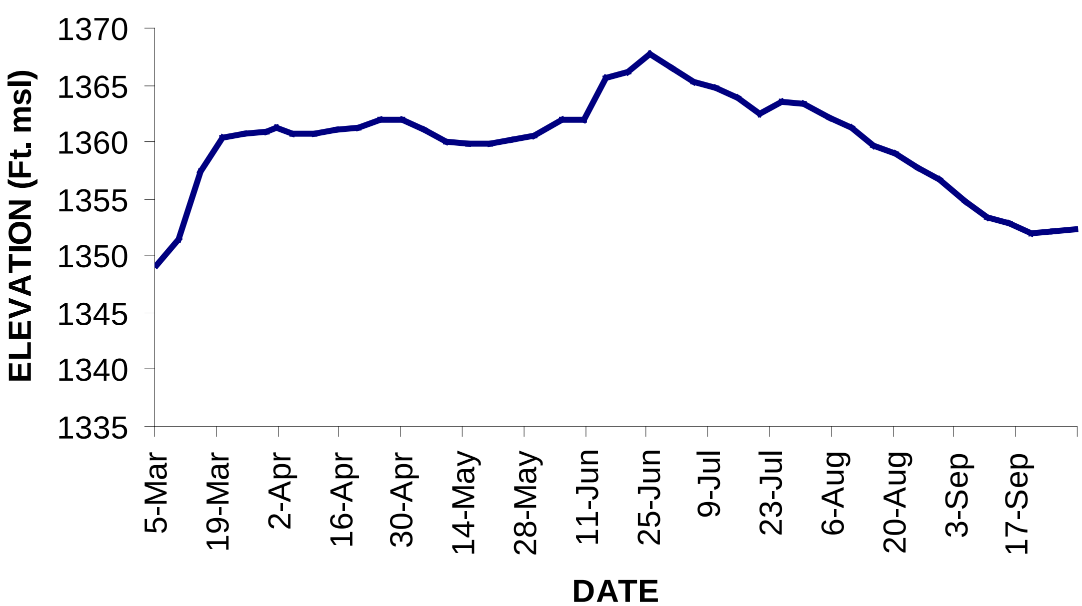

Figure 2. Spring 2010 Lake Francis Case reservoir elevation.

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 (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 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 in April, smallmouth bass in May and June, and age-0 walleye in 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.

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. All walleye were measured.

Water temperature data was collected with submersible HOBO Water Temp Pro temperature loggers. Loggers, configured to record temperature every two hours, were deployed at four locations (Figure 1) on the reservoir April 9, 2010 and retrieved October 10, 2010.

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 (PSD) values for preferred- (PSD-P) and memorable- (PSD-M) length fish were calculated for channel catfish, sauger, smallmouth bass, walleye, white bass, and yellow perch (Anderson and Weithman 1978; Gabelhouse 1984). Length categories (Gabelhouse 1984) used to calculate PSD are listed in Table 3.

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

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

Relative weight (W_r; Anderson 1980), for stock-to-quality (S-Q), quality-to-preferred (Q-P), and preferred-length (P) fish (Table 3) was calculated using length designations established by Gablehouse (1984). Relative weight (W_r) values were generated using standard weight (W_s) equations developed for walleye (Murphy et al. 1990), sauger (Guy et al. 1990), smallmouth bass (Kolander and Willis 1993), channel catfish (Brown et al. 1995), yellow perch (Willis et al. 1991), and white bass (Brown and Murphy 1991). Standard weight equations used in this report are provided in Appendix 3. Mean W_r values were tested for differences among length-class designations using a one-way analysis of variance (SYSTAT, 1998). A mean W_r value for stock-length fish is reported when no significant differences were detected among length categories and alpha values were set at $P = 0.05$.

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

Surveying was conducted from 1 April 2010 through 30 September 2010, 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 implications for current reservoir fisheries management.

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

RESULTS

FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES

Species Composition and Relative Abundance

Overall walleye electrofishing CPUE in 2010, near Chamberlain, was similar to values measured in 2009 (Table 4). Sampling near Ft. Randall Dam, during 2010, yielded a CPUE within the range of the five-year period (Table 5). Walleye electrofishing CPUE near Chamberlain peaked on 12 April 2010 and were similar for all sampling dates (Table 6). Electrofishing CPUE 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, 2006-2010. Catch per unit effort (CPUE) values with the same letter are not significantly different at the $P = 0.2$ level.

Year	Sampling time (min)	Number of fish	CPUE (fish/min)
2006	68	788	11.6 ab
2007	82	824	10.0 a
2008	54	893	16.5 b
2009	61	972	15.9 b
2010	55	990	18.2 b

Table 5. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Ft. Randall Dam, 2006-2010. 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)
2006	60	288	4.8 a
2007	64	404	6.3 a
2008	60	260	4.3 a
2009	60	332	5.5 a
2010	62	362	5.8 a

Table 6. Electrofishing data, by location and date, for walleye from Lake Francis Case, 2010. 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	4/12/10	10.8	20	393	19.7 a
Chamberlain	4/19/10	11.1	15	271	18.1 a
Chamberlain	4/27/10	11.2	20	326	16.3 a
Ft. Randall Dam	4/20/10	7.6	32	192	6.0 a
Ft. Randall Dam	4/28/10	7.7	30	170	5.7 a

Catch-per-unit-effort of smallmouth bass in 2010 was similar to those measured previously for the Chamberlain, Pease Creek and Fort Randall sampling stations (Table 7). A significant decrease in smallmouth bass CPUE was observed at the Platte Creek sampling station while the Big Bend Tailwater sampling station experienced a significant increase in smallmouth bass CPUE (F=14.1; p=0.00). Smallmouth bass CPUE of 2.1 fish/min. was the highest of the five-year period for the Big Bend sampling station (Table 7).

Table 7. Electrofishing catch of smallmouth bass during spring sampling, at five locations on Lake Francis Case, 2006-2010. Catch per unit effort (CPUE) values within sites with the same letter code are not significantly different at the *P* = 0.2 level.

Year	Sampling time (min)	Number of fish	Fish/min
Big Bend Dam Tailwater			
2006	45	65	1.4 a
2007	45	33	0.9 ab
2008	45	26	0.6 b
2009	45	32	0.7 b
2010	45	95	2.1 c
Chamberlain			
2006	47	102	2.2 a
2007	36	95	2.6 a
2008	30	47	1.6 a
2009	45	104	2.3 a
2010	30	59	2.0 a
Platte Creek			
2006	45	62	1.4 a
2007	60	55	0.9 ab
2008	45	21	0.5 bc
2009	45	63	1.4 a
2010	45	15	0.3 c
Pease Creek			
2006	45	61	1.4 a
2007	45	79	1.8 a
2008	45	61	1.4 a
2009	45	76	1.7 a
2010	45	44	1.0 a
Ft. Randall Dam			
2006	45	66	1.5 a
2007	45	44	1.0 a
2008	30	64	2.1 b
2009	45	53	1.2 a
2010	45	112	2.5 a

Fall gill-net sampling collected 18 species of fish from LFC in 2010 (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 36% of gill net catches in 2010, followed by gizzard shad, sauger, yellow perch, white crappie, and channel catfish, which accounted for 14%, 10%, 9%, 9% and 8% of the catch, respectively. Common carp, freshwater drum, goldeye, and smallmouth bass were also common in gill-net catches during 2010.

Walleye gill net CPUE for 2010 was 18.9 walleye/net. Walleye gill net CPUE was higher than 2009 and similar to the 2006 value (Table 8). An increase in abundance was anticipated resulting from high production of walleye in 2005 and 2006 grow and comprise a bulk of the population. Good walleye reproduction occurred during 2010.

Channel catfish gill net CPUE, of 4.2 fish/net in 2010, was similar to other years of the five-year period. Sauger gill net CPUE increased in 2010 to 5.2 sauger/net and is at a high for the five-year period. Smallmouth bass gill net CPUE for 2010 increased to 0.9 smallmouth bass/net. Yellow perch gill net CPUE increased to 4.9 yellow perch/net in 2010, within the range of the five-year period. A 2010 white bass gill net CPUE of 0.4 white bass/net was the lowest for the five-year period.

Eighteen species of age-0 fishes or small littoral species were collected by seining in 2010 (Table 9). All species had been previously reported for LFC (Lott et al. 1994). Age-0 white bass dominated the seine catches making up 54% of the total seine catch. Emerald shiners and gizzard shad comprised three and 38 percent of the total seine catch, respectively. Black bullhead, fathead minnows, goldeye and yellow perch were also common in seine samples.

The 2010 age-0 walleye seining CPUE of 0.6 fish/seine haul was the low for the five-year period. Age-0 walleye were collected at the North Point, Pease Creek and American Creek sampling locations in 2010. A majority of age-0 walleye are usually collected in the upper half of the reservoir. Sixteen age-0 walleye were collected by seines in mid-July, 2010 and averaged 90.0 mm TL (Table 10).

Table 8. Mean gill net catch per lift (CPUE; No./net night), sampling stations combined, on Lake Francis Case, 2006-2010. SE is standard error. Trace (T) < 0.05.

Species	2006		2007		2008		2009		2010	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Black bullhead	0.0		0.0		0.0		0.0		0.4	0.2
Channel catfish	5.7	0.7	5.7	0.8	5.6	0.9	5.0	0.7	4.2	0.7
Common carp	1.7	0.4	1.8	0.5	1.6	0.4	1.0	0.3	0.9	0.3
Emerald shiner	T	-	0.0		0.0		0.0		0.0	
Freshwater drum	1.1	0.3	0.8	0.2	0.8	0.2	1.1	0.2	1.2	0.4
Gizzard shad	17.1	9.2	4.0	1.4	2.0	0.9	5.2	2.2	7.2	2.6
Goldeye	3.1	1.2	1.6	0.5	0.3	0.1	1.3	0.6	0.9	0.3
Northern pike	0.0		0.0		0.0		0.1	0.1	0.7	0.4
Rainbow trout	0.0		0.0		0.0		0.0		0.0	
River carpsucker	0.4	0.2	0.2	0.1	0.1	0.1	0.2	0.1	0.3	0.1
Sauger	3.9	0.6	2.7	0.8	1.4	0.3	2.3	0.5	5.2	1.4
Shorthead redhorse	T	-	0.1	0.1	T	-	0.1	0.1	0.4	0.2
Shortnose gar	0.2	0.2	0.4	0.3	0.6	0.5	T	-	0.5	0.3
Shovelnose sturgeon	0.0		0.0		0.0		T	-	0.0	
Smallmouth bass	0.9	0.2	0.3	0.1	0.3	0.2	0.6	0.2	0.9	0.3
Smallmouth buffalo	0.1	0.1	T	-	T	-	0.1	0.1	T	-
Spottail shiner	T	-	0.0		T	-	T	-	0.3	0.1
Walleye	18.4	1.8	8.7	1.2	8.3	1.2	12.0	1.4	18.9	3.4
White bass	1.3	0.4	1.1	0.3	0.5	0.2	0.7	0.2	0.4	0.3
White crappie	0.1	0.1	2.0	1.6	0.1	0.1	0.4	0.3	4.6	3.3
Yellow perch	0.8	0.2	0.3	0.1	0.6	0.2	1.0	0.3	4.9	1.4

Table 9. Mean catch per seine haul (CPUE; No./haul), sampling stations combined, of age-0 fishes and small littoral species from Lake Francis Case, 2006-2010. SE is standard error. Trace (T) < 0.05

Species	2006		2007		2008		2009		2010	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Bigmouth buffalo	0.0		T	-	0.1	0.1	0.3	0.2	0.2	0.1
Black bullhead	0.0		0.0		0.0		0.0		34.1	24.4
Black crappie	0.0		0.0		0.0		T	-	0.0	
Channel catfish	0.1	0.1	0.3	0.2	0.4	0.3	0.0		0.0	
Common carp	0.0		0.3	0.1	0.1	0.1	0.1	0.1	0.3	0.1
Common shiner	0.0		0.0		0.0		0.6	0.3	0.0	
Emerald shiner*	80.3	53.4	24.1	11.2	54.3	15.7	44.1	14.0	54.4	12.4
Fathead minnow*	T	-	0.1	0.1	0.0		0.1	0.1	11.6	5.8
Freshwater drum	1.9	0.8	16.5	8.8	17.3	8.3	0.1	0.1	0.0	
Gizzard shad	241.7	105.2	437.4	124.2	700.3	320.4	158.8	66.2	785.2	219.2
Goldeye	T	-	0.0		0.0		1.7	1.7	12.1	8.1
Johnny darter*	0.1	0.1	0.2	0.1	1.6	1.2	0.4	0.1	0.2	0.1
Largemouth bass	0.0		T	-	0.1	0.1	0.0		0.0	
North. Redbelly dace	0.0		0.0		0.0		T	-	0.2	0.2
Red shiner*	0.3	0.1	0.6	0.3	0.3	0.1	T	-	1.4	0.9
River carpsucker	0.0		0.1	0.1	T	-	0.4	0.2	0.0	
Sauger	0.1	0.1	0.1	0.1	T	-	0.0		T	-
Shorthead redhorse	0.0		0.0		T	-	0.0		0.0	
Silvery minnow	0.0		0.0		0.0		0.0		T	-
Smallmouth bass	0.7	0.2	1.6	0.6	1.7	0.5	2.4	0.7	7.5	5.1
Smallmouth buffalo	0.0		T	-	T	-	0.1	0.1	0.0	
Spottail shiner*	9.5	3.0	1.7	0.5	2.9	0.9	6.8	4.8	10.2	5.3
Walleye	0.9	0.4	1.0	0.3	0.6	0.3	1.2	0.6	0.6	0.5
White bass	3.1	1.0	14.6	7.0	92.4	40.1	6.0	2.5	1109.0	499.9
White crappie	0.0		0.0		0.0		T	-	2.4	1.3
Yellow perch	1.8	0.9	0.7	0.4	8.6	3.1	2.8	1.1	11.5	4.1

*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, 2006 – 2010.

Year	No.	CPUE	Mean TL (mm)	Total length (mm) range
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
2010	14	0.5	90.0	68-97

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 shows Lake Francis Case walleye typically reach the minimum legal length (381 mm; table 11) at age 3 suggesting that the large 2005 and 2006 year classes should have reached legal length in 2008 and 2009, respectively. Mean annual growth increments for walleye indicate that growth decreased during the 2005-2007 period, possibly a result of large 2005 and 2006 year classes but improved during the 2008-2010 time period (Table 12). Mean walleye age decreased to 2.6 years in 2010 (Table 13). Walleye from ten year-classes were collected in the 2010 gill net survey (Table 13) and ranged in TL from 120-mm to 570-mm (Figure 3).

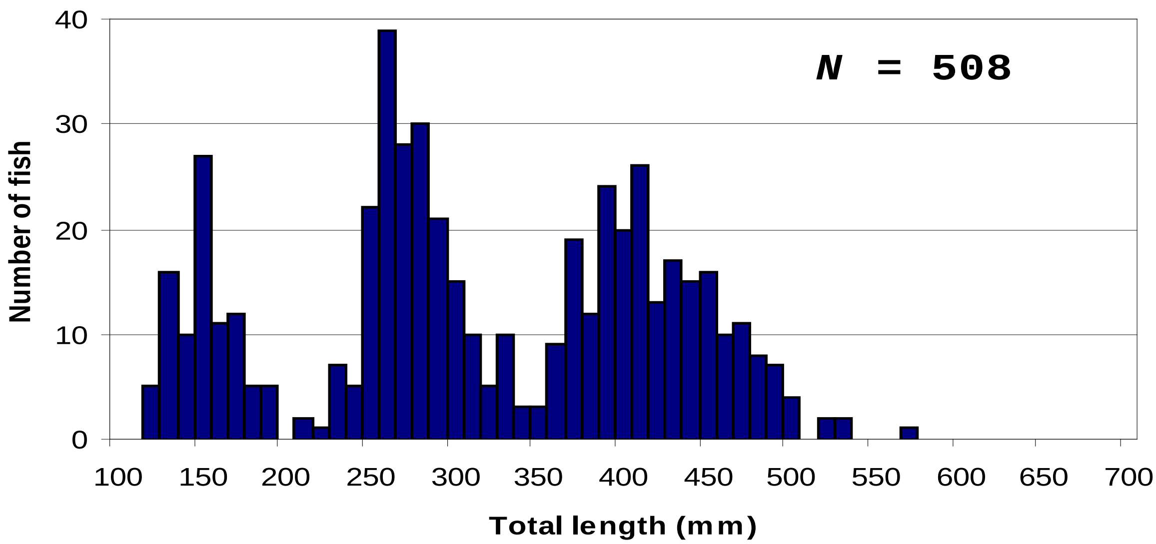

Figure 3. Length frequency of walleye collected with gill nets from Lake Francis Case, 2010. N = sample size.

Annual survival for pooled 2009 and 2010 data was estimated at 59% (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 2010 were higher than values measured over the past five years (Table 15). Walleye proportional size distribution (PSD) for 2010 increased to 47 while PSD-P remained at one (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, 2006-2010, Lake Francis Case, South Dakota. *N*=sample size

Year		Length at age at capture (mm)												
		1	2	3	4	5	6	7	8	9	10	11	12	13
2006	**Mean**	257	350	394	433	444	454	477	469	573				
	N	168	103	58	17	5	4	5	3	1	0	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	0
	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	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	0
	SE	4.9	6.9	3.0	2.8	12.2	17.4	NA		24.7	128.0	NA		
2010	**Mean**	273	358	413	437	442	455	493		481				524
	N	165	79	35	68	56	6	2	0	2	0	0	0	1
	SE	1.5	4.5	6.2	4.4	5.0	16.9	7.0		24.5				NA
Mean of means		249	329	383	419	440	458	489	486	505	542	641	522	524

Table 12. Mean annual growth increments for walleye collected in the standard September gill net survey on Lake Francis Case, South Dakota for 2005-2006, 2006-2007, 2007-2008, 2008-2009 and 2009-2010 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
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
2009-2010	122	97	69	49	38	66	--	--	--	--

Table 13. Age distribution, from otolith analysis, of walleye collected from Lake Francis Case with variable-mesh gill nets, 2006-2010. Mean age excludes age-0 fish.

Year	Age														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
2006	1	168	103	58	17	5	4	5	3	1	0	0	0	0	2.0
2007	10	36	110	33	15	7	4	2	2	0	1	0	2	0	2.5
2008	14	23	44	101	21	11	6	1	3	4	1	0	0	0	3.1
2009	4	41	44	70	122	10	4	1	0	2	2	1	0	0	3.2
2010	90	165	79	35	68	56	6	2	0	2	0	0	0	1	2.6

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

Species	Years	S	A	-Z	R^2
Walleye	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
	2009-2010	0.59	0.41	0.524	0.893
Sauger	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
	2009-2010	0.45	0.55	0.795	0.998
Smallmouth bass	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
	2009-2010	0.26	0.74	1.355	0.717

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, 2006-2010. S-Q = stock-to-quality length, Q-P = quality-to-preferred length, P = preferred length. *N* = sample size.

Walleye				
Year	**S-Q**	**Q-P**	**P**	***N***
2006	80	76	80	317
2007	79	75	73	196
2008	84	81	80	196
2009	81	79	75	271
2010	84	93	79	402
Sauger				
Year	**S-Q**	**Q-P**	**P**	***N***
2006	78	71	68	102
2007	74	73	68	70
2008	68	74	67	37
2009	77	76	78	51
2010	81	82	85	110
Smallmouth bass				
Year	**S-Q**	**Q-P**	**P**	***N***
2006	102	92	92	20
2007	93	98	-	7
2008	117	99	91	8
2009	107	103	101	17
2010	103	108	-	17

Table 16. Walleye, sauger, and smallmouth bass proportional size distribution (PSD) and proportional size distribution for preferred- and memorable-length fish (PSD-P and PSD-M, respectively) for Lake Francis Case gill net data, 2006-2010.

Species	2006	2007	2008	2009	2010
Walleye	29 (1,0)	29 (2,0)	31 (0,0)	46 (1,1)	47 (1,0)
Sauger	62 (30,0)	87 (1,0)	84 (27,0)	82 (26,0)	38 (16,0)
Smallmouth bass	50 (10,0)	71 (0,0)	88 (13,0)	71 (6,0)	12 (0,0)

Walleye population improvements were noted soon after sport-fishing-regulation changes were implemented in 1990 (Stone and Wickstrom 1991a; Figure 4). The population also positively responded to habitat/nutrient conditions provided by the high runoff into the Missouri River system during 1993–1997 (Stone 1997b). The general decline in overall walleye abundance beginning in 1996 through 2004 can be attributed to angler harvest coupled with declining productivity, as Missouri River water yield returned to more normal levels in 1998 and 1999, followed by eight consecutive years of drought conditions. Poor nutrient conditions caused by reduced localized run-off resulted in poor production and recruitment during 2001-2004. Following a sharp decline in water elevation during the peak walleye egg incubation period in 2002, the Department of Game, Fish and Parks stocked 400,000 walleye fingerlings and 4 million walleye fry. There appeared to be a large walleye year class produced in 2002 and although origin of these age-0 fish could not be determined, their smaller-than-average size in fall gill net samples led to the assumption that a majority of these fish were a result of stocking efforts. Unfortunately, the strong 2002 year class did not translate into a strong age-1 or age-2 year class in 2003 and 2004 and a significant portion of these fish were lost from the population. Walleye abundance increased to levels similar to the early 2000's during 2005 and 2006, but remains well below abundance levels experienced in the late 1990's. Walleye abundance in 2010 increased from 2009. Walleye produced in 2005, 2006 and 2010 currently comprise a majority of the Lake Francis Case walleye population.

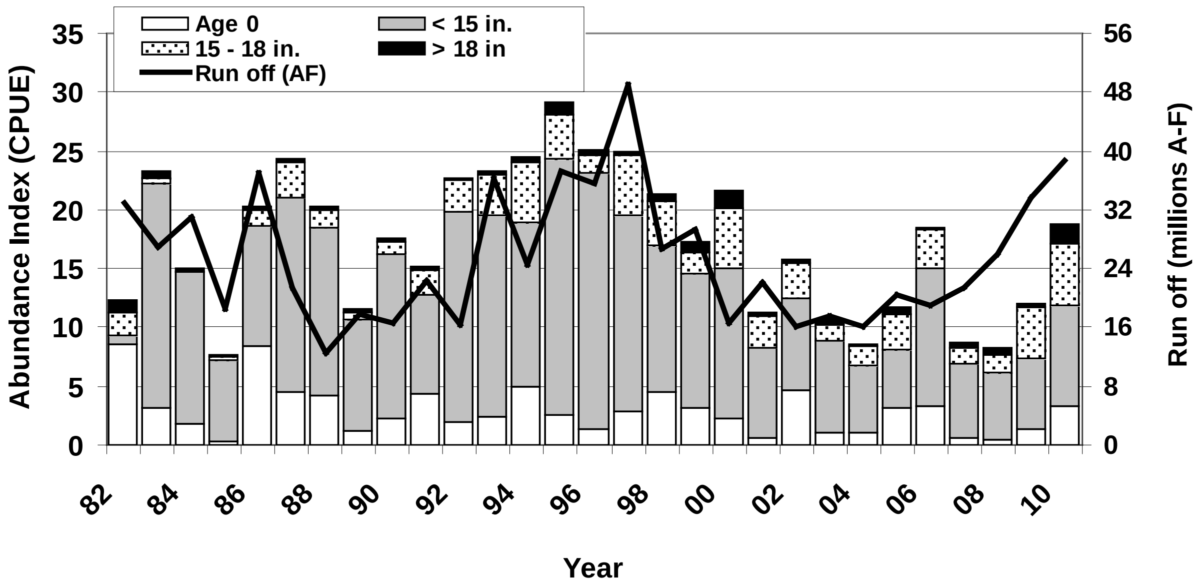

Figure 4. Lake Francis Case total walleye abundance (No. per net night) partitioned by walleye age and length groups and plotted against total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA. 1988-2010.

Population Parameters for Sauger

The 2010 Lake Francis Case sauger abundance index, at a mean CPUE of 5.2 fish/net night increased from 2009 and is a 5-year high (Table 8). Lengths of sauger sampled in the 2010 gill net survey ranged from 129 mm to 495 mm TL (Figure 5). Sauger average length-at-age-at-capture indicates that LFC sauger typically surpass 381mm at three years of age (Table 17). Sauger up to age five were collected in the 2010 gill net survey (Table 17). Sauger growth for the 2009-2010 period increased from that measured during 2008-2009 (Table 18). Mean sauger condition, for the various length categories increased during 2010 (Table 15).

Six year classes of sauger were collected by gill nets in 2010 (Table 19). The mean age of 1.5 years is the lowest for the five-year period (Table 19). The strong 2009 year class comprises a majority of the current adult sauger population. 2010 appears to be a year of high sauger production. Annual sauger survival for 2009-2010 pooled data decreased to 45%, a high for the five-year period (Table 14). Sauger PSD decreased during 2010 to 38 while PSD-P decreased to 16 (Table 16).

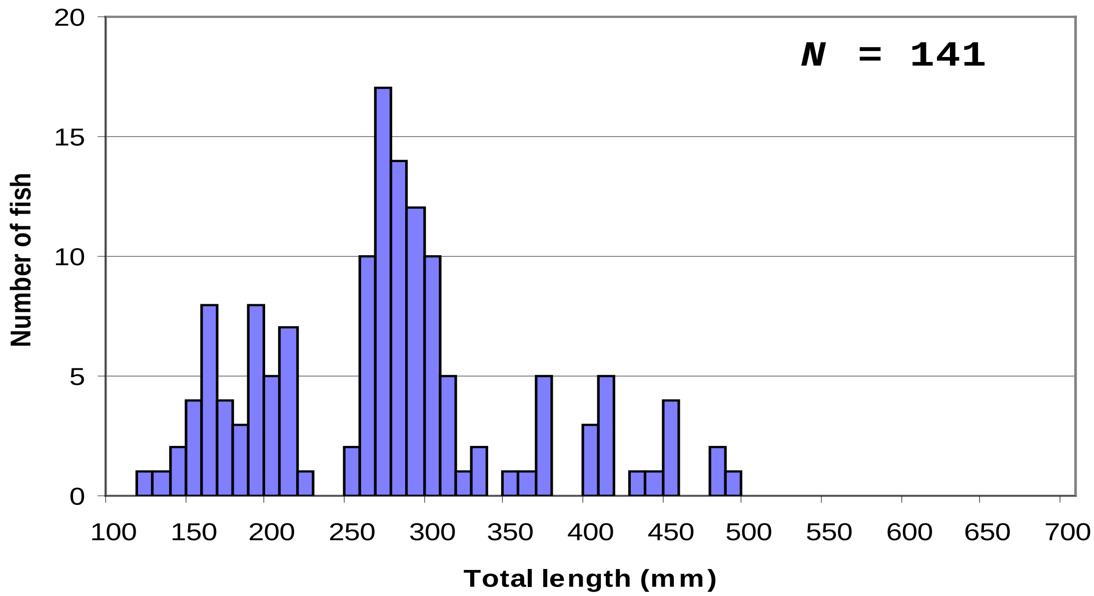

Figure 5. Length frequency of sauger collected with gill nets from Lake Francis Case, 2010.
N = sample size.

Table 17. Mean length-at-age-at-capture (mm) for sauger, as determined by aging otoliths, collected in the standard September gill net survey, 2006-2010, Lake Francis Case, South Dakota. *N* = sample size.

Year		**Length at age at capture (mm)**						
		1	**2**	**3**	**4**	**5**	**6**	**7**
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			
2010	**Mean**	288	388	443	433	430	0	0
	N	74	9	8	5	1		
	SE	2.7	7.8	11.5	24.1	NA		
Mean of means		282	352	387	414	409	433	461

Table 18. Mean annual growth increments for sauger collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2005-2006, 2006-2007, 2007-2008, 2008-2009 and 2009-2010 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
2005-2006	74	41	37	0	16	0
2006-2007	72	24	61	0	0	19
2007-2008	21	23	17	0	2	0
2008-2009	83	37	20	--	--	--
2009-2010	100	95	58	30	--	--

Table 19. Age distribution, from otolith analysis, of sauger collected from Lake Francis Case with variable-mesh gill nets, 2006-2010. Mean age excludes age-0 fish.

	Age								
Year	0	1	2	3	4	5	6	7	Mean
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
2010	43	74	9	8	5	1	0	0	1.5

Population Parameters for Smallmouth Bass

Smallmouth bass CPUE for the 2010 gill net survey (Table 8) increased to 0.9 fish/net night, a high for the 2006-2010 sampling period. Smallmouth bass CPUE in 2010 electrofishing samples (Table 7) increased to five-year highs at the Big Bend Dam and Ft. Randall Dam sampling locations. Smallmouth bass electrofishing CPUE in 2010 decreased at the Platte Creek and Pease Creek sampling stations while the Chamberlain sampling station remained similar to 2009 (Table 7). Mean length-at-age-at capture data for LFC smallmouth bass for the 2006-2010 period are presented in Table 20. Lake Francis Case smallmouth bass typically surpass 300 mm in length at age 2 (Table 20). Smallmouth bass growth decreased during 2009 and 2010 for age 2 smallmouth bass (Table 20). Smallmouth bass condition for stock-quality size smallmouth bass remains excellent, as W_r values from fish in the gill net survey were above 100 for all length categories (Table 15). W_r values for stock-quality and quality-preferred length smallmouth bass was 103 and 108 respectively in 2010 (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, 2006-2010, Lake Francis Case, South Dakota. N=sample size.

Year		Length at age at capture (mm)			
		1	2	3	4
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	
2010	**Mean**	222	270		
	N	12	4	0	0
	SE	63.9	19.2		
Mean of means		226	304	321	400

Table 21. Mean annual growth increments for smallmouth bass collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2005-2006, 2006-2007, 2007-2008, 2008-2009 and 2009-2010 periods, as determined by aging otoliths.

Year	Growth increment added during period (mm)		
	1-2	2-3	3-4
2005-2006	70	0	0
2006-2007	95	5	0
2007-2008	60	22	93
2008-2009	--	11	--
2009-2010	79	--	--

Three year classes were present in the 2010 gill net sample, with a mean age of 1.3 years (Table 22). Smallmouth bass PSD for the gill net sample decreased in 2010 (Table 16). Age-1 smallmouth bass accounted for a majority of the fish in the sample.Smallmouth bass production in 2010 was good. Annual survival, for pooled 2009 and 2010 gill net data was 26%, the low for the five-year period (Table 14). Lengths of fish collected by spring electrofishing ranged from 70mm to 430 mm TL, while those collected by fall gill nets ranged from 94 mm to 300 mm TL (Figure 6).

Table 22. Age distribution, from otolith analysis, of smallmouth bass collected from Lake Francis Case with variable-mesh gill nets, 2006-2010. Mean age excludes age-0 fish.

	Age					
Year	**0**	**1**	**2**	**3**	**4**	**Mean**
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
2010	7	12	4	0	0	1.3

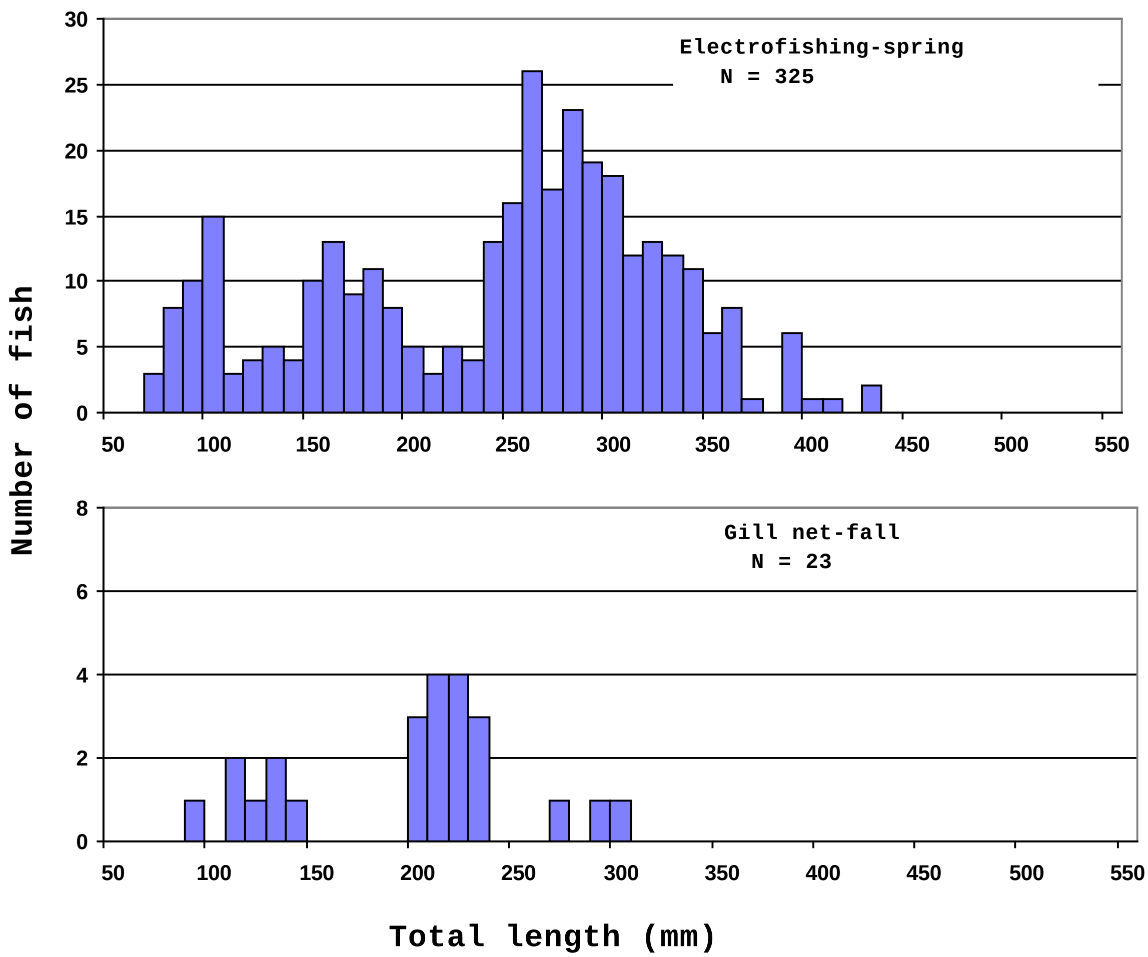

Figure 6. Length frequencies of smallmouth bass collected by spring electrofishing and fall gill netting from Lake Francis Case, 2010. *N* = sample size

Population Parameters for Channel Catfish

Channel catfish gill net CPUE in 2010, at 4.2 fish/net (Table 8), was similar to previous years in the five-year period. Channel catfish ranging from 57 mm to 573 mm TL were collected in the 2010 gill net survey (Figure 7). Mean annual back-calculated total length for 2010 showed similar growth to that seen in 2009 for younger age fish and increased growth for older age fish (Table 23). Channel catfish PSD, PSD-P and mean W_r values are presented in Appendix 5.

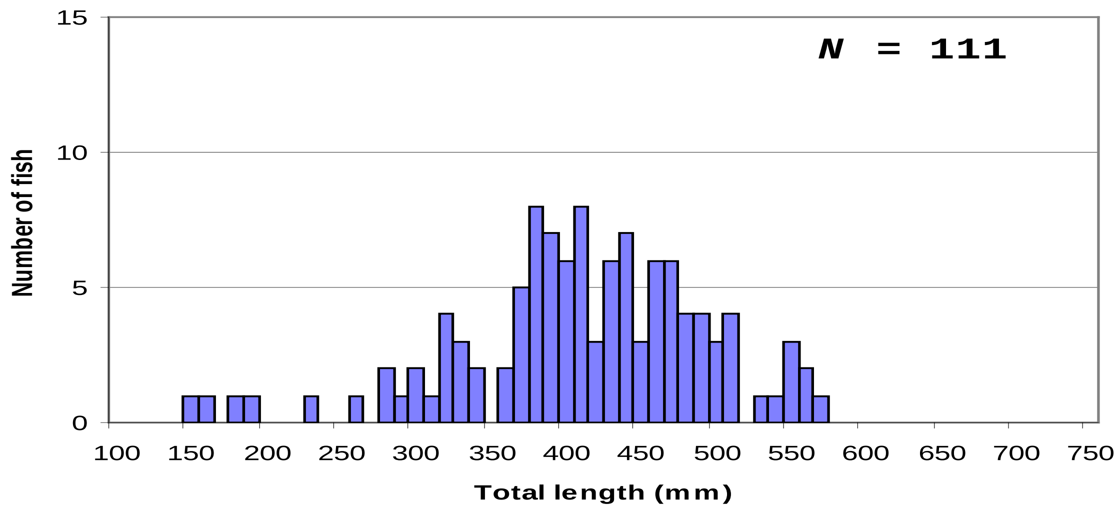

Figure 7. Length frequency of channel catfish collected with gill nets from Lake Francis Case, 2010. *N* = sample size.

Table 23. Mean annual back-calculated total lengths (mm) for each year class of channel catfish collected with variable-mesh gill nets during September 2010 from Lake Francis Case. *N* = sample size.

Year Class	Age	*N*	Back-calculation Age														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2010	0	1															
2009	1	2	79														
2008	2	4	88	174													
2007	3	15	81	162	238												
2006	4	11	90	181	284	331											
2005	5	18	88	153	251	324	366										
2004	6	16	103	199	277	342	384	414									
2003	7	14	95	173	263	318	361	393	420								
2002	8	7	95	161	266	315	354	389	416	438							
2001	9	5	97	145	240	304	342	372	402	428	454						
2000	10	4	103	178	265	311	348	376	408	429	449	465					
1999	11	3	96	157	219	291	339	363	390	412	445	461	483				
1998	12	4	95	161	228	320	358	378	394	429	447	463	482	501			
1997	13	2	98	182	284	331	355	373	386	427	444	471	498	522	548		
1995	15	1	104	198	278	325	366	386	399	433	453	480	513	520	527	534	540
All Classes			94	171	258	319	357	383	402	428	449	468	494	514	538	534	540
N		107	77	87	61	38	25	19	26	21	19	26	20	23	-	7	

Water Temperature Monitoring

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

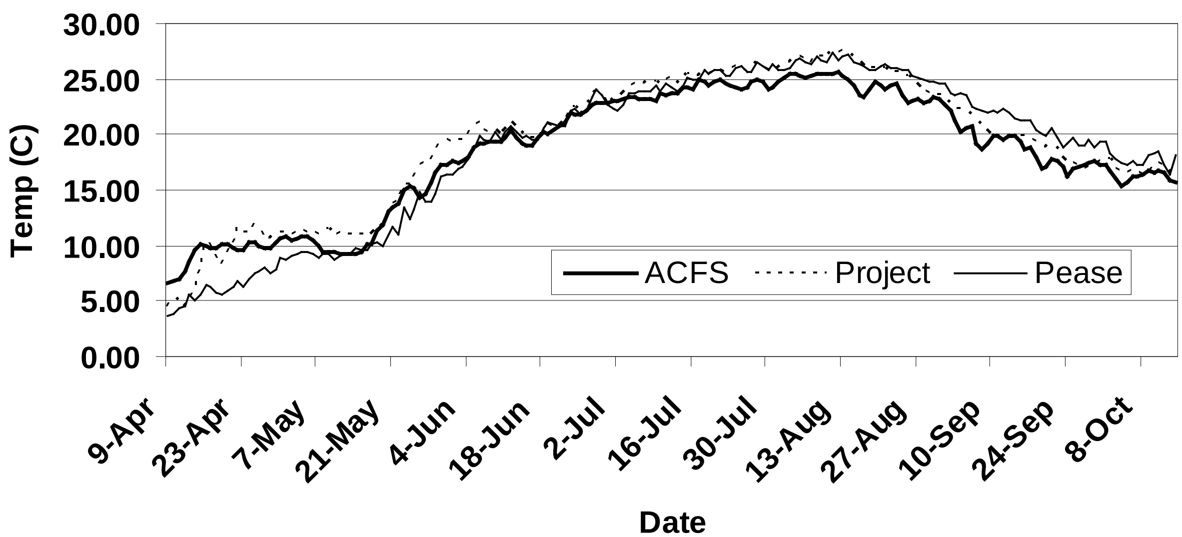

Figure 8. Water temperature in Lake Francis Case at American Creek Fisheries Station (ACFS, Pease Creek (Pease) and Project Bay (Project), 2010

ANGLER USE AND SPORT FISH HARVEST SURVEY

Fishing Pressure

Lake Francis Case anglers spent an estimated 480,884 hours (+/- 32,345 h, 80% CI) fishing during the April through September, 2010 creel survey period (Table 24). This estimate is similar to the 587,768 hours estimated for the same period in 2009 and significantly lower than annual estimates 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, 2010 (+/- 80% confidence interval).

Zone	Apr	May	Jun	Jul	Aug	Sep	Total
1 - upper	44,373 (15,881)	29,181 (6,401)	41,508 (13,242)	30,503 (7,218)	19,389 (4,955)	20,925 (4,935)	185,879 (23,865)
2 - middle	13,342 (4,525)	36,769 (8,706)	34,963 (9,262)	22,525 (5,101)	9,676 (2,358)	13,251 (7,739)	130,527 (16,539)
3 - lower	3,087 (1,307)	28,526 (7,748)	45,802 (6,402)	32,245 (5,654)	34,883 (6,922)	19,934 (4,528)	164,478 (14,251)
Total	60,803 (16,565)	94,476 (13,296)	122,273 (17,382)	85,274 (10,492)	63,947 (8,833)	54,111 (10,234)	480,884 (32,345)

Estimated fishing pressure for the entire reservoir averaged 13.6 angler-h/ha (Table 25). The lower portion of the reservoir (Figure 1) received the heaviest pressure at 14.3 angler-h/ha, similar to the 14.2 angler-h/ha in the middle portion (Table 25). The upper portion of the reservoir received 12.7 angler-h/ha (Table 25). Peak fishing pressure occurred in May and June, a typical LFC pattern (Table 24, Figure 9).

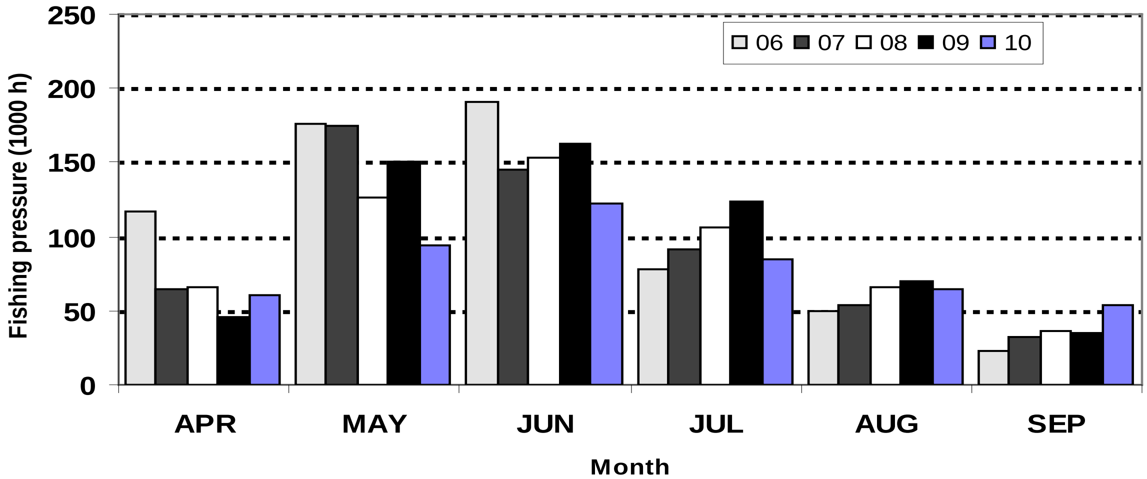

Figure 9. Estimated fishing pressure, by month, on Lake Francis Case, 2006-2010.

Table 25. Estimated total angler hours, for boat anglers, shore anglers, and angling methods combined, by zone, for Lake Francis Case, April-September, 2010.

	Boat			Shore			Combined		
Zone	Total angler hours	%	No. h/ha	Total angler hours	%	No. h/ha	Total Angler hours	%	No. h/ha
1 - upper	169,370	37	11.6	16,510	74	1.1	185,879	39	12.7
2 - middle	126,829	28	13.8	3,697	16	0.4	130,527	27	14.2
3 - lower	162,249	35	14.1	2,229	10	0.2	164,478	34	14.3
Tot/Ave	458,448	100	13.0	22,436	100	0.6	480,884	100	13.6

Fish Harvest

Anglers fishing LFC, during the April-September 2010 period, harvested an estimated 136,457 fish (+/- 18,290 fish, 80% CI); all species, fishing methods and zones combined, including an estimated walleye harvest of 102,973 fish (+/- 12,964 fish, 80% CI; Table 26). Eighteen species of fish were observed in the 2010 harvest, with walleye accounting for 76% of the total number harvested (Table 26). Channel catfish, white bass, smallmouth bass, yellow perch, and sauger accounted for 6.7%, 6.1%, 4.4%, 2.1%, and 2.0% of the 2010 estimated total harvest, respectively. Estimated sauger harvest in 2010 was 2,755 fish, a significant decrease over the 2009 harvest estimate (Table 26). Sauger production from 2006 and 2007 currently supports a bulk of the sauger harvest. Harvest estimates for channel catfish increased for 2010 (Table 26). The 2010 white bass harvest estimate of 8,292 fish was a significant decrease from the 2009 estimate of 21,733 fish (Sorensen and Knecht, 2010b; Table 26). Excellent white bass production occurred in 2010 (Table 9). Smallmouth bass harvest in 2010 remained similar to 2009 (Sorensen and Knecht 2010b). Poor smallmouth bass recruitment since 2005 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, 2010 (+/- 80% confidence interval).

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	9,511 (3,258)	631 (307)	299 (191)	493 (272)	364 (254)	20 (33)	93 (117)	178 (178)	11,590 (3,436)
May	12,449 (2,777)	408 (167)	566 (365)	187 (22)	493 (206)	50 (45)	69 (46)	252 (261)	14,474 (3,106)
June	29,259 (7,911)	689 (333)	2,854 (2,351)	756 (265)	4,738 (3,492)	16 (9)	366 (278)	303 (243)	38,947 (11,464)
July	24,140 (6,697)	347 (224)	916 (575)	1,828 (892)	920 (790)	0 (-)	450 (195)	111 (73)	28,712 (7,295)
August	14,434 (3,500)	184 (93)	401 (190)	2,518 (365)	1,076 (461)	14 (23)	363 (297)	3,095 (3,688)	22,083 (6,654)
September	13,180 (5,482)	532 (238)	1,026 (654)	3,369 (3,139)	700 (233)	0 (-)	1,572 (556)	243 (392)	20,652 (9,174)
Total	102,973 (12,964)	2,755 (591)	6,061 (2,548)	9,153 (3,306)	8,292 (3,632)	100 (61)	2,913 (727)	4,182 (4,835)	136,457 (18,290)

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

Estimated fish harvest during 2010, by survey zone (see Figure 1 for zone identification), resulted in anglers who fished the upper portion of the reservoir accounting for 57% of the harvest, followed by the lower and middle zones with 26 % and 17% of the harvest, respectively (Table 27). Walleye, sauger, smallmouth bass, and white bass harvest in 2010 was highest in the upper zone, while smallmouth bass harvest was highest in the lower zone of the reservoir (Table 27).

Table 27. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2010 (+/- 80% confidence interval).

Zone	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
1 - upper	60,550 (11,085)	2,061 (507)	2,524 (1,123)	3,307 (750)	5,627 (3,581)	83 (55)	2,365 (601)	728 (572)	77,243 (14,404)
2 - middle	17,589 (2,932)	658 (299)	1,028 (513)	2,336 (715)	1,737 (501)	17 (25)	283 (142)	178 (140)	23,827 (3,653)
3 - lower	24,835 (6,049)	36 (51)	2,509 (2,229)	3,510 (3,139)	928 (339)	0 (-)	265 (384)	3,306 (3,840)	35,388 (10,663)
Total	102,973 (12,964)	2,755 (591)	6,061 (2,548)	9,153 (3,306)	8,292 (3,632)	100 (61)	2,913 (727)	4,182 (4,835)	136,457 (18,290)

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

Estimated total fish harvest peaked in June during 2010 (Table 26). Walleye harvest also peaked in June (Figure 10), a typical LFC pattern (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.

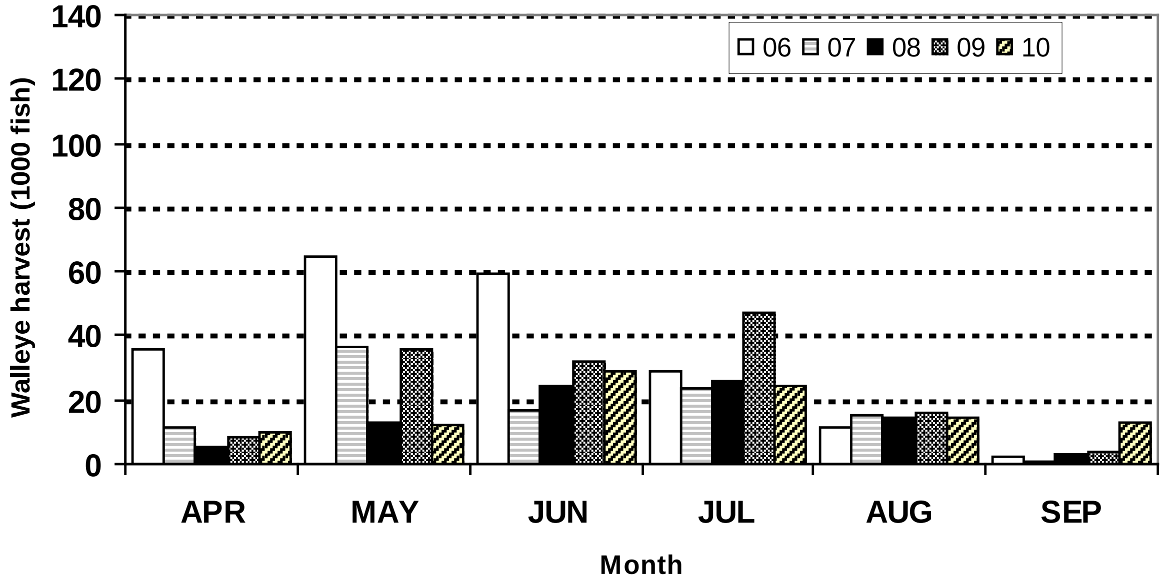

Figure 10. Estimated total walleye harvest, by month, for anglers fishing Lake Francis Case, 2006-2010.

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 2010, 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 above 381-mm (minimum length limit) during all months, including July and August when the minimum length restriction is not in effect (Figure 11). Overall, mean length of walleye harvested by anglers has been considerably higher since the 1990 changes in walleye sport fishing regulations were implemented (Table 1). The percentage of angling parties harvesting a limit was 6% in 2010 (Table 28), similar to the 7% measured in 2009.

Monthly length frequencies of angler-caught smallmouth bass are presented in Figure 12. The average length of harvested smallmouth bass exceeded 300-mm during all months of the April-September creel survey period.

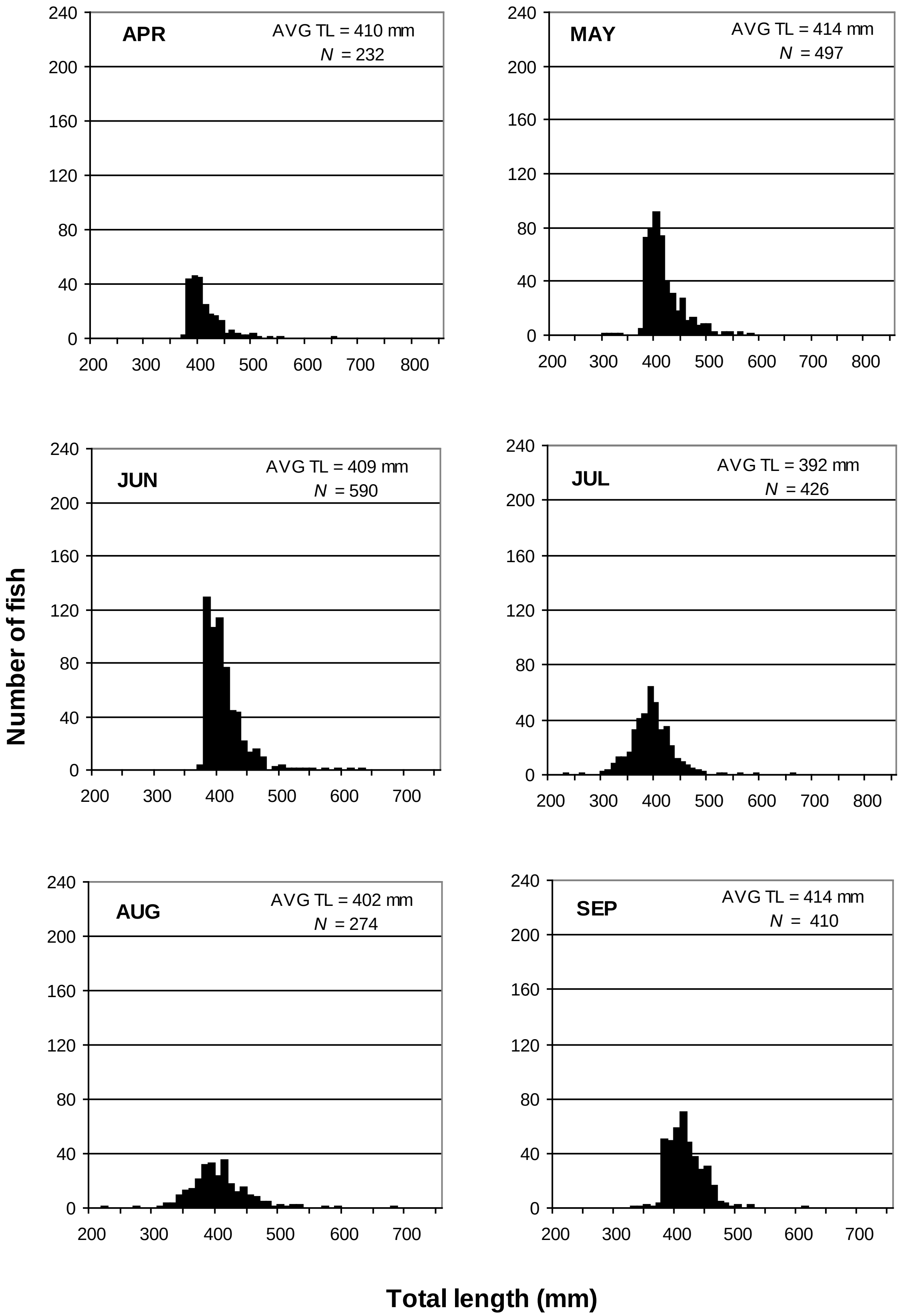

Figure 11. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2010. N = sample size.

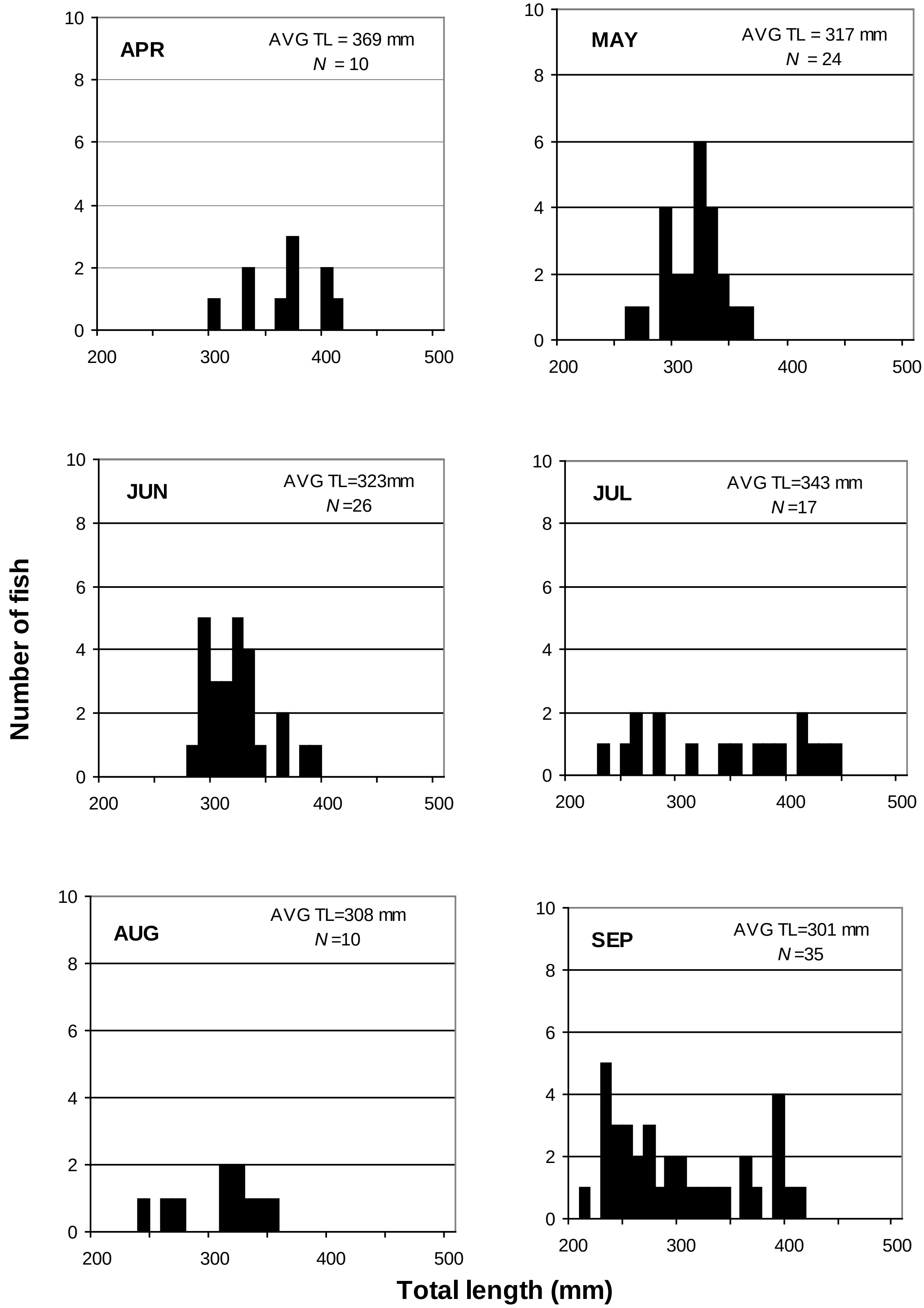

Figure 12. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2010.
N = sample size.

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, 2006-2010.

Party success walleye-sauger/angler	2006	2007	2008	2009	2010
Limit (4)	11	3	3	7	6
3.0 - 3.9	10	5	4	8	5
2.0 - 2.9	13	9	10	11	7
1.0 - 1.9	20	16	15	16	14
0.1 - 0.9	15	16	17	15	16
0	31	50	51	43	52

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. For each species listed in Table 29 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 2010 was 222,915, a decrease from the 2009 estimate of 436,083 fish (Sorensen and Knecht 2010b).

Table 29. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2010.

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	13,328	221	241	263	853	20	34	612	15,573
May	17,194	168	11,698	469	3,401	17	131	999	34,075
June	57,356	540	5,544	821	10,348	206	453	2,698	78,029
July	16,433	275	872	3,061	1,506	0	1,260	1,714	25,123
August	8,450	120	2,523	2,888	2,123	0	2,995	4,727	23,824
September	19,404	1,334	5,526	2,814	1,660	105	10,194	5,251	46,291
Total	132,165	2,658	26,404	10,316	19,891	348	15,067	16,001	222,915

* OTH includes black bullhead, black crappie, bluegill, common carp, flathead catfish, freshwater drum, goldeye, largemouth bass, rainbow trout, shortnose gar, shovelnose sturgeon, smallmouth buffalo, white crappie and yellow bullhead.

Harvest, Release and Catch Rates

Mean harvest rate (species, type of fishing, and zones combined) for LFC, in 2010, was 0.28 fish/angler-h (Table 30), within the range of previous surveys (Table 1). An overall catch rate (the 2010 harvest rate plus estimated release rate of 0.46 fish/angler-h) of 0.75 fish/angler-hour was estimated for the April through September 2010 daylight period (Table 31). Mean catch and harvest rates were highest during September (Table 31).

The mean walleye harvest rate was 0.21 walleye/angler-h (Table 32) for the 2010 April–September daytime period. Walleye harvest rates were highest in July when there is no minimum length restriction. When the harvest rate for walleye was combined with the release rate, an overall catch rate of 0.49 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).

Smallmouth bass harvest and catch rate estimates for 2010 were 0.013 and 0.068 fish/angler-h respectively and were similar to 2009 esltimates (Sorensen and Knecht 2010b; Table 33).

Table 30. Estimated harvest rate, release rate and catch rate, by species (+/- 80% confidence interval), for anglers fishing Lake Francis Case, 2010.

Species	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
Walleye	0.214 (0.040)	0.275 (0.065)	0.489 (0.102)
Sauger	0.006 (0.002)	0.006 (0.002)	0.011 (0.004)
Smallmouth bass	0.013 (0.006)	0.055 (0.015)	0.068 (0.019)
Channel catfish	0.019 (0.007)	0.022 (0.006)	0.041 (0.009)
White bass	0.017 (0.008)	0.041 (0.017)	0.059 (0.021)
Northern pike	0.0002 (0.0002)	0.001 (0.001)	0.001 (0.001)
Yellow perch	0.006 (0.002)	0.031 (0.010)	0.037 (0.010)
Other*	0.009 (0.009)	0.033 (0.012)	0.042 (0.019)
Species combined	0.284 (0.054)	0.464 (0.094)	0.747 (0.142)

* Other includes black bullhead, black crappie, bluegill, common carp, freshwater drum, goldeye, largemouth bass, rainbow trout, shortnose gar, shovelnose sturgeon, smallmouth buffalo, white crappie and yellow bullhead.

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, 2010.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.191 (0.109)	0.256 (0.174)	0.447 (0.282)
May	0.153 (0.049)	0.361 (0.119)	0.514 (0.162)
June	0.319(0.136)	0.638 (0.309)	0.957 (0.442)
July	0.337 (0.130)	0.295 (0.133)	0.631 (0.248)
August	0.345 (0.135)	0.373 (0.100)	0.718 (0.216)
September	0.382 (0.232)	0.856 (0.386)	1.237 (0.565)
Combined	0.284 (0.054)	0.464 (0.094)	0.747 (0.142)

Table 32. Estimated harvest rate, release rate, and catch rate of walleye (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2010.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.156 (0.096)	0.219 (0.148)	0.376 (0.243)
May	0.132 (0.043)	0.182 (0.072)	0.314 (0.114)
June	0.239 (0.094)	0.469 (0.231)	0.708 (0.327)
July	0.283 (0.115)	0.193 (0.115)	0.476 (0.213)
August	0.226 (0.079)	0.132 (0.043)	0.358 (0.118)
September	0.244 (0.146)	0.359 (0.165)	0.602 (0.297)
Combined	0.214 (0.040)	0.275 (0.065)	0.489 (0.102)

Table 33. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2010.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.005 (0.004)	0.004 (0.003)	0.009 (0.005)
May	0.006 (0.004)	0.124 (0.055)	0.130 (0.056)
June	0.023 (0.025)	0.045 (0.031)	0.069 (0.054)
July	0.011 (0.010)	0.010 (0.004)	0.021 (0.013)
August	0.006 (0.000)	0.040 (0.007)	0.046 (0.000)
September	0.019 (0.018)	0.102 (0.070)	0.121 (0.086)
Combined	0.013 (0.006)	0.055 (0.015)	0.068 (0.019)

Angler Demographics and Economics

Twenty-nine percent of anglers contacted on LFC in 2010 were non-residents, similar to values estimated for the previous five years (Sorensen and Knecht 2007, 2008, 2009, 2010a, 2010b). Non-resident anglers from 16 states and one Canadian Province were contacted in 2010, (Table 34) with Iowa, Nebraska and Minnesota anglers accounting for the majority of non-resident angler contacts. Eighty-five percent of resident LFC anglers in 2010 came from counties in the southeastern ¼ of the state (Figure 13).

Table 34. Percentage of non-resident anglers who fished Lake Francis Case, 2006-2010, by state of residence, expressed as percent of total non-residents.

State	2006	2007	2008	2009	2010
Iowa	44.0	38.9	42.8	42.5	44.0
Nebraska	32.6	40.0	39.6	39.1	36.3
Minnesota	13.2	9.8	11.2	12.7	11.9
Colorado	1.2	1.1	1.1	0.7	1.6
Wisconsin	0.4	0.8	1.3	0.2	1.2
Kansas	0.4	0.8	0.5	0.7	1.4
Missouri	1.4	1.1	0.5	0.2	0.7
Illinois	0.6	0.5	-	-	0.2
North Dakota	0.4	1.4	0.3	-	0.5
Florida	0.6	0.3	0.5	0.2	0.2
Montana	0.4	0.3	-	-	0.2
Wyoming	1.6	1.9	0.3	1.2	0.5
California	0.8	-	-	-	0.5
Other*	2.4	3.1	1.9	2.5	0.8

*Other includes: Ontario, New Mexico, Texas, and Washington.

Mean angler trip length (boat and shore combined) on LFC was 4.3 h (Table 1), for the April-September, 2010 daylight period. The average angling party consisted of approximately 2.3 individuals in 2010 and anglers traveling at least 100 miles (one-way) to fish LFC, accounted for 64 % of all trips (Table 35). A majority of anglers fishing Lake Francis Case in 2010 targeted walleye, similar to the past four years (Table 36).

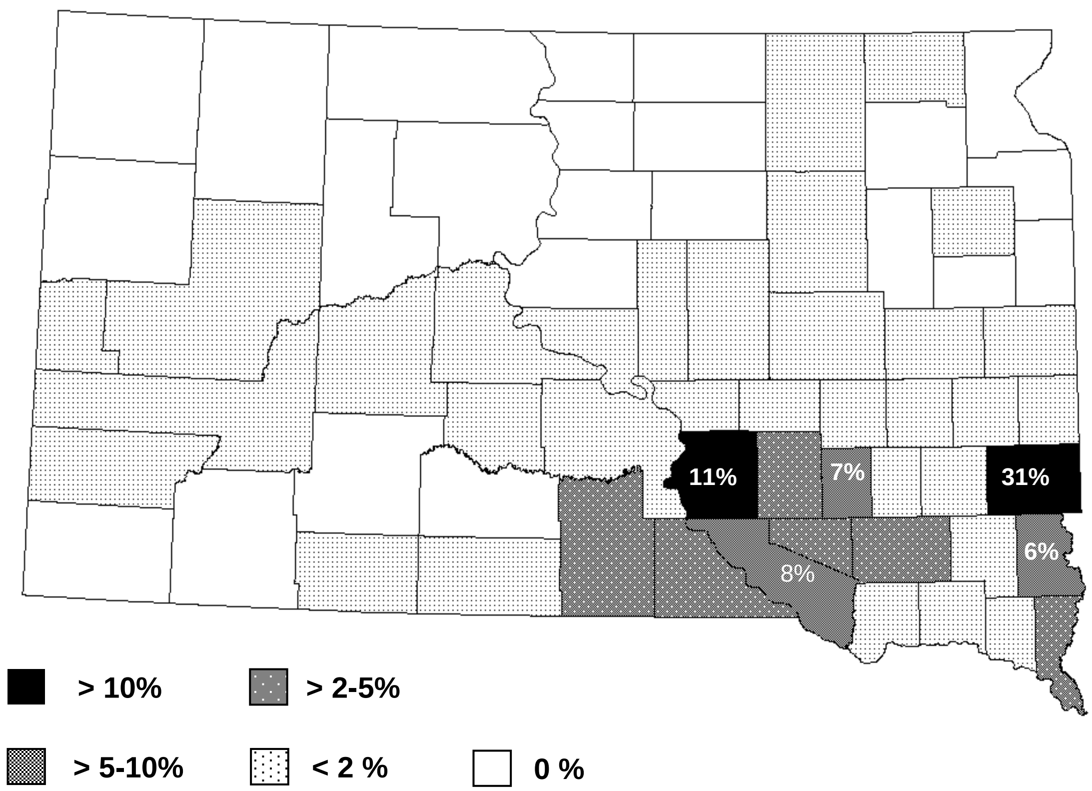

Figure 13. County of residence for resident anglers fishing Lake Francis Case in 2010. Percentage of total resident anglers is shown for the top four represented counties.

The 2010 LFC fishery had an estimated economic impact of nearly 8.6 million dollars to local economies, based on approximately 112,094 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 2006-2010.

Distance (miles)	2006	2007	2008	2009	2010
<25	11.0	15.9	15.0	15.9	13.4
25-50	17.7	16.2	17.2	16.9	17.2
51-100	15.6	15.8	17.3	15.3	17.4
101-200	40.7	35.6	36.9	40.2	37.5
201+	15.0	16.5	13.6	11.7	14.5

Table 36. Target species of Lake Francis Case anglers, during 2006-2010, expressed as a percentage of total angling trips.

Target species	2006	2007	2008	2009	2010
Walleye	95.6	92.0	89.3	85.4	81.4
Anything	1.6	5.1	6.4	6.5	8.7
Smallmouth bass	1.6	0.9	2.1	2.0	2.3
Other	1.2	2.0	2.2	6.1	7.6

ANGLER PREFERENCE AND ATTITUDE SURVEY

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

The following results build on angler preference and attitude survey data collected previously from Lake Francis Case (Stone et.al. 1993; Stone 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b).

Angling Trip Satisfaction

How anglers feel about their fishing experience is important when evaluating the success of fishery management efforts. Angler responses help evaluate if current management practices and regulations are providing a fishery that meets angler needs and expectations. Overall, 68% of LFC anglers expressed some degree of satisfaction with their days fishing in 2010 versus approximately 26% who expressed some degree of dissatisfaction (Table 37). The 68% satisfaction rating falls within the range of previous surveys (Sorensen and Knecht 2007, 2008,2009, 2010a, 2010b) but falls short of the Missouri River Fisheries Program management objective of 70 % (SDGFP, unpublished document).

Table 37. Responses of 2010 Lake Francis Case anglers, by month, to the question: “Considering all factors, how satisfied are you with your fishing trip today?” 1 = Very Satisfied, 2 = Moderately satisfied, 3 = Slightly satisfied, 4 = Neutral, 5 = Slightly dissatisfied, 6 = Moderately dissatisfied, 7 = Very dissatisfied, N.O. = No opinion. Median excludes those with no opinion.

Month	Satisfied →			Neut.	←		Dissatisfied			
	1	2	3	4	5	6	7	N.O.	Total	Median
Apr	41	32	21	7	12	7	11	0	131	3
May	52	58	21	19	19	11	13	0	193	3
Jun	38	44	18	7	14	10	17	0	148	3
Jul	29	30	19	8	17	9	9	0	121	3
Aug	16	30	17	11	7	7	10	0	98	3
Sep	36	25	12	4	13	4	14	0	108	3
Total	212	219	108	56	82	48	74	0	799	3
Percent	26.5	27.4	13.5	7.0	10.3	6.0	9.3	0.0	100	-
Combined	67.5			7.0	25.5			0.0	100	-

Angler satisfaction increases as the number of walleye harvested per angler increases (Table 38). These results follow the pattern documented in previous surveys (Stone 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b) showing a decrease in satisfaction and a corresponding increase in dissatisfaction as the number of walleye harvested per angler decreases. However, 58% of 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 2010 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	41	97.6	1	2.4	0	-
3 -- 3.9	38	95.0	2	5.0	0	-
2 – 2.9	47	88.7	6	11.3	0	-
1 – 1.9	84	76.4	19	17.3	7	6.4
0.1 – 0.9	80	63.0	38	29.9	9	7.1
0	249	58.3	138	32.3	40	9.4
Total	539	67.5	204	25.5	56	7.0

With current management regulations requiring the mandatory release of certain sizes of walleye/sauger, coupled with the voluntary release of a significant number of fish by LFC anglers, how anglers feel about their fishing trip, based on the total number of walleye/sauger caught versus harvested, may also be important. About 61% of anglers questioned were still satisfied with their fishing trip despite catching no walleye (Table 38; 39). Eighty-eight 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 2010 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 >	6	100.0	0	-	0	-
12-15.9	12	92.3	1	7.7	0	-
8-11.9	31	93.9	2	6.1	0	-
4-7.9	89	88.1	9	8.9	3	3.0
>0-3.9	227	63.2	106	29.5	26	7.2
0	174	60.6	86	30.0	27	9.4
Total	539	67.5	204	25.5	56	7.0

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 2010 angler use and harvest survey were asked questions concerning these events. When asked whether or not they had participated in a tournament held on Lake Francis Case within the past twelve months, nearly 20% of those interviewed during 2010 indicated they had (Table 40). Survey results concerning tournament participation in 2010 were consistent with previous survey results (Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008,2009, 2010a, 2010b).

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?”, 2006-2010. Responses are presented as percentage of total responses. *N* = number of responses.

	2006		2007		2008		2009		2010	
No. of Tournaments Participated in	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
0	664	77.2	486	86.5	504	82.6	619	82.3	546	80.9
1	112	13.0	44	7.8	64	10.5	66	8.8	70	10.4
2	35	4.1	10	1.8	19	3.1	28	3.7	29	4.3
3	21	2.4	9	1.6	7	1.1	22	2.9	14	2.1
4	8	1.0	5	0.9	6	1.0	10	1.3	7	1.0
>4	20	2.3	8	1.4	10	1.6	7	0.9	8	1.2

The majority of competitive angling events on Lake Francis Case occur during the April-June period. This also encompasses the months with highest overall angler use. Crowding at access facilities where such events are being held is a concern. To help understand the significance of such user conflicts, anglers were asked if they have ever not used an access site because a tournament was being held there. Overall, 77 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 41). Due to the early start times of many fishing tournaments, other anglers may not be aware that a fishing tournament is being held at the access site they choose to use and they may just view the access site as being generally crowded. However, with twenty-three percent of anglers being displaced by competitive angling events, this issue should be carefully monitored in the future (Table 41).

Table 41. Responses of Lake Francis Case anglers to the question: "Did you ever decide not to use an access site on Lake Francis Case because a tournament was being held there?" Responses are presented as number of responses and percentage of total responses by year.

	Response		
Year	**Yes**	**No**	**No Opinion**
2006	190 (22.1)	654 (76.1)	16 (1.9)
2007	150 (26.3)	411 (73.0)	1 (0.2)
2008	167 (27.4)	445 (72.6)	1 (0.2)
2009	154 (20.4)	598 (79.3)	2 (0.3)
2010	152 (22.5)	522 (77.3)	1 (0.2)

When anglers were asked how they felt about the number of tournaments held on Lake Francis Case each year, 40% 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, 56% of anglers believed there were too many tournaments on Lake Francis Case (Table 42). In addition, 42% believed there was about the right number, and 2% believed that there were too few tournaments held on Lake Francis Case annually (Table 42).

Table 42. Responses of 2010 Lake Francis Case anglers to the question: "In general, how do you feel about the number of fishing tournaments held on Lake Francis Case each year?" *N* = number of responses.

Response	**N**	**Percent**
	Including "No Opinion" Responses	
Too Many	227	33.6
About the Right Number	170	25.2
Too Few	6	0.9
No Opinion	272	40.3
	Excluding "No Opinion" Responses	
Too Many	227	56.3
About the Right Number	170	42.2
Too Few	6	1.5

DISCUSSION

Lake Francis Case, supporting one of South Dakota's most important walleye fisheries, continues to attract anglers from across the upper Midwest. Walleye, ranked the favorite species by 69% of respondents to a 1992 survey of South Dakota anglers (Mendelsohn 1994), remains the target species of most LFC anglers. Since a peak in total walleye abundance in 1995, the LFC walleye population generally declined in abundance until 2005. A significant portion of the initially abundant 2002 LFC walleye year class did not recruit to age-1, so the expected downturn in population abundance was longer in duration than initially expected. Water yield in the Missouri River basin began to recover in 2005 following nine years of below normal water yield. Walleye abundance increased during 2005 and 2006 due to the presence of consecutive strong year classes. In spite of strong 2005 and 2006 walleye year classes, overall abundance declined in 2007 and 2008 to levels similar to 2003 and 2004 due to poor walleye production in 2007 and 2008 coupled with angler harvest. Poor production and recruitment commonly follows years with excellent walleye production, such as 2005 and 2006. Moderate walleye production in 2009 and excellent production in 2010 along with the continued presence of the 2005 and 2006 year classes led to increases in abundance the past couple of years. Angler harvest can have 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 2001-2004 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 decreased in 2006 and 2007 due to the presence of two large year classes of walleye in the population. Walleye growth increased from 2008 to 2010. 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. However, walleye W_r for quality-preferred length fish increased during 2010 possibly due to increased availability of forage species caused by increased localized run-off into the reservoir.

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 was above normal during 2009 and 2010, indicating a break in the drought cycle experience during the previous eight years. Increased water yield resulted in moderate walleye production in 2009 and excellent production in 2010.

In recent years, a decrease in abundance of harvestable sized walleye had resulted in reduced walleye harvest rates as well as overall harvest. Improvements in walleye population structure, as a result of length limit regulations, is reflected in the 411-mm (16.2 in.) mean length of walleye harvested during 2010, versus the 343-mm (13.5 in.) average estimated in 1989 (Stone 1995). Mean length of harvested walleye during 2010 was above 400-mm (15.7 in.) for the first year since 2007. Abundance of harvestable size walleye increased during 2010 as the large 2005 and 2006 walleye year classes surpassed the 15-inch minimum size. With recent increases in overall walleye population abundance, a high proportion of anglers are attaining the daily creel limit of four walleye during certain periods of the year. In this regard, the daily creel limit remains an important factor in the regulation of the fishery and distribution of the walleye harvest, at least during years of low walleye abundance or high harvest. Survey results also suggest that while most LFC anglers are satisfied with their overall fishing trip experience, they can be less satisfied (based on trip rating) with the numbers and sizes of fish caught (Stone and Sorensen 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009, 2010a, 2010b).

Smallmouth bass, which in previous years has ranked second in the sport fishery in terms of total fish caught (harvest and released), remain an important component in angler catches. Initially introduced as an alternative species that could direct fishing pressure away from walleye, they are now the target species of a small portion of LFC anglers. Smallmouth bass abundance, as measured by spring electrofishing CPUE increased during 2010 for the Ft. Randall Dam and Big Bend Dam sampling locations while decreasing at the Platte Creek and Pease Creek sampling locations. The 2009 smallmouth bass year class comprises a majority of the current Lake Francis Case smallmouth bass population. Excellent smallmouth bass production occurred in 2010. 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. Sauger harvest decreased in 2010 as angler harvest takes its toll on the 2007 sauger year-class. White bass significantly contributed to the 2009 sport fish harvest and to a lesser extent during 2010. White bass production during 2010 was excellent. The white bass population has a well distributed size structure and is capable of providing additional recreational opportunity. Channel catfish have maintained adequate abundance in recent years to support additional harvest, while the average size channel catfish in netting surveys continues to exceed 16 inches in length. Similar to other species, channel catfish growth has increased during the past couple of years.

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 in 2009 and excellent production in 2010 spurred an increase in overall abundance. Walleye growth slowed from 2005 to 2008 delaying the 2005 and 2006 year classes from entering the sport fish harvest. An increase in walleye growth occurred in 2009 and 2010, 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 2011 should expect higher catches of harvestable sized walleye as well as increased catches of sub-legal-length walleye than those experienced in 2009. A conservative walleye harvest in 2011 should prolong the quality of fishing provided by strong walleye year-classes in recent years. 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. 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. A moderate 2009 and strong 2010 walleye year-classes should enter the sport-fishing harvest beginning in 2012

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LITERATURE CITED

Anderson, R.O. 1980. Proportional stock density (PSD) and relative weight (*W<u>r</u>*): interpretive indices for fish populations and communities. Pages 27-33 *in* S. Gloss and B. Shupp, editors. Practical fisheries management: more with less in the 1980's. New York Chapter American Fisheries Society, Ithaca.

Anderson, R.O., and A.S. Weithman. 1978. The concept of balance for coolwater fish populations. Pages 371-378 *in* R.L. Kendall, editor. Selected coolwater fishes of North America. American Fisheries Society, Bethesda, Maryland.

Benson, N.G. 1968. Review of fishery studies on Missouri River mainstem reservoirs. United States Fish and Wildlife Service. Research Report 71, Washington, D.C.

Brown, M.L., and B.R. Murphy. 1991. Standard weights (W_s) for striped bass, white bass and hybrid striped bass. North American Journal of Fisheries Management 11:451-467.

Brown, M.L., F. Jaramillo, Jr., D.M. Gatlim III, and B.R. Murphy. 1995. A revised standard weight (W_s) equation for channel catfish. Journal of Freshwater Ecology 10:295-302.

Carlander, K.D. 1982. Standard intercepts for calculating lengths from scale measurements for some centrarchid and percid fishes. Transactions of the American Fisheries Society 111:332-336.

Colby, P.J., R.E. McNicol, and R.A. Ryder. 1979. Synopsis of biological data on the walleye. Food and Agriculture Organization, Fisheries Synopsis Number 119.

DeVries, D.J. and R.V. Frie. 1996. Determination of age and growth. Pages 483-512 in B.R. Murphy and D.W. Willis, editors. Fisheries Techniques, 2nd Edition. American Fisheries Society, Bethesda, Maryland.

Francis, J. 1999. WinFin: Version 2.95; Microsoft Access program for data entry. Nebraska Game and Parks Commission, Lincoln.

Francis, J. 2000. WinFin analysis program. Version 1.5. Nebraska Game and Parks Commission, Lincoln.

Gabelhouse, D.W., Jr. 1984. A length-categorization system to assess fish stocks. North American Journal of Fisheries Management 4:273-285.

Gasaway, C.R. 1970. Changes in the fish populations in Lake Francis Case in South Dakota in the first 16 years of impoundment. United States Fish and Wildlife Service, Technical Paper 56, Washington , D.C.

Gigliotti, L.M. 2011. Fishing in South Dakota-2010: Resident fishing activity, harvest and angler opinion survey. Report ID#: HD-7-11.AMS. South Dakota Department of Game, Fish and Parks. Pierre, SD

Gigliotti, L.M. 1996. South Dakota angler use and preference survey. Supplement: 1, attributes of a “good fishing spot” cluster analysis. South Dakota Department of Game, Fish and Parks, Wildlife Division, Supplemental Report No. 96-1, Pierre.

Guy, C.S., E.A. Bettross, and D.W. Willis. 1990. A proposed standard weight (*W<u>s</u>*) equation for sauger. The Prairie Naturalist 22: 41-48.

Jones, C.M. and D.S. Robson, 1991. Improving precision in angler surveys: traditional access design versus bus route design. Pages 177-188 *in* D.Guthrie, J.M. Hoenig, M. Holliday, C.M. Jones, M.J. Mills, S.A. Moberly, K.H. Pollock, and D.R. Talhelm, editors. Creel and Angler Surveys in Fisheries Management. American Fisheries Society Symposium 12, Bethesda, Maryland.

Jones, C.M., D.S. Robson, D. Otis, and S. Gloss. 1990. Use of a computer simulation model to determine the behavior of a new survey estimator or recreational angling. Transactions of the American Fisheries Society 119:41-54.

Kinman, B.T. and R.D. Hoyt. 1984. Kentucky fishermen attitude survey: 1982. Kentucky Department of Fish and Wildlife Resources Bulletin No. 69.

Kolander, T.D., D. W. Willis, B.R. Murphy. 1993. Proposed revision of the standard weight (Ws) equation for smallmouth bass. North American Journal of Fisheries Management 13:398-400.

Lott, J., D. Fielder, B. Johnson, J. Riis, C. Stone and G. Wickstrom. 1994. Annual fish population surveys on South Dakota Missouri River reservoirs, 1993. South Dakota Department of Game, Fish and Parks, Wildlife Division, Annual Report No. 94-8, Pierre.

Martin, D.B., L.J. Mengel, J.F. Novotny, and C.H. Walburg. 1981. Spring and summer water levels in a Missouri River reservoir: effects on age-0 fish and zooplankton. Transactions of the American Fisheries Society 110: 370-381.

McPhillips, K. 1989. Recreational use and harvest of South Dakota fisheries, a statewide creel and angler preference survey. South Dakota Department of Game, Fish and Parks, Wildlife Division Report No. 88-7, Pierre.

Mendelsohn, R. 1994. South Dakota angler use and preference survey. South Dakota Department of Game, Fish and Parks, Wildlife Division, Completion Report No. 94-14, Pierre.

Michaletz, P., B. Johnson, J. Riis, C. Stone, D. Unkenholz, and D. Warnick. 1986. Annual fish population surveys on South Dakota Missouri River reservoirs, 1981-1985. South Dakota Department of Game, Fish and Parks, Wildlife Division, Progress Report No. 86-11, Pierre.

Miller, L.W. 1984. An aerial angler harvest survey on Lake Francis Case, South Dakota. Thesis. South Dakota State University, Brookings.

Murphy, B.R., M.L. Brown, and T.A. Springer. 1990. Evaluation of the relative weight (*W*r) index, with new applications to walleye. North American Journal of Fisheries Management 10: 85-97.

Nelson, W.R. 1961. Report of fisheries investigations during the eighth year of impoundment of Fort Randall reservoir, South Dakota, 1960. South Dakota Department of Game, Fish and Parks, Dingell-Johnson Project F-1-R-10, Pierre.

Pollock, K.H., C.M. Jones, and T.L. Brown. 1994. Angler Survey Methods and Their Applications in Fisheries Management. American Fisheries Society Special Publication 25. Bethesda, Maryland.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin of the Fisheries Research Board of Canada, Bulletin 191.

Robson, D.S. and C.M. Jones. 1989. The theoretical basis of an access site angler survey design. Biometrics 45: 83-98.

Schmidt, B.R. 1975. Results and evaluation of an aerial creel survey technique on Lake Sharpe, South Dakota. Thesis, South Dakota State University, Brookings.

Shields, J.T. 1955. Report of fisheries investigations during the second year of impoundment of Fort Randall reservoir, South Dakota, 1954. South Dakota Department of Game, Fish and Parks, Dingell-Johnson Project F-1-R-4, Pierre.

Shields, J.T. 1956. Report of fisheries investigations during the third year of impoundment of Fort Randall reservoir, South Dakota, 1955. South Dakota Department of Game, Fish and Parks, Dingell-Johnson Project F-1-R-5, Pierre.

Shields, J.T. 1957. Report of fisheries investigations during the fourth year of impoundment of Fort Randall reservoir, South Dakota, 1956. South Dakota Department of Game, Fish and Parks, Dingell-Johnson Project F-1-R-6, Pierre.

Sorensen, J.S. 2004. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2003. South Dakota Department of Game, Fish and Parks, Annual Report 04-19, Pierre.

Sorensen, J.S. and G. Knecht. 2006. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2004. South Dakota Department of Game, Fish and Parks, Annual Report 06-20, Pierre.

Sorensen, J.S. and G. Knecht. 2007. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2005. South Dakota Department of Game, Fish and Parks, Annual Report 07-29, Pierre.

Sorensen, J.S. and G. Knecht. 2008. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2006. South Dakota Department of Game, Fish and Parks, Annual Report 08-13, Pierre.

Sorensen, J.S. and G. Knecht. 2009. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2007. South Dakota Department of Game, Fish and Parks, Annual Report 09-17, Pierre.

Sorensen, J.S. and G. Knecht. 2010a. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2008. South Dakota Department of Game, Fish and Parks, Annual Report 10-06, Pierre.

Sorensen, J.S. and G. Knecht. 2010b. 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, Annual Report 10-13, Pierre.

Soupir, C.A. and M.L. Brown. 2002. Comprehensive evaluation and modification of the South Dakota angler creel program. South Dakota Department of Game, Fish and Parks, Completion Report 02-10, Pierre.

South Dakota Department of Game, Fish and Parks. 1994. Systematic approach to management. Wildlife Division, Pierre.

Stone, C.C. 1985. Angler use and sport fishing harvest survey on Lake Francis Case, South Dakota, 1984. South Dakota Department of Game, Fish and Parks, Completion Report 85-1, Pierre.

Stone, C.C. 1990. Lake Francis Case walleye management plan. South Dakota Department of Game, Fish and Parks, Wildlife Division, unpublished report, Pierre.

Stone, C.C. 1995. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 1994. South Dakota Department of Game, Fish and Parks, Annual Report 95-3, Pierre.

Stone, C.C. 1996. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 1995. South Dakota Department of Game, Fish and Parks, Annual Report 96-4, Pierre.

Stone, C.C. 1997a. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 1996. South Dakota Department of Game, Fish and Parks, Annual Report 97-6, Pierre.

Stone, C.C. 1997b. Factors affecting walleye recruitment in Lake Francis Case. South Dakota Department of Game, Fish and Parks, Completion Report 97-14, Pierre.

Stone, C.C. 1998. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 1997. South Dakota Department of Game, Fish and Parks, Annual Report 98-5, Pierre.

Stone, C., D. Fielder, and D. Unkenholz 1993. Angler preference and attitude survey on Lakes Oahe, Sharpe, and Francis Case, South Dakota, 1992. South Dakota Department of Game, Fish and Parks, Wildlife Division, Completion Report 93-15, Pierre.

Stone, C. and J. Lott 2002. Use of a minimum length limit to manage walleye in Lake Francis Case, South Dakota. North American Journal of Fisheries Management 22:975-984.

Stone, C., J. Riis, and B. Johnson. 1994. Angler use and sport fishing harvest survey on Lake's Francis Case, Sharpe, and Oahe, South Dakota, 1992 and 1993. South Dakota Department of Game, Fish and Parks, Wildlife Division, Annual Report 94-9, Pierre.

Stone, C.C. and J. Sorensen. 1999. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 1998. South Dakota Department of Game, Fish and Parks, Annual Report 99-9, Pierre.

Stone, C.C. and J. Sorensen. 2000. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 1999. South Dakota Department of Game, Fish and Parks, Annual Report 00-08, Pierre.

Stone, C.C. and J. Sorensen. 2001. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2000. South Dakota Department of Game, Fish and Parks, Annual Report 01-08, Pierre.

Stone, C.C. and J. Sorensen. 2002. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2001. South Dakota Department of Game, Fish and Parks, Annual Report 02-03, Pierre.

Stone, C.C. and J. Sorensen. 2003. Annual fish population and angler use and sport fish harvest surveys on Lake Francis Case, South Dakota, 2002. South Dakota Department of Game, Fish and Parks, Annual Report 03-08, Pierre.

Stone, C.C. and G.A. Wickstrom. 1991a. Angler use and sport fishing harvest survey on Lake Francis Case, South Dakota, 1989. South Dakota Department of Game, Fish and Parks, Wildlife Division, Progress Report 91-3, Pierre.

Stone, C.C. and G.A. Wickstrom. 1991b. Angler use and sport fishing harvest survey on Lake Francis Case and Ft. Randall tailwaters, South Dakota, 1990. South Dakota Department of Game, Fish and Parks, Wildlife Division, Annual Report 91-4, Pierre.

Stone, C.C. and G.A. Wickstrom. 1992. Angler use and sport fishing harvest survey on Lake Francis Case, South Dakota, 1991. South Dakota Department of Game, Fish and Parks, Wildlife Division, Annual Report, Pierre.

SYSTAT. 1998. Systat for Windows, Version 8.0. Systat, Inc. Evanston, IL.

Unkenholz, D.G., P.H. Michaletz, and C.C. Stone. 1984. Fisheries studies related to the Gregory County Pumped Storage Project, 1983. South Dakota Department of Game, Fish and Parks, Wildlife Division, Progress Report 84-5, Pierre.

United States Department of the Interior, Fish and Wildlife Service and United States Department of Commerce, Bureau of the Census. 2006. 2006 National survey of fishing, hunting, and wildlife-associated recreation. U.S Government Printing Office, Washington, DC.

Walburg, C.H. 1977. Lake Francis Case, a Missouri River reservoir: changes in the fish populations in 1954-75, and suggestions for management. United States Fish and Wildlife Service, Technical Paper 95, Washington, DC.

Willis, D.W., C.S. Guy, and B.R. Murphy. 1991. Development and evaluation of a standard weight (W_s) equation for yellow perch. North American Journal of Fisheries Management 11:374-380.

Appendix 1. Monthly water volume (1000's acre-feet) released through (power) or over (spill) Ft. Randall Dam, 2006-2010.

Month	2006		2007		2008		2009		2010	
	Power	**Spill**	**Power**	**Spill**	**Power**	**Spill**	**Power**	**Spill**	**Power**	**Spill**
Jan	526	0	778	0	724	0	672	0	870	0
Feb	647	0	536	0	537	0	335	0	644	0
Mar	712	0	253	0	407	0	664	0	420	0
Apr	681	0	408	0	711	0	756	0	743	0
May	1,063	0	471	0	610	0	1,011	0	1,402	0
Jun	1,399	0	922	0	395	0	1,337	0	1,119	0
Jul	1,599	0	1,298	0	961	0	1,498	0	1,952	0
Aug	1,816	0	1,254	0	1,349	0	1,571	0	2,414	101
Sep	1,564	0	1,187	0	1,167	0	1,710	0	2,346	322
Oct	764	0	706	0	950	0	1,598	0	2,193	702
Nov	588	0	470	0	399	0	935	0	2,276	339
Dec	651	0	658	0	780	0	881	0	1,401	0
Total	12,010	0	8,941	0	8,990	0	12,968	0	17,780	1,464

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

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

Appendix 3. Standard weight equations used for relative weight calculations. Length is in millimeters, weight is in grams, and logarithms are to the base 10.

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

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

Species	**Year**	***N***	**Equation**	**R^2**	**X TL (mm)**	**X WT (gm)**
Walleye	2006	497	LogWT=3.045LogTL-5.217	0.99	314	288
	2007	234	LogWT=3.122LogTL-5.420	0.99	332	328
	2008	223	LogWT=3.120LogTL-5.384	0.99	337	376
	2009	323	LogWT=3.114LogTL-5.383	0.99	341	386
	2010	509	LogWT=3.286LogTL-5.778	0.99	361	500
Sauger	2006	106	LogWT=2.916LogTL-4.952	0.94	338	295
	2007	73	LogWT=2.994LogTL-5.152	0.97	352	316
	2008	35	LogWT=2.691LogTL-4.365	0.84	345	315
	2009	60	LogWT=3.126LogTL-5.453	0.99	310	266
	2010	141	LogWT=3.207LogTL-5.629	0.99	306	266
SM Bass	2006	23	LogWT=2.930LogTL-4.687	0.99	280	328
	2007	9	LogWT=3.461LogTL-5.990	0.99	255	309
	2008	8	LogWT=2.501LogTL-3.588	0.96	311	450
	2009	17	LogWT=3.057LogTL-4.965	0.99	278	350
	2010	24	LogWT=3.270LogTL-5.482	0.99	232	190

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 2006-2010, for fish collected from Lake Francis Case. N = sample size.

Species	**2006**				**2007**				**2008**				**2009**				**2010**			
	PSD	**PSD P**	**PSD M**	W_r	**PSD**	**PSD P**	**PSD M**	W_r	**PSD**	**PSD P**	**PSD M**	W_r	**PSD**	**PSD P**	**PSD M**	W_r	**PSD**	**PSD P**	**PSD M**	W_r
Channel catfish	40	2	0	80	52	1	0	77	37	1	0	82	35	0	0	84	59	0	0	82
N =	153				154				151				135				114			
White bass	100	29	18	95	96	85	24	95	100	90	30	90	100	86	7	97	0	0	0	69
N =	34				30				14				19				8			
Yellow perch	33	8	0	89	25	0	0	77	27	0	0	86	25	0	0	90	25	2	0	83
N =	22				9				15				28				131			