SOUTH DAKOTA FISHERIES

ANNUAL FISH POPULATION AND ANGLER USE AND SPORT FISH HARVEST SURVEYS ON LAKE FRANCIS CASE, SOUTH DAKOTA, 2008

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ANNUAL FISH POPULATION
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ON
LAKE FRANCIS CASE, SOUTH DAKOTA, 2008

by

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PREFACE

Information collected during 2008 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 2004 through 2008, for Lake Francis Case (LFC), South Dakota. These surveys, their results and interpretation, are major strategy and evaluation tools for planning efforts outlined in the Missouri River Fisheries Program Strategic Plan. Results and discussion presented pertain to changes in fish community and population characteristics, sport fishing use and harvest, and evaluation of management activities and regulations.

Walleye catch per unit of effort (CPUE; No./min.), during 2008 spring-spawning-run electrofishing near Chamberlain, increased from 2007 and a high for the five-year period. Walleye electrofishing CPUE at the face of Ft. Randall Dam decreased from 2007 and was similar to other values in the five-year period.

Fall gill netting collected sixteen fish species. Walleye CPUE (No./net night) in 2008, was similar to that observed in 2007. Sauger CPUE decreased to a five-year low. Channel catfish CPUE in 2008 was similar to that observed in 2007. Mean white bass CPUE in 2008 decreased to a five-year low. Smallmouth bass CPUE during 2008 was similar to that from 2007. Yellow perch mean CPUE increased during 2008.

Eighteen species of age-0 fishes or small littoral prey species were collected by seining in 2008. Age-0 gizzard shad were most common in 2008 seine catches, accounting for 80% of the total catch, while white bass and emerald shiners accounted for 10% and 6% of the total catch respectively. Bigmouth buffalo, channel catfish, common carp, freshwater drum, johnny darter, largemouth bass, red shiner, smallmouth bass, spottail shiner, walleye, and yellow perch were also common in seine catches.

Walleye mean age and survival increased in 2008 while relative weight (Wr) and proportional size distribution (PSD) were similar to 2007 values. Overall walleye abundance during 2008 was similar to that in 2007. Walleye growth during 2008 decreased from 2007. Sauger gill net CPUE in 2008 decreased from 2007. Sauger PSD in 2008 remained similar to 2007 while survival decreased during 2008. Sauger mean age increased during 2008 while growth decreased from 2007 values. The number of smallmouth bass collected in fall netting surveys was inadequate to allow meaningful population parameter comparisons.

Anglers spent an estimated 553,822 hours fishing LFC, during the April-September 2008 daylight period, similar to the 562,447 hours estimated for 2007, but over 400,000 hours less than the high estimated for 1999. Total fish harvest in 2008 was estimated at 139,346 fish. Walleye dominated the harvest, with an estimated 86,352 fish harvested in the April-September 2008 survey period. Estimated mean length of harvested walleye was 39.4 cm (15.5 in). White bass, channel catfish, smallmouth bass, and sauger were also common in the harvest. An overall catch rate (harvest and release rates combined) of 1.1 fish/angler-h was estimated for the April-September 2008 daylight period. Total catch, release, and harvest rates for walleye were 0.79 walleye/angler-h, 0.63 walleye/angler-h, and 0.16 walleye/angler-h, respectively. Approximately 71% of LFC anglers expressed some degree of satisfaction with their angling trip. Anglers from South Dakota and 17 other states, fishing LFC, generated a local economic impact estimated at approximately 10.2 million dollars in 2008. Results from several questions regarding LFC angler attitudes and preferences are reported.

TABLE OF CONTENTS

Page

PREFACE ..... **ii**

EXECUTIVE SUMMARY ..... **iii**

TABLE OF CONTENTS ..... **iv**

LIST OF TABLES ..... **v**

LIST OF FIGURES ..... **viii**

LIST OF APPENDICES ..... **ix**

INTRODUCTION **1**

OBJECTIVES **3**

STUDY AREA **3**

SAMPLING METHODS AND SCHEDULE **6**
FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES 6
Data Collection 6
Data Analysis 6
ANGLER USE AND SPORT FISH HARVEST SURVEY 7
ANGLER PREFERENCE AND ATTITUDE SURVEY 8

RESULTS **8**
FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES 8
Species Composition and Relative Abundance 8
Population Parameters for Walleye 14
Population Parameters for Sauger 18
Population Parameters for Smallmouth Bass 20
Population Parameters for Channel Catfish 23
Water Temperature Monitoring 23
ANGLER USE AND SPORT FISH HARVEST SURVEY 24
Fishing Pressure 24
Fish Harvest 25
Fish Caught and Released 30
Harvest, Release and Catch Rates 31
Angler Demographics and Economics 33
ANGLER PREFERENCE AND ATTITUDE SURVEY 35
Angling Trip Satisfaction 35
Angler Preference and Attitude Survey: Competitive Angling Events 37

DISCUSSION **39**

RECOMMENDATIONS **41**

LITERATURE CITED **42**

APPENDICES **46**

LIST OF TABLES

Table Page

1. Angler use and sport fish harvest statistics from creel surveys conducted on Lake Francis Case since 1954. TL = total length. 2

2. Physical characteristics at base of flood control, management classification, and sampling times and depths for annual fish population surveys on Lake Francis Case. 5

3. Minimum lengths (mm) of length class designations (Gabelhouse 1984) 7

4. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Chamberlain, 2004-2008. Catch per unit effort (CPUE) values with the same letter code are not significantly different at the *P* = 0.2 level. 8

5. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Ft. Randall Dam, 2004-2008. Catch per unit effort (CPUE) values with the same letter code are not significantly different at the *P* = 0.2 level. 9

6. Electrofishing data, by location and date, for walleye from Lake Francis Case, 2008. Catch per unit effort (CPUE) values, by location, with the same letter code are not significantly different at the *P* = 0.2 level. 9

7. Electrofishing catch of smallmouth bass during spring sampling, at five locations on Lake Francis Case, 2004-2008. Catch per unit effort (CPUE) values within sites with the same letter code are not significantly different at the *P* = 0.2 level. 10

8. Mean gill net catch per lift (CPUE; No./net night), sampling stations combined, on Lake Francis Case, 2004-2008. SE is standard error. Trace (T) < 0.1 12

9. Mean catch per seine haul (CPUE; No./haul), sampling stations combined, of age-0 fishes and small littoral species, from Lake Francis Case, 2004-2008. SE is standard error. Trace (T) < 0.1. 13

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, 2004–2008. 14

11. Mean length-at-age-at-capture (mm) for walleye, as determined by aging otoliths, collected in the standard September gill net survey, 2004-2008, Lake Francis Case, South Dakota. *N*=sample size.. 15

12. Mean annual growth increments for walleye collected in the standard September gill net survey on Lake Francis Case, South Dakota for 2003-2004, 2004-2005, 2005-2006, 2006-2007 and 2007-2008 as determined by aging otoliths. 15

13. Age distribution, from otolith analysis, of walleye collected from Lake Francis Case with variable-mesh gill nets, 2004-2008. Mean age excludes age-0 fish 16

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 16

15. Mean relative weight, by length category, for Lake Francis Case walleye, sauger, and smallmouth bass, collected in gill net catches in early September, 2004-2008. S-Q = stock-to-quality length, Q-P = quality-to-preferred length, P = preferred length. *N* = sample size. 17

List of tables continued...

Table Page

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, 2004-2008. 17

17. Mean length-at-age-at-capture (mm) for sauger, as determined by aging otoliths, collected in the standard September gill net survey, 2004-2008, Lake Francis Case, South Dakota. *N*=sample size. 19

18. Mean annual growth increments for sauger collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2003-2004, 2004-2005, 2005-2006, 2006-2007 and 2007-2008 periods, as determined by aging otoliths. 20

19. Age distribution from otolith analysis, of sauger collected from Lake Francis Case with variable-mesh gill nets, 2004-2008. Mean age excludes age-0 fish 20

20. Mean length-at-age-at-capture (mm) for smallmouth bass, as determined by aging otoliths collected in the standard September gill net survey, 2004-2008, Lake Francis Case, South Dakota. *N* = sample size. 21

21. Mean annual growth increments for smallmouth bass collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2003-2004, 2004-2005, 2005-2006, 2006-2007, and 2007-2008 periods, as determined by aging otoliths……21

22. Age distribution, from otolith analysis, of smallmouth bass collected from Lake Francis Case with variable-mesh gill nets, 2004-2008. Mean age excludes age-0 fish 22

23. Estimated total fishing pressure (angler hours), by month and zone, on Lake Francis Case, April-September, 2008 (+/- 80% confidence interval) 24

24. Estimated total angler hours, for boat anglers, shore anglers and angling methods combined, by zone, for Lake Francis Case, April-September, 2008 25

25. Estimated total fish harvest, by month, for anglers fishing Lake Francis Case, April-September, 2008 (+/- 80% confidence interval) 25

26. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2008 (+/- 80% confidence interval) 26

27. 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, 2004-2008 30

28. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2008 30

29. Estimated harvest rate, release rate and catch rate, by species (+/- 80% confidence interval), for anglers fishing Lake Francis Case, 2008. 31

List of tables continued...

Table

Page

30. Estimated harvest rate, release rate, and catch rate for all species combined (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2008. 32

31. Estimated harvest rate, release rate, and catch rate of walleye (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2008. 32

32. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2008. 32

33. Percentage of non-resident anglers who fished Lake Francis Case, 2004-2008, by state of residence, expressed as percent of total non-residents. 33

34. Percentage of anglers traveling specified distances, one way, to fish Lake Francis Case during 2004-2008 35

35. Target species of Lake Francis Case anglers, during 2004-2008, expressed as a percentage of total angling trips. 35

36. Responses of 2008 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.. 36

37. Responses of 2008 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. 36

38. Responses of 2008 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. 37

39. 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?", 2004-2008. Responses are presented as percentage of total responses. *N* = number of responses 37

40. Responses of 2008 Lake Francis Case anglers to the question: "Within the last 12 months, how many fishing tournaments have you participated in on Lake Francis Case?" Responses are presented as number of responses with percentage of total responses in parenthesis by month 38

41. Responses of 2008 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 38

42. Responses of 2008 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 month. 39

LIST OF FIGURES

Figure Page

1. Lake Francis Case study area 4

2. Spring 2008 Lake Francis Case reservoir elevation. 5

3. Length frequency of walleye collected with gill nets from Lake Francis Case, 2008. *N* = sample size. 14

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, 1988-2008 18

5. Length frequency of sauger collected with gill nets from Lake Francis Case, 2008. *N* = sample size. 19

6. Length frequencies of smallmouth bass collected by spring electrofishing and fall gill netting from Lake Francis Case, 2008. *N* = sample size. 22

7. Length frequency of channel catfish collected with gill nets from Lake Francis Case, 2008. *N* = sample size. 23

8. Water temperature in Lake Francis Case at American Creek , Boyer and Pease Creek, 2008. 23

9. Estimated fishing pressure, by month, on Lake Francis Case, 2004-2008 25

10. Estimated total walleye harvest, by month, for anglers fishing Lake Francis Case, 2004-2008. 26

11. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2008. *N* = sample size. 28

12. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2008. *N* = sample size. 29

13. County of residence for resident anglers fishing Lake Francis Case in 2008. Percentage of total resident anglers is shown for the top five represented counties. 34

LIST OF APPENDICES

Appendix Page

1. Monthly water volume (1000's acre-feet) released through (power) or over (spill) Ft. Randall Dam, 2004-2008. 46

2. Common and scientific names of fishes mentioned in this report 47

3. Standard weight equations used for relative weight calculations. Length is in millimeters, weight is in grams, and logarithms are to the base 10 48

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. 48

5. Channel catfish, white bass, and yellow perch proportional size distribution (PSD) of preferred and memorable-length fish (PSD-P and PSD-M, respectively), and relative weight (W_r), for 2004-2008, for fish collected from Lake Francis Case. *N* = sample size. 49

ANNUAL FISH POPULATION
AND
ANGLER USE AND SPORT FISH HARVEST SURVEYS
ON
LAKE FRANCIS CASE, SOUTH DAKOTA, 2008

INTRODUCTION

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

Walleye, and to a lesser extent smallmouth bass, white bass and channel catfish, provide the majority of sport fishing opportunity available in this reservoir. Over the past 25 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 2008 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 "hi-grade" walleye/sauger or hybrids.
- anglers fishing through the ice in the lower half of the reservoir are required to keep the first four walleye/sauger or hybrids they catch and size restrictions do not apply.
- closed area: the area in the upper portion of the reservoir, between I-90 and the railroad bridge, referred to as the "dredge hole" is closed to fishing (except shore fishing on the Brule County side) during the months of January through April and December.

LFC anglers fishing in the late 1990s and early 2000s benefited from high walleye abundance resulting from conditions provided by unusually high water levels in 1995 and 1997. Water yield in the Missouri River Basin was below normal for the 2000-2007 periods. Water yield in the basin returned to above average condition in 2008 following eight consecutive years of drought. Past research (Stone 1997b) and observations would suggest that it is unrealistic to expect to maintain fish population abundance at the levels observed in the mid-to-late 1990s during low run-off conditions. Walleye abundance steadily decreased from 1995 to 2004 due to persistent drought conditions. Increases in overall walleye abundance have been documented during 2005 and 2006 followed by a sharp decrease in 2007. Walleye abundance in 2008 was similar to 2007.

Maintaining LFC as one of South Dakota's most productive fisheries resources requires that it be effectively managed to produce optimal recreational benefits, within the framework of protecting and maintaining the overall integrity of the aquatic community. The Missouri River Fisheries Program Strategic Plan (SDGFP 1994) documents the goal, objectives and strategies developed for management of this system. Annual acquisition and analysis of data describing the fish community and fish population parameters, in association with data describing angler use and sport fish harvest, is a primary strategy outlined in that plan. This work is required for evaluation of objectives and strategies outlined in the strategic plan and as a prerequisite to effective development of future management strategies. This report describes data collected in 2008 from LFC and the discussion focuses on changes in fish populations and associated angler use and sport fish harvest since 2004.

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

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

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

OBJECTIVES

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

Annual Fish Population Surveys (Federal Aid Project 2102):

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

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

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

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

STUDY AREA

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

Water yield in the Missouri River system in 2008 returned to normal levels following eight consecutive years of below normal water yield (Appendix 1; U.S. Army Corps of Engineers, unpublished data). During the spring of 2008, the elevation of LFC increased as was forecasted by the U.S. Army Corps of Engineers (USCOE). Reservoir elevation reached 413 m msl (1354.3 ft. msl) by early March and remained above this level until late August when the annual fall draw-down began. Appendix 1 presents monthly data on water released through Ft. Randall Dam.

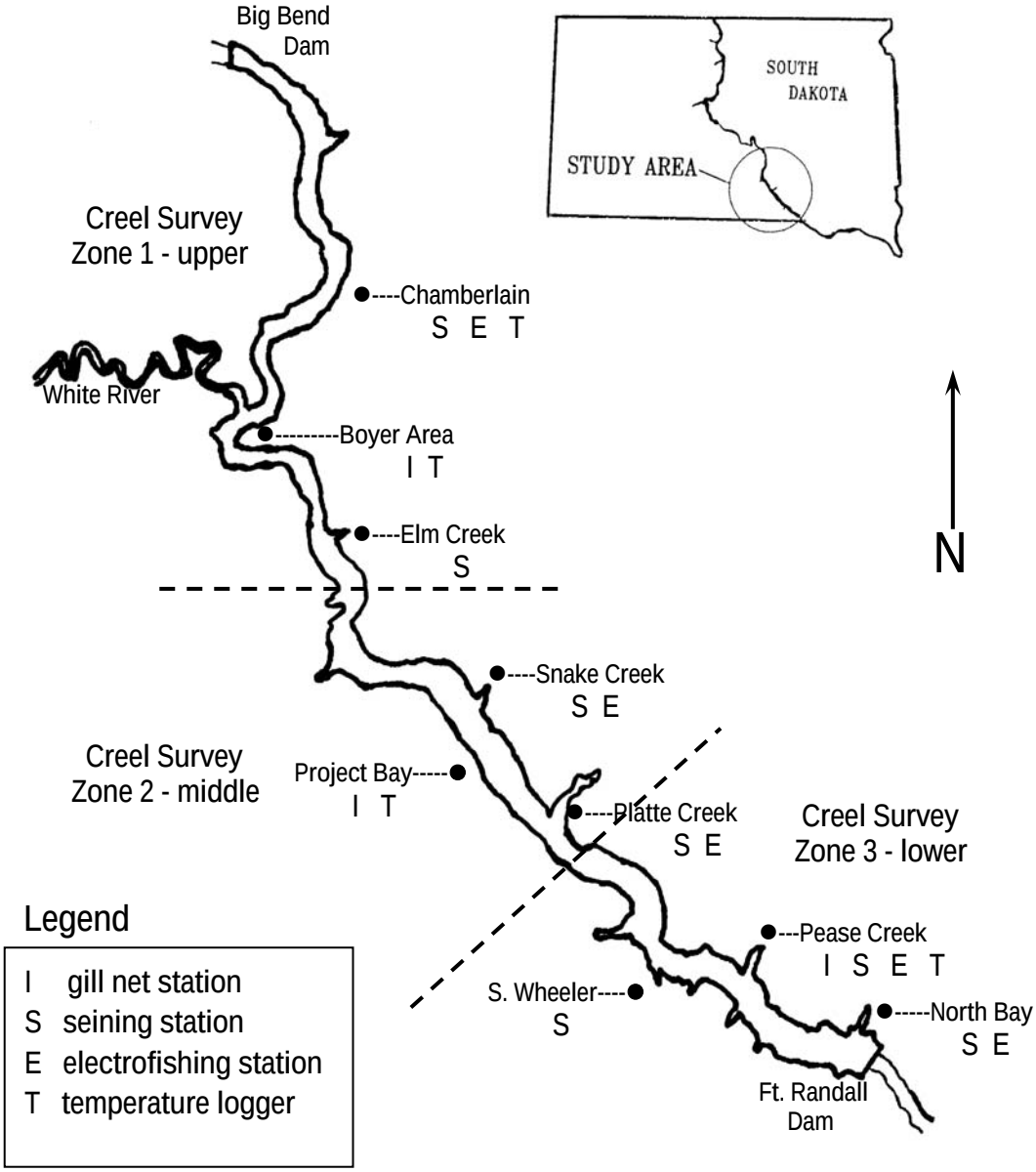

Figure 1. Lake Francis Case study area.

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

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

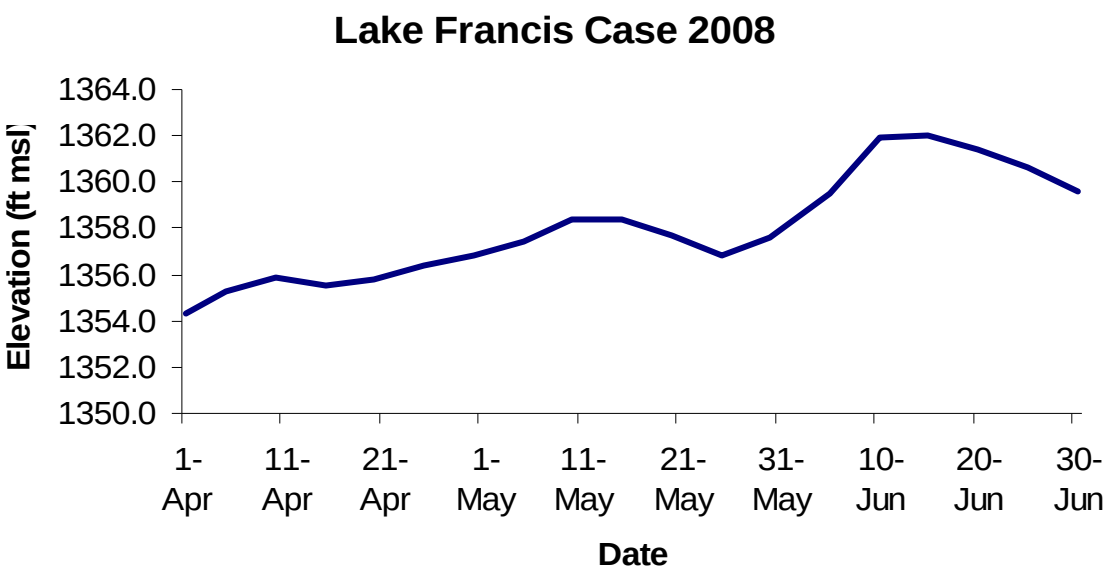

Figure 2. Spring 2008 Lake Francis Case reservoir elevation.

SAMPLING METHODS AND SCHEDULE

FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES

Data Collection

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

Pulsed-DC (60 pps, 6-8 amps) electrofishing, using a Smith Root GPP electrofishing boat, was used to collect walleye during April and smallmouth bass during May and June, for population monitoring (fish/min) and tagging studies. Nine and six 10-minute electrofishing runs were conducted at night near Chamberlain and on the face of Ft. Randall Dam, respectively, to collect walleye. Smallmouth bass were collected at five locations: Chamberlain, Big Bend Dam tailwater, Platte Creek, Pease Creek and near Ft. Randall Dam (Figure 1). Three, 15-minute electrofishing runs were conducted at each sampling location. All fish were measured for total length.

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

Water temperature data was collected with submersible HOBO Water Temp Pro temperature loggers. Loggers, configured to record temperature every two hours, were deployed at four locations (Figure 1) on the reservoir April 12, 2007 and retrieved September 5, 2007.

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) 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 and 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 et al 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. Statistical significance was set at $P < 0.05$.

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

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

ANGLER USE AND SPORT FISH HARVEST SURVEY

A bus route creel survey design (Jones and Robson 1991; Soupir and Brown 2002), first utilized in 2000 (Stone and Sorensen 2001), was conducted to estimate angler use and harvest on LFC. Prior to 2000, fishing pressure was estimated by either aerial counts of fishing boats and shore anglers (Schmidt 1975) or by ground counts of boat trailers and shore anglers (Stone and Sorensen 1999). A bus route design is a modified access survey typically used for fisheries with numerous access sites spread over a broad geographical region (Robson and Jones 1989; Jones et. al. 1990). For a more detailed description of the bus route theory and techniques see Robson and Jones (1989), Jones and Robson (1991) and Pollock et al. (1994). Estimates of angler catch, harvest, and release rates, along with information on mean party size, mean angler day length, and angler residency were collected by interviewing anglers. Total fish catch, harvest and release estimates were calculated by multiplying the pressure estimate (angler hours) by the estimated catch, harvest, or release rate (fish/angler-h). Despite the modification to the fishing pressure estimate technique, the survey design provides statistics comparable to those previously determined for LFC (Miller 1984; Unkenholz et al. 1984; Stone 1985; Stone and Wickstrom 1991a, 1991b, 1992; Stone et al. 1994; Stone 1995, 1996b, 1997a, 1998; Stone and Sorensen 1999, 2000, 2001, 2002, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009).

Sampling was conducted from 1 April 2008 through 30 September 2008, for the daylight period (sunrise to sunset). Creel zones are identified in Figure 1.

ANGLER PREFERENCE AND ATTITUDE SURVEY

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

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

RESULTS

FISH POPULATION SURVEYS AND ASSOCIATED WORK ACTIVITIES

Species Composition and Relative Abundance

Results of spring electrofishing, conducted to monitor timing and abundance of spawning walleye, are presented in Tables 4 - 6. Overall walleye electrofishing CPUE in 2008, near Chamberlain, was higher than values measured in previous years (Table 4). Sampling near Ft. Randall Dam, during 2008, yielded a CPUE within the range of the five-year period (Table 5). Walleye electrofishing CPUEs near Chamberlain peaked on 16 April 2008 (Table 6). Electrofishing CPUEs near Ft. Randall Dam were similar for both sampling dates (Table 6).

Table 4. Electrofishing catch of walleye during spring-spawning-run sampling from Lake Francis Case, near Chamberlain, 2004-2008. Catch per unit effort (CPUE) values with the same letter code are not significantly different at the *P* = 0.2 level.

Year	Sampling time (min)	Number of fish	CPUE (fish/min)
2004	90	749	8.3 a
2005	75	773	10.3 a
2006	68	788	11.6 a
2007	82	824	10.0 a
2008	54	893	16.5 b

Table 5. Electrofishing catch of walleye during spring spawning-run sampling from Lake Francis Case, near Ft. Randall Dam, 2004-2008. 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)
2004	60	245	4.1 a
2005	60	360	6.0 a
2006	60	288	4.8 a
2007	64	404	6.3 a
2008	60	260	4.3a

Table 6. Electrofishing data, by location and date, for walleye from Lake Francis Case, 2008. 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	4/16/08	7.3	15	330	22.0 a
Chamberlain	4/21/08	9.3	16	310	19.4 a
Chamberlain	4/28/08	7.8	23	253	11.0 b
Ft. Randall Dam	4/22/08	6.0	30	126	4.2 a
Ft. Randall Dam	4/29/08	6.9	30	134	4.5 a

Catch-per-unit-effort of smallmouth bass during 2008 was similar to those measured previously for all sampling stations (Table 7). Although not statistically significant, decreases in smallmouth bass CPUE were observed at all sampling stations with the exception of Ft. Randall Dam. Smallmouth bass CPUE of 2.1 fish/min. was the highest of the five-year period for the Ft. Randall Dam sampling station (Table 7).

Table 7. Electrofishing catch of smallmouth bass during spring sampling, at five locations on Lake Francis Case, 2004-2008. Catch per unit effort (CPUE) values within sites with the same letter code are not significantly different at the *P* = 0.2 level.

Big Bend Dam Tailwater			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2004	30	67	2.2 a
2005	60	55	0.9 b
2006	45	65	1.4 ab
2007	45	33	0.9 b
2008	45	26	0.6 b
Chamberlain			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2004	55	62	1.1 a
2005	60	67	1.1 a
2006	47	102	2.2 a
2007	36	95	2.6 a
2008	30	47	1.6 a
Platte Creek			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2004	45	30	0.7 a
2005	60	59	1.0 ab
2006	45	62	1.4 b
2007	60	55	0.9 ab
2008	45	21	0.5 a
Pease Creek			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2004	55	24	0.4 a
2005	45	71	1.6 ab
2006	45	61	1.4 ab
2007	45	79	1.8 b
2008	45	61	1.4 ab
Ft. Randall Dam			
Year	**Sampling time (min)**	**Number of fish**	**Fish/min**
2004	30	23	0.8 a
2005	60	62	1.0 a
2006	45	66	1.5 a
2007	45	44	1.0 a
2008	30	64	2.1 a

Fall gill net sampling collected 16 species of fish from LFC in 2008 (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 37% of gill net catches in 2008, followed by channel catfish, gizzard shad, common carp and sauger, which accounted for 25%, 9%, 7% and 6% of the catch, respectively. Freshwater drum, goldeye, shortnose gar, smallmouth bass, white bass and yellow perch were also common in gill-net catches during 2008.

Walleye gill net CPUE for 2008 was 8.3 walleye/net. Walleye gill net CPUE was similar to 2007 and was the lowest value recorded in the five-year period (Table 8). A decrease in abundance was not predicted due to high production of walleye in 2005 and 2006.

Channel catfish gill net CPUE, of 5.6 fish/net in 2008 was similar to other years and near the high for the five-year period. Sauger gill net CPUE decreased in 2008 for the second consecutive year to 1.4 sauger/net. Smallmouth bass gill net CPUE for 2008 remained at 0.3 smallmouth bass/net, a low for the five-year period. Yellow perch gill net CPUE increased to 0.6 yellow perch/net in 2008, within the range of the five-year period. The 2008 white bass gill net CPUE of 0.5 white bass/net was the low for the five-year period.

Eighteen species of age-0 fishes or small littoral species were collected by seining in 2008 (Table 9). All species had been previously reported for LFC (Lott et al. 1994). Age-0 gizzard shad dominated the seine catches, as they have for the previous five years, making up 80% of the total seine catch. White bass, emerald shiners and freshwater drum comprised 10, 6 and 2 percent of the total seine catch, respectively. Channel catfish, johnny darters, smallmouth bass, spottail shiners, walleye and yellow perch were also common in seine samples.

The 2008 age-0 walleye seining CPUE of 0.6 fish/seine haul was lower than that measured the previous three years. Age-0 walleye were collected at the Pease Creek, Platte Creek, Elm Creek and American Creek sampling locations in 2008. A majority of age-0 walleye are usually collected in the upper half of the reservoir. Seventeen age-0 walleye were collected by seines in mid-July, 2008 and averaged 64.9 mm (Table 10), 25 percent smaller than the previous five years.

Table 8. Mean gill net catch per lift (CPUE; No./net night), sampling stations combined, on Lake Francis Case, 2004-2008. SE is standard error. Trace (T) < 0.1.

Species	2004		2005		2006		2007		2008	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Black bullhead	0.0		0.0		0.0		0.0		0.0	
Channel catfish	4.4	0.8	4.1	0.5	5.7	0.7	5.7	0.8	5.6	0.9
Common carp	0.8	0.2	0.9	0.2	1.7	0.4	1.8	0.5	1.6	0.4
Emerald shiner	0.0		0.0		T	-	0.0		0.0	
Freshwater drum	0.8	0.3	1.3	0.4	1.1	0.3	0.8	0.2	0.8	0.2
Gizzard shad	0.8	0.3	2.8	1.2	17.1	9.2	4.0	1.4	2.0	0.9
Goldeye	1.5	0.6	1.5	0.5	3.1	1.2	1.6	0.5	0.3	0.1
Northern pike	0.0		T	-	0.0		0.0		0.0	
Rainbow trout	T	-	0.0		0.0		0.0		0.0	
River carpsucker	0.5	0.2	0.1	0.1	0.4	0.2	0.2	0.1	0.1	0.1
Sauger	4.7	0.7	3.3	0.4	3.9	0.6	2.7	0.8	1.4	0.3
Shorthead redhorse	0.1	0.1	T	-	T	-	0.1	0.1	T	-
Shortnose gar	0.2	0.1	0.1	0.1	0.2	0.2	0.4	0.3	0.6	0.5
Shovelnose sturgeon	0.0		0.0		0.0		0.0		0.0	
Smallmouth bass	0.7	0.4	0.7	0.3	0.9	0.2	0.3	0.1	0.3	0.2
Smallmouth buffalo	T	-	0.1	0.1	0.1	0.1	T	-	T	-
Spottail shiner	0.1	0.1	T	-	T	-	0.0		T	-
Walleye	8.6	1.0	11.7	1.7	18.4	1.8	8.7	1.2	8.3	1.2
White bass	0.6	0.2	3.0	0.8	1.3	0.4	1.1	0.3	0.5	0.2
White crappie	T	-	0.0		0.1	0.1	2.0	1.6	0.1	0.1
Yellow perch	1.2	0.4	2.4	0.7	0.8	0.2	0.3	0.1	0.6	0.2

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, 2004-2008. SE is standard error. Trace (T) < 0.1

Species	2004		2005		2006		2007		2008	
	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE	CPUE	SE
Bigmouth buffalo	0.0		T	-	0.0		T	-	0.1	0.1
Black bullhead	0.0		0.0		0.0		0.0		0.0	
Black crappie	0.0		0.0		0.0		0.0		0.0	
Channel catfish	0.5	0.3	0.2	0.1	0.1	0.1	0.3	0.2	0.4	0.3
Common carp	0.6	0.3	0.1	0.1	0.0		0.3	0.1	0.1	0.1
Common shiner	0.0		0.0		0.0		0.0		0.0	
Emerald shiner*	45.1	12.2	17.8	3.3	80.3	53.4	24.1	11.2	54.3	15.7
Fathead minnow*	0.0		0.0		T	-	0.1	0.1	0.0	
Freshwater drum	0.4	0.2	8.9	2.6	1.9	0.8	16.5	8.8	17.3	8.3
Gizzard shad	290.6	100.6	332.8	116.8	241.7	105.2	437.4	124.2	700.3	320.4
Goldeye	0.1	0.1	2.5	1.5	T	-	0.0		0.0	
Johnny darter*	8.4	5.4	0.1	0.1	0.1	0.1	0.2	0.1	1.6	1.2
Largemouth bass	0.0		0.0		0.0		T	-	0.1	0.1
North. Redbelly dace	0.0		0.0		0.0		0.0		0.0	
Red shiner*	0.4	0.2	0.2	0.2	0.3	0.1	0.6	0.3	0.3	0.1
River carpsucker	5.4	1.8	T	-	0.0		0.1	0.1	T	-
Sauger	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	T	-
Shorthead redhorse	0.0		0.0		0.0		0.0		T	-
Silvery minnow	0.0		0.0		0.0		0.0		0.0	
Smallmouth bass	2.6	0.7	2.6	0.5	0.7	0.2	1.6	0.6	1.7	0.5
Smallmouth buffalo	T	-	T	-	0.0		T	-	T	-
Spottail shiner*	6.8	2.5	6.5	1.9	9.5	3.0	1.7	0.5	2.9	0.9
Walleye	0.3	0.1	0.8	0.3	0.9	0.4	1.0	0.3	0.6	0.3
White bass	65.2	21.0	38.7	16.1	3.1	1.0	14.6	7.0	92.4	40.1
White crappie	0.0		0.0		0.0		0.0		0.0	
Yellow perch	5.8	2.3	1.7	0.6	1.8	0.9	0.7	0.4	8.6	3.1

*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, 2004 – 2008.

Year	No.	CPUE	Mean TL (mm)	Total length (mm) range
2004	9	0.3	88.5	85-92
2005	21	0.8	102.3	85-116
2006	26	1.0	86.5	62-108
2007	27	1.0	86.8	64-117
2008	21	0.8	64.9	52-75

Population Parameters for Walleye

Beginning in 2003, otoliths were removed from walleye collected during the September gill netting survey. Mean length-at-age-at-capture for each age group is listed in Table 11. Mean length-at-age-at-capture shows Lake Francis Case walleye typically reach the minimum legal length (381 mm) at age 3 suggesting that the large 2005 year class should have reached legal length in 2008. Mean annual growth increments for walleye indicate that growth decreased during the 2005-2007 period (Table 12) possibly a result of large 2005 and 2006 year classes present in the population. Mean walleye age in gill net samples, at 3.1 years, is the highest recorded from 2004-2008 (Table 13). Walleye from eleven year-classes were collected in the 2008 gill net survey (Table 13) and ranged in TL from 120-mm to 505-mm (Figure 3).

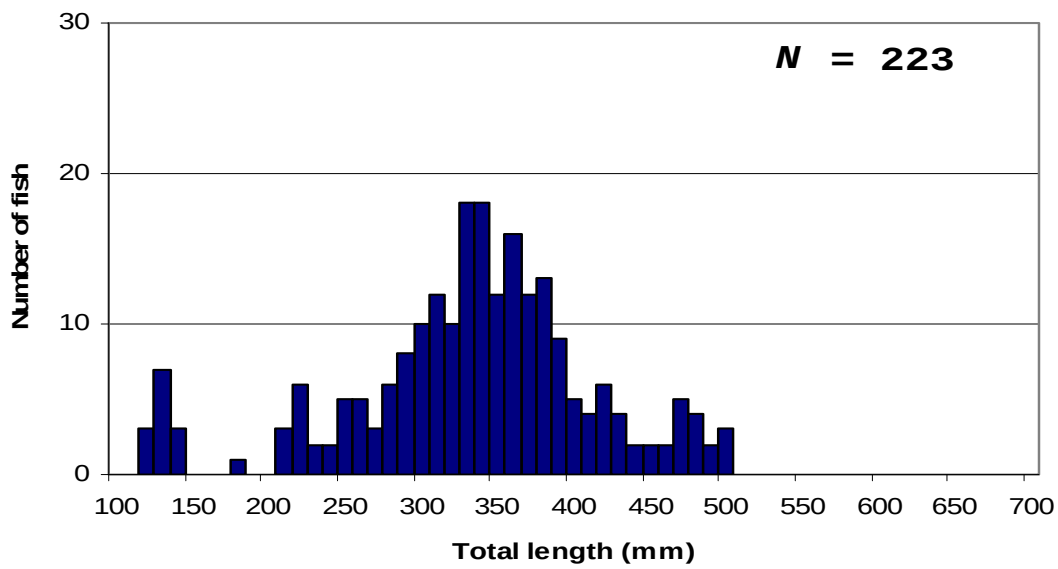

Figure 3. Length frequency of walleye collected with gill nets from Lake Francis Case, 2008. N = sample size.

Annual survival, for pooled 2007 and 2008 data, was estimated at 65% (Table 14), within the range of the five-year period. Relative weights for stock-quality (S-Q) length and quality-preferred (Q-P) length fish sampled in 2008 were higher than in 2007 (Table 15). Relative weight for preferred length walleye also increased during 2008 (Table 15). Walleye proportional size distribution (PSD) for 2008 increased to 31 while PSD-P dropped to 0 (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, 2004-2008, 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
2004	**Mean**	266	347	385	418	438	410	465	421				
	N	63	75	22	19	12	1	1	1	0	0	0	0
	SE	3.3	2.9	7.3	4.7	10.7	NA	NA	NA				
2005	**Mean**	298	374	413	455	447	477						
	N	80	82	40	12	5	7	0	0	0	0	0	0
	SE	2.0	2.2	4.4	8.2	11.1	15.2						
2006	**Mean**	257	350	394	433	444	454	477	469	573			
	N	168	103	58	17	5	4	5	3	1	0	0	0
	SE	2.7	8.0	14.8	26.4	67.5	107.9	127.5	98.8	NA			
2007	**Mean**	247	312	382	418	445	471	467	501		542		522
	N	36	110	33	15	7	4	2	2	0	1	0	2
	SE	6.6	3.0	4.1	9.4	8.8	17.6	20.5	19.5		NA		33.5
2008	**Mean**	237	309	357	416	453	482	445	488	513	540		
	N	23	44	101	21	11	6	1	3	4	1	0	0
	SE	4.6	3.1	2.9	8.2	12.0	13.5	NA	13.8	32.1	NA		
Mean of means		260	338	386	428	445	459	463	470	543	541	0	522

Table 12. Mean annual growth increments for walleye collected in the standard September gill net survey on Lake Francis Case, South Dakota for 2003-2004, 2004-2005, 2005-2006, 2006-2007 and 2007-2008 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
2003-2004	85	53	41	15	0	40	0	--	--	--
2004-2005	108	66	70	29	39	--	--	--	--	--
2005-2006	94	42	38	14	0	13	0	104	--	--
2006-2007	55	32	24	12	27	13	24	--	0	--
2007-2008	62	45	34	35	37	--	21	12	--	--

Table 13. Age distribution, from otolith analysis, of walleye collected from Lake Francis Case with variable-mesh gill nets, 2004-2008. Mean age excludes age-0 fish.

	Age													
Year	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**Mean**
2004	6	63	75	22	19	12	1	0	2	0	0	0	0	2.3
2005	6	80	82	40	12	5	7	0	0	0	0	0	0	2.1
2006	1	168	103	58	17	5	4	5	3	1	0	0	0	2.0
2007	10	36	110	33	15	7	4	2	2	0	1	0	2	2.5
2008	14	23	44	101	21	11	6	1	3	4	1	0	0	3.1

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	2003-2004	0.46	0.54	0.769	0.954
	2004-2005	0.54	0.46	0.621	0.905
	2005-2006	0.51	0.49	0.668	0.976
	2006-2007	0.59	0.41	0.531	0.892
	2007-2008	0.65	0.35	0.434	0.858
Sauger	2003-2004	0.52	0.48	0.652	0.821
	2004-2005	0.38	0.62	0.977	0.812
	2005-2006	0.43	0.57	0.837	0.759
	2006-2007	0.48	0.52	0.739	0.963
	2007-2008	0.43	0.57	0.595	0.849
Smallmouth bass	2003-2004	0.20	0.80	1.590	0.938
	2004-2005	0.36	0.64	1.010	0.862
	2005-2006	0.67	0.33	0.400	0.429
	2006-2007	0.88	0.12	0.125	0.307
	2007-2008	0.86	0.14	0.298	0.153

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, 2004-2008. 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***
2004	83	82	77	185
2005	84	84	77	229
2006	80	76	80	317
2007	79	75	73	196
2008	84	81	80	196
Sauger				
Year	**S-Q**	**Q-P**	**P**	***N***
2004	74	74	73	124
2005	82	75	75	83
2006	78	71	68	102
2007	74	73	68	70
2008	68	74	67	37
Smallmouth bass				
Year	**S-Q**	**Q-P**	**P**	***N***
2004	112	105	-	15
2005	118	108	110	14
2006	102	92	92	20
2007	93	98	-	7
2008	117	99	91	8

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, 2004-2008.

Species	2004	2005	2006	2007	2008
Walleye	27 (1,0)	42 (1,0)	29 (1,0)	29 (2,0)	31 (0,0)
Sauger	75 (11,0)	95 (41,0)	62 (30,0)	87 (1,0)	84 (27,0)
Smallmouth bass	33 (0,0)	64 (14,0)	50 (10,0)	71 (0,0)	88 (13,0)

Yearly total walleye abundance (CPUE), as indexed by fall gill netting, partitioned by selected age and size groups and plotted with total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA is presented in Figure 4. Walleye population parameter improvements were noted soon after sport-fishing regulation changes were implemented in 1990 (Stone and Wickstrom 1991a). The population also positively responded to habitat/nutrient conditions provided by the high runoff into the Missouri River system during 1993–1997 (Stone 1997b). The general decline in overall walleye abundance beginning in 1996 through 2004 can be attributed to angler harvest coupled with declining productivity, as Missouri River water yield returned to more normal levels in 1998 and 1999, followed by eight consecutive years of drought conditions. Poor nutrient conditions caused by reduced localized run-off resulted in poor production and recruitment during 2001-2004. Following a sharp decrease in water elevation during the peak walleye egg incubation period in 2002, the Department of Game, Fish and Parks stocked 400,000 walleye fingerlings and 4 million walleye fry. There appeared to be a large

walleye year class produced in 2002 and although origin of these age-0 fish could not be determined, their smaller-than-average size in fall gill net samples led to the assumption that a majority of these fish were a result of stocking efforts. Unfortunately, the strong 2002 year class did not translate into a strong age-1 or age-2 year class in 2003 and 2004 and a significant portion of these fish were lost from the population. Walleye abundance increased to levels similar to the early 2000's during 2005 and 2006, but remains well below abundance levels experienced in the late 1990's. Walleye abundance in 2008 decreased slightly from 2007 to an all-time low. Walleye produced in 2005 and 2006 currently comprise a majority of the Lake Francis Case walleye population.

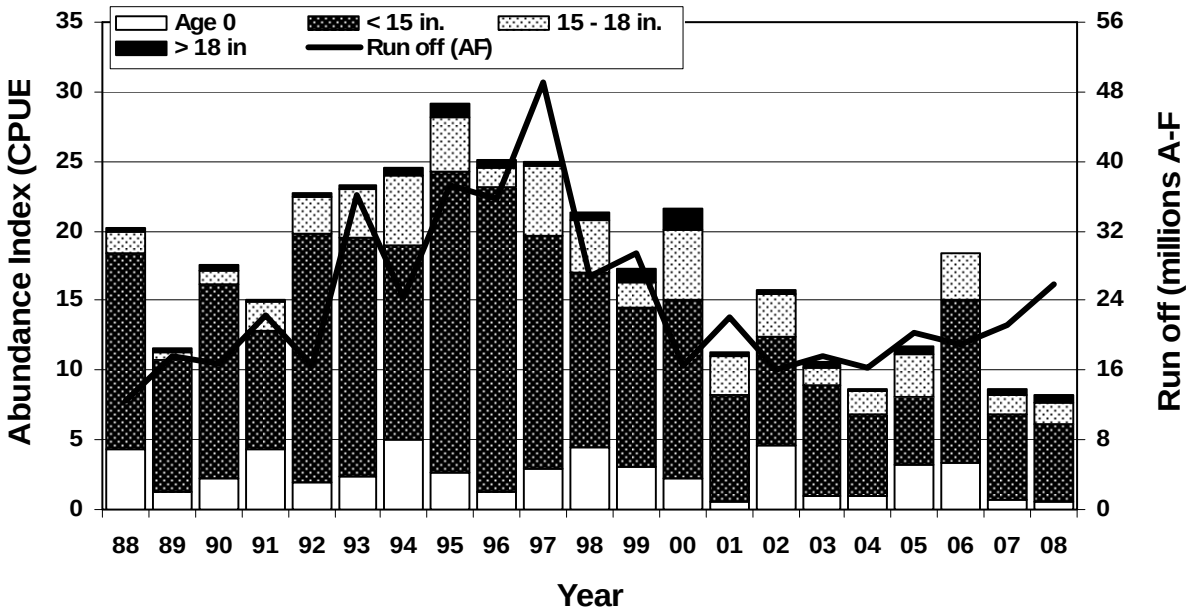

Figure 4. Lake Francis Case total walleye abundance (No. per net night) partitioned by walleye age and length groups and plotted against total runoff (millions of acre-feet) into the Missouri River system above Sioux City, IA. 1988-2008.

Population Parameters for Sauger

The 2008 Lake Francis Case sauger abundance index, at a mean CPUE of 1.4 fish/net night was lower than that measured in 2007 and was the lowest for the five-year period (Table 8). Lengths of sauger sampled in the 2008 gill net survey ranged from 230mm to 432 mm TL (Figure 5). Sauger average length-at-age-at-capture indicates that LFC saugers surpass 381mm at 3 years of age (Table 17). Sauger up to age six were sampled in the 2008 gill net survey (Table 17). Sauger growth for the 2007-2008 period was similar to what was measured during 2006-2007, but remains below average (Table 18). Mean sauger W_r values, for the various length categories were similar to previous years (Table 15).

Five year classes of sauger were sampled by gill nets in 2008 (Table 19). The mean age of 2.4 years is within the range for the five-year period (Table 19). The 2005 and 2006 year classes comprise a majority of the current adult sauger population. The strong 2002 and 2003 sauger year classes have diminished and 2008 appears to be a year of low sauger production. Annual sauger survival for 2007-2008 pooled data decreased to 43% (Table 14). Sauger PSD during 2008 was 84 due to the lack of recruitment of sub-stock length sauger to the population.

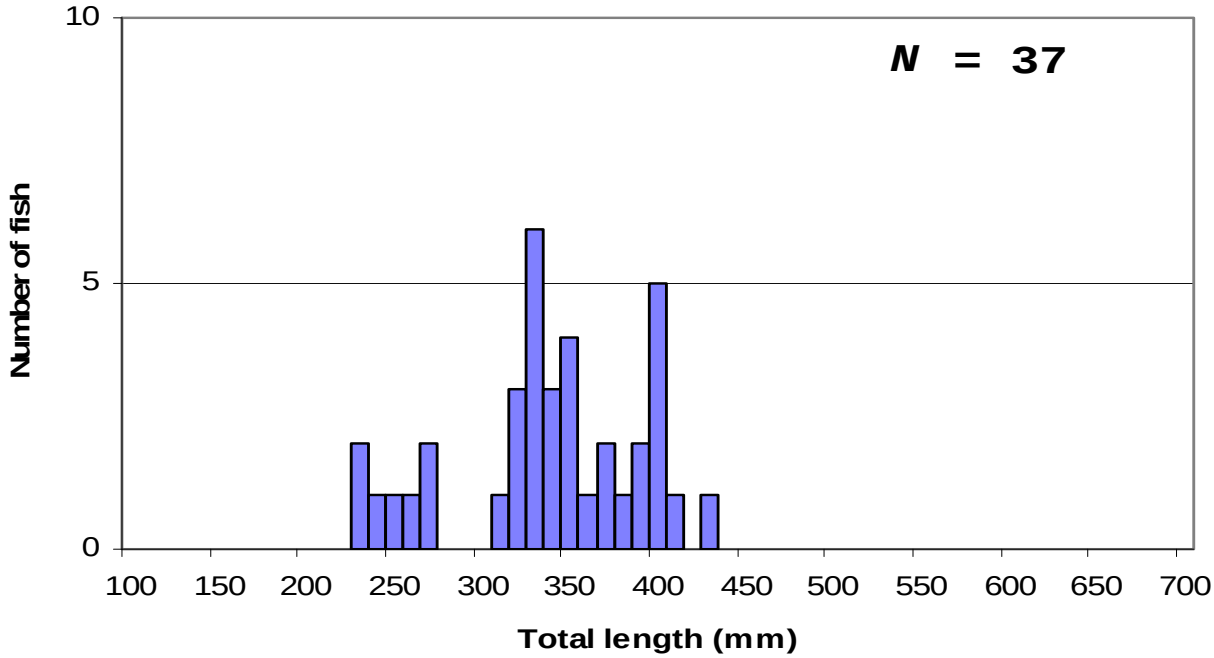

Figure 5. Length frequency of sauger collected with gill nets from Lake Francis Case, 2008. *N* = sample size.

Table 17. Mean length-at-age-at-capture (mm) for sauger, as determined by aging otoliths, collected in the standard September gill net survey, 2004-2008, Lake Francis Case, South Dakota. *N* = sample size.

Year		Length at age at capture (mm)						
		1	2	3	4	5	6	7
2004	**Mean**	272	325	362	399	393	397	
	N	30	71	13	5	1	1	0
	SE	5.5	3.0	8.8	10.2	NA	NA	
2005	**Mean**	306	352	392	396	426	439	
	N	9	31	32	3	1	1	0
	SE	2.2	6.4	4.5	24.5	NA	NA	
2006	**Mean**	285	362	393	428		442	
	N	55	8	19	17	0	2	0
	SE	3.6	5.3	5.7	8.3		35.0	
2007	**Mean**	317	357	386	454	414		461
	N	11	43	2	2	4	0	1
	SE	16.4	4.8	49.5	35.5	11.0		NA
2008	**Mean**	265	338	380	403		416	
	N	8	15	10	2	0	2	0
	SE	11.1	3.3	8.6	2.0		16.0	
Mean of means		285	347	382	416	411	424	461

Table 18. Mean annual growth increments for sauger collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2003-2004, 2004-2005, 2005-2006, 2006-2007 and 2007-2008 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
2003-2004	71	16	31	0	17	0
2004-2005	80	67	34	27	46	0
2005-2006	74	41	37	0	16	0
2006-2007	72	24	61	0	0	19
2007-2008	21	23	17	0	2	0

Table 19. Age distribution, from otolith analysis, of sauger collected from Lake Francis Case with variable-mesh gill nets, 2004-2008. Mean age excludes age-0 fish.

Year	Age								
	0	1	2	3	4	5	6	7	Mean
2004	0	30	71	13	5	1	1	0	2.0
2005	2	9	31	32	3	1	1	0	2.5
2006	0	55	8	19	17	0	2	0	2.1
2007	2	11	43	2	2	4	0	1	2.2
2008	0	8	15	10	2	0	2	0	2.4

Population Parameters for Smallmouth Bass

Smallmouth bass CPUE for the 2008 gill net survey (Table 8) remained at 0.3 fish/net night, a low for the 2004-2008 period. Smallmouth bass CPUE in 2008 electrofishing samples (Table 7) decreased at all sampling locations with the exception of Ft. Randall Dam. Mean length-at-age-at capture data for LFC smallmouth bass for the 2004-2008 period are presented in Table 20. Lake Francis Case smallmouth bass surpass 300 mm in length at age 2. Smallmouth bass growth decreased during 2008 for age 1 to 2 smallmouth bass but increased for older cohorts when compared to 2007 data. Smallmouth bass condition for stock-quality size smallmouth bass remains excellent, as W_r values from fish in the gill net survey were 117 (Table 15). W_r values for quality-preferred length smallmouth bass was 99 while preferred length smallmouth bass had a W_r of 91 during 2008 (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, 2004-2008, Lake Francis Case, South Dakota. N=sample size.

Year		Length at age at capture (mm)			
		1	2	3	
2004	**Mean**	230	306	286	
	N	11	3	1	0
	SE	6.2	19.1	NA	
2005	**Mean**	232	317	374	
	N	4	9	1	0
	SE	5.5	7.2	NA	
2006	**Mean**	235	302	307	
	N	7	9	4	0
	SE	6.1	9.4	35.2	
2007	**Mean**	251	330	307	
	N	2	2	3	0
	SE	6.5	1.5	20.3	
2008	**Mean**		311	352	400
	N	0	8	1	1
	SE		30.1	NA	NA
Mean of means		334	311	325	400

Table 21. Mean annual growth increments for smallmouth bass collected in the standard September gill net survey, Lake Francis Case, South Dakota, for 2003-2004, 2004-2005, 2005-2006, 2006-2007 and 2007-2008 periods, as determined by aging otoliths.

Year	Growth increment added during period (mm)		
	1-2	2-3	3-4
2003-2004	86	0	0
2004-2005	87	68	0
2005-2006	70	0	0
2006-2007	95	5	0
2007-2008	60	22	93

Three year classes were represented in the 2008 gill net sample, with a mean age of 2.3 years (Table 22). Smallmouth bass PSD for the gill net sample increased from 71 in 2007 to 88 in 2008 (Table 16). Older smallmouth bass account for a majority of the fish in the population with little evidence of recruitment during 2007 and 2008. Annual survival, for pooled 2007 and 2008 gill net data was 86%, near the high for the five-year period (Table 14). Lengths of fish sampled by spring electrofishing ranged from 90 mm to 470 mm TL, while those collected by fall gill nets ranged from 260 mm to 400 mm TL (Figure 6).

Table 22. Age distribution, from otolith analysis, of smallmouth bass collected from Lake Francis Case with variable-mesh gill nets, 2004-2008. Mean age excludes age-0 fish.

Year	Age					
	0	1	2	3	4	Mean
2004	3	11	3	1	0	1.3
2005	4	4	9	1	0	1.8
2006	0	7	9	4	0	1.9
2007	1	2	2	3	0	2.1
2008	0	0	8	1	1	2.3

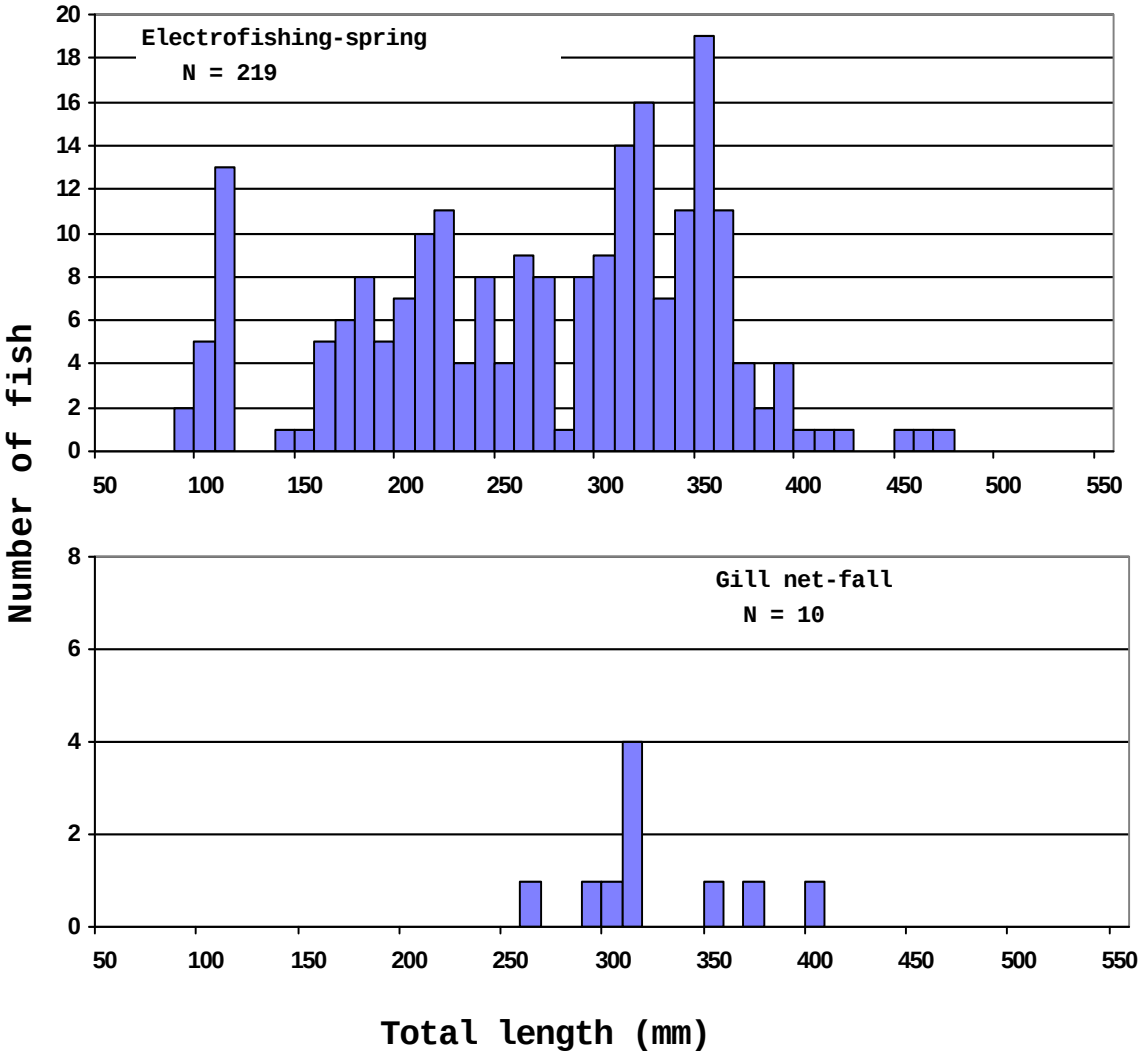

Figure 6. Length frequencies of smallmouth bass collected by spring electrofishing and fall gill netting from Lake Francis Case, 2008. *N* = sample size

Population Parameters for Channel Catfish

Channel catfish gill net CPUE in 2008 (Table 8) was similar to previous years in the five-year period. Channel catfish ranging from 140 mm to 660 mm TL (Figure 7) were collected in the 2008 gill net survey. Channel catfish PSD, PSD and mean W_r values are presented in Appendix 5.

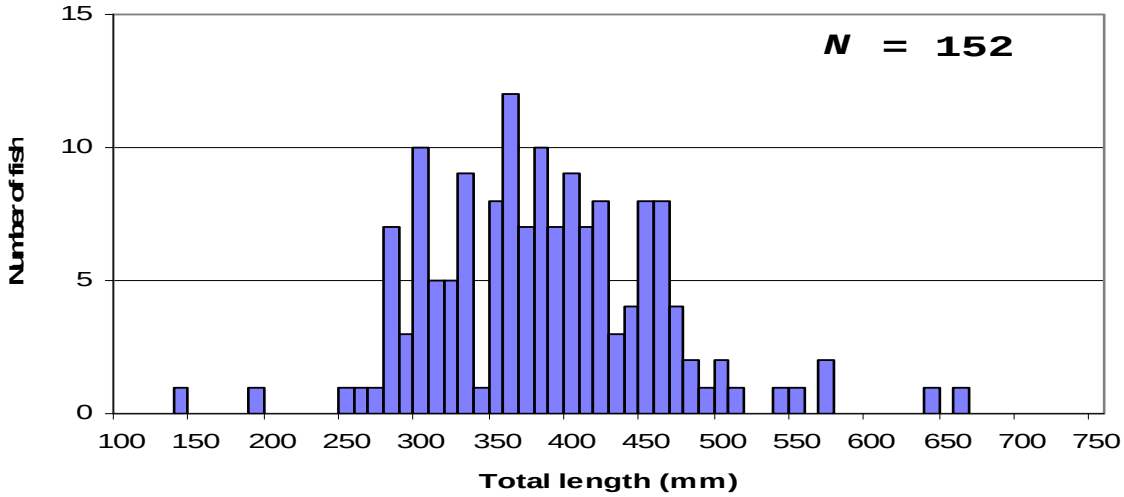

Figure 7. Length frequency of channel catfish collected with gill nets from Lake Francis Case, 2008. *N* = sample size.

Water Temperature Monitoring

Due to a malfunctioning temperature logger, data was not available from the Project Bay sampling station during 2008 (Figure 8). Water temperatures warmed rapidly, reaching 25 C by early July. The 2008 American Creek, Boyer and Pease Creek water temperature profiles were similar to profiles from recent years (Stone 1997a, 1998; Stone and Sorensen 1999, 2000, 2003; Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009).

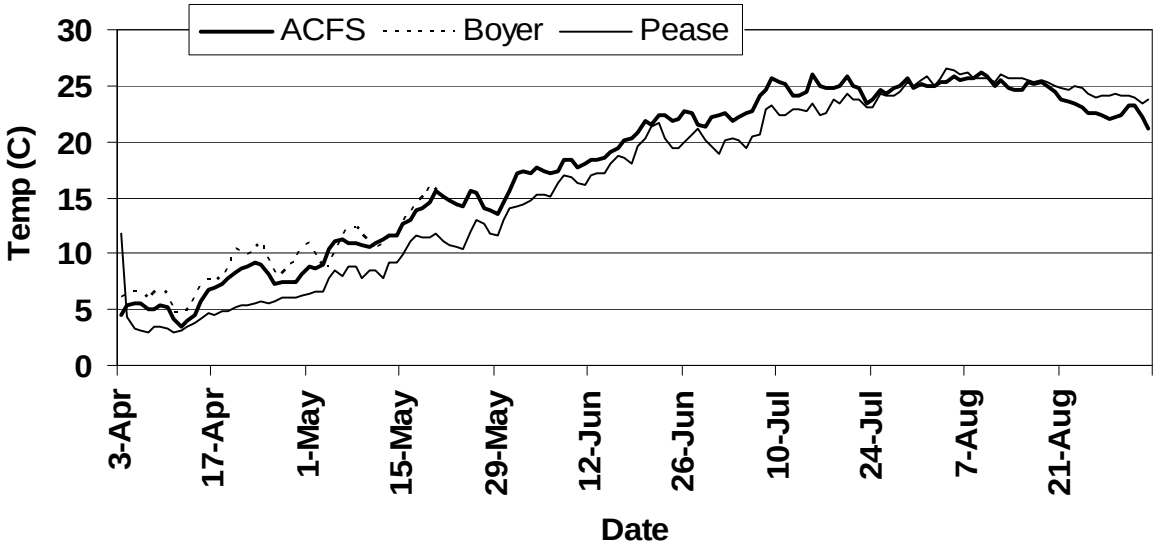

Figure 8. Water temperature in Lake Francis Case at American Creek, Boyer, and Pease Creek, 2008.

ANGLER USE AND SPORT FISH HARVEST SURVEY

Fishing Pressure

Lake Francis Case anglers spent an estimated 553,822 hours (+/- 40,606 h, 80% CI) fishing during the April through September, 2008 creel survey period (Table 23). This estimate is lower than the 562,447 hours estimated for the same period in 2007 and significantly lower than that estimated during the 1998-2001 period (Table 1).

Table 23. Estimated total fishing pressure (angler hours), by month and zone, on Lake Francis Case, April-September, 2008 (+/- 80% confidence interval).

Zone	Apr	May	Jun	Jul	Aug	Sep	Total
1 - upper	54,558 (20,055)	26,194 (11,839)	46,073 (14,903)	26,206 (8,208)	14,863 (2,843)	8,794 (1,730)	176,687 (29,033)
2 - middle	7,832 (4,399)	63,910 (17,808)	45,939 (10,150)	38,599 (6,739)	24,685 (4,499)	12,579 (3,757)	193,544 (22,787)
3 - lower	3,873 (1,673)	36,377 (11,100)	61,078 (9,900)	40,986 (5,363)	26,229 (4,598)	15,048 (3,577)	183,592 (16,933)
Total	66,263 (20,599)	126,481 (24,093)	153,090 (20,570)	105,792 (11,898)	65,777 (7,033)	36,420 (5,469)	553,823 (40,606)

Estimated fishing pressure for the entire reservoir averaged 15.7 angler-h/ha (Table 24). The middle portion of the reservoir (Figure 1) received the heaviest pressure at 21.1 angler-h/ha. The lower and upper portions of the reservoir received 16.0 and 12.1 angler-h/ha, respectively (Table 24). Peak fishing pressure occurred in May and June, a typical LFC pattern (Table 23, Figure 9).

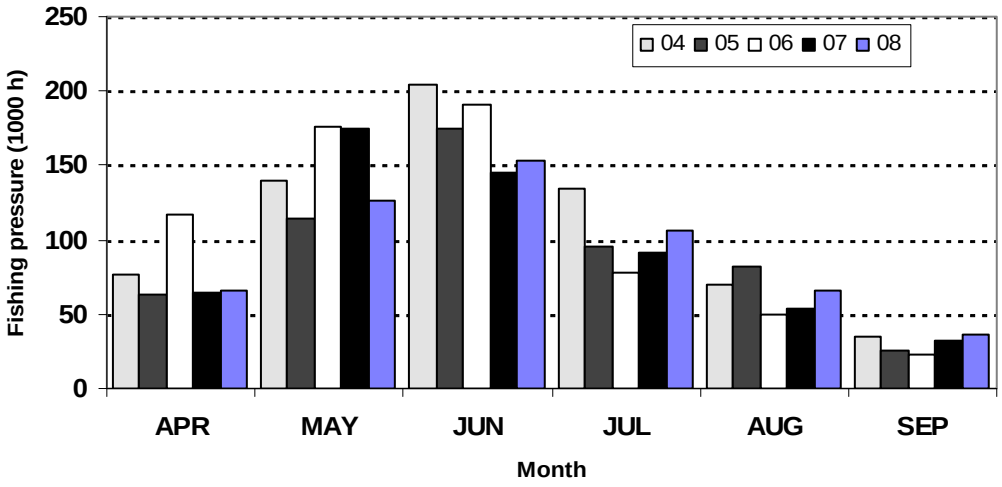

Figure 9. Estimated fishing pressure, by month, on Lake Francis Case, 2004-2008.

Table 24. Estimated total angler hours, for boat anglers, shore anglers, and angling methods combined, by zone, for Lake Francis Case, April-September, 2008.

	Boat			Shore			Combined		
Zone	Total angler hours	%	No. h/ha	Total angler hours	%	No. h/ha	Total Angler hours	%	No. h/ha
1 - upper	152,304	30	10.4	24,383	73	1.7	176,687	32	12.1
2 - middle	189,058	36	20.6	4,485	13	0.5	193,544	35	21.1
3 - lower	178,993	34	15.6	4,599	14	0.4	183,592	33	16.0
Tot/Avg	520,355	100	14.7	33,467	100	0.9	553,822	100	15.7

Fish Harvest

Anglers fishing LFC, during the April-September 2008 period, harvested an estimated 139,346 fish (+/- 15,048 fish, 80% CI); all species, fishing methods and zones combined, including an estimated walleye harvest of 86,352 fish (+/- 8,144 fish, 80% CI; Table 25). Fourteen species of fish were observed in the 2008 harvest, with walleye accounting for 62% of the total number harvested (Table 25). White bass, channel catfish, smallmouth bass and sauger accounted for 17.3%, 8.7%, 8.2% and 2.3% of the 2008 estimated total harvest, respectively. The 86,352 estimated walleye harvest for 2008 was the lowest recorded since 1990. Estimated sauger harvest in 2008 was 3,271 fish (Table 25). Moderate production in 2005 and 2007 currently supports a bulk of the sauger population. The harvest estimate for smallmouth bass increased from the 2007 estimate while decreasing for channel catfish (Table 25). The 2008 white bass harvest estimate of 24,139 fish was an increase from the 2007 estimate of 13,555 fish and similar to the 2006 estimate of 23,391 fish (Sorensen and Knecht, 2008, 2009; Table 25). Good white bass production in 2004 and 2005 provided harvestable size fish during 2008 (Table 9). Smallmouth bass harvest increased from 9,622 in 2007 to 11,360 in 2008 (Sorensen and Knecht 2009). Moderate smallmouth bass recruitment occurred in 2003 and 2004 (Sorensen 2004; Sorensen and Knecht 2006).

Table 25. Estimated total fish harvest, by month, for anglers fishing Lake Francis Case, April-September, 2008 (+/- 80% confidence interval).

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	5,340 (2,179)	1,614 (1,158)	318 (-)	125 (88)	0 (-)	0 (-)	0 (-)	0 (-)	7,397 (2,634)
May	12,739 (3,052)	776 (310)	5,238 (2,893)	179 (138)	4,855 (7,975)	0 (-)	0 (-)	120 (91)	23,907 (9,417)
June	24,069 (4,758)	313 (188)	2,119 (1,095)	1,983 (741)	4,020 (2,218)	77 (79)	0 (-)	565 (614)	33,146 (5,884)
July	26,188 (4,402)	421 (153)	2,970 (287)	4,245 (1,534)	5,190 (1,704)	77 (53)	201 (113)	430 (336)	39,722 (6,482)
August	14,628 (2,855)	107 (56)	418 (269)	4,895 (1,540)	6,290 (3,541)	0 (-)	137 (171)	411 (520)	26,886 (5,486)
September	3,387 (1,448)	40 (31)	297 (154)	751 (382)	3,774 (4,320)	40 (31)	0 (-)	0 (-)	8,288 (4,909)
Total	86,352 (8,144)	3,271 (1,225)	11,360 (3,122)	12,179 (2,334)	24,129 (10,130)	193 (99)	338 (206)	1,524 (1,290)	139,346 (15,048)

*OTH includes bigmouth buffalo, black bullhead, black crappie, bluegill, flathead catfish, freshwater drum, and largemouth bass.

Estimated fish harvest during 2008, by survey zone (see Figure 1 for zone identification), resulted in anglers who fished the upper portion of the reservoir accounting for 38% of the harvest, followed by the lower and middle zones with 33 % and 29% of the harvest respectively (Table 26). Walleye and smallmouth bass harvest in 2008 was highest in the lower zone, while sauger, white bass and channel catfish harvest was highest in the upper zone of the reservoir (Table 26).

Table 26. Estimated total fish harvest, by zone, for anglers fishing Lake Francis Case, April-September, 2008 (+/- 80% confidence interval).

Zone	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
1 - upper	25,555 (5,650)	2,024 (1,180)	1,342 (685)	6,744 (1,800)	16,424 (9,928)	82 (75)	0 (-)	428 (540)	52,599 (12,891)
2 - middle	29,558 (4,047)	731 (177)	1,646 (716)	5,129 (1,476)	3,286 (943)	111 (65)	74 (52)	147 (137)	40,682 (5,348)
3 - lower	31,240 (4,246)	515 (276)	8,372 (2,960)	305 (165)	4,418 (1,780)	0 (-)	238 (196)	977 (771)	46,065 (5,627)
Total	86,352 (8,144)	3,271 (1,225)	11,360 (3,122)	12,179 (2,334)	24,129 (10,130)	193 (99)	338 (206)	1,524 (1,290)	139,346 (15,048)

*OTH includes bigmouth buffalo, black bullhead, black crappie, bluegill, flathead catfish, freshwater drum, and largemouth bass.

Estimated total fish harvest (Table 25) peaked in July during 2008. Walleye harvest also peaked in July (Figure 10), not typical of LFC, where pressure and harvest is normally highest in May and June (Stone 1995; Stone et al. 1994). Changes in walleye harvest regulations, initiated in 1990 and modified in 1999 and 2004, continue to maintain the walleye size structure at a level that allows sufficient numbers of legal-sized fish to be available for harvest during the period of the year that size limit regulations are in effect.

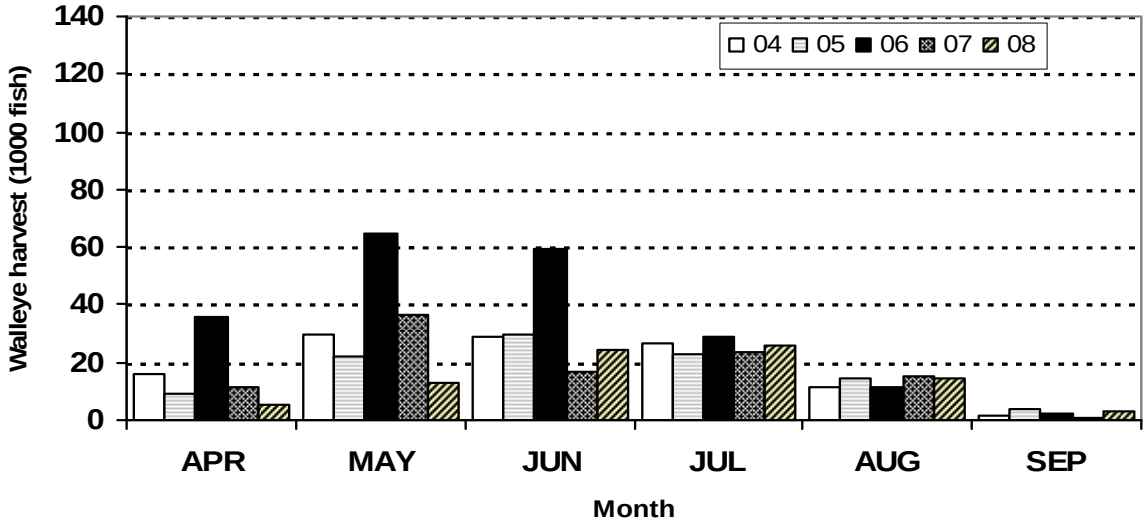

Figure 10. Estimated total walleye harvest, by month, for anglers fishing Lake Francis Case, 2004-2008.

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 2008, very few walleye under 381 mm were harvested (illegal), while in July and August, fish under 381 mm were common in the walleye harvest. Mean size of walleye harvested by month remained near or above 381 mm (minimum length limit) during all months except July and August when the minimum length restriction

is not in effect (Figure 11). Overall, mean length of walleye harvested by sport anglers has been considerably higher since the 1990 changes in walleye sport fishing regulations were implemented (Table 1). Table 27 provides statistics on the percentage of angling parties that caught a daily limit of walleye/sauger. The percentage of angling parties harvesting a limit was 3% in 2008 (Table 27), the same as 2007 but lower than the previous few years.

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

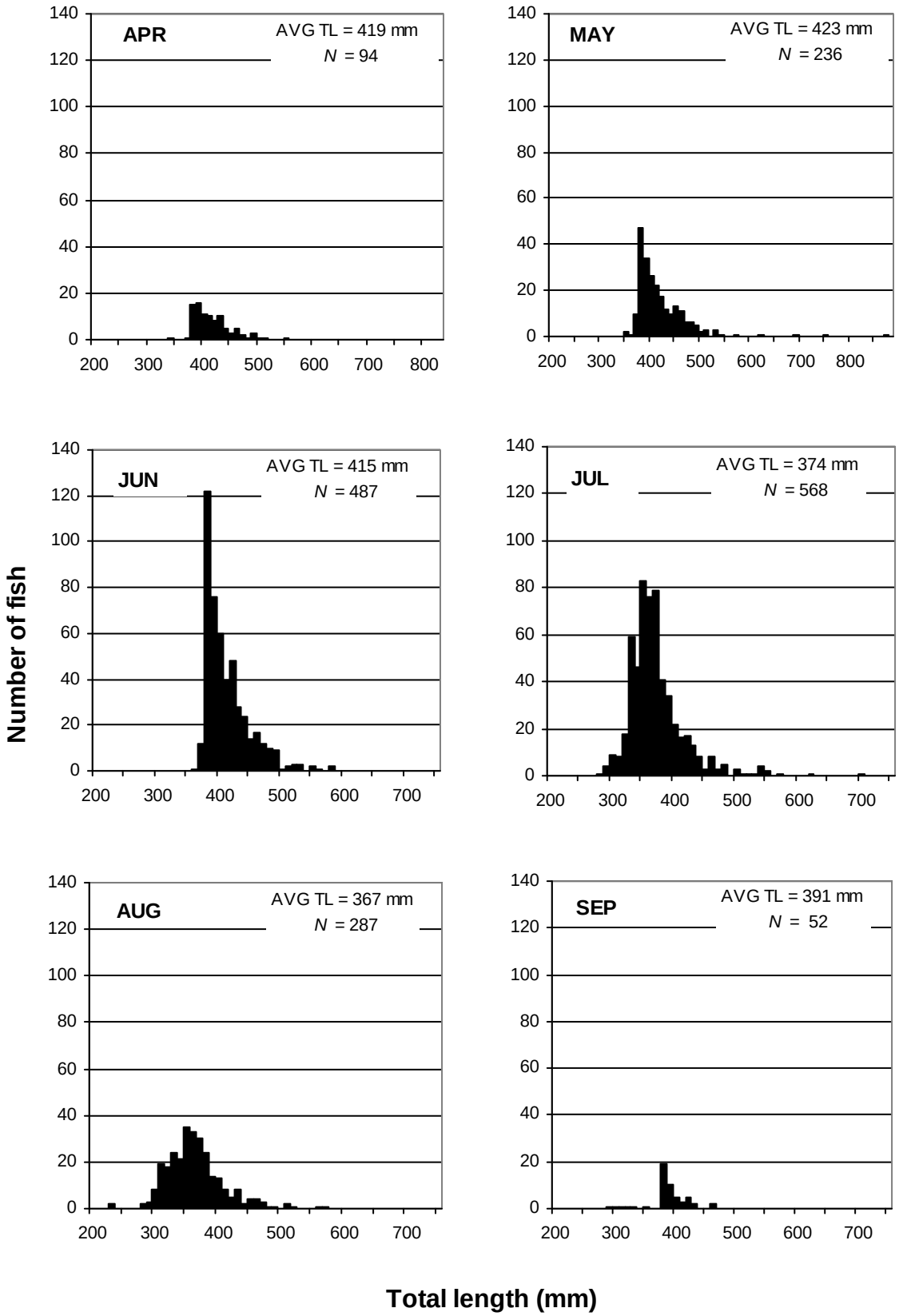

Figure 11. Monthly length frequencies of angler-caught walleye from Lake Francis Case, 2008. N = sample size.

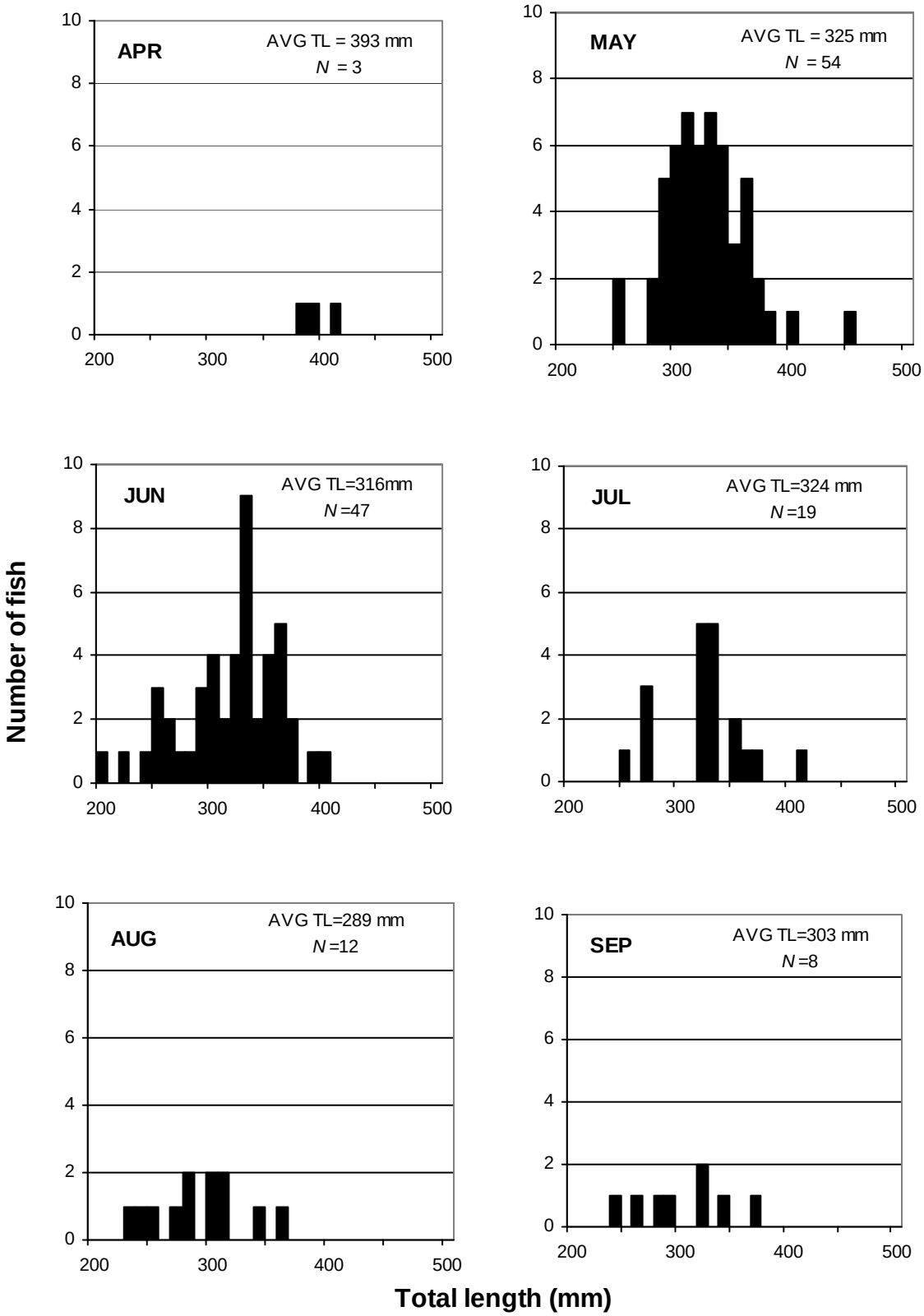

Figure 12. Monthly length frequencies of angler-caught smallmouth bass from Lake Francis Case, 2008. N = sample size.

Table 27. 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, 2004-2008.

Party success walleye-sauger/angler	2004*	2005*	2006	2007	2008
Limit (4)			11	3	3
3.0 - 3.9	9	9	10	5	4
2.0 - 2.9	7	8	13	9	10
1.0 - 1.9	18	15	20	16	15
0.1 - 0.9	17	18	15	16	17
0	49	50	31	50	51

* The daily limit for walleye/sauger was 3 in 2004 and 2005

Fish Caught and Released

Catch and release, either mandated by length-limit regulations or voluntary, has become an important component of the LFC sport fishery. Table 28 presents estimates of the number of fish released by month. For each species listed in Table 28 the number of fish estimated to have been caught and released exceeded harvest estimates (Table 25). 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 2008 was 450,616, a decrease from the 2007 estimate of 754,842 fish (Sorensen and Knecht 2009).

Table 28. Estimated number of fish caught and released, by month, for anglers fishing Lake Francis Case, 2008.

Month	WAE	SAR	SMB	CCF	WHB	NOP	YEP	OTH*	Total
April	49,183	2,568	0	289	1,434	58	19	241	53,792
May	67,453	446	9,065	270	1,752	24	94	1,000	80,104
June	164,086	745	8,334	2,140	13,521	137	41	3,352	192,356
July	42,679	26	2,736	4,827	12,772	193	396	3,445	67,074
August	12,903	0	1,454	7,600	9,918	94	389	1,400	33,758
September	13,662	79	1,726	1,693	3,809	198	438	1,926	23,531
Total	349,966	3,864	23,315	16,819	43,206	703	1,377	11,366	450,616

* OTH includes bigmouth buffalo, black bullhead, black crappie, bluegill, common carp, freshwater drum, goldeye, largemouth bass, shortnose gar and shovelnose sturgeon.

Harvest, Release and Catch Rates

Mean harvest rate (species, type of fishing, and zones combined) for LFC, during 2008, was 0.25 fish/angler-h (Table 29), on the low end of the range observed during previous surveys (Table 1). An excellent overall catch rate (the 2008 harvest rate plus estimated release rate of 0.81 fish/angler-h) of 1.07 fish/angler-hour was estimated for the April through September 2008 daylight period (Table 29). Mean catch rates were highest during June while the mean harvest rate was highest during August (Table 30).

The mean walleye harvest rate was 0.16 walleye/angler-h (Table 31) for the April–September daytime period. Walleye harvest rates during July and August, when there is no minimum length restriction, were higher than other months in the survey period. When the harvest rate for walleye was combined with the release rate, an overall catch rate of 0.79 walleye/angler-h was estimated (Table 31). This value is higher than 0.30 fish/angler-h that is considered by most biologists to be indicative of an excellent walleye fishery (Colby et al. 1979).

Catch and harvest rates for smallmouth bass, during 2008, are presented in Table 32. Smallmouth bass harvest and catch rate estimates for 2008 were similar to 2007 (Sorensen and Knecht 2009).

Table 29. Estimated harvest rate, release rate and catch rate, by species (+/- 80% confidence interval), for anglers fishing Lake Francis Case, 2008.

Species	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
Walleye	0.156 (0.026)	0.632 (0.152)	0.788 (0.174)
Sauger	0.006 (0.003)	0.007 (0.003)	0.013 (0.006)
Smallmouth bass	0.021 (0.006)	0.042 (0.012)	0.063 (0.016)
Channel catfish	0.022 (0.006)	0.030 (0.007)	0.052 (0.011)
White bass	0.044 (0.023)	0.078 (0.018)	0.122 (0.038)
Northern pike	0.000 (-)	0.001 (0.001)	0.002 (0.001)
Yellow perch	0.156 (0.026)	0.632 (0.152)	0.788 (0.174)
Other*	0.003 (0.003)	0.021 (0.007)	0.024 (0.009)
Species combined	0.252 (0.049)	0.814 (0.176)	1.065 (0.218)

* Other includes bigmouth buffalo, black bullhead, black crappie, bluegill, common carp, flathead catfish, freshwater drum, goldeye, largemouth bass, shortnose gar, and shovelnose sturgeon.

Table 30. Estimated harvest rate, release rate, and catch rate for all species combined (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2008.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.112 (0.086)	0.812 (0.700)	0.923 (0.783)
May	0.189 (0.138)	0.633 (0.374)	0.822 (0.490)
June	0.217 (0.065)	1.257 (0.474)	1.473 (0.534)
July	0.376 (0.093)	0.634 (0.174)	1.010 (0.261)
August	0.409 (0.124)	0.513 (0.145)	0.922 (0.251)
September	0.228 (0.160)	0.646 (0.323)	0.874 (0.455)
Combined	0.252 (0.049)	0.814 (0.176)	1.065 (0.218)

Table 31. Estimated harvest rate, release rate, and catch rate of walleye (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2008.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.081 (0.067)	0.742 (0.651)	0.823 (0.716)
May	0.101 (0.045)	0.533 (0.340)	0.634 (0.378)
June	0.157 (0.048)	1.072 (0.423)	1.229 (0.468)
July	0.248 (0.067)	0.403 (0.116)	0.651 (0.179)
August	0.222 (0.063)	0.196 (0.060)	0.419 (0.113)
September	0.093 (0.058)	0.375 (0.218)	0.468 (0.273)
Combined	0.156 (0.026)	0.632 (0.152)	0.788 (0.267)

Table 32. Estimated harvest rate, release rate, and catch rate of smallmouth bass (+/- 80% confidence interval), by month, for anglers fishing Lake Francis Case, 2008.

Month	Harvest rate (fish/angler-h)	Release rate (fish/angler-h)	Catch rate (fish/angler-h)
April	0.005 (0.002)	0.000 (-)	0.005 (0.002)
May	0.041 (0.026)	0.072 (0.046)	0.113 (0.066)
June	0.014 (0.007)	0.054 (0.020)	0.068 (0.025)
July	0.028 (0.004)	0.026 (0.009)	0.054 (0.012)
August	0.006 (0.004)	0.022 (0.014)	0.029 (0.016)
September	0.008 (0.004)	0.047 (0.035)	0.056 (0.037)
Combined	0.021 (0.006)	0.042 (0.012)	0.063 (0.016)

Angler Demographics and Economics

Thirty-one percent of anglers contacted on LFC during 2008 were non-residents, similar to values estimated for the previous five years (Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008, 2009). Non-resident anglers from 17 states were contacted during 2008, (Table 33) with Nebraska, Iowa and Minnesota anglers accounting for the majority of non-resident angler contacts. Figure 13 provides information on the county of residence of South Dakota anglers who fished LFC in 2008. Over 87% of the resident LFC anglers in 2008 came from counties in the southeastern ¼ of the state (Figure 13).

Table 33. Percentage of non-resident anglers who fished Lake Francis Case, 2004-2008, by state of residence, expressed as percent of total non-residents.

State	2004	2005	2006	2007	2008
Iowa	42.0	42.6	44.0	38.9	42.8
Nebraska	36.2	39.2	32.6	40.0	39.6
Minnesota	13.9	12.6	13.2	9.8	11.2
Colorado	1.2	0.7	1.2	1.1	1.1
Wisconsin	0.5	0.7	0.4	0.8	1.3
Kansas	0.7	1.1	0.4	0.8	0.5
Missouri	0.4	-	1.4	1.1	0.5
Illinois	0.7	-	0.6	0.5	-
North Dakota	0.5	-	0.4	1.4	0.3
Florida	0.2	0.2	0.6	0.3	0.5
Montana	0.5	-	0.4	0.3	-
Wyoming	0.7	0.9	1.6	1.9	0.3
California	-	-	0.8	-	-
Other*	2.5	2.0	2.4	3.1	1.9

*Other includes: Hawaii, Michigan, Nevada, New Mexico, New York, Vermont and Washington.

Mean angler trip length (boat and shore combined) on LFC was 4.3 hours (Table 1), for the April-September, 2008 daylight period. The average angling party consisted of approximately 2.3 individuals in 2008 and anglers traveling at least 100 miles (one-way) to fish LFC, accounted for about 51 % of all trips (Table 34). A majority of anglers fishing Lake Francis Case in 2008 targeted walleye, similar to the past four years (Table 35).

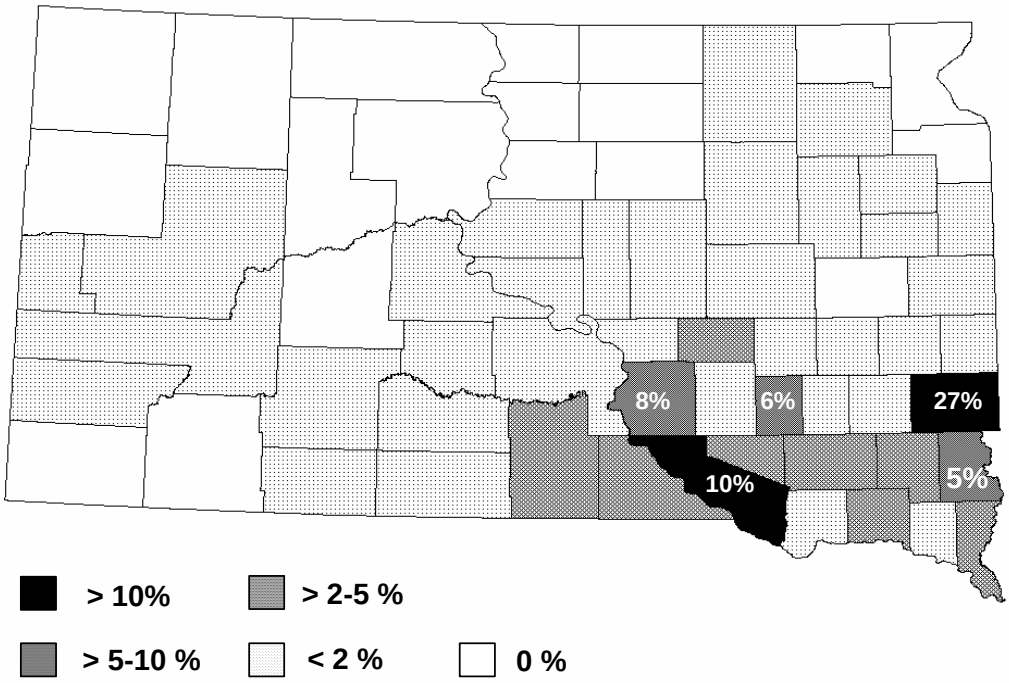

Figure 13. County of residence for resident anglers fishing Lake Francis Case in 2008. Percentage of total resident anglers is shown for the top four represented counties.

The 2008 LFC fishery had an estimated economic impact of nearly 10.2 million dollars to local economies, based on approximately 128,497 angling trips. This estimate is based on an average expenditure of $79/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 34. Percentage of anglers traveling specified distances, one way, to fish Lake Francis Case during 2004-2008.

Distance (miles)	2004	2005	2006	2007	2008
<25	13.3	12.2	11.0	15.9	15.0
25-50	17.0	16.5	17.7	16.2	17.2
51-100	16.2	15.5	15.6	15.8	17.3
101-200	37.1	39.8	40.7	35.6	36.9
201+	16.4	16.0	15.0	16.5	13.6

Table 35. Target species of Lake Francis Case anglers, during 2004-2008, expressed as a percentage of total angling trips.

Target species	2004	2005	2006	2007	2008
Walleye	94.6	90.9	95.6	92.0	89.3
Anything	2.2	4.6	1.6	5.1	6.4
Smallmouth bass	1.1	1.7	1.6	0.9	2.1
Other	2.1	2.8	1.2	2.0	2.2

ANGLER PREFERENCE AND ATTITUDE SURVEY

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

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

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, 71% of LFC anglers expressed some degree of satisfaction with their days fishing in 2008 versus approximately 23% who expressed some degree of dissatisfaction (Table 36). The 71% satisfaction rating falls within the range of previous surveys (Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008,2009) and does meet the Missouri River Fisheries Program management objective of 70 % (SDGFP, unpublished document).

Table 36. Responses of 2008 Lake Francis Case anglers, by month, to the question: "Considering all factors, how satisfied are you with your fishing trip today?" 1 = Very Satisfied, 2 = Moderately satisfied, 3 = Slightly satisfied, 4 = Neutral, 5 = Slightly dissatisfied, 6 = Moderately dissatisfied, 7 = Very dissatisfied, N.O. = No opinion. Median excludes those with no opinion.

	Satisfied →			Neut.	← Dissatisfied					
Month	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**N.O.**	**Total**	**Median**
Apr	17	19	13	3	10	10	3	2	77	3
May	46	34	18	6	7	11	9	1	132	3
Jun	41	44	28	8	19	7	13	2	162	3
Jul	32	34	19	5	9	9	6	2	116	3
Aug	17	29	9	6	8	4	4	0	77	3
Sep	7	17	8	1	5	2	4	1	45	3
Total	160	177	95	29	58	43	39	8	609	3
Percent	26.3	29.1	15.6	4.8	9.5	7.1	6.4	1.3	100	-
Combined	70.9			4.8	23.0			1.3	100	-

Angler satisfaction positively correlates to the number of walleye harvested per angler (Table 37). 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) showing a decrease in satisfaction and a corresponding increase in dissatisfaction as the number of walleye harvested per angler decreases. However, nearly 63% of the anglers who did not harvest a walleye still indicated that they were satisfied with their fishing trip (Table 37). 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 37. Responses of 2008 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	17	94.4	0	-	1	5.6
3 -- 3.9	23	95.8	1	4.2	0	-
2 – 2.9	54	87.1	3	4.8	5	8.1
1 – 1.9	72	80.0	16	17.8	2	2.2
0.1 – 0.9	66	69.5	22	23.1	7	7.4
0	200	62.7	97	30.4	22	6.9
Total	432	71.1	139	22.8	37	6.1

With current management regulations requiring the mandatory release of certain sizes of walleye/sauger, coupled with the voluntary release of a significant number of fish by LFC anglers, how anglers feel about their fishing trip, based on the total number of walleye/sauger caught versus harvested, may also be important. Table 39 provides angler satisfaction data categorized by the average number of walleye caught per angler. Similar to results presented in Table 37, over 59% of anglers questioned were still satisfied with their fishing trip despite catching no walleye (Table 38). Eighty-two percent of anglers who caught at least 4 to 7.9 walleye/angler indicated they were satisfied with their trip (Table 38).

Table 38. Responses of 2008 Lake Francis Case anglers to the question: "Considering all factors, how satisfied are you with your fishing trip today?" by the average number of walleye caught per angler. Responses are grouped as satisfied, dissatisfied and neutral/no-opinion, based on the more detailed breakdowns defined in Table 37.

No. WAE Caught/ angler	Satisfied		Dissatisfied		Neutral/No-opinion	
	No.	Percent	No.	Percent	No.	Percent
16 or >	23	92.0	2	8.0	0	0.0
12-15.9	19	73.1	4	15.4	3	11.5
8-11.9	32	80.0	6	15.0	2	5.0
4-7.9	100	82.0	17	13.9	5	4.1
>0-3.9	175	68.4	64	25.0	17	6.6
0	83	59.7	46	33.1	10	7.2
Total	432	71.1	139	22.9	37	6.1

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 2008 angler use and harvest survey were asked questions concerning these issues. When asked whether or not they had participated in a tournament held on Lake Francis Case within the past twelve months, 17% of those interviewed during 2008 indicated they had (Table 39). Survey results concerning tournament participation in 2008 were consistent with previous survey results (Sorensen 2004; Sorensen and Knecht 2006, 2007, 2008,2009).

Table 39. 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?", 2004-2008. Responses are presented as percentage of total responses. *N* = number of responses.

	2004		2005		2006		2007		2008	
No. of Tournaments Participated in	N	Percent	N	Percent	N	Percent	N	Percent	N	Percent
0	748	84.5	705	83.5	664	77.2	486	86.5	504	82.6
1	62	7.0	85	10.1	112	13.0	44	7.8	64	10.5
2	33	3.7	26	3.1	35	4.1	10	1.8	19	3.1
3	21	2.4	9	1.1	21	2.4	9	1.6	7	1.1
4	8	0.9	8	0.9	8	1.0	5	0.9	6	1.0
>4	13	1.5	11	1.3	20	2.3	8	1.4	10	1.6

The majority of competitive angling events on Lake Francis Case take place during the April-June period. Angler participation in tournaments during this time frame might be different than other months of the survey period. However, except for the month of April, the percentage of anglers not participating in tournaments was consistent among all months surveyed (Table 40) suggesting that tournament anglers represent a small portion of anglers using Lake Francis Case.

Table 40. Responses of 2008 Lake Francis Case anglers to the question: "Within the last 12 months, how many fishing tournaments have you participated in on Lake Francis Case?" Responses are presented as number of responses with percentage of total responses in parenthesis by month.

	Number of Tournaments Participated In						
Month	**0**	**1**	**2**	**3**	**4**	**>4**	**Total**
April	42 (59.2)	13 (18.3)	8 (11.3)	3 (4.2)	3 (4.2)	2 (2.8)	71
May	113 (86.3)	14 (10.7)	2 (1.5)	0 (0.0)	1 (0.8)	1 (0.8)	131
June	135 (83.3)	19 (11.7)	3 (1.9)	1 (0.6)	2 (1.2)	2 (1.2)	162
July	100 (84.0)	9 (7.6)	5 (4.2)	1 (0.8)	0 (0.0)	4 (3.4)	119
August	69 (87.3)	7 (8.9)	1 (1.3)	1 (1.3)	0 (0.0)	1 (1.3)	79
Septembe r	45 (93.8)	2 (4.2)	0 (0.0)	1 (2.1)	0 (0.0)	0 (0.0)	48
Total	504 (82.6)	64 (10.5)	19 (3.1)	7 (1.1)	6 (1.0)	10 (1.6)	610

When anglers were asked how they felt about the number of tournaments held on Lake Francis Case each year, 45% of respondents had no opinion on the issue, suggesting tournaments are not an important issue for this portion of the angling public (Table 41). However, when "no opinion" responses were removed from the analysis, 69% of anglers believed there were too many tournaments on Lake Francis Case (Table 41). In addition, 28% believed there was about the right number, and 3% believed that there were too few tournaments held on Lake Francis Case annually (Table 42).

Table 41. Responses of 2008 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	233	38.1
About the Right Number	93	15.2
Too Few	10	1.6
No Opinion	273	44.6
	Excluding "No Opinion" Responses	
Too Many	233	69.3
About the Right Number	93	27.7
Too Few	10	3.0

With increasing frequency of competitive angling events, crowding at access facilities is a concern. To help understand the significance of such user conflicts, anglers were asked if they have ever not used an access site because a tournament was being held there. Overall, 73 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 42). 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 over twenty-seven percent of all anglers being displaced by fishing tournaments and competitive angling events becoming more popular, this issue should be carefully monitored in the future (Table 42).

Table 42. Responses of 2008 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 month.

	Response			
Month	**Yes**	**No**	**No Opinion**	**Total**
Apr	12	62	0	74
May	31	99	1	131
Jun	49	113	0	162
Jul	33	86	0	119
Aug	26	53	0	79
Sep	16	32	0	48
Total	167	445	1	613
Percent	27.2	72.6	0.2	

DISCUSSION

Lake Francis Case, supporting one of South Dakota's most important walleye fisheries, continues to attract anglers from across the upper Midwest. Walleye, ranked the favorite species by 69% of respondents to a 1992 survey of South Dakota anglers (Mendelsohn 1994), continued to remain the target species of most LFC anglers. Since a peak in total walleye abundance in 1995, the LFC walleye population has generally declined in abundance. That decline has been attributed to angler harvest coupled with continuing drought conditions in the Missouri River basin, limiting walleye reproduction and recruitment. From 1996 through 2001, the estimated LFC walleye harvest was near or exceeded 200,000 fish, peaking at over 339,000 in 1998. This harvest, combined with low recruitment in 2000-2004 began to impact the number of legal-size walleye available for harvest beginning in 2003. A significant portion of the initially abundant 2002 LFC walleye year class did not recruit to age 1, so the expected downturn in population abundance was longer in duration than previously thought. However, walleye abundance increased during 2005 and 2006 due to the presence of consecutive strong year classes. Walleye growth rates increased during 2005, but have decreased since 2005 due to the presence of two large year classes of walleye in the population. Walleye growth rates will need to be monitored closely in future surveys as the walleye population responds to modifications in size limit regulations and fluctuations in gizzard shad abundance. Walleye condition, as indexed by W_r, has remained unchanged since the initial 1990 regulation changes, despite variability in walleye and gizzard shad abundance over that same time period.

Water yield in the Missouri River system ranged between two extremes during the late 1990's to 2000's; from the record water yield measured in 1997 to drought conditions experienced between 2000 and 2008.

These extremes in water yield undoubtedly played a significant role in shaping the fish populations of LFC. While changes to walleye management regulations in 1990 were given much of the credit for restructuring the LFC walleye population, resulting in the outstanding fishing that occurred throughout the latter half of the 1990's, the high water yield in the mid-1990's played a role that cannot be overlooked (Stone and Lott 2002). While walleye population abundance, size structure, and growth were showing positive trends in the early 1990's, when drought conditions still existed, the high walleye abundance levels reached in 1997 and 1998 were probably the result of improved habitat and nutrient conditions created by high water yield in 1995 and 1997 (Stone 1997b). As water yield in the Missouri River basin returned to normal 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 has been below normal for the past eight years. 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.

Decreasing abundance of harvestable sized walleye has reduced walleye harvest rates as well as overall harvest to sustainable levels. Improvements in walleye population structure, as a result of length limit regulations, is reflected in the 405 mm (15.9 in.) mean length of walleye harvested over the past five years, versus the 343 mm (13.5 in.) average estimated in 1989 (Stone 1995). Mean length of harvested walleye during 2008 dropped below 400 mm (15.7 in.) for the first time since 1999. However, despite a decline in overall walleye population abundance the past several years, a high proportion of anglers are still attaining the daily creel limit of four walleye during certain periods of the year. In this regard, the daily creel limit remains an important factor in the regulation of the fishery and distribution of the walleye harvest, at least during years of low walleye abundance or high harvest. Survey results also 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).

Smallmouth bass, which in previous years had ranked second in the sport fishery in terms of total fish caught (harvest and released), remain an important component in angler catches. Initially introduced as an alternative species that could direct fishing pressure away from walleye, they are now the target species of a small portion of LFC anglers. Smallmouth bass abundance, as measured by spring electrofishing CPUE, was similar to values observed during the 2007 survey. The 2006 smallmouth bass year class comprises a majority of the current Lake Francis Case smallmouth bass population. Smallmouth bass are targeted by a small group of Lake Francis Case anglers and continue to gain popularity. In a 1992 survey of South Dakota anglers (Mendelsohn 1994) smallmouth bass were ranked in the top half of 14 species listed as most favorite by over 65% of the respondents. Along with smallmouth bass, sauger continue to contribute to the harvest. The white bass population has a well distributed age and size structure and is capable of providing additional recreational opportunity. Channel catfish have maintained adequate abundance in recent years to support additional harvest.

Results from these surveys document the contribution and importance of the LFC fishery to the overall angling opportunities provided by the Missouri River system in South Dakota. Lake Francis Case continues to meet or exceed the objective of providing 100,000 angler days of recreation annually, as established in the Missouri River Fisheries Program Strategic Plan (SDGFP 1994). While overall walleye abundance in LFC increased during 2005 and 2006 due to strong year-classes produced during those years, decreasing overall abundance occurred in 2007 and 2008. Walleye growth slowed during the past couple of years and has prolonged the 2005 and 2006 year classes from entering the sport fish harvest. Walleye growth should be closely monitored in future years. Anglers fishing Lake Francis Case in 2009 should expect lower walleye harvest rates than those experienced in 2008. Improvement in overall catch rates are expected with most fish being sub-legal size. A conservative walleye harvest in 2009 is needed to lessen the degree of reduction in fishery quality that anglers have begun to experience. High angler catch rates combined with reduced overall walleye abundance and continuing drought conditions in the basin, will continue to have an effect on the Lake Francis Case walleye population in the near future.

Prey fish abundance remains an additional area of concern. The LFC walleye population relies heavily on annual production of age-0 gizzard shad as prey. A missing year class of shad could greatly impact the growth and condition of LFC walleye. Continued monitoring of fish populations and associated sport

fisheries through annual surveys is essential to allow fisheries managers the ability to monitor and react to changing conditions in fish populations, angler demographics and expectations, and reservoir operation.

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

1) As discussed previously, history suggests that this walleye fishery is not capable of sustaining 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. If water yield in the basin remains at or below normal, it is expected that walleye abundance will remain low and that the population cannot sustain the high harvest that has occurred in the past. Walleye harvest from LFC will need to be conservative when walleye abundance is low.

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

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

RECOMMENDATIONS

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

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

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

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

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

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

7. Consider using fall age-0 nighttime electrofishing as an index to walleye year-class strength.

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

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

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

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

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Appendix 1. Monthly water volume (1000's acre-feet) released through (power) or over (spill) Ft. Randall Dam, 2004-2008.

Month	2004		2005		2006		2007		2008	
	Power	Spill	Power	Spill	Power	Spill	Power	Spill	Power	Spill
Jan	896	0	754	0	526	0	778	0	724	0
Feb	609	0	342	0	647	0	536	0	537	0
Mar	638	0	817	0	712	0	253	0	407	0
Apr	1,186	0	958	0	681	0	408	0	711	0
May	1,580	0	1,156	0	1,063	0	471	0	610	0
Jun	1,585	0	982	0	1,399	0	922	0	395	0
Jul	1,561	0	1,279	0	1,599	0	1,298	0	961	0
Aug	1,494	0	1,420	0	1,816	0	1,254	0	1,349	0
Sep	1,365	0	1,439	0	1,564	0	1,187	0	1,167	0
Oct	738	0	638	0	764	0	706	0	950	0
Nov	460	0	553	0	588	0	470	0	399	0
Dec	687	0	763	0	651	0	658	0	780	0
Total	12,799	0	11,101	0	12,010	0	8,941	0	8,990	0

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

Common name	Scientific name	Abbreviation
Bigmouth buffalo	*Ictiobus cyprinellus*	BIB
Black bullhead	*Ameiurus melas*	BLB
Black crappie	*Pomoxis nigromaculatus*	BLC
Bluegill	*Lepomis macrochirus*	BGL
Brown trout	*Salmo trutta*	BNT
Channel catfish	*Ictalurus punctatus*	CCF
Common carp	*Cyprinus carpio*	CAP
Common shiner	*Notropis cornutus*	COS
Emerald shiner	*Notropis atherinoides*	EMS
Fathead minnow	*Pimephales promelas*	FHM
Flathead catfish	*Pylodictis olivaris*	FCF
Freshwater drum	*Aplodinotus grunniens*	FRD
Gizzard shad	*Dorosoma cepedianum*	GIS
Goldeye	*Hiodon alosoides*	GOE
Johnny darter	*Etheostoma nigrum*	JOD
Largemouth bass	*Micropterus salmoides*	LMB
Northern pike	*Esox lucius*	NOP
Northern redbelly dace	*Phoxinus eos*	NRD
Paddlefish	*Polyodon spathula*	PAH
Rainbow trout	*Oncorhynchus mykiss*	RBT
Red shiner	*Notropis lutrensis*	RES
River carpsucker	*Carpiodes carpio*	CPS
Sauger	*Sander canadense*	SAR
Shorthead redhorse	*Moxostoma macrolepidotum*	SHR
Shortnose gar	*Lepisosteus platostomus*	SNG
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	SNS
Silvery minnow	*Hybognathus argyritis*	SIM
Smallmouth bass	*Micropterus dolomieui*	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	2004	206	LogWT=3.153LogTL-5.469	0.99	336	352
	2005	316	LogWT=3.244LogTL-5.693	0.99	363	447
	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
Sauger	2004	124	LogWT=3.122LogTL-5.463	0.94	320	244
	2005	89	LogWT=3.076LogTL-5.333	0.99	365	374
	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
SM Bass	2004	18	LogWT=3.044LogTL-4.914	0.98	249	259
	2005	18	LogWT=3.286LogTL-5.499	0.99	297	453
	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

Appendix 5. Channel catfish, white bass, and yellow perch proportional size distribution (PSD) of preferred and memorable length fish (PSD-P and PSD-M, respectively), and relative weight (W_r), for 2004-2008, for fish collected from Lake Francis Case. *N* = sample size.

Species	2004				2005				2006				2007				2008			
	PSD	PSD		W_r	PSD	PSD		W_r	PSD	PSD		W_r	PSD	PSD		W_r	PSD	PSD		W_r
		P	M			P	M			P	M			P	M			P	M	
Channel catfish	36	0	0	76	46	2	0	78	40	2	0	80	52	1	0	77	37	1	0	82
N =	118				110				153				154				151			
White bass	100	83	25	101	22	22	36	99	100	29	18	95	96	85	24	95	100	90	30	90
N =	15				81				34				30				14			
Yellow perch	5	0	0	80	23	0	0	80	33	8	0	89	25	0	0	77	27	0	0	86
N =	32				66				22				9				15			