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ANNUAL FISH POPULATION SURVEYS OF LEWIS AND CLARK LAKE, 2006

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ANNUAL FISH POPULATION SURVEYS OF LEWIS AND CLARK LAKE, 2006

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American Creek Fisheries Station
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PREFACE

Information collected from Lewis and Clark Lake during 2006 is summarized in this report. Copies of this report and references to the data can be made with permission from the author or the 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

Information presented in this report was derived from 2006 fish population surveys on Lewis and Clark Lake and the Missouri River from Lewis and Clark Lake upstream to Fort Randall Dam. Trends in fish population structure are reported and compared with previous year's surveys. These results are used to determine the health of the fishery and make management recommendations to improve the current fishery.

Some species-specific management objectives were met in 2006, while others were not. Three mature year classes of walleye were present; however, the proportional stock density (PSD) index for walleye captured in gill nets was above the management objective range of 30-60. Relative stock density for preferred length fish (RSD-P) did not meet the management objective of 10. Walleye catch per unit effort (CPUE) was also above the management objective of 4.0 fish/net night.

Three mature year classes of sauger were also present in 2006 and both PSD and RSD-P were well above the management ranges of 30-60 and 10, respectively, for sauger captured in gill nets. Sauger CPUE did not meet the management objective of 6 fish/net night.

Channel catfish management objectives of 30-60 for PSD and 10 for RSD-P were met. The management objective of 3 channel catfish /gill net night was also met.

Largemouth bass management objectives of 30-60 for PSD and 10 for RSD-P, as well as CPUE of 10 fish/hour were met during 2006 electrofishing surveys. Smallmouth bass CPUE was well above the management objective of 10 fish/hour while PSD and RSD-P were below the management objective ranges of 30-60 and 10, respectively.

Gizzard shad catch rates in the shoreline seining survey were the highest for any prey species in 2006, followed by emerald shiners. These species remain the most numerically important prey species in Lewis and Clark Lake.

Freshwater drum, sauger and walleye were the most frequently sampled fish species in gill nets from Lewis and Clark Lake in 2006.

Presently, fish population trends seem stable in the Lewis and Clark reservoir system with many population structural index values similar to those of previous surveys. Stability in water management during the current drought period may be related to current population trend stability; however, water levels and flow regimes in this system and their effects on fish populations are relatively unknown. Combined with the changing nature of the system due to expansion of the Niobrara River delta and overall increases in rate of sediment deposition, the fishery present in Lewis and Clark Lake and the upstream Missouri River stretch will likely exhibit more variability in population structure and fish habitat use in the future.

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LIST OF ABBREVIATIONS

a ..... annual mortality

CI ..... confidence interval

CPUE ..... catch per unit effort

DC ..... direct current

g ..... grams

h ..... hour

ha ..... hectares

in ..... inches

km ..... kilometers

M ..... memorable length

m ..... meters

mm ..... millimeters

N ..... sample size

P ..... preferred length

PSD ..... proportional stock density

Q ..... quality length

RM ..... river mile

RSD-M ..... relative stock density for memorable length fish

RSD-P ..... relative stock density for preferred length fish

S ..... stock length

SD ..... South Dakota

s ..... survival

spp. ..... Species (multiple)

TL ..... total length

W_r ..... relative weight

W_s ..... standard weight

-z ..... instantaneous mortality rate

ANNUAL FISH POPULATION SURVEY OF LEWIS AND CLARK LAKE, 2006

INTRODUCTION

Closure of Gavins Point Dam in 1955 led to the formation of Lewis and Clark Lake, the lowermost of four Missouri River reservoirs in South Dakota. The series of reservoirs was created to lessen the effects of flooding in the lower basin, provide flows for navigation in the unimpounded portion of the Missouri River below Sioux City, Iowa, and to provide irrigation and power generation. Recreational pursuits on the reservoirs have developed into one of the most prominent and economically important uses of the Missouri River. Based on a value of $61/per trip (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census 2003), the Missouri River reservoir fisheries in South Dakota contribute over $25 million annually to the economy of South Dakota. This equates to over 350,000 angler days annually throughout the four reservoirs (Lott et al. 2007, Lott et al. 2006, Sorenson and Knecht In prep), with Lewis and Clark contributing over 30,000 angler days in 2005. Lewis and Clark Lake had an estimated direct economic impact of $2.51 million in 2005.

Reservoir aging has altered and will continue to alter these systems through silt retention and limitation of sediment transport. On Lewis and Clark Lake, delta habitat at the mouth of the Niobrara River has been forming since its inception in 1955. This dynamic habitat has added braided channels, backwaters, warmer water temperatures and higher turbidity, reminiscent of the historic Missouri River. Changes in fish habitat use have corresponded with alterations to Lewis and Clark Lake. Graeb (2006) showed a shift in sauger spawning habitat from below Fort Randal Dam to within the Niobrara River delta. As the reservoir aging process continues, there will undoubtedly be further changes to fish communities and associated habitat use.

Active management and research of the fish community of Lewis and Clark Lake has taken place since 1955, with annual surveys conducted over the past two decades. Little is known about the effects of the Niobrara River delta on the biota of Lewis and Clark Lake. Continuation of this long-term data set will aid in effectively managing and addressing future concerns dealing with the fishery of Lewis and Clark Lake.

The purpose of this report is to summarize sampling data collected from Lewis and Clark Lake during 2006 and to suggest management recommendations to enhance recreational fishing.

MANAGEMENT OBJECTIVES

Reservoir-wide Objective and Strategies

- Provide a fishery which can annually support 25,000 angler trips with a catch rate of 0.5 fish/hour.
    - Annually protect and enhance the quality and diversity of the fish community and aquatic habitats in Lewis and Clark Lake and the river reach upstream.
    - Increase public knowledge and awareness of problems and issues affecting Lewis and Clark Lake.
    - Continually maintain adequate access.

Species Specific/Lake Specific Objectives

<u>Walleye</u>

- Maintain three mature year-classes in the population.
- Manage for a balanced population with a PSD between 30 and 60 and an RSD-P of at least 10.
- Maintain a population survey gill net catch per unit effort of at least 4 fish/net-night.
- Provide a population that can sustain 25,000 angler days annually, with a harvest of 10,000 walleye at a rate of 0.1 fish/hour.

<u>Sauger</u>

- Maintain three mature year-classes in the population.
- Manage for a balanced population with a PSD between 30 and 60 and an RSD-P of at least 10.
- Maintain a population survey gill net catch per unit effort of at least 6 fish/net-night.
- Provide a population that can sustain 25,000 angler days annually, with a harvest of 5,000 sauger at a rate of 0.1 fish/hour.

<u>Channel catfish</u>

- Manage for a balanced population with a PSD between 30 and 60 an RSD-P of at least 10.
- Maintain a gill net CPUE of 3.0 fish/net night.

<u>Largemouth and Smallmouth bass</u>

- Maintain a PSD between 30 and 60 and an RSD-P of 20 for largemouth bass.
- Maintain an electrofishing catch rate of 10 fish/hour for both species.
- Document or index population structure and function.

Sampling Objectives (Federal Aid Code 2102)

- Species composition
- Relative abundance
- Age structure
- Growth
- Condition
- Reproduction and recruitment
- Survival and mortality rates
- Population size structure
- Effects of regulations

Emphasis is given to important sport and prey species, as well as species that are threatened or endangered. Common and scientific names and abbreviations of fishes contained in this report are provided in Appendix 1.

STUDY AREA

Lewis and Clark Lake is the lowermost reservoir of the Missouri River system. Stretching 110 km from Fort Randall Dam to Gavins Point Dam, the Lewis and Clark reservoir system contains reservoir, delta and riverine habitats (Figure 1). The upstream river reach (referred to as the Missouri River from here on) is approximately 60-km long and extends from Springfield, SD, upstream to Fort Randall Dam. Normal pool elevation for Lewis and Clark Lake is 1,208 feet above mean sea level. Reservoir surface area is 12,707 ha at normal pool, with a storage capacity of 6.06 million cubic meters. Maximum depth is 13.7 m with a mean depth of 5.0 m. There is approximately 144 km of shoreline surrounding the lake when it is at normal pool elevation. The Lewis and Clark Lake watershed drains 41,440 square kilometers, with the area above Gavins Point Dam draining 682,410 square kilometers.

Major sedimentation processes in the lake include shoreline erosion, littoral drift and delta encroachment. Beginning in Wyoming and running through Nebraska, the Niobrara River is the main tributary entering Lewis and Clark Lake from the southwest. Draining over 12,000 square miles of the Nebraska Sandhills, the Niobrara River contributes over half of the 4 million tons of sediment deposited in the lake annually.

Authorized water uses for Lewis and Clark Lake, as listed in the U.S. Army Corps of Engineers Master Plan, include flood control, navigation, hydropower, fish and wildlife, recreation, irrigation, and municipal and industrial water supply.

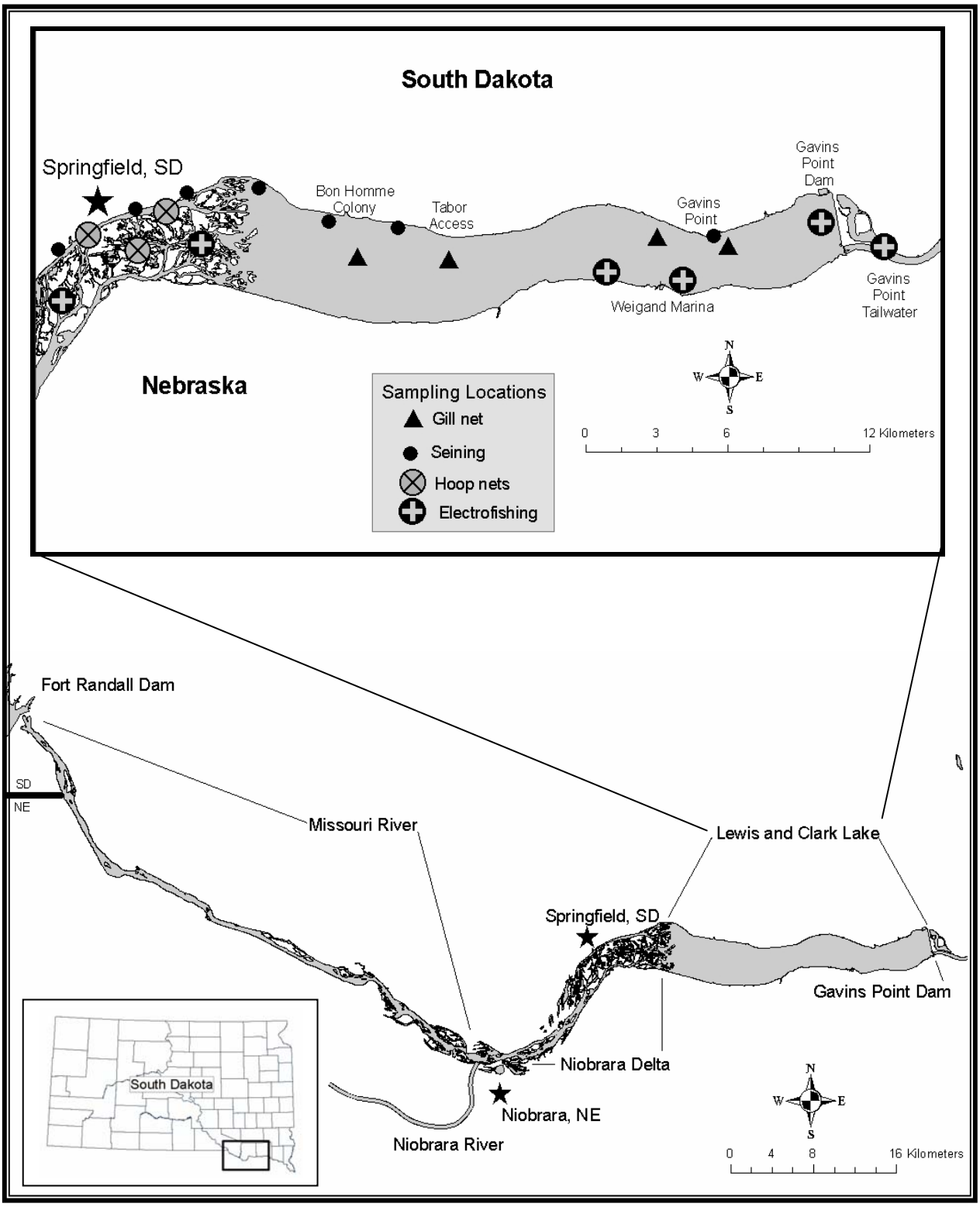

Figure 1. Lewis and Clark reservoir system, Fort Randall Dam to Gavins Point Dam, South Dakota.

METHODS

Fish populations in the Lewis and Clark reservoir system were sampled by gill netting, hoop netting, seining and electrofishing during 2006. Table 1 provides sampling efforts for the various gears and locations.

Table 1. Sampling methods, target species and effort for Lewis and Clark Lake sampling, 2006.

	Lewis and Clark Lake				**Missouri River**			
Method	*Gill Net*	*Electrofishing*		*Seine*	*Electrofishing*		*Seine*	*Hoop net*
Target species	All	SMB	FCF	All	SMB	LMB	All	CCF
Effort	12 net nights	60 m	140 m	8 hauls	60 m	60 m	10 hauls	80 net nights

Lewis and Clark Lake

Experimental multifilament gill nets were used to sample two depth strata, 0-12 m and 12-24 m, in Lewis and Clark Lake on September 20 and 21, 2006. Gill nets were 91.4 m in length and 1.8 m deep. Each gill net consisted of six panels 15.2 m in length with variable bar measure mesh sizes of 12.7, 19.1, 25.4, 31.8, 38.1 and 50.8 mm. Each net set overnight counted as one net night of effort. Three nets were set in the 0-12 m depth stratum near the Bon Homme Colony (RM 824) with three additional nets set in the same depth stratum near the Tabor Access Area (RM 820). Six nets were set near Gavins Point Dam (RM 814); three in the 0-12 m stratum and three in the 12-24 m stratum. Total length (mm) and weight (g) were recorded for all species captured. Scales and otoliths were collected from walleye and sauger (Tesch 1971) and a pectoral spine was collected from channel catfish for age analysis (Sneed 1951; Ashley and Garling 1980).

A bag seine was used to target age-0 fishes and adult prey species (e.g., shiner spp., cyprinid spp.) in Lewis and Clark Lake. Seine dimensions were 30.5-m long by 2.4-m deep and composed of 6.4-mm bar measure nylon mesh, with a bag with dimensions of 1.8 m by 1.8 m. The quarter-arc haul method was used as described by Hayes et al. (1996). Two seine hauls were made on July 24, 2006, at each of the following sites: Sand Creek (RM 828), Charlie Creek (RM 825), Bon Homme colony (RM 822), and Gavins Point (RM815). All fish collected were identified and enumerated.

Smallmouth bass were sampled by nighttime electrofishing near Gavins Point Dam on May 22, 2006, with a boom-mounted electrofishing boat utilizing pulsed DC settings of 185 volts, 6-8 amps and 60 pulses/second. Electrofishing effort using one dipper and one

boat operator consisted of three runs totaling 60 minutes. Effort was measured in pedal time which was defined as the amount of time the generator was creating an electric current. All smallmouth bass were measured for total length (mm) and weight (g) and scales were collected from below the lateral line near the distal end of the pectoral fin for age analysis (DeVries and Frie 1996).

Flathead catfish were collected by electrofishing along the south shore of Lewis and Clark Lake (RM 815-820) on June 12 and 19, 2006, with a boom-mounted electrofishing boat utilizing pulsed DC settings of 460 volts, 2 amps and 15 pulses/second. Electrofishing effort using one dipper and one boat operator consisted of six runs totaling 140 minutes. All flathead catfish were measured for total length (mm) and weight (g) and a pectoral spine was collected for age analysis (Sneed 1951; Ashley and Garling 1980).

Missouri River

A seine was used to target age-0 fishes and adult prey species (e.g., shiner spp., cyprinid spp.) in the Missouri River between RM 829 and 835 on July 25, 2006. Seine dimensions were 9.1 m long by 1.2 m deep with 6.6 mm bar measure. The quarter-arc haul method was used as described by Hayes et al. (1996). Ten hauls were made at various locations throughout the Niobrara River delta. All fish collected were identified and counted.

Smallmouth bass were sampled by daytime electrofishing from the Gavins Point Dam tail water area on May 23, 2006, with a boom-mounted electrofishing boat utilizing pulsed DC settings of 185 volts, 6-8 amps and 60 pulses/second. Electrofishing effort using one dipper and one boat operator consisted of three runs totaling 60 minutes. All smallmouth bass were measured for total length (mm) and weight (g) and scales were collected from below the lateral line near the distal end of the pectoral fin for age analysis (DeVries and Frie 1996).

Largemouth bass and smallmouth bass were collected by electrofishing near Springfield, South Dakota on May 23, 2006, with a boom-mounted electrofishing boat utilizing pulsed DC settings of 185 volts, 6-8 amps and 60 pulses/second. Electrofishing effort using one dipper and one boat operator consisted of three runs totaling 60 minutes. All largemouth and smallmouth bass were measured for total length (mm) and weight (g) and scales were collected from below the lateral line near the distal end of the pectoral fin for age analysis (DeVries and Frie 1996).

Channel catfish were collected from the Niobrara River delta area using hoop nets on August 14 and 18, 2006. Hoop net diameter was 508 mm with two different mesh sizes of 25 mm and 38 mm. Twenty nets were baited with cheese and remained in the water for two consecutive nights. Nets were reset and remained in the water for two additional nights for a total of 80 net nights of effort. All channel catfish were measured for total

length (mm), weighed (g), and a pectoral fin ray was collected from channel catfish for age analysis (Sneed 1951; Ashley and Garling 1980).

Fall drawdown on Lake Francis Case occurred earlier than normal in 2006; therefore, releases from Fort Randall Dam were too low to allow smallmouth bass to be sampled in the tail water area during October 2006.

Data Analysis

Structural indices were used to describe recruitment, growth and mortality of Lewis and Clark Lake and Missouri River sport fish species. The variable nature of field data obtained during these surveys did not lend itself to hypothesis testing, thus 80% confidence intervals were used to statistically compare data (Johnson 1999).

Relative abundance was expressed as catch per unit effort (CPUE) for standard gill netting (number/net night), seining (number/seine haul), electrofishing (number/hour) and hoop netting (number/net night) surveys. Length data were described by proportional stock density (PSD; Anderson 1976) and relative stock density (RSD; Wege and Anderson 1978). Length categories are listed in Table 2.

Table 2. Length categories (mm) used for calculating stock density indices for various fish species (Gabelhouse 1984).

Species	**Stock**	**Quality**	**Preferred**	**Memorable**	**Trophy**
Walleye	250	380	510	630	760
Sauger	200	300	380	510	630
Channel catfish	280	410	610	710	910
Smallmouth bass	180	280	350	430	510
Largemouth bass	200	300	380	510	630

Condition was assessed through relative weight calculations by dividing the weight of a fish by a length-specific standard weight for that species (Wege and Anderson 1978). Standard weight equations used for walleye (Murphy et al. 1990), sauger (Guy et al. 1990), smallmouth bass (Gablehouse 1984), largemouth bass (Gablehouse 1984) and channel catfish (Brown et al. 1995) are listed in Appendix 2**.**

Age and growth information was obtained from scales, otoliths and pectoral fin rays (DeVries and Frie 1996). Aging structures were removed from all walleye, sauger, channel catfish, largemouth bass and smallmouth bass and age distributions were developed by assigning ages based on enumeration of annual marks. Scales were removed from the area directly below the dorsal fin on walleye and sauger and from

below the lateral line near the distal end of the pectoral fin ray on smallmouth and largemouth bass. Scale ages were determined by counting annual marks and back-calculations were made using WinFin 4.4 (Francis 2003a) and Winfin Analysis 2.3 (Francis 2003b) computer software. Back-calculations were used to determine mean length at age, which was then compared with statewide averages or averages from other Missouri River reservoirs when available. Otoliths were removed from walleye and sauger by methods described in DeVries and Frie (1996), allowed to dry and then were cracked through the focus. One otolith from each fish was sanded with a precision rotary tool using the rotating disc sander attachment to clarify annuli and subsequently viewed under a microscope. Pectoral spines were allowed to dry, then sectioned and viewed under a microscope (Sneed 1951; Ashley and Garling 1980). Back-calculations were also done for channel and flathead catfish aged with pectoral fin rays.

Catch curve estimates of annual survival, annual mortality and instantaneous mortality rates were made utilizing FAST 2.1 software (FAST 2001) from methods developed by Ricker (1975). To reduce the effects of variable recruitment, two consecutive years of age distribution data were combined for analysis.

RESULTS AND DISCUSSION

Lewis and Clark Lake

Seines

Catch per unit effort, or number of fish per seine haul for 2006, was below the long-term average for the fifth consecutive year (Figure 2). The same number of species, fourteen, were sampled in 2005 and 2006. Age-0 gizzard shad and emerald shiners were the most common species sampled in 2006 (Table 3). Gizzard shad CPUE increased for the second consecutive year, while emerald shiner CPUE decreased for the third consecutive year. White bass were the third most common species sampled while age-0 walleye CPUE was < 1 fish/haul.

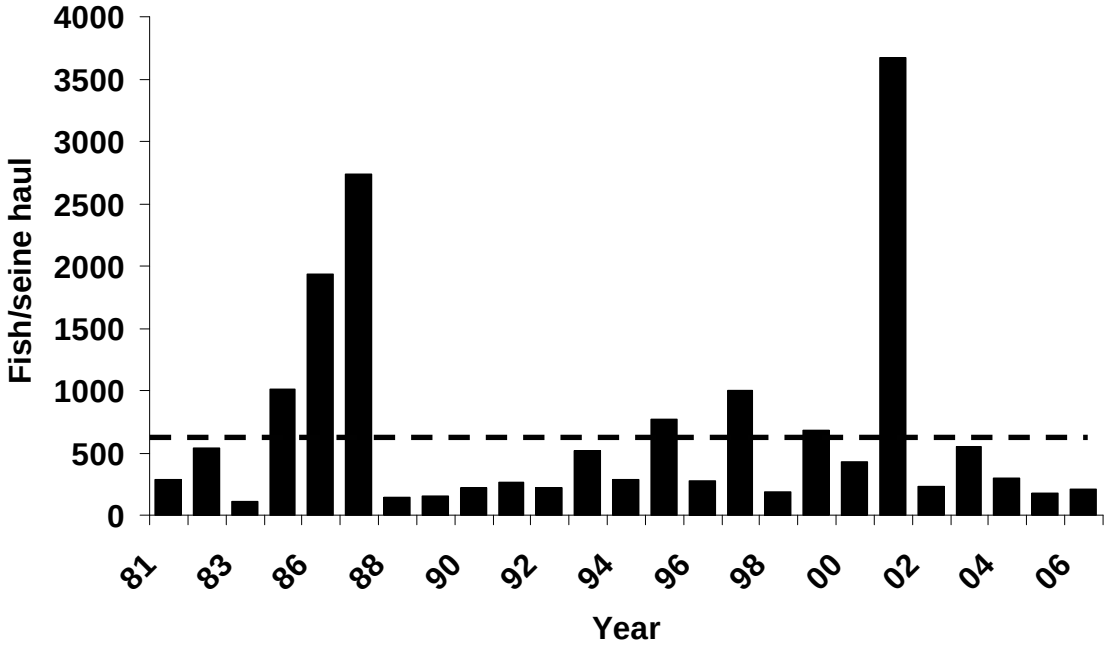

Figure 2. Mean number of fish captured per seine haul from Lewis and Clark Lake, South Dakota, 1981-2006. Dotted line represents long-term mean catch per haul.

Shields (1957) listed 22 species captured with seines in 1956 during the second year of impoundment of Lewis and Clark Lake (Table 3). Abundant species sampled included common carp, river carpsucker, buffalo spp., and a wide variety of minnows, chubs and shiners. Species such as western silvery minnow, redfin shiner, silverstripe shiner,

flathead chub and sand shiner were sampled during the period directly after impoundment; however, these species are rarely sampled during current surveys.

Newly formed delta habitats have been shown to affect fish habitat utilization (Graeb 2006). Kaemingk et al. (*in* press) looked at species richness and diversity in the Niobrara River delta. Species richness was greater in the Niobrara River delta (N=37 species) compared to Lewis and Clark Lake (N=23). Thirteen species were found exclusively in the delta area, while no species were found exclusively in the reservoir area. These findings, along with decreases in species richness since dam closure with certain species absent from current surveys, imply that delta habitat may function more similarly to the historic Missouri River than current reservoir habitats. Delta habitats could provide improved habitat diversity to positively affecting aquatic systems and fish communities.

Table 3. Catch per unit effort (fish/seine haul) for seining surveys at Lewis and Clark Lake, South Dakota, 1956 and 2001-2006. Standard error is in parenthesis. *includes both age-0 and adults. a-total number sampled

Species	***1956a***	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Bigmouth buffalo	91	-	<1 (0.1)	-	-	-	-
Black bullhead	4	-	-	-	-	-	-
Black crappie	191	-	<1 (0.1)	-	-	-	-
Bluegill	15	<1 (0.2)	<1 (0.1)	-	<1 (0.3)	0	<1 (0.4)
Bluntnose minnow	-	<1 (0.1)	-	-	-	1 (0.6)	-
Brassy minnow*	-	-	-	<1 (0.2)	-	-	-
Channel catfish	1	-	-	-	-	-	-
Common carp	1951	<1 (0.4)	-	<1 (0.1)	-	-	-
Common shiner	-	<1 (0.2)	-	6 (5)	-	-	-
Creek chub	-	<1 (0.5)	-	-	<1 (0.9)	-	-
Emerald shiner*	34	1400 (1808)	190 (72)	412 (222)	207 (64)	65 (16)	53 (14)
Fathead minnow	24	-	-	-	-	-	-
Freshwater drum	-	4 (2)	2 (2)	-	5 (3)	5 (2)	5 (2)
Gizzard shad	132	6 (4)	17 (15)	77 (53)	11 (7)	93 (30)	116 (35)
Golden shiner	-	<1 (0.1)	-	-	-	-	-
Green sunfish	1	-	-	-	-	-	-
Hybopsis sp.	-	<1 (0.1)	-	-	<1 (0.7)	-	-
Johnny darter*	-	<1 (0.3)	<1 (0.2)	1 (0.7)	4 (3)	2 (1)	<1 (0.2)
Largemouth bass	63	1 (0.5)	<1 (0.5)	<1 (0.4)	<1 (0.3)	<1 (0.2)	<1 (0.2)
Northern redhorse	33	-	-	-	-	-	-
Orangespotted sunfish	2	-	-	-	-	-	-
Rainbow smelt	-	<1 (0.1)	-	-	-	-	-
Red shiner*	-	<1 (0.4)	-	-	-	<1 (0.4)	<1 (0.2)
Redfin shiner	48	-	-	-	-	-	-
River carpsucker	575	<1 (0.2)	<1 (0.2)	<1 (0.2)	<1 (0.2)	0.0	<1 (0.1)
Sauger	21	<1 (0.2)	<1 (0.2)	<1 (0.1)	<1 (0.4)	<1 (0.1)	<1 (0.1)
Shorthead redhorse	-	<1 (0.1)	-	-	<1 (0.1)	-	-
Shortnose gar	9	-	-	<1 (0.1)	-	-	-
Silverstripe shiner	4	-	-	-	-	-	-
Smallmouth bass	-	<1 (0.3)	1 (0.6)	2 (0.7)	3 (0.9)	1 (0.3)	2 (0.7)
Smallmouth buffalo	164	<1 (0.2)	-	-	-	-	-
Spotfin shiner*	-	9 (3)	<1 (0.1)	12 (9)	2 (1)	4 (2)	<1 (0.1)
Spottail shiner*	-	31 (24)	3 (2)	12 (11)	19 (14)	1.1 (1)	<1 (0.3)
Walleye	-	2 (1)	3 (1)	1 (0.6)	2 (1)	<1 (0.4)	<1 (0.2)
Western silvery minnow	1843	-	-	-	-	-	-
White bass	-	91 (47)	15 (10)	20 (16)	40 (19)	6 (2)	15 (6)
White crappie	196	-	1 (1)	<1 (0.1)	-	-	-
Yellow perch	92	22 (16)	1 (0.7)	<1 (0.6)	3 (3)	<1 (0.1)	-

Seining efficiency can vary greatly for individual species. Species most vulnerable to collection by seine include those that inhabit the middle of the water column, while benthic species are less vulnerable and subsequently can be underestimated (Lyons 1986, Parsley et al. 1989). As a method of assessing age-0 and small littoral fishes, seining may underestimate species such as darter spp., redhoarse spp. and river carpsucker. Additionally, fluvial habitats can inhibit proper deployment of seining gear as can woody debris and vegetation. Push trawl developments have recently allowed sampling to occur in shallow water habitats that were previously inaccessible (Jeff Finley, United States Fish and Wildlife Service, personal communication). This tool could be beneficial for sampling age-0 and small fishes inhabiting shallow waters by increasing efficiency and targeting areas of Lewis and Clark Lake that are difficult to sample (e.g., Niobrara River delta).

Gill Nets

Fifteen species were captured with gill nets in 2006, up from ten species in 2005 (Table 4). Freshwater drum was the most abundant species sampled in gill nets comprising 25% of the total catch (Figure 3). Sauger and walleye were the second and third most abundant species sampled, respectively. Gizzard shad exhibited the largest decline in CPUE from 2005. Walleye and channel catfish CPUE also declined from 2005, while sauger CPUE remained the same. Catch per unit effort for all other species was ≤1 fish/net night.

Species sampled with gill nets has varied over the years. Gill net sampling shortly after the closure of Gavins Point Dam in 1955 captured nineteen species throughout the entire sampling season with 12 species sampled during fall netting (Table 4; Shields 1957). Channel catfish, common carp and goldeye were the most abundant species sampled in 1956 with a low number of sauger and no walleye sampled (Table 4; Shields 1957). Blue sucker, Northern redhorse, pallid sturgeon and shovelnose sturgeon were routinely sampled in the years immediately following Gavins Point Dam closure. Since the early 1970s, these species have been absent from gill net samples. In 1983, ten species were sampled, with gizzard shad, sauger and walleye being the most abundant species sampled.

Riverine species (e.g., blue sucker, sturgeon spp.) have been negatively impacted to the greatest extent by reservoir formation. Delta formation in Lewis and Clark Lake has led to changes in fish communities (Graeb 2006; Kaemingk *in* press). As the sedimentation process proceeds, species richness and diversity could continue to increase in delta areas.

Table 4. Catch per unit effort (fish/net night) for gill nets at Lewis and Clark Lake, South Dakota, 1956, 1983, 2001-2006. Standard error is in parenthesis (no standard errors listed for 1956 sampling).

Species	***1956***	***1983***	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Bigmouth buffalo	0	0	0	0	0	<1 (0.1)	0	0
Blue sucker	0.3	0	0	0	0	0	0	0
Channel catfish	6.3	1.7(0.7)	5 (1)	3 (1)	2 (1)	3 (1)	7 (8)	3 (1.8)
Common carp	9.3	0.5(0.2)	<1 (0.1)	<1 (0.2)	<1 (0.1)	<1 (0.1)	1 (1.2)	<1 (0.1)
Emerald shiner	0	0	0	0	0	<1 (0.1)	0	0
Flathead catfish	0	0	0	0	0	0	0	<1 (0.1)
Freshwater drum	0.8	6.1(3.4)	25 (9)	5 (1)	6 (1)	5 (1)	3 (9)	5 (1)
Gizzard shad	2.8	15.6(8)	14 (5)	6 (2)	3 (1)	3 (1)	11 (20)	1 (1)
Goldeye	5.3	0	0	0	0	0	<1(0.4)	0
Northern redhorse	0.8	0	0	0	0	0	0	0
Paddlefish	0	0	0	<1 (0.1)	0	0	0	0
Pallid sturgeon	0	0	0	<1 (0.1)	<1 (0.1)	0	0	0
River carpsucker	2.0	1.9(1)	7 (2)	2 (1)	<1 (0.2)	2 (1)	<1 (0.4)	1 (0.7)
Rock bass	0	0	0	0	0	0	0	<1 (0.1)
Sauger	1.5	10.1(1.5)	14 (1)	9 (1)	8 (2)	5 (1)	5 (4)	5 (0.8)
Shorthead redhorse	0	0	<1 (0.1)	<1 (0.2)	<1 (0.4)	<1 (0.2)	2 (3)	<1 (0.4)
Shortnose gar	2.0	0	<1 (0.5)	0	<1 (0.3)	<1 (0.1)	<1 (0.9)	<1 (0.1)
Shovelnose sturgeon	1.5	0	0	0	0	0	0	0
Smallmouth buffalo	0	0	<1 (0.2)	0	<1 (0.1)	<1 (0.1)	0	<1 (0.1)
Spottail shiner	0	0	<1 (0.1)	0	<1 (0.1)	0	0	<1 (0.1)
Walleye	0	10.1(1.7)	12 (3)	8 (1)	11 (1)	4 (1)	9 (9)	5 (0.6)
White bass	0	0.07(0.1)	<1 (0.3)	<1 (0.2)	<1 (0.1)	<1 (0.1)	0	<1 (0.1)
White crappie	0.5	1.2(0.1)	3 (2)	2 (1)	<1 (0.6)	<1 (0.1)	0	<1 (0.1)
Yellow perch	0.2	0.14(0.1)	<1 (0.1)	0	<1 (0.1)	0	0	0

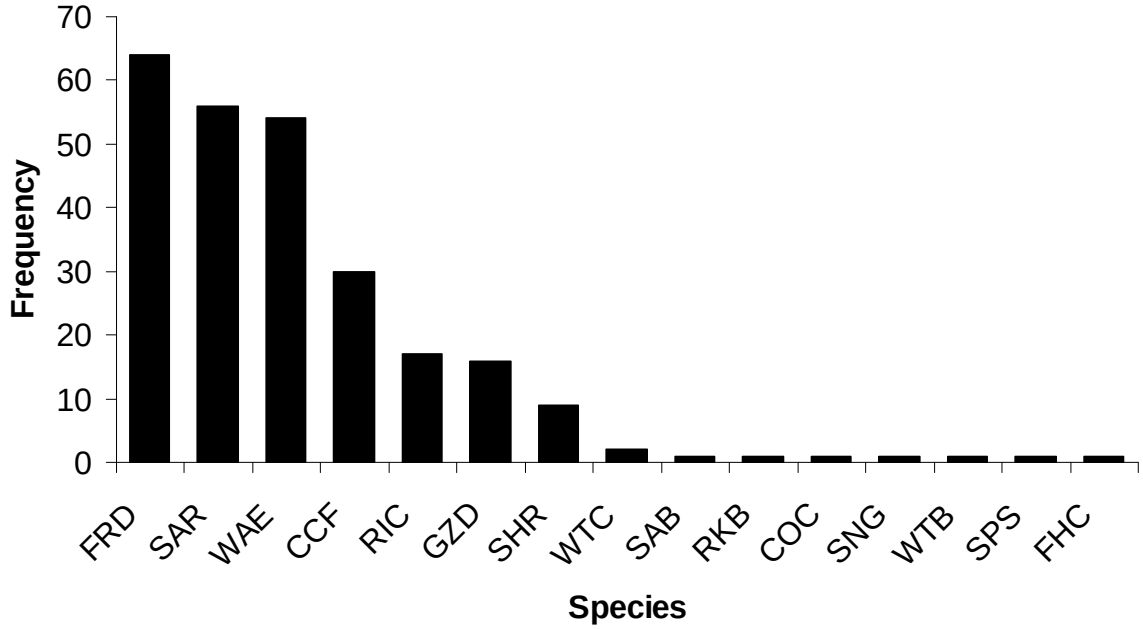

Figure 3. Number of fish caught, by species, for fish sampled with gill nets from Lewis and Clark Lake, 2006. Abbreviations used are defined in Appendix 1.

Walleye population parameters

Mean gill net CPUE for walleye 381-mm (15 inches) and longer was 3.4, down from 2005 (Table 5). However, the percentage of walleye sampled over 381-mm has increased for six consecutive years. In 2006, 78% of walleye sampled in gill nets were longer than 381 mm. Walleye length frequency distribution reveals a small year-class of walleye near 150 mm in 2005 sampling (Figure 4). Additional growth during 2006 moved this year-class past stock length as evidenced by 2006 sampling. A year-class of walleye near 150 mm was not sampled during 2006. Larger walleye will gradually exit the system due to fishing mortality with the remaining walleye exiting due to natural mortality. Without replacement fish (<355 mm or 14 in), CPUE for larger walleye will eventually decrease. In coordination with the decreased size structure of walleye, catch and harvest rates of walleye by anglers will most likely also decline. High production with corresponding recruitment will be necessary in the immediate future to maintain the quality of walleye angling currently available in Lewis and Clark Lake.

Table 5. Mean gill net catch per unit effort (fish/net night) for sauger and walleye, 381 mm and longer collected in standard gill net surveys, Lewis and Clark Lake, 2001-2006. 80% confidence interval (±) in parenthesis.

Year	Sauger	Walleye
2001	4.8 (0.8)	3.5 (1.4)
2002	4.4 (1.3)	2.7 (0.7)
2003	4.2 (1.0)	5.5 (0.9)
2004	2.7 (0.8)	2.3 (0.9)
2005	3.1 (1.3)	6.2 (2.6)
2006	2.3 (0.5)	3.4 (0.5)

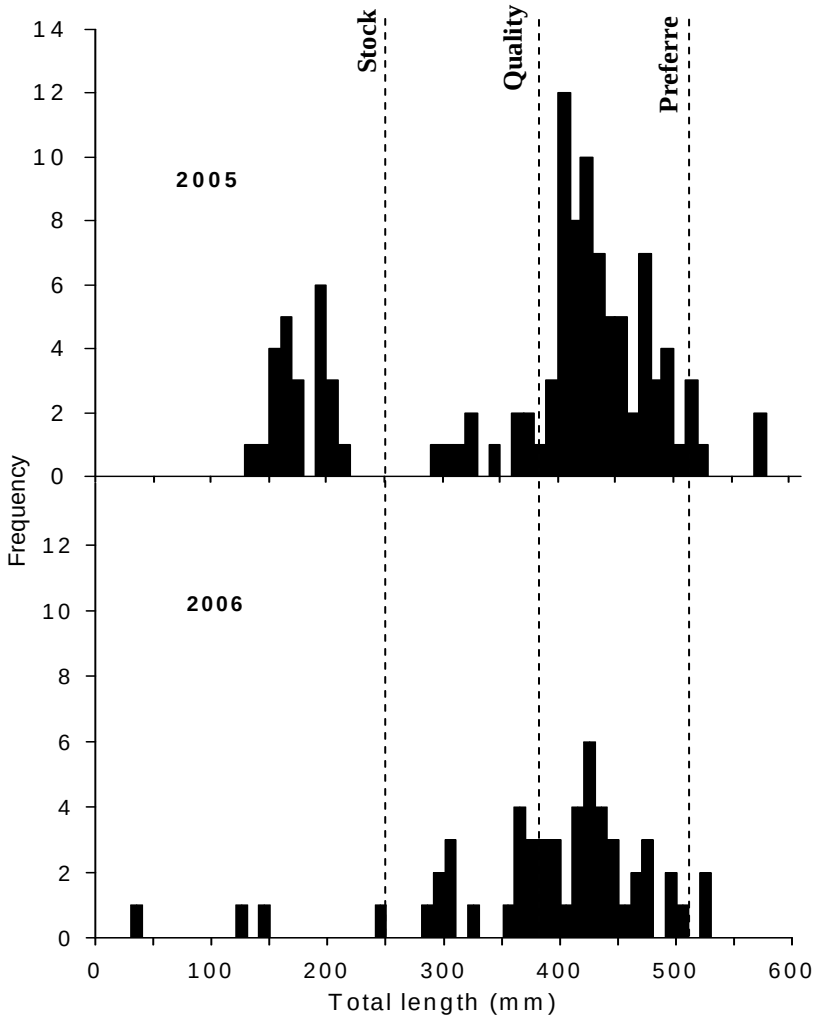

Figure 4. Length frequency for walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2005 and 2006.

Walleye PSD for 2006 was 75 and RSD-P was 6 compared with 88 and 7, respectively, during 2005 sampling (Table 6). Values for PSD in 2005 and 2006 were slightly above the generally accepted stock density index range of 30-60 for balanced walleye populations (Anderson and Weithman 1978).

Table 6. Walleye proportional stock density (PSD) and relative stock density of preferred and memorable-length fish (RSD-P and RSD-M) collected in standard gill net surveys, Lewis and Clark Lake, South Dakota, 2001-2006.

Year	PSD	RSD-P	RSD-M	Sample Size
2001	67	10	0	142
2002	42	4	0	100
2003	61	11	0	127
2004	58	2	0	51
2005	88	7	0	108
2006	75	6	0	54

Walleye relative weights for various length categories for Lewis and Clark Lake are generally between 80 and 90 annually (Table 7). By definition, values below 100 for relative weight indicate a problem may exist with food or feeding conditions (Anderson and Neumann 1996). Wickstrom (2006) conducted a food habits study in 2005 to address this issue. Seasonal distributions of walleye and sauger were found to be similar during summer and autumn suggesting competition for food resources may exist during this time period. Diet overlap and insufficient quantity and quality of prey items were suggested as a possible explanation of moderate relative weight values for walleye in Lewis and Clark Lake. However, relative weights for walleye in Missouri River reservoirs are generally between 80 and 90 and only approach 100 when prey species, such as rainbow smelt, are overly abundant (John Lott, South Dakota Game, Fish and Parks, personal communication). Also, in a large, complex reservoir system such as Lewis and Clark Lake, relative weight values can vary between habitats and seasons. Growth should also be considered when addressing relative weight values in a reservoir system.

Table 7. Relative weight of walleye, by incremental stock density indices, captured during September in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006. 80% confidence interval (±) in parenthesis.

Year	Stock-quality	Quality-preferred	Preferred-memorable	N
2001	85 (1.1)	87 (1.2)	85 (3.5)	63
2002	80 (0.9)	81 (1.3)	84 (1.8)	76
2003	87 (1.3)	82 (0.9)	80 (2.9)	108
2004	81 (1.5)	80 (1.2)	81 (--)	48
2005	81 (2.7)	83 (0.9)	80 (1.2)	85
2006	89 (2.6)	83 (1.3)	85 (7.8)	54

Mean age of walleye dropped from 3.3 in 2005 to 3.0 in 2006 (Table 8). Age-0 walleye CPUE declined from 2005 to 2006, emphasizing the need for quality production in the near future to maintain the current walleye fishery status. Growth of Lewis and Clark Lake walleye appears to mirror that of the statewide average after age 1. Growth of walleye in Lewis and Clark Lake is initially similar to that of Lake Francis Case walleye, but is faster for age-4 and age-5 walleye (Figure 5).

Age-0 walleye production is currently based on gill net catches. Fall night electrofishing can provide an index to age-0 and age-1 walleye abundance (Serns 1982, 1983). Additional sampling with this method may allow age-0 walleye to be better indexed in Lewis and Clark Lake in the future.

Table 8. Age distribution of walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006, as determined from otoliths. Mean age excludes age-0 fish.

Year	Age														
class	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
2001	79	18	10	26	2	3	2	2	0	0	0	0	0	0	2.6
2002	9	39	21	5	11	0	0	0	0	0	0	0	0	0	1.8
2003	10	24	52	10	6	5	1	2	4	3	0	1	0	0	2.8
2004	3	7	20	13	7	1	0	0	0	0	0	0	0	0	2.5
2005	24	6	15	28	23	4	4	4	0	0	0	0	0	0	3.3
2006	2	10	14	11	9	6	1	0	0	0	0	0	0	1	3.0

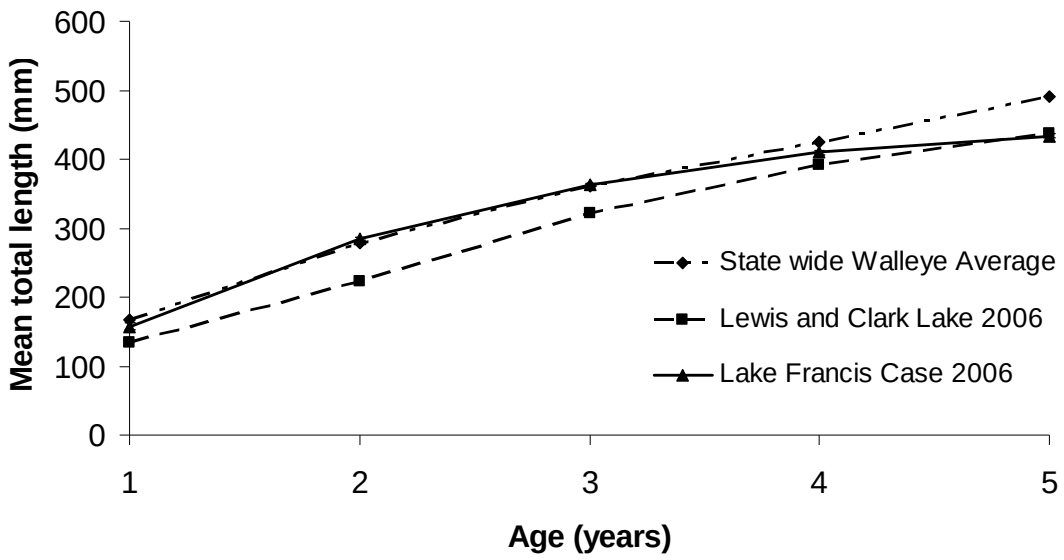

Figure 5. Mean back-calculated length at age for walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2006, as determined from scales. Statewide walleye average-Willis et al. 2005, Lake Francis Case 2006-Sorensen and Knecht In prep.

Annual survival for 2005-2006 pooled walleye data, as estimated from catch curve analysis (Ricker 1975) and excluding age-0 fish, was 74% (Table 9). Increases in survival may be attributed to drought conditions. Age-0 fish have been shown to be flushed from the Lewis and Clark reservoir system due to high flow-through rates and reservoir discharge (Walburg 1971). Decreased flow-through rates for Lewis and Clark Lake during periods of drought may decrease flushing of fish from the reservoir. However, inconsistent recruitment may convolute interpretation of mortality estimates. This inconsistency in recruitment or even lack of recruitment is another possible cause for variations in mortality.

Table 9. Catch curve estimates of annual survival (S), annual mortality (A), and instantaneous mortality rates (-Z) for age-1-and-older walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2000-2006, as determined from scales.

Years	S	A	-Z
2000-2001	0.62	0.38	0.473
2001-2002	0.53	0.47	0.638
2002-2003	0.66	0.34	0.422
2003-2004	0.67	0.33	0.395
2004-2005	0.62	0.38	0.471
2005-2006	0.74	0.26	0.301

Sauger population parameters

Mean gill net CPUE for sauger 381-mm (15 inches) and longer was 2.3 fish/net night, down from 2005 (Table 5). Similar to walleye, a year-class of sauger was present in 2005 near 150 mm (Figure 6). Gill netting efforts in 2006 yielded no sauger in this size class; however, sauger near quality size (300 mm) were present in 2006 but not in 2005. With the majority of sauger above quality size in 2006, production and subsequent recruitment in the near future are going to be critical to maintaining current sauger abundance.

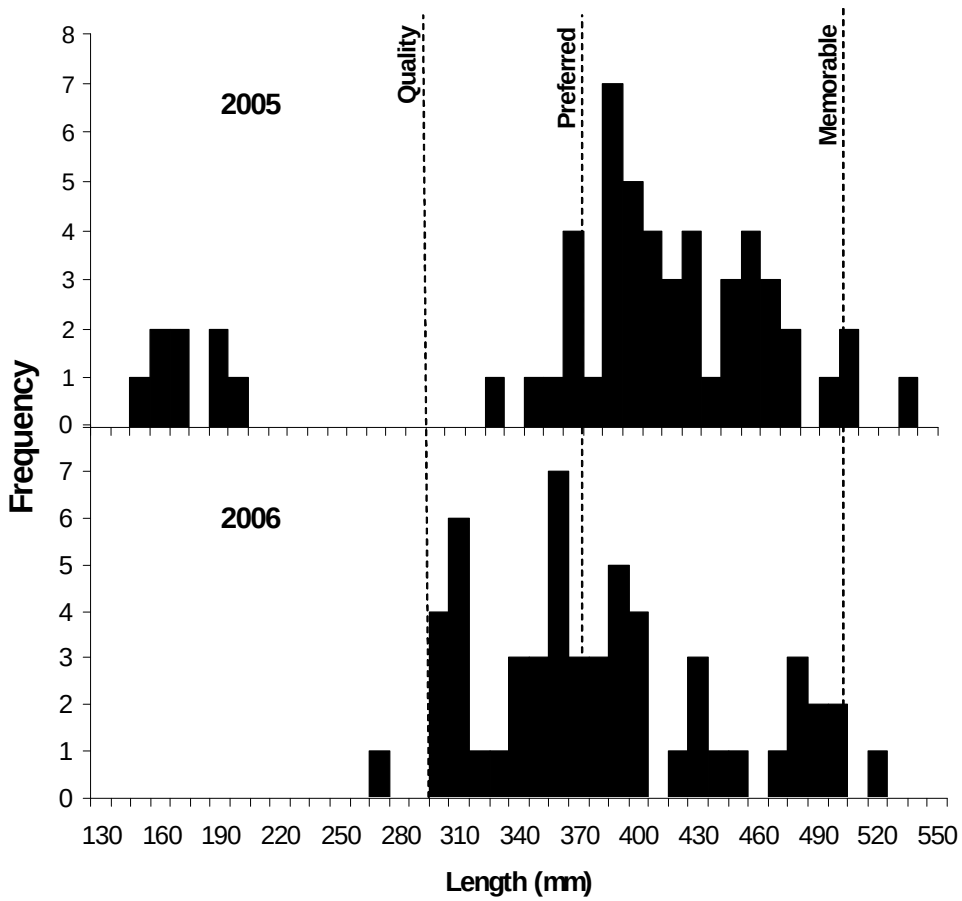

Figure 6. Length frequency for sauger collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2005 and 2006.

Sauger PSD for 2006 was 98 and RSD-P was 48, compared to 95 and 77, respectively, during 2005 sampling (Table 10). While a generally accepted stock density index range is not readily available for sauger, the generally accepted range for walleye is 30-60. Sauger PSD for Lewis and Clark Lake is consistently well above this range indicating the quality of the size structure for this species.

Table 10. Sauger proportional stock density (PSD) and relative stock density for preferred and memorable-length fish (RSD-P and RSD-M) collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006.

Year	PSD	RSD-P	RSD-M	Sample Size
2001	86	61	6	165
2002	76	53	3	107
2003	93	62	2	96
2004	86	63	4	51
2005	96	78	6	56
2006	98	48	2	56

Similar to walleye, sauger relative weights for Lewis and Clark Lake are generally between 80 and 90 (Table 11). Diet overlap with walleye along with insufficient quantity and quality of prey items as suggested by Wickstrom (2006) could be a possible explanation for moderate relative weights of sauger in Lewis and Clark Lake.

Mean age of sauger decreased from 3.3 to 2.7 during 2006 (Table 12). There were no age-1 sauger sampled in 2005, while age-2 sauger were the most prevalent sampled age class in 2006. Sauger generally grow slower than walleye (Malison et al. 1990); however, growth of sauger in Lewis and Clark Lake is similar to that of walleye in Lewis and Clark Lake and the statewide average for walleye (Figure 7). This disparity could be due to an increase in habitat resembling the historic Missouri River due to delta formation in Lewis and Clark Lake, which would favor sauger over walleye.

Table 11. Relative weight of sauger, by incremental stock density indices, collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006. 80% confidence interval (±) in parenthesis.

Year	Stock-quality	Quality-preferred	Preferred-memorable	N
2001	80 (2.1)	84 (1.5)	81 (0.9)	95
2002	77 (1.4)	78 (1.1)	78 (1.0)	102
2003	80 (4.4)	80 (2)	78 (1.6)	84
2004	78 (1.4)	77 (1.2)	76 (1.2)	51
2005	78 (4.4)	81 (2)	82 (1.3)	49
2006	82 (--)	80 (1.6)	80 (2.1)	56

Table 12. Age distribution of sauger collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006, as determined from otoliths. Mean age excludes age-0 fish.

Year	Age									
class	0	1	2	3	4	5	6	7	8	Mean
2001	78	21	17	27	9	8	3	0	0	2.7
2002	5	34	32	6	23	4	1	2	0	2.4
2003	1	6	20	28	13	12	3	0	0	3.2
2004	4	7	7	28	7	1	1	0	0	2.8
2005	4	0	12	18	11	3	2	1	0	3.3
2006	0	14	22	4	5	4	2	2	1	2.7

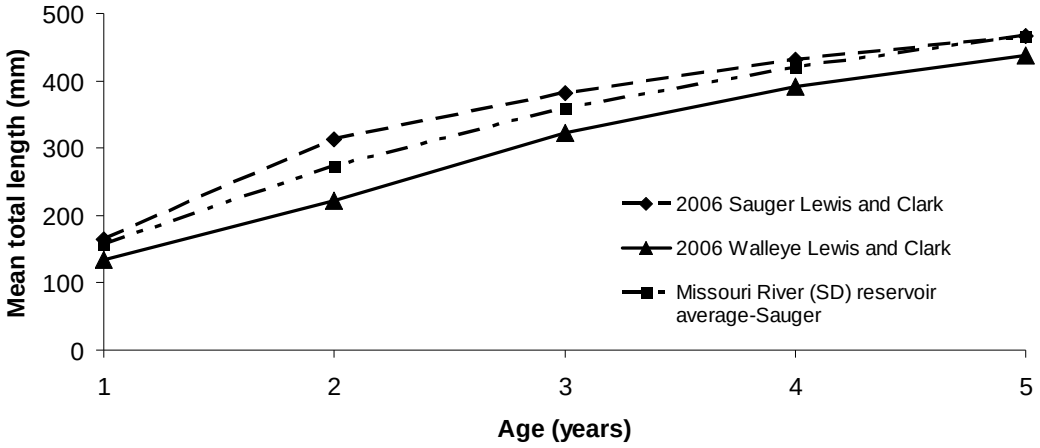

Figure 7. Mean back-calculated length at age for sauger and walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2006, as determined from scales. Missouri River reservoir sauger average-Willis et al. 2005

Annual survival for 2005-2006 pooled sauger data was 65% (Table 13), as estimated from catch curve analysis (Ricker 1975) and excluding age-0 fish. Mortality for sauger in 2005-2006 was the same as that derived from 2004-2005 data.

Table 13. Catch curve estimates of annual survival (S), annual mortality (A), and instantaneous mortality rates (-Z) for age-1-and-older walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2000-2006, as determined from scales.

Years	S	A	-Z
2000-2001	0.64	0.36	0.453
2001-2002	0.66	0.34	0.413
2002-2003	0.65	0.35	0.428
2003-2004	0.77	0.23	0.260
2004-2005	0.65	0.35	0.428
2005-2006	0.65	0.35	0.435

Channel catfish population parameters

A total of 30 channel catfish were sampled with lengths ranging from 145-722 mm. Mean gill net CPUE for channel catfish decreased from 7.0 fish/net-night in 2005 to 2.5 fish/net night in 2006. Seventy-two percent of the channel catfish sampled in 2006 were above quality length (Figure 8).

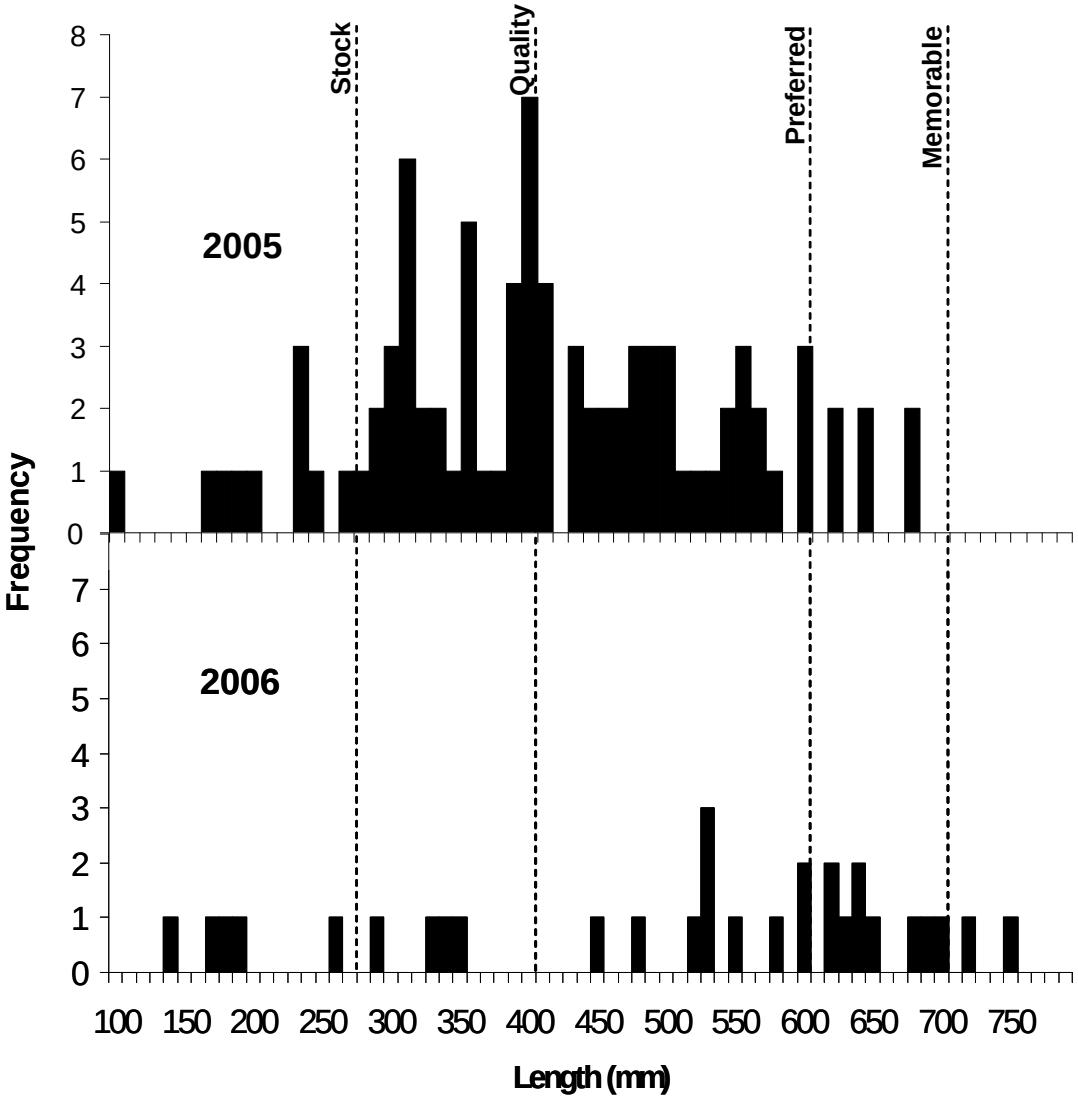

Figure 8. Length frequency for channel catfish collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2005 and 2006.

Channel catfish PSD for the 2006 gill net sample was 84 and RSD-P was 44 compared with 64 and 11, respectively, during 2005 sampling (Table 14). Channel catfish PSD and RSD-P in the standard gill net survey have increased for two consecutive years. In 2006, memorable length channel catfish were captured for the first time since 2003, with a relative stock density for memorable length channel catfish of 8 during 2006.

Table 14. Channel catfish proportional stock density (PSD) and relative stock density for preferred and memorable length fish (RSD-P and RSD-M), collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006.

Year	PSD	RSD-P	RSD-M	Sample Size
2001	43	8	2	56
2002	70	9	3	40
2003	62	24	7	29
2004	52	0	0	31
2005	64	11	0	54
2006	84	44	8	30

Relative weights for channel catfish are generally between 85 and 90; however, in 2005 and 2006, W_r values for quality-to-preferred-length channel catfish were above 90 (Table 15). Estimated annual survival for 2005-2006 was 80%, similar to that estimated for 2004-2005 (Table 16).

Table 15. Relative weight of channel catfish, by incremental stock density indices, collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006. 80% confidence interval (±) in parenthesis.

Year	Stock-quality	Quality-preferred	Preferred-memorable	N
2001	87 (1.3)	86 (2.0)	95 (11)	53
2002	85 (1.3)	85 (2.0)	84 (--)	33
2003	86 (2.7)	88 (3.0)	88 (3.4)	29
2004	90 (2.4)	84 (2.5)	--	27
2005	79 (3.2)	86 (1.6)	95 (4.2)	29
2006	87 (1.3)	94 (3.3)	88 (4.6)	30

Table 16. Catch curve estimates of annual survival (S), annual mortality (A), and instantaneous mortality rates (-Z) for age-1 and older channel catfish collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2001-2006, as determined from pectoral spines.

Years	S	A	-Z
2000-2001	0.69	0.31	0.377
2002-2003	0.88	0.12	0.130
2003-2004	0.91	0.10	0.100
2004-2005	0.84	0.16	0.170
2005-2006	0.80	0.19	0.214

Electrofishing

Smallmouth bass population parameters

A total of 62 smallmouth bass were sampled near Gavins Point Dam with lengths ranging from 106-376 mm (Figure 9). Size structure from 2006 sampling was similar to that of 2005, with the majority of the smallmouth bass sampled above stock length. Proportional stock density for smallmouth bass in the 2006 sample was 19; down from 37 in 2005, while CPUE was similar (Table 17). Relative weight for stock to quality length smallmouth bass was 88, down from 94 in 2005, while quality to preferred and preferred length smallmouth bass relative weights were similar to the previous year. Growth for smallmouth bass sampled near Gavins Point Dam in 2006 was similar to the statewide average for ages 1 to 5 (Figure 10). Age distribution for smallmouth bass was similar to that of 2005 sampling. Smallmouth bass ages ranged from age1 to age 6, with age-2 fish comprising 50% of the sample (Table 18).

Smallmouth bass annual survival, as estimated from catch curve analysis (Ricker 1975) of 2005-2006 pooled data, was 51%, with an –z value of 0.66. Due to under representation of age-1 smallmouth bass, only age-2 or older smallmouth bass were used for mortality estimates. Estimated annual survival was similar to estimates from previous years (40-50%).

Smallmouth bass size structure is known to be underestimated with electrofishing (Beamesderfer and Rieman 1988; Milewski and Willis 1991). The percentage of smallmouth bass sampled near Gavins Point Dam above quality length is often low, while creel survey results indicate larger smallmouth bass are regularly caught and released through angling. In 2006, 15% of the smallmouth bass sampled were above quality length, while creel survey results indicate that 60% of the smallmouth bass caught in 2006 were above quality length (Jeff Schuckman, Nebraska Game and Parks Commission, personal communication).

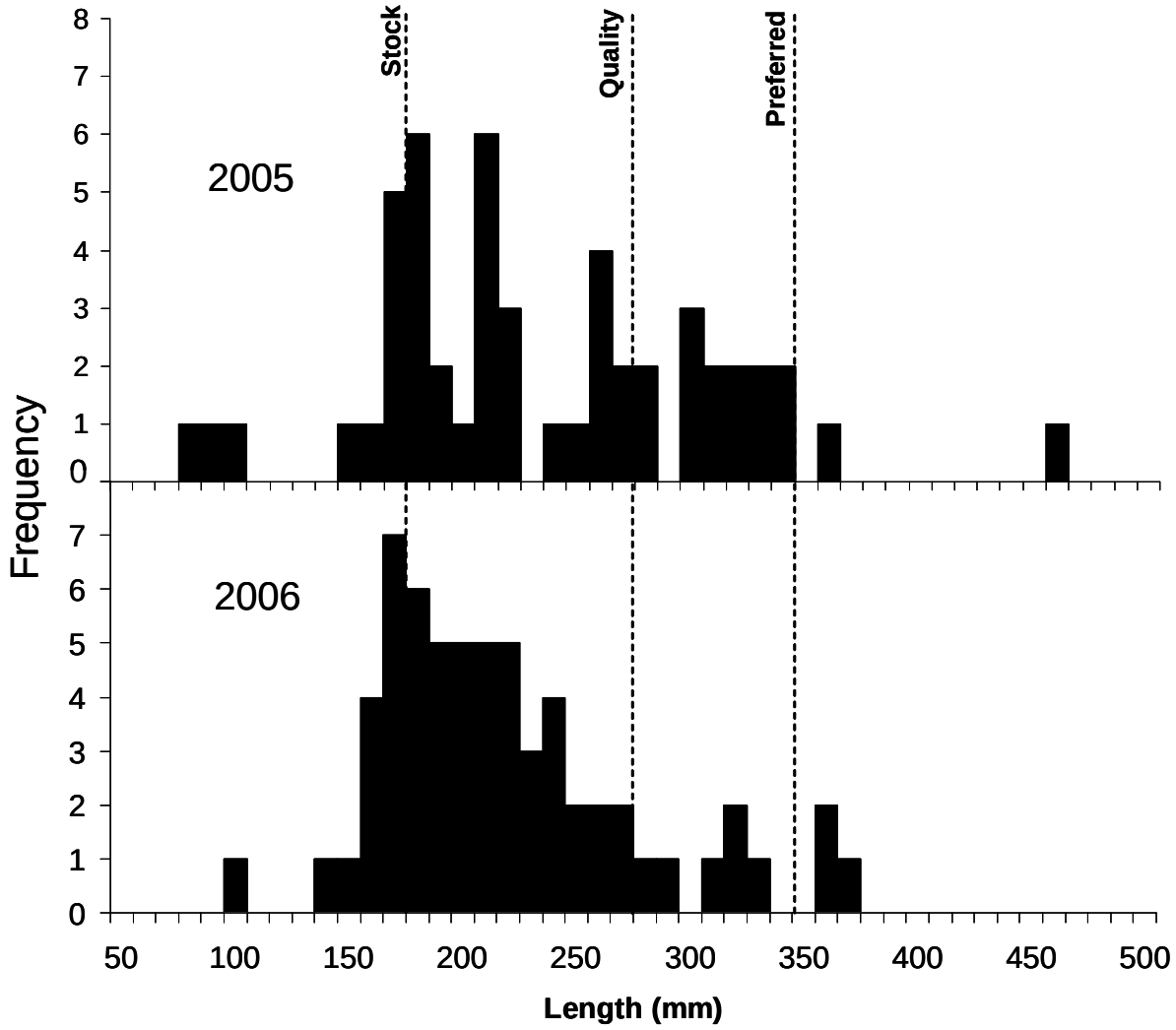

Figure 9. Length frequency for smallmouth bass sampled by nighttime electrofishing near Gavins Point Dam in Lewis and Clark Lake, South Dakota, 2005 and 2006.

Table 17. Catch per unit effort (CPUE), proportional stock density (PSD), relative stock density for preferred and memorable-length fish (RSD-P, RSD-M), and mean relative weight of stock-quality (S-Q), quality-preferred (Q-P), and preferred-length (P) smallmouth bass collected by electrofishing Gavins Point Dam face, Lewis and Clark Lake, 2001-2006. N is the number of stock-length fish sampled. 80% confidence interval (±) in parenthesis.

					Relative weight			
Year	**CPUE (fish/h)**	**PSD**	**RSD-P**	**RSD-M**	**S-Q**	**Q-P**	**P-M**	**N**
2001	59 (18)	17	4	0	94 (1.2)	84 (2.8)	87 (17)	54
2002	75 (24)	49	11	3	92 (1.6)	88 (2)	93 (6.6)	70
2003	25 (15)	48	22	9	90 (3.2)	91 (3)	96 (2.8)	23
2004	44 (21)	38	10	0	91 (1.6)	87 (2)	86 (4.5)	42
2005	44 (30)	37	5	2	94 (2.1)	83 (3.1)	75 (--)	41
2006	62 (6.8)	19	6	0	89 (1.5)	91(6.5)	86 (12)	62

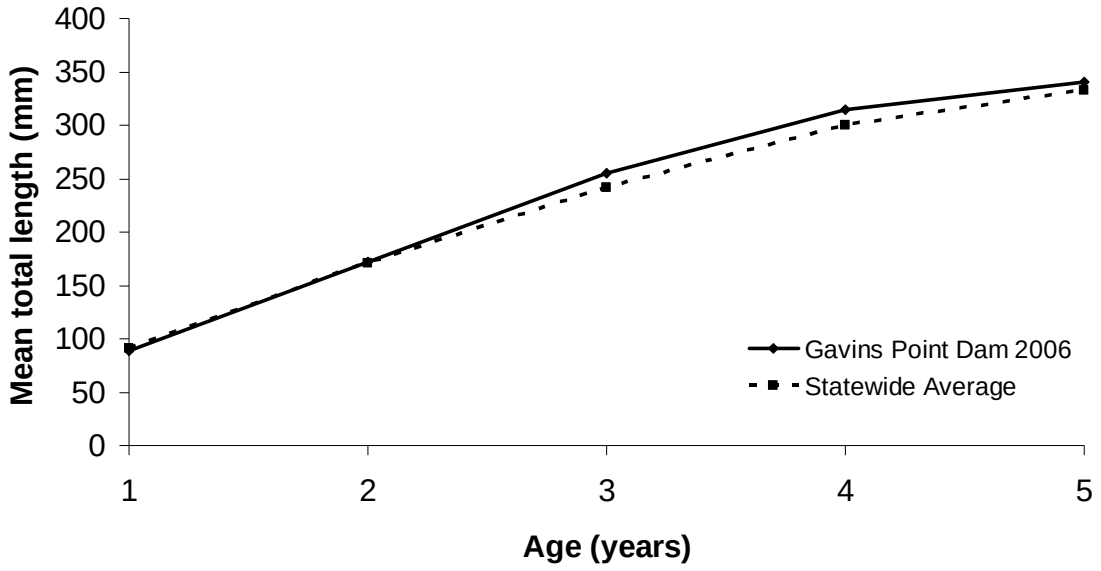

Figure 10. Mean back-calculated length at age for smallmouth bass sampled near the Gavins Point Dam face, Lewis and Clark Lake, South Dakota, 2006, as determined from scales. Statewide smallmouth bass average-Willis et al. 2005

Table 18. Age distribution of smallmouth bass collected by electrofishing Lewis and Clark Lake near Gavins Point Dam, 2001-2006, as determined from otoliths. Mean age excludes age-0 fish.

Year	Age							
class	1	2	3	4	5	6	7	Mean
2001	4	45	4	5	1	0	0	2.2
2002	2	29	33	5	1	5	0	2.9
2003	0	10	8	1	5	0	1	3.2
2004	1	16	16	9	1	0	0	2.8
2005	3	23	13	10	1	0	0	2.7
2006	1	29	14	6	3	5	0	2.9

Flathead catfish population parameters

Forty-five flathead catfish were sampled by daytime electrofishing along the south shore of Lewis and Clark Lake during June 2006. Catch per unit effort values for 2005 and 2006 were similar (Table 19). Proportional stock density for the electrofishing sample in 2006 was 10, down from 39 in 2005. Flathead catfish lengths ranged from 74 to 594 mm. Size structure showed a similar distribution as 2005, with 77% of flathead catfish sampled below stock length (Figure 11). Relative weight for stock-to-quality-length flathead catfish was 88, similar to the six year average (Table 19).

Flathead catfish captured by electrofishing in 2006 ranged in age from 1 to 9, with a mean age of 3.7 (Table 20). Similar to previous years, the majority (81%) of flathead catfish were age-5 or younger. Flathead catfish annual survival, estimated from catch curve analysis (Ricker 1975) for 2005-2006 pooled catch data, was 74% with an –z value of 0.3.

Growth of flathead catfish in Lewis and Clark Lake is slower than that of the Des Moines River, Iowa from age 1 to age 5 (Mayhew 1969). From age 5 through age 8, growth of Lewis and Clark Lake flathead catfish is similar to that of the Des Moines River (Figure 12).

Table 19. Catch per unit effort (CPUE), proportional stock density, relative stock density for preferred and memorable length fish (RSD-P, RSD-M), and relative weights of stock-quality (S-Q), quality-preferred (Q-P), and preferred-length (P) fish for flathead catfish collected by electrofishing Lewis and Clark Lake, 2001-2006. N is the number of stock-length fish sampled. 80% confidence interval (±) in parenthesis.

	CPUE				**Relative weight**		
Year	**(fish/h)**	**PSD**	**RSD-P**	**RSD-M**	**S-Q**	**Q-P**	**P**
2001	28 (13.5)	34	0	0	87 (2.1)	82 (--)	-
2002	36 (13)	18	0	0	85 (5.3)	93 (--)	-
2003	22 (5.5)	30	0	0	85 (2)	91 (7.4)	-
2004	2 (8.1)	36	0	0	90 (2.8)	--	-
2005	23 (7)	39	0	0	92 (4.8)	84 (5.4)	-
2006	20 (6.1)	10	0	0	88 (2.1)	92 (--)	-

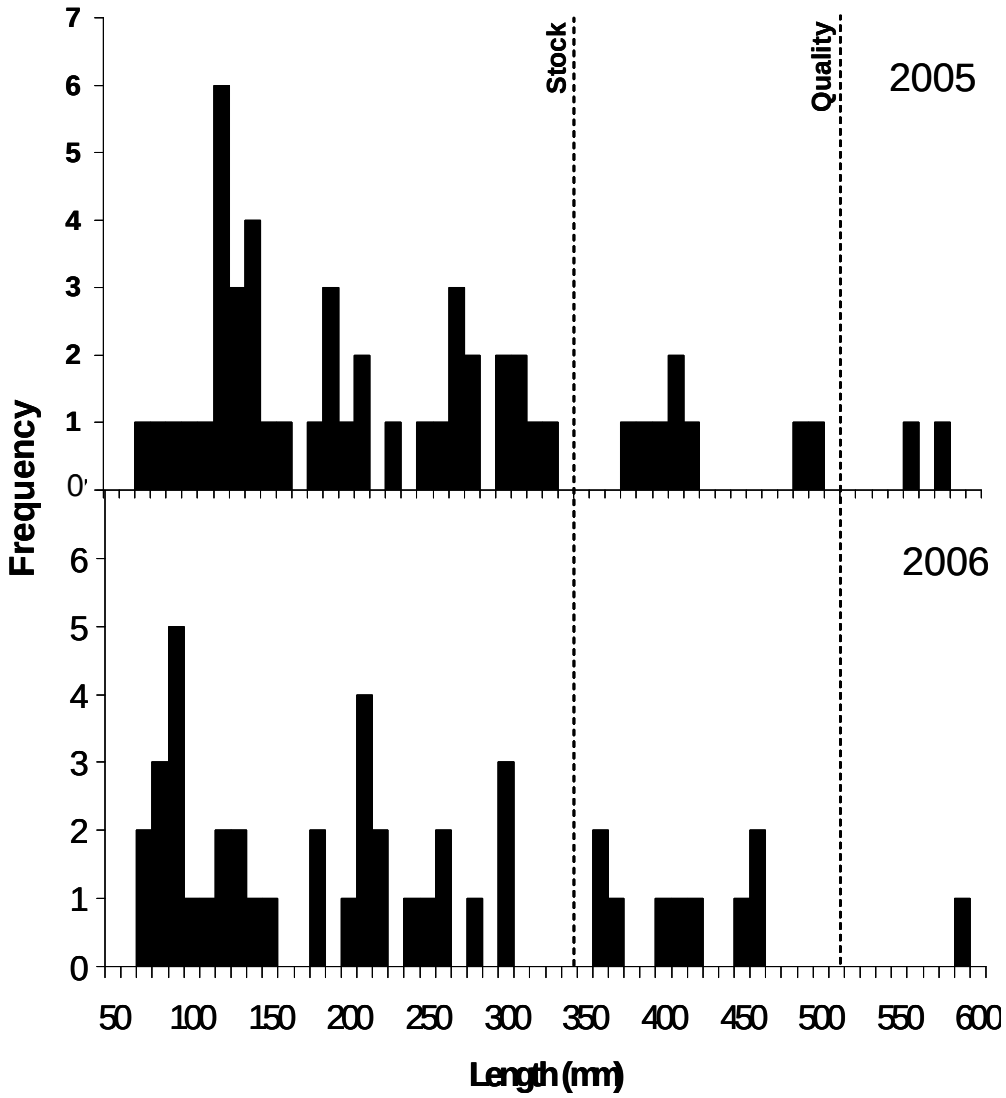

Figure 11. Length frequency of flathead catfish sampled by electrofishing Lewis and Clark Lake during June 2005 and 2006.

Table 20. Age distribution of flathead catfish sampled by electrofishing Lewis and Clark Lake during 2001-2006, as determined from pectoral spines.

Year class	Age										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
2001	0	3	23	24	5	9	2	0	2	0	4.1
2002	7	11	12	34	16	1	5	2	0	1	3.9
2003	5	9	9	7	11	9	1	2	2	1	4.2
2004	0	2	21	10	3	8	4	2	2	0	4.5
2005	8	10	7	10	1	4	4	1	0	0	3.4
2006	6	6	4	7	4	1	2	2	1	0	3.7

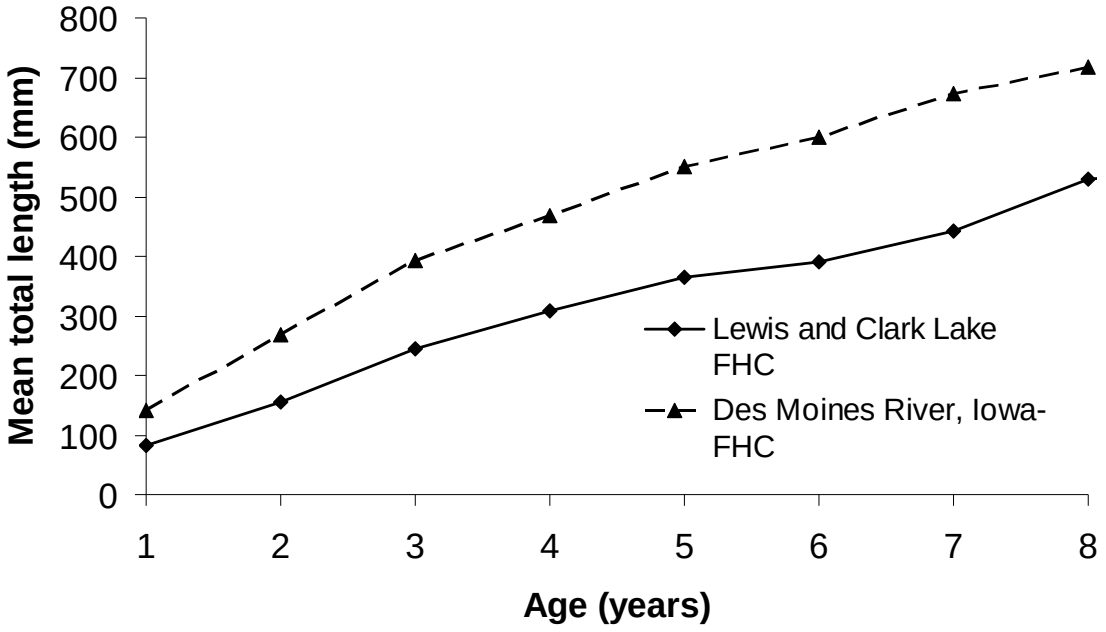

Figure 12. Mean back-calculated length at age for flathead catfish sampled from Lewis and Clark Lake, South Dakota, 2006 and the Des Moines River, Iowa, as determined from pectoral spines. Des Moines River Iowa- Mayhew 1969.

Missouri River

Electrofishing

Largemouth bass population parameters

A total of 13 largemouth bass were sampled near Springfield, South Dakota, with lengths ranging from 117-428 mm (Figure 13). Size structure from 2006 sampling was similar to 2005, with the majority of the largemouth bass sampled above stock length. Mean CPUE for largemouth bass was 15.7 fish/h; similar to the 2005 value of 9 fish/h (Table 21). Relative weight for quality to preferred length largemouth bass was 102, down from 106 in 2005.

Age distribution for largemouth bass is depicted in Table 22. Largemouth bass ranged in age from 1 to 10, with a mean age of 6.5. Age 3 and age 4 largemouth bass comprised 64 percent of all largemouth bass aged in 2005, while only one percent of the largemouth bass sampled in 2006 were age 3 and age 4.

Largemouth bass annual survival, as estimated from catch curve analysis (Ricker 1975) of 2005-2006 pooled data was 97 percent, with an –z value of 0.03. Estimated annual survival has increased for three consecutive years; however, this is based on a low sample size.

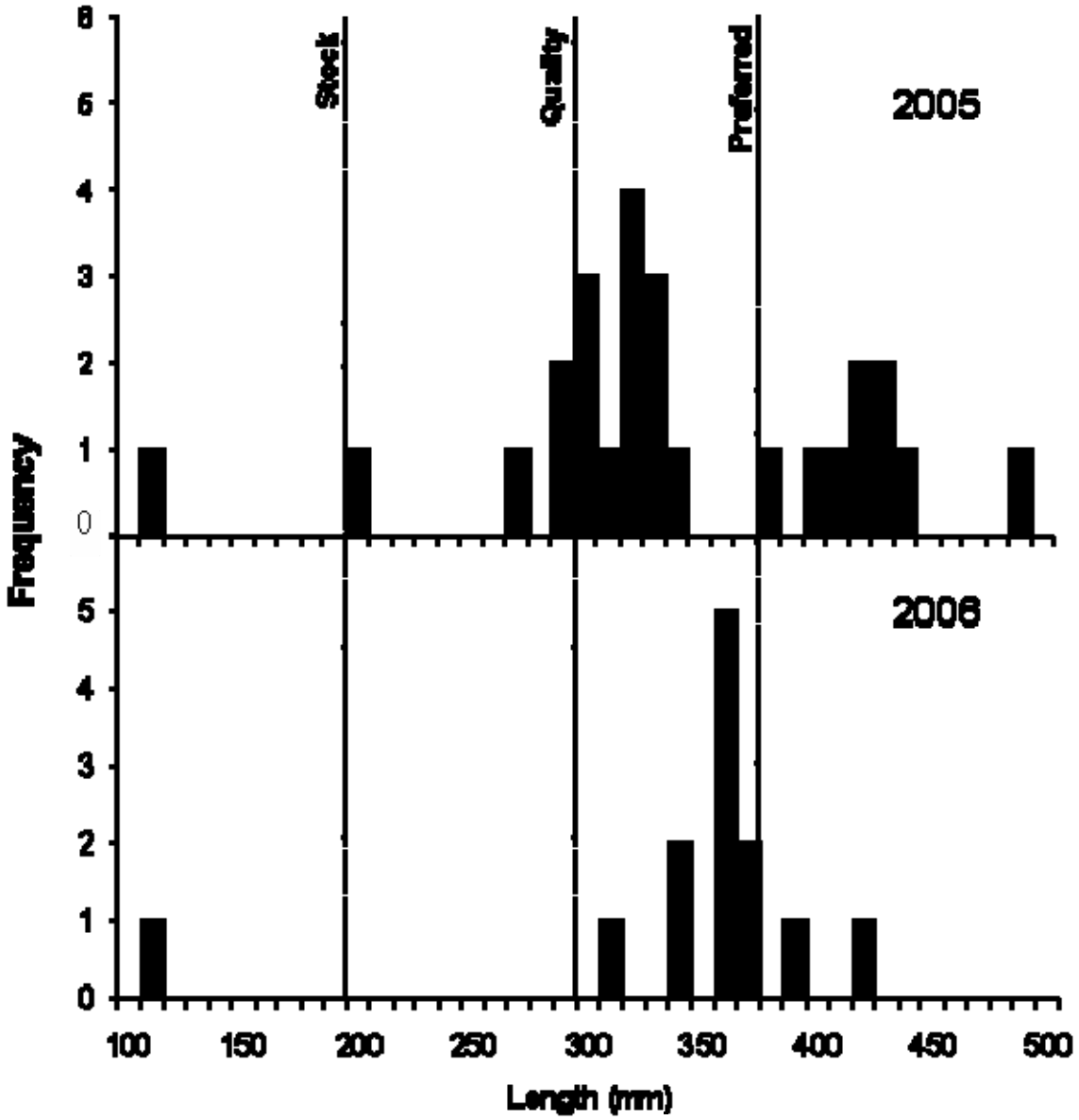

Figure 13. Length frequency of largemouth bass sampled by electrofishing the Missouri River near Springfield, South Dakota, May 2005 and 2006.

Table 21. Spring electrofishing catches (fish/h) for largemouth bass from the Missouri River near Springfield, SD, 2000-2006. 80% confidence interval (±) in parenthesis.

Year	CPUE (fish/h)	PSD	RSD-P	RSD-M	Relative weight S-Q	Q-P	P	N
2000	15 (8.3)	44	19	0	107 (3.6)	111 (9.8)	108 (18)	16
2001	9.8 (4.5)	43	43	0	92 (5.2)	99 (--)	101 (12)	7
2003	21.2 (11.7)	57	30	0	107 (4.1)	103 (2.1)	103 (7.6)	23
2004	20 (5.1)	77	47	0	98 (3.5)	99 (4.0)	96 (3)	30
2005	9 (4.7)	84	36	0	108 (4.6)	106 (2.7)	101 (3)	25
2006	15.7 (9.2)	100	16	0	-	102 (2.8)	99 (15)	12

Table 22. Age distribution of largemouth bass collected by electrofishing the Missouri River near Springfield, SD, 2000-2006, as determined from scales.

Year class	Age 1	2	3	4	5	6	7	8	9	10	Mean
2000	23	12	4	0	1	3	0	0	1	0	2.1
2001	0	0	3	1	0	1	1	1	0	0	4.9
2003	43	14	5	2	2	4	3	2	1	0	2.3
2004	5	3	7	6	5	9	5	2	0	0	4.4
2005	1	0	7	9	0	2	3	3	0	0	4.6
2006	1	1	1	0	0	2	2	4	1	1	6.5

Smallmouth bass population parameters

A total of 27 smallmouth bass were sampled in the Gavins Point Dam tail water area with lengths ranging from 102-358 mm. Mean CPUE for smallmouth bass was 35 fish/h; down from 78 fish/h in 2005 (Table 23). Smallmouth bass PSD and RSD-P increased from 2005 to 2006; however, this is based on a low sample size (N=27). Length frequency for smallmouth bass is shown in Figure 14. Relative weight for stock to quality and quality to preferred-length smallmouth bass in 2006 were similar to 2005 (Table 23).

Age distribution for smallmouth bass is depicted in Table 24. Smallmouth bass collected ranged in age from 1 to 5, with a mean age of 2.2. Age-1 and age-2 smallmouth bass comprised 76% of smallmouth bass aged in 2006.

Smallmouth bass annual survival, as estimated from catch curve analysis (Ricker 1975) of 2005-2006 pooled data was 29%, with an –z value of 1.22. Estimated annual survival is generally 20-30%.

Table 23. Catch per unit effort (CPUE), proportional stock density (PSD), relative stock density for preferred and memorable-length fish (RSD-P, RSD-M), and relative weight of stock-quality (S-Q), quality-preferred (Q-P), and preferred-length (P) smallmouth bass sampled by spring electrofishing the Missouri River below Gavins Point Dam, 2001-2006. N equals the number of stock-length fish sampled. 80% confidence interval (±) in parenthesis.

	CPUE				**Relative weight**			
Year	**(fish/h)**	**PSD**	**RSD-P**	**RSD-M**	**S-Q**	**Q-P**	**P**	**N**
2001	44 (22)	4	4	0	105 (3.4)	-	102 (--)	28
2002	53 (97)	0	0	0	96 (1.9)	-	-	16
2003	34 (15)	4	4	0	88 (2)	-	90 (--)	27
2004	66 (74)	8	0	0	97 (2.1)	96 (7.4)	-	42
2005	78 (84)	11	0	0	92 (1)	90 (5)	-	70
2006	35 (33)	29	4	0	93 (1.7)	93 (5)	-	27

Table 24. Age distribution of smallmouth bass sampled by electrofishing the Missouri River below Gavins Point Dam, 2001-2006, as determined from scales.

Year class	Age					
	1	2	3	4	5	Mean
2001	11	31	1	0	1	1.8
2002	13	18	4	0	0	1.7
2003	3	24	5	0	1	2.2
2004	1	29	10	3	0	2.3
2005	1	50	24	2	0	2.4
2006	7	18	3	3	2	2.2

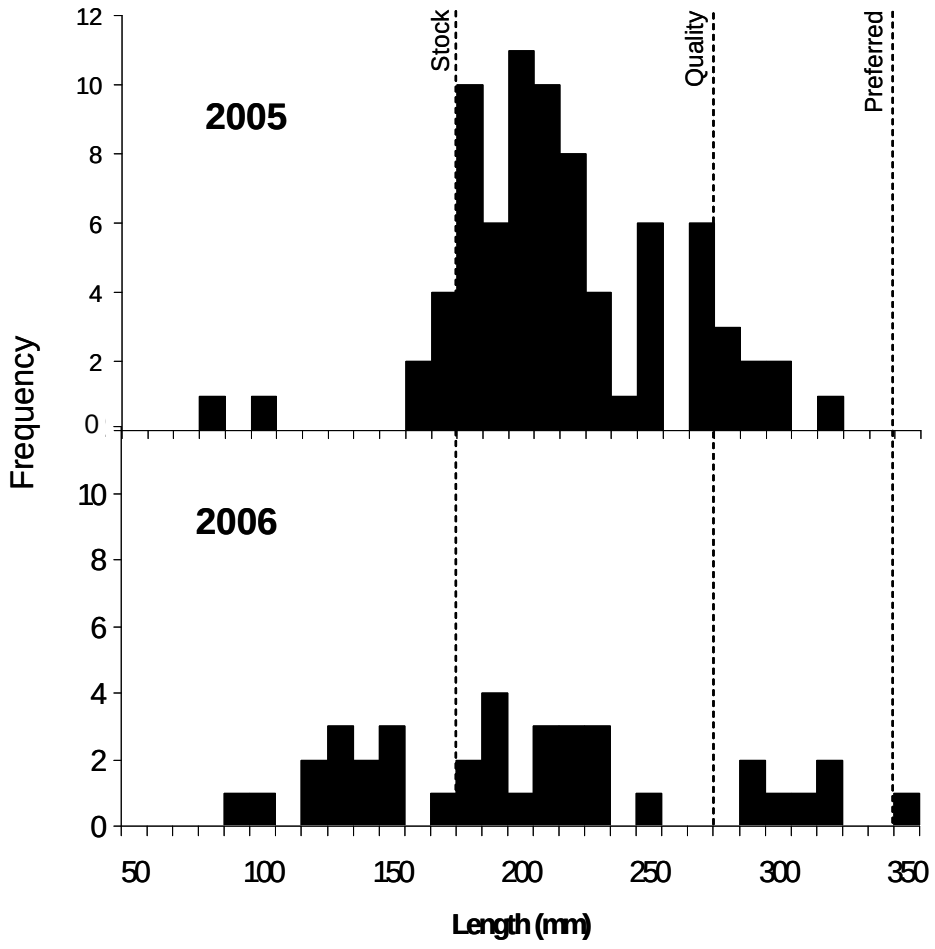

Figure 14. Length frequency of smallmouth bass sampled by electrofishing the Missouri River below Gavins Point Dam in May 2006.

Hoop Nets

Channel catfish population parameters

A total of 36 channel catfish were sampled from the Niobrara River delta area with hoop nets during 2006. Lengths of channel catfish collected ranged from 218-615 mm (Figure 15). Mean CPUE for channel catfish in 2006 was 0.5 fish/net night; down from 2.5 fish/net night in 2003 (Table 25).

Table 25. Total annual hoop net catches (CPUE) of channel catfish from the Missouri River near Springfield, SD, 1999-2006. 80% confidence interval (±) in parenthesis

Year	Number of fish	Net-nights	CPUE	Mean length (mm)
1999	24	80	0.3 (0.1)	435 (41)
2000	99	88	1.1 (0.8)	304 (14)
2001	76	88	0.9 (0.9)	386 (27)
2002	140	86	1.6 (0.9)	277 (8.2)
2003	206	82	2.5 (1.2)	296 (8.4)
2006	36	80	0.5 (0.2)	287 (19)

Channel catfish PSD and RSD-P in 2006 were similar to 2005; however, this is based on a low sample size (N=36). Length frequency indicates the majority (69%) of the channel catfish sampled with hoop nets were below stock length (Figure 15). Relative weights for stock-to-quality and quality-to-preferred-length channel catfish were similar to previous years (between 80 and 90) (Table 26).

Table 26. Proportional stock density (PSD), relative stock density for preferred and memorable length fish (RSD-P, RSD-M), and mean relative weight (80% confidence intervals in parenthesis) for stock-quality (S-Q), quality-preferred (Q-P), and preferred-length (P) channel catfish sampled with hoop nets from the Missouri River near Springfield, SD, 1999-2006. N is sample size.

Year	PSD	RSD-P	RSD-M	Relative weight			N
				S-Q	Q-P	P	
1999	74	21	5	90 (7.3)	85 (4)	95 (7)	19
2000	24	8	0	84 (2)	84 (2)	85 (12)	40
2001	27	7	2	91 (2.2)	90 (7.7)	95 (3.7)	44
2002	22	2	0	84 (1.8)	79 (4.4)	68 (--)	46
2003	21	4	4	84 (1.4)	80 (3)	79 (--)	84
2006	27	9	0	81 (9.2)	84 (13)	75 (--)	36

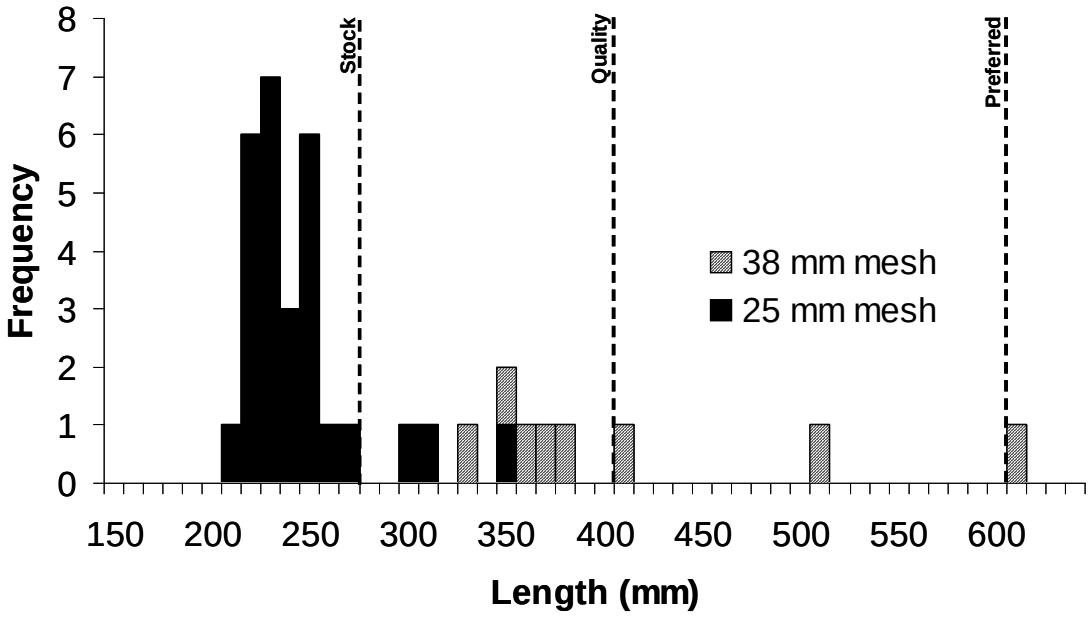

Figure 15. Length frequency of channel catfish sampled in hoop nets from the Missouri River in August of 2006.

Growth for Lewis and Clark Lake channel catfish from 2006 sampling was similar to that of channel catfish from Lake Francis Case, 2005, from age 1 through age 6. From age 6 through age 10, Lewis and Clark Lake channel catfish grew faster than their Lake Francis Case counterparts (Figure 16).

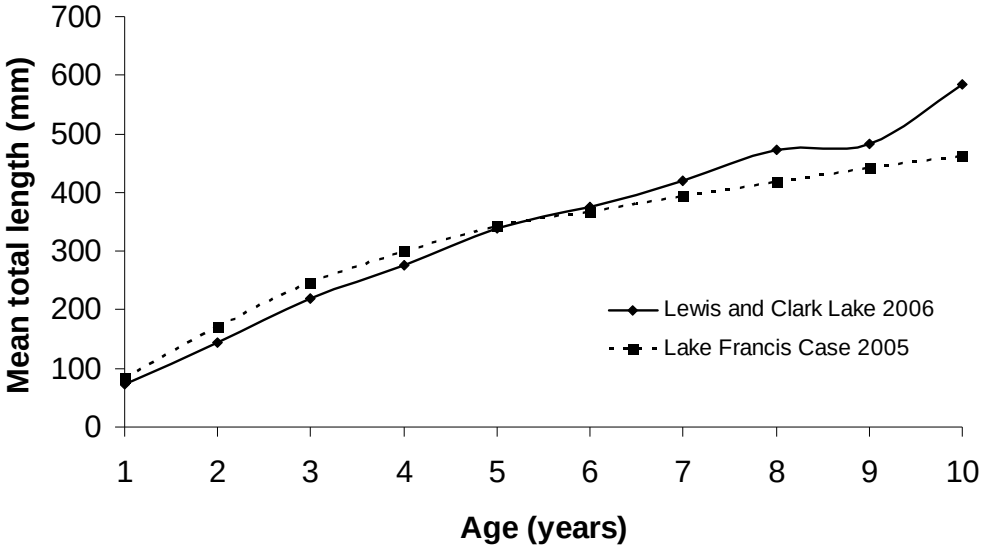

Figure 16. Mean back-calculated length at age for channel catfish sampled in hoop nets from Lewis and Clark Lake, South Dakota, 2006, and Lake Francis Case, 2005, as determined from pectoral spines.

Age distribution for channel catfish is depicted in Table 27. Channel catfish ages ranged from 2 to 10, with a mean age of 3.4. Age-2 channel catfish comprised 59% of channel catfish in the 2006 sample.

Table 27. Age distribution of channel catfish sampled in hoop nets from the Missouri River, 2000-2006, as determined from pectoral spines.

Year class	**Age**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Mean**
2000	0	48	20	6	14	1	0	0	1	0	0	0	0	0	2.9
2001	1	3	29	16	10	7	4	2	1	2	0	0	1	0	4.4
2002	0	72	19	25	16	3	1	1	0	1	1	1	0	0	3.2
2004	0	27	32	7	2	2	2	2	1	3	2	0	0	1	3.8
2006	0	20	4	2	3	1	1	1	1	1	0	0	0	0	3.4

Channel catfish annual survival, as estimated from catch curve analysis (Ricker 1975) of 2006 data was 29%, with an –z value of 1.22. Estimated annual survival is typically 20-30%.

Size structure and abundance of channel catfish sampled in the Niobrara River delta area is variable among years and sampling locations. Habitat characteristics at a given location can change greatly between years (e.g., shifting sandbars/braided channels) and has lead to difficulty in maintaining standard sampling sites. This could be causing variability in fish population structure index values for channel catfish hoop net surveys.

Seines

Five species of age-0 fishes and adult littoral species were collected with seines near Springfield, SD during July of 2006 (Table 28). All species sampled have been previously reported from Lewis and Clark Lake. Emerald shiner and gizzard shad were the most abundant species sampled during 2006.

Table 28. Catch per unit effort (fish/seine haul) for seining surveys in the Missouri River near Springfield, South Dakota, 2002-2006. Standard error is in parenthesis. *includes both age-0 and adults.

Species	2002	2003	2004	2005	2006
Bigmouth buffalo	-	-	-	-	-
Black crappie	0.2(0.2)	-	-	-	t
Bluegill	t	-	-	0.2(0.1)	-
Bluntnose minnow*	-	-	-	0.2(0.1)	-
Emerald shiner*	0.6(0.6)	1.3(0.4)	4.0(2.9)	0.9(0.2)	0.6 (0.4)
Common carp	0.1(0.1)	-	-	-	-
Gizzard shad	-	-	t	3.1(2.5)	0.55 (0.3)
Hybognathus sp.	t	-	-	-	-
Johnny darter*	0.6(0.4)	0.1(0.1)	-	-	-
Largemouth bass	1.6(0.6)	0.8(0.4)	0.4(0.2)	0.80.3)	t
Rock bass	-	-	t	-	-
Red shiner*	-	-	-	0.1(0.1)	-
River carpsucker	0.4(0.2)	0.1(0.1)	t	0.4(0.2)	0.1 (0.1)
Sauger	0.2(0.2)	-	-	-	-
Shorthead redhorse	-	-	-	-	-
Smallmouth bass	0.6(0.2)	0.4(0.2)	0.1(0.1)	0.4(0.2)	-
Smallmouth buffalo	-	-	-	-	-
Spotfin shiner	0.2(0.2)	0.7(0.3)	0.3(0.1)	0.4(0.2)	-
Spottail shiner*	-	-	-	-	-
Walleye	0.1(0.1)	0.2(0.1)	t	0.2(0.1)	-
White bass	t	-	t	0.2(0.1)	-
White crappie	0.2(0.1)	0.1(0.1)	-	0.2(0.1)	-
Yellow perch	-	-	t	-	-

RARE FISH OBSERVATIONS

No state threatened or endangered fishes were observed during sampling activities for fish population surveys on Lewis and Clark Lake or the Missouri River upstream and downstream of Lewis and Clark Lake during 2006.

CONCLUSIONS

Many of the species-specific management objectives were met during 2006. Three mature year classes of walleye were present (2001-2004). Proportional stock density was above the management objective range of 30 to 60, while the RSD-P management objective of 10 was not met. Walleye CPUE for fall gill netting efforts was also above the management objective of 4.0 fish/net night. Relative weights in 2006 were within the typical range for walleye in this reservoir (80-90).

Age-0 walleye production is currently indexed through standard fall gill net assessments. Fall night electrofishing can provide a useful index to age-0 and age-1 walleye abundance (Serns 1982, 1983), while others have indicated utility of this sampling method could be based upon water temperatures at the time of sampling (Borkholder and Parsons 2001). Also, Hansen et al. (2004) indicated that CPUE from fall night electrofishing should only be used as a crude index to abundance. Utility of this sampling method should be considered for indexing age-0 walleye in the future on Lewis and Clark Lake.

Three mature year classes of sauger were also sampled during 2006. Sauger PSD and RSD-P were well above management objective ranges of 30-60 for PSD and 10 for RSD-P. Sauger CPUE for fall gill netting efforts did not meet the management objective of 6 fish/net night. Relative weights were within the typical range for sauger in this reservoir (80-90).

Many sauger populations have experienced declines during the last several decades in some areas leading to listing as a 'species of concern' (McMahon and Gardner 2001; Pegg et al. 1996). The sauger population in Lewis and Clark Lake appears to be one of the most stable in their range. Niobrara River delta habitat is expanding annually, increasing the amount of habitat resembling the pre-dam Missouri River with increases in channel braiding, backwater area and turbidity. This expanding habitat should help enhance the current sauger population in Lewis and Clark Lake. Hybridization of walleye and sauger is relatively high when compared with other reservoirs (Graeb 2006). Loss of pure sauger from this stretch of Missouri River could greatly impact this sauger fishery.

Channel catfish were again one of the most commonly sampled species during fall gill netting efforts in 2006. Management objectives of 30 to 60 for PSD and 10 for RSD-P were both met. Channel catfish CPUE also met the management objective range of 3

fish/net night. Channel catfish continue to be one of the most underutilized resources in the Missouri River system in South Dakota.

Largemouth bass management objectives of 30 to 60 for PSD and 10 for RSD-P, as well as CPUE of 10 fish/h were met during 2006. Smallmouth bass CPUE continues to be well above the management objective of 10 fish/h while PSD and RSD-P were below the management objective range of 30 to 60 and 10, respectively, indicating a moderate to high abundance smallmouth bass population with a small size structure; however, population parameters are based on low sample sizes. Gilliland (1985) suggested that a sample size of 50 was insufficient for largemouth bass, while a sample size of 150 mirrored that of 500 when analyzing size structure. With sample sizes generally below 50, an increase in sampling effort may be necessary in the future for largemouth bass and smallmouth bass in Lewis and Clark Lake for better representation of population structure.

Flathead catfish CPUE for 2006 was similar to that of 2005, while PSD declined from 39 in 2005 to 10 in 2006. Preferred length and larger flathead catfish were absent from the 2006 sample. Condition of flathead catfish was similar to previous sampling with relative weight values between 85 and 95.

Currently, an objective in the Missouri River Fisheries program strategic plan addresses angler days and harvest rates for all waters in the Missouri River system in South Dakota. The Lewis and Clark Lake strategic plan also contains objectives for angler days and fish harvest rates, verifying the importance of these metrics to fisheries management. While Lewis and Clark Lake does not annually provide as many angler days or harvest as other Missouri River reservoirs, it is an important fishery for the people of southeast South Dakota as well as the surrounding states. With management objectives dealing with creel data, annual creel surveys should be performed on Lewis and Clark Lake.

Reservoir aging, more specifically sedimentation and delta formation, is an ongoing issue in Missouri River reservoirs. As these systems age, the amount of sediment present increases, leading to decreased capacity for water storage and access issues for recreational use. The Niobrara River delta on Lewis and Clark Lake has been expanding and will continue to expand over time. The full impact of this novel habitat on the fish communities present in Lewis and Clark Lake is yet unknown. Research has shown that fish habitat use for certain species has changed over time as the habitats themselves have changed. As this process continues to occur, fish locations and utilization of various habitats will undoubtedly change as well. Increases in habitat diversity through delta formation may harbor greater species diversity than reservoir and riverine habitats and provide increased habitat for various native species.

MANAGEMENT RECOMMENDATIONS

- Conduct annual angler use and harvest surveys
- Update Lewis and Clark Lake strategic plan
- Acquire additional information on species diversity in the Niobrara River delta
    - Utilize Federal Aid projects to aid in sport fish management in Lewis and Clark Lake
    - Identify future research needs in the Niobrara River delta that will aid in sport fish management
- Evaluate sampling strategy for all species in Lewis and Clark Lake
    - Determine if fall night electrofishing could provide an index of abundance for age-0 and age-1 walleye in Lewis and Clark Lake
    - Determine alternate sampling methods or increase effort for smallmouth/largemouth bass sampling
    - Determine utility of push trawl for reservoir and delta sampling
- Increase sampling effort or add new sampling techniques where necessary
- Consider effects of hybridization of walleye and sauger in Lewis and Clark Lake

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APPENDICES

Appendix 1. 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*	BLG
Blue sucker	*Cycleptus elongatus*	BSR
Bluntnose minnow	*Pimephales notatus*	BLM
Brassy minnow	*Hybognathus hankinsoni*	BRM
Buffalo spp.	*Ictiobus spp.*	--
Channel catfish	*Ictalurus punctatus*	CCF
Common carp	*Cyprinus carpio*	COC
Common shiner	*Notropis cornutus*	COS
Creek chub	*Semotilus atromaculatus*	CRC
Emerald shiner	*Notropis atherinoides*	EMS
Fathead minnow	*Pimephales promelas*	FHM
Flathead catfish	*Pylodictis olivaris*	FHC
Flathead chub	*Platygobio gracilis*	FLC
Freshwater drum	*Aplodinotus grunniens*	FRD
Gizzard shad	*Dorosoma cepedianum*	GZD
Golden shiner	*Notemigonus crysoleucas*	GOS
Goldeye	*Hiodon alosoides*	GOE
Green sunfish	*Lepomis cyanellus*	GRS
Johnny darter	*Etheostoma nigrum*	JOD
Largemouth bass	*Micropterus salmoides*	LMB
Northern redhorse	*Moxostoma macrolepidotum*	NOR
Orangespotted sunfish	*Lepomis humilis*	ORS
Paddlefish	*Polyodon spathula*	PAH
Pallid sturgeon	*Scaphirhynchus albus*	PLS
Rainbow smelt	*Osmerus mordax*	RBS
Red shiner	*Notropis lutrensis*	RES
Redfin shiner	*Lythrurus umbratilis*	RES

Appendix 1. Continued.

Common name	Scientific name	Abbreviation
River carpsucker	*Carpiodes carpio*	RIC
Rock bass	*Ambloplites rupestris*	RKB
Sauger	*Sander canadense*	SAR
Sand shiner	*Notropis stramineus*	SAS
Shorthead redhorse	*Moxostoma macrolepidotum*	SHR
Shortnose gar	*Lepisosteus platostomus*	SNG
Shovelnose sturgeon	*Scaphirhynchus platorynchus*	SHS
Silverstripe shiner	*Notropis stilbius*	SIS
Smallmouth bass	*Micropterus dolomieu*	SMB
Smallmouth buffalo	*Ictiobus bubalus*	SAB
Spotfin shiner	*Notropis spilopterus*	SFS
Spottail shiner	*Notropis hudsonius*	SPS
Walleye	*Sander vitreus*	WAE
Western silvery minnow	*Hybognathus argyritis*	WSM
White bass	*Morone chrysops*	WTB
White crappie	*Pomoxis annularis*	WHC
Yellow perch	*Perca flavescens*	YEP

Appendix 2. Standard weight equations used for relative weight calculations. Length is in millimeters and weight is in grams.

Species	Equation
Channel catfish	$Log_{10}(Ws)= 3.2494*Log_{10}(TL)-5.800$
Flathead catfish	$Log_{10}(Ws)= 3.082*Log_{10}(TL)-5.156$
Largemouth bass	$Log_{10}(Ws)= 3.19*Log_{10}(TL)-5.316$
Sauger	$Log_{10}(Ws)= 3.187*Log_{10}(TL)-5.492$
Smallmouth bass	$Log_{10}(Ws)= 3.200*Log_{10}(TL)-5.329$
Walleye	$Log_{10}(Ws)= 3.180*Log_{10}(TL)-5.453$