SOUTH DAKOTA FISHERIES

ANNUAL FISH POPULATION SURVEYS ON LEWIS AND CLARK LAKE, SOUTH DAKOTA, 2007

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ANNUAL FISH POPULATION SURVEYS
ON
LEWIS AND CLARK LAKE, SOUTH DAKOTA, 2007

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American Creek Fisheries Station
South Dakota Department of Game, Fish and Parks

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PREFACE

Information collected from Lewis and Clark Lake during 2007 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 2007 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 2007, 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) also met 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 2007 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 was above 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.

Smallmouth bass CPUE was well above the management objective of 10 fish/hour while PSD was below the management objective ranges of 30-60; however RSD-P was above the objective range of 10 in 2007.

Emerald shiner catch rates for shoreline seining survey were the highest for any prey species in 2007, followed by gizzard shad. These species remain the most numerically important prey species in Lewis and Clark Lake.

Walleye, channel catfish, and sauger were the most frequently sampled fish species in gill nets from Lewis and Clark Lake in 2007.

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

min .... minutes

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 ON LEWIS AND CLARK LAKE, SOUTH DAKOTA, 2007

INTRODUCTION

Lewis and Clark Lake was formed by the construction of Gavins Point Dam, which was completed in 1955. Lewis and Clark Lake is one of four Missouri River reservoirs in South Dakota and is the lowermost of the four. The main purposes of dam construction along the Missouri River was to lessen flooding in the lower basin, provide flows for navigation in the unimpounded portion of the river, provide irrigation, and generate power. Recreation was a small part of the original purpose of the Missouri River reservoirs, but became the largest financial contributor to the State of South Dakota. Based on the $61/trip estimate (U.S. Department of the Interior, Fish and Wildlife Service, and U.S. Department of Commerce, Bureau of the Census 2003), reservoir fisheries contribute over 25 million dollars annually to the economy of South Dakota. The four reservoirs produce over 350,000 angler days annually (Lott et al. 2006, Lott et al. 2007, Sorensen and Knecht In prep), with Lewis and Clark Lake contributing over 30,000 angler days in 2005. Lewis and Clark Lake had an economic impact of 2.51 million dollars in 2005.

Sedimentation brought into the system from the Niobrara River continues to create new habitats. These habitats contain braided channels and backwater areas that increase water temperatures and turbidity. These factors have resulted in a change in fish habitat use in Lewis and Clark Lake. Graeb (2006) showed a shift in the sauger spawning location from below Fort Randall Dam to within the Niobrara River delta. As the limitation of sediment transport continues, there will likely be more changes in fish communities and their use of habitats.

Monitoring and management of the fish communities of Lewis and Clark Lake has taken place since 1955, with annual surveys conducted for the past two decades. Although little is known about the effects of Niobrara River sedimentation on the biota of Lewis and Clark Lake, continuation of research and management will aid in addressing future concerns dealing with the fishery of Lewis and Clark Lake.

This report summarizes data collected from Lewis and Clark Lake during 2007 and suggests 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 both species.
- 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.

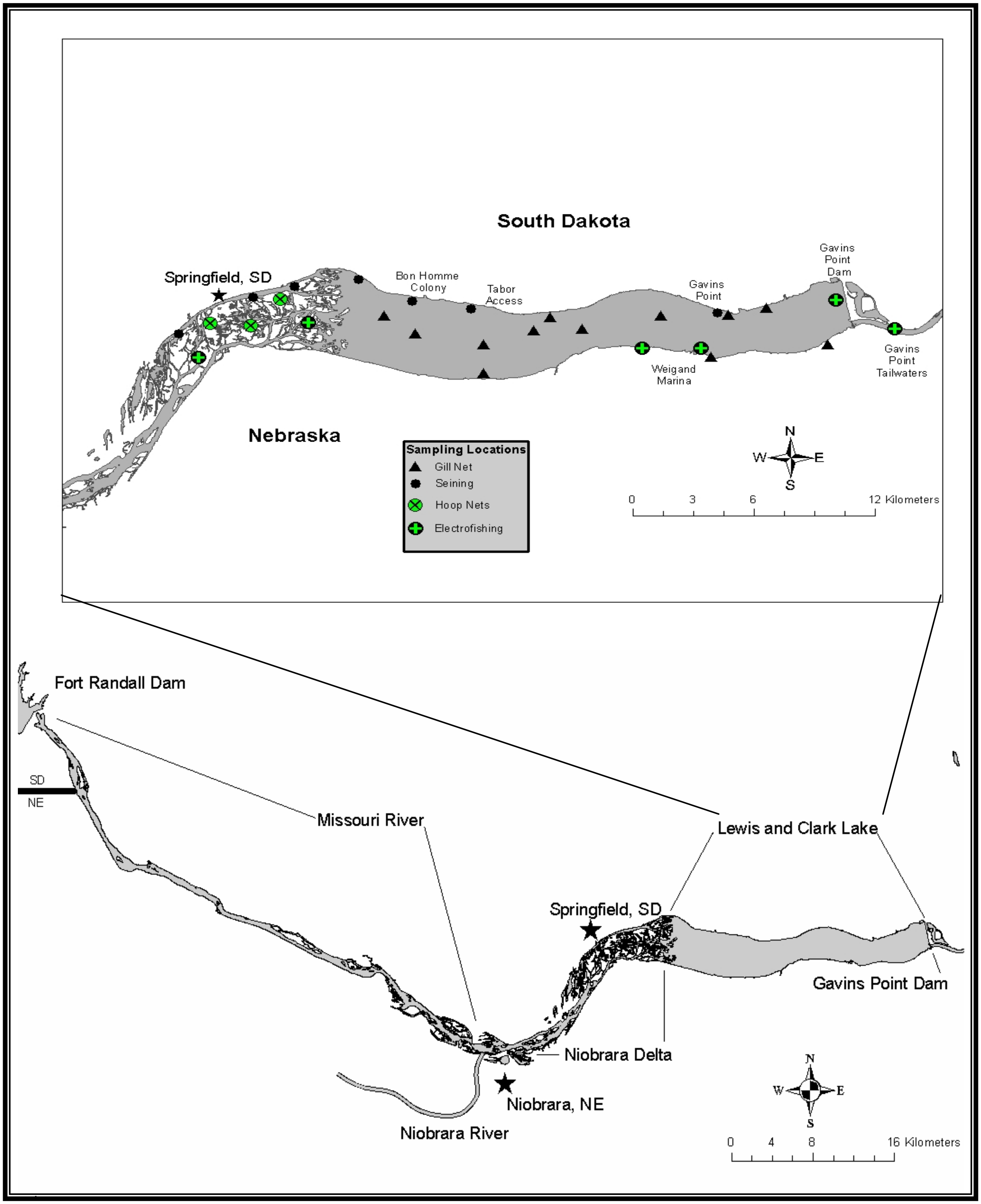

Figure 1. Lewis and Clark reservoir system, Fort Randall Dam to Gavins Point Dam, South Dakota.

METHODS

Fish populations in the Lewis and Clark reservoir system were sampled by gill netting, hoop netting, seining and electrofishing during 2007. 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, 2007.

	Lewis and Clark Lake				**Missouri River**		
Method	*Gill Net*	*Electrofishing*		*Seine*	*Electrofishing*	*Seine*	*Hoop net*
Target species	All	SMB	FCF	All	SMB	All	CCF
Effort	12 net nights	60 min	80 min	8 hauls	60 min	10 hauls	78 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 18 and 19, 2007. 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 bag 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 18, 2007, 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 29, 2007, 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 15 and 21, 2007, 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 80 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 28, 2007. 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 22, 2007, 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).

Smallmouth bass were collected by electrofishing near Springfield, South Dakota on May 29, 2007, 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. 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).

Due to low water conditions access to backwater areas was limited; therefore, largemouth bass were not sampled during May 2007.

Channel catfish were collected from the Niobrara River delta area using hoop nets on August 17 and 19, 2007. 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).

Smallmouth bass were also collected by electrofishing from the Fort Randall Dam tail water area on October 11, 2007 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).

Experimental Missouri River Sampling

Exploratory efforts were made to determine if percids could be sampled in the delta area and Missouri River portions of the system. Sampling near Springfield, South Dakota on September 17 and 19, 2007 was performed 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 five runs totaling 65 minutes. All species were measured for total length (mm) and weight (g) and scales were collected on sauger, smallmouth bass, largemouth bass, crappie, white bass, and walleye. Experimental multifilament gill nets were used to sample the Missouri River below Fort Randall Dam on September 18 and 20, 2007. Six nets were set in the area of each location. 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.

A push trawl was used to sample shallow water species near Springfield, South Dakota on September 17, 2007 with a boom mounted trawl operated by an electric winch system. The trawl is 2.2 meters across the top edge by 2.9 meters across the bottom edge. The sides are 0.6 meter high. The bag portion of the trawl is 3.1 meters long. All species were measured for total length (mm) and weight (g).

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

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. Length 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 using a low speed diamond blade saw and viewed under a microscope (Sneed 1951; Ashley and Garling 1980). Back-calculated lengths were also estimated 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 2007 was below the long-term average for the sixth consecutive year (Figure 2). Twenty-one species were sampled in 2007, an increase over the previous two years. Emerald shiner and age-0 gizzard shad were the most common species sampled in 2007 (Table 3). Gizzard shad CPUE decreased, while emerald shiner CPUE increased for the first time in two years. Freshwater drum was the third most common species sampled, while age-0 walleye catch per unit effort was below one for the third consecutive year.

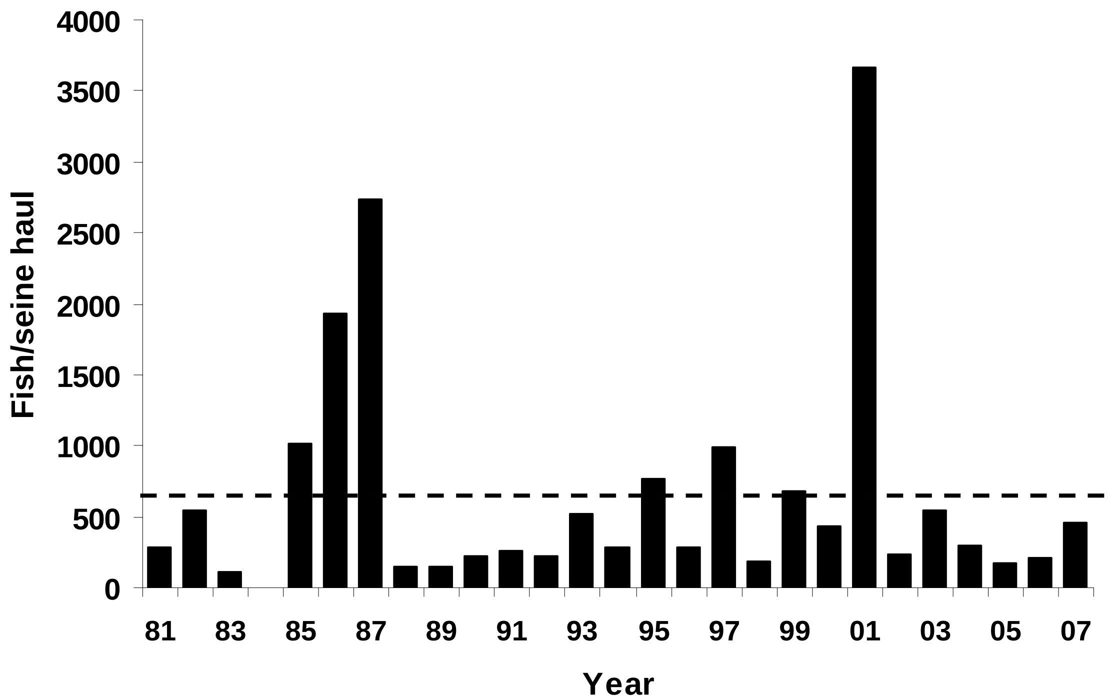

Figure 2. Mean number of fish captured per seine haul from Lewis and Clark Lake, South Dakota, 1981-2007. Dotted line represents long-term mean catch per haul.

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.

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.

Table 3. Catch per unit effort (fish/seine haul) for seining surveys at Lewis and Clark Lake, South Dakota, 1956 and 2002-2007. Standard error is in parenthesis. *includes both age-0 and adults. a-total number sampled

Species	***1956a***	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Bigmouth buffalo	91	<1 (0.1)	-	-	-	-	<1 (0.1)
Black bullhead	4	-	-	-	-	-	
Black crappie	191	<1 (0.1)	-	-	-	-	<1 (0.1)
Bluegill	15	<1 (0.1)	-	<1 (0.3)	0	<1 (0.4)	<1 (0.4)
Bluntnose minnow	-	-	-	-	1 (0.6)	-	-
Brassy minnow*	-	-	<1 (0.2)	-	-	-	-
Channel catfish	1	-	-	-	-	-	<1 (0.3)
Common carp	1951	-	<1 (0.1)	-	-	-	<1 (0.1)
Common shiner	-	-	6 (5)	-	-	-	-
Creek chub	-	-	-	<1 (0.9)	-	-	-
Emerald shiner*	34	190 (72)	412 (222)	207 (64)	65 (16)	53 (14)	375 (237)
Fathead minnow	24	-	-	-	-	-	-
Flathead catfish	-	-	-	-	-	-	<1 (0.1)
Freshwater drum	-	2 (2)	-	5 (3)	5 (2)	5 (2)	13 (8)
Gizzard shad	132	17 (15)	77 (53)	11 (7)	93 (30)	116 (35)	74 (38)
Golden shiner	-	-	-	-	-	-	-
Green sunfish	1	-	-	-	-	-	-
Hybopsis sp.	-	-	-	<1 (0.7)	-	-	-
Johnny darter*	-	<1 (0.2)	1 (0.7)	4 (3)	2 (1)	<1 (0.2)	<1 (0.4)
Largemouth bass	63	<1 (0.5)	<1 (0.4)	<1 (0.3)	<1 (0.2)	<1 (0.2)	<1 (0.3)
Northern redhorse	33	-	-	-	-	-	-
Orangespotted sunfish	2	-	-	-	-	-	<1 (0.1)
Rainbow smelt	-	-	-	-	-	-	-
Red shiner*	-	-	-	-	<1 (0.4)	<1 (0.2)	<1 (0.4)
Redfin shiner	48	-	-	-	-	-	-
River carpsucker	575	<1 (0.2)	<1 (0.2)	<1 (0.2)	0.0	<1 (0.1)	<1 (0.3)
Sauger	21	<1 (0.2)	<1 (0.1)	<1 (0.4)	<1 (0.1)	<1 (0.1)	-
Shorthead redhorse	-	-	-	<1 (0.1)	-	-	1.5 (0.8)
Shortnose gar	9	-	<1 (0.1)	-	-	-	<1 (0.5)
Silverstripe shiner	4	-	-	-	-	-	-
Smallmouth bass	-	1 (0.6)	2 (0.7)	3 (0.9)	1 (0.3)	2 (0.7)	1 (0.7)
Smallmouth buffalo	164	-	-	-	-	-	-
Spotfin shiner*	-	<1 (0.1)	12 (9)	2 (1)	4 (2)	<1 (0.1)	-
Spottail shiner*	-	3 (2)	12 (11)	19 (14)	1.1 (1)	<1 (0.3)	-
Walleye	-	3 (1)	1 (0.6)	2 (1)	<1 (0.4)	<1 (0.2)	<1 (0.2)
Western silvery minnow	1843	-	-	-	-	-	-
White bass	-	15 (10)	20 (16)	40 (19)	6 (2)	15 (6)	12 (9)
White crappie	196	1 (1)	<1 (0.1)	-	-	-	<1 (0.2)
Yellow perch	92	1 (0.7)	<1 (0.6)	3 (3)	<1 (0.1)	-	1.9 (1.7)

Gill Nets

Twelve species were captured with gill nets in 2007, down from fifteen species in 2006 (Table 4). Walleye were the most abundant species sampled in gill nets representing 35% of the total catch (Figure 3). Channel catfish and sauger were the second and third most abundant species sampled, respectively. Channel catfish exhibited the largest increase in CPUE from 3 in 2006 to 8 in 2007. Walleye, sauger, and gizzard shad also showed increases in CPUE in 2007. Catch per unit effort for all other species was similar to 2006 or decreased from 2006.

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, 2002-2007. Standard error is in parenthesis (no standard errors listed for 1956 sampling).

Species	***1956***	***1983***	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Bigmouth buffalo	0	0	0	0	<1 (0.1)	0	0	0
Black crappie	0	0	0	0	0	0	0	<1 (0.2)
Blue sucker	0.3	0	0	0	0	0	0	0
Channel catfish	6.3	1.7(0.7)	3 (1)	2 (1)	3 (1)	7 (8)	3 (1.8)	8 (2)
Common carp	9.3	0.5(0.2)	<1 (0.2)	<1 (0.1)	<1 (0.1)	1 (1.2)	<1 (0.1)	<1 (0.2)
Emerald shiner	0	0	0	0	<1 (0.1)	0	0	0
Flathead catfish	0	0	0	0	0	0	<1 (0.1)	0
Freshwater drum	0.8	6.1(3.4)	5 (1)	6 (1)	5 (1)	3 (9)	5 (1)	3.7 (1.1)
Gizzard shad	2.8	15.6(8)	6 (2)	3 (1)	3 (1)	11 (20)	1 (1)	3.5 (1.2)
Goldeye	5.3	0	0	0	0	<1(0.4)	0	0
Northern redhorse	0.8	0	0	0	0	0	0	0
Paddlefish	0	0	<1 (0.1)	0	0	0	0	0
Pallid sturgeon	0	0	<1 (0.1)	<1 (0.1)	0	0	0	0
River carpsucker	2.0	1.9(1)	2 (1)	<1 (0.2)	2 (1)	<1 (0.4)	1 (0.7)	1.1 (0.5)
Rock bass	0	0	0	0	0	0	<1 (0.1)	0
Sauger	1.5	10.1(1.5)	9 (1)	8 (2)	5 (1)	5 (4)	5 (0.8)	6.4 (1.8)
Shorthead redhorse	0	0	<1 (0.2)	<1 (0.4)	<1 (0.2)	2 (3)	<1 (0.4)	1.5 (0.5)
Shortnose gar	2.0	0	0	<1 (0.3)	<1 (0.1)	<1 (0.9)	<1 (0.1)	<1 (0.1)
Shovelnose sturgeon	1.5	0	0	0	0	0	0	0
Smallmouth buffalo	0	0	0	<1 (0.1)	<1 (0.1)	0	<1 (0.1)	<1 (0.1)
Spottail shiner	0	0	0	<1 (0.1)	0	0	<1 (0.1)	0
Walleye	0	10.1(1.7)	8 (1)	11 (1)	4 (1)	9 (9)	5 (0.6)	9 (2.1)
White bass	0	0.07(0.1)	<1 (0.2)	<1 (0.1)	<1 (0.1)	0	<1 (0.1)	0
White crappie	0.5	1.2(0.1)	2 (1)	<1 (0.6)	<1 (0.1)	0	<1 (0.1)	<1 (0.1)
Yellow perch	0.2	0.14(0.1)	0	<1 (0.1)	0	0	0	0

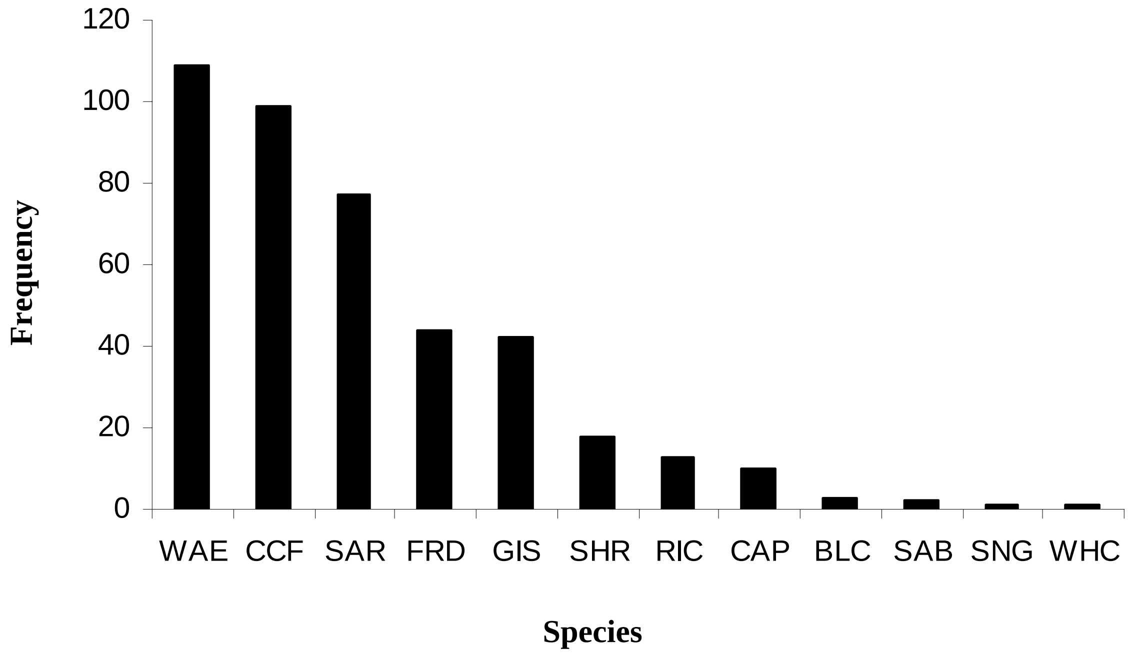

Figure 3. Number of fish caught, by species, for fish sampled with gill nets from Lewis and Clark Lake, 2007. Abbreviations used are defined in Appendix 1.

Walleye population parameters

Mean gill net CPUE for walleye 381-mm (15 inches) and longer was 4.8, increasing from 2006 (Table 5). In 2007, only 52% of walleye sampled in gill nets were longer than 381 mm compared to 78% in 2006. Walleye length frequency distribution reveals a large year-class of walleye near 180 mm in the 2007 gillnet sampling. Additional growth during 2007 moved many of the 2006 fish into quality class (Figure 4). 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. The high production combined with good recruitment in 2007 will help 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, 2002-2007. 80% confidence interval (±) in parenthesis.

Year	Sauger	Walleye
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)
2007	2.8 (1.1)	4.8 (1.7)

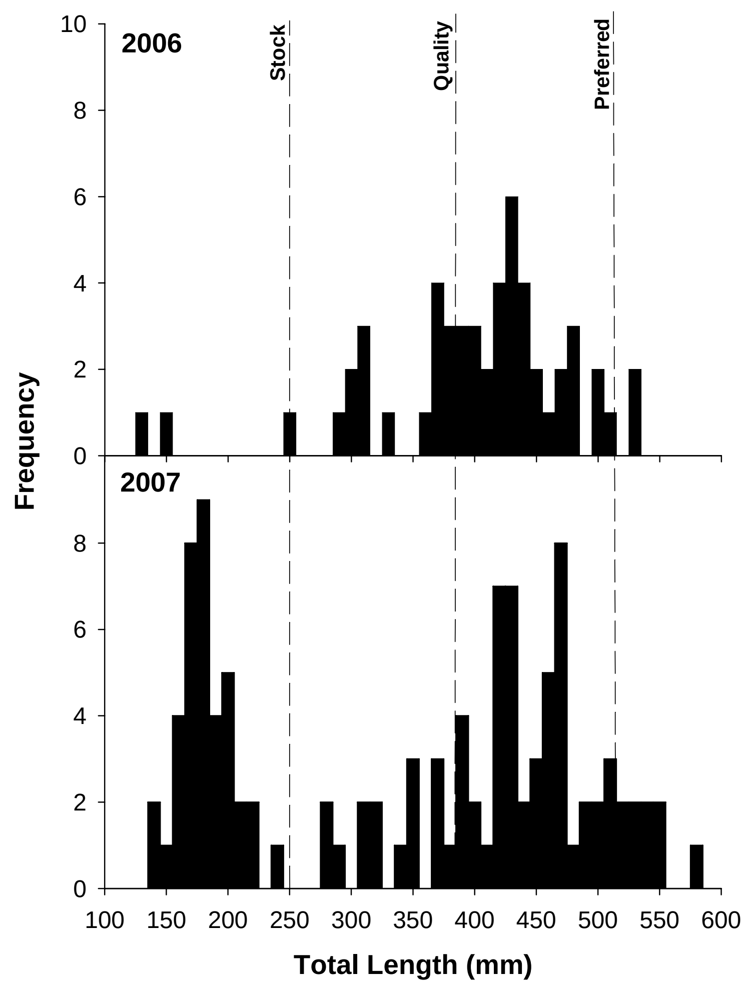

Figure 4. Length frequency for walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2006 and 2007.

Walleye PSD for 2007 was 80 and RSD-P was 17 compared with 75 and 6, respectively, during 2006 sampling (Table 6). Values for PSD in 2006 and 2007 were 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, 2002-2007.

Year	PSD	RSD-P	RSD-M	Sample Size
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
2007	80	17	0	109

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) completed 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. During this time period, gizzard shad abundance can be high enough that competition is not an issue for walleye and sauger. 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, 2002-2007. 80% confidence interval (±) in parenthesis.

Year	Stock-quality	Quality-preferred	Preferred-memorable	N
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
2007	88 (2.2)	91 (1.1)	87 (1.7)	71

Mean age of walleye dropped for the second year to 2.8 in 2007 (Table 8). Catch of Age-0 walleye dramatically increased in 2007 to 38. Growth of Lewis and Clark Lake walleye appears similar to the statewide and Missouri River average after age 1 (Figure 5).

Table 8. Age distribution of walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2002-2007, as determined from otoliths. Mean age excludes age-0 fish.

Year	Age													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Mean
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
2007	38	14	22	17	8	3	3	2	0	1	0	0	0	0	2.8

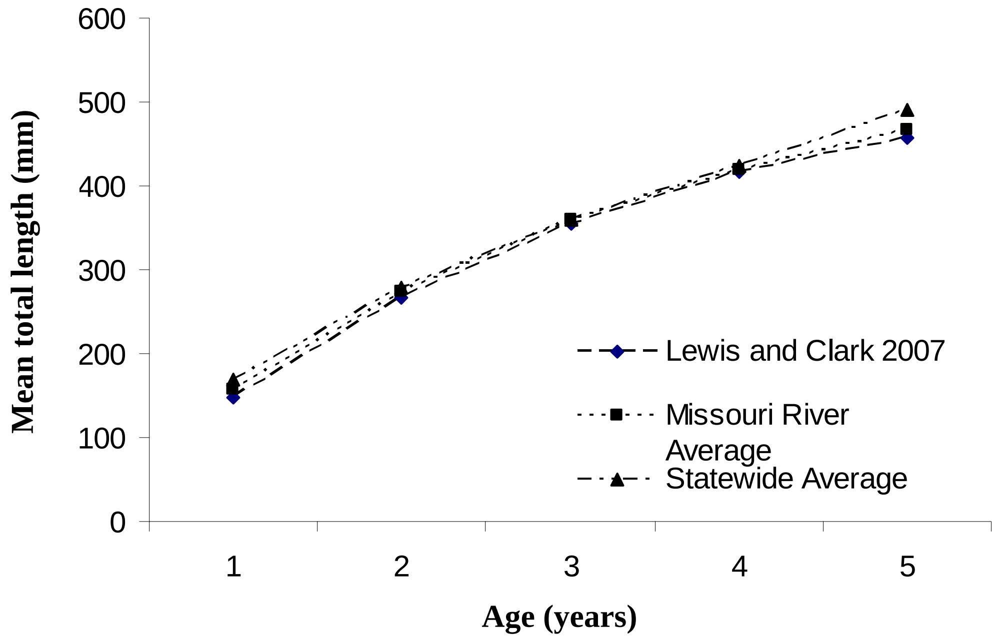

Figure 5. Mean back-calculated length at age for walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2007, as determined from scales. Statewide walleye average-Willis et al. 2005, Lake Francis Case 2006-Sorensen and Knecht In prep.

Annual survival for 2006-2007 pooled walleye data, as estimated from catch curve analysis (Ricker 1975) and excluding age-0 fish, was 68% (Table 9). Increased survival in the 2005-2006 pooled data may be attributed to drought conditions. Catch curve estimates for 2006-2007 are comparable to the previous years. 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, 2001-2007, as determined from scales.

Years	**s**	**a**	**-z**
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
2006-2007	0.68	0.31	0.382

Sauger population parameters

Mean gill net CPUE for sauger 381-mm (15 inches) and longer was 2.8 fish/net night, similar to 2006 (Table 5). Similar to walleye, a year-class of sauger was present in 2007 near 200 mm (Figure 6). Gill netting efforts in 2006 yielded no sauger in this size class; however, sauger near preferred size (380 mm) increased in 2007.

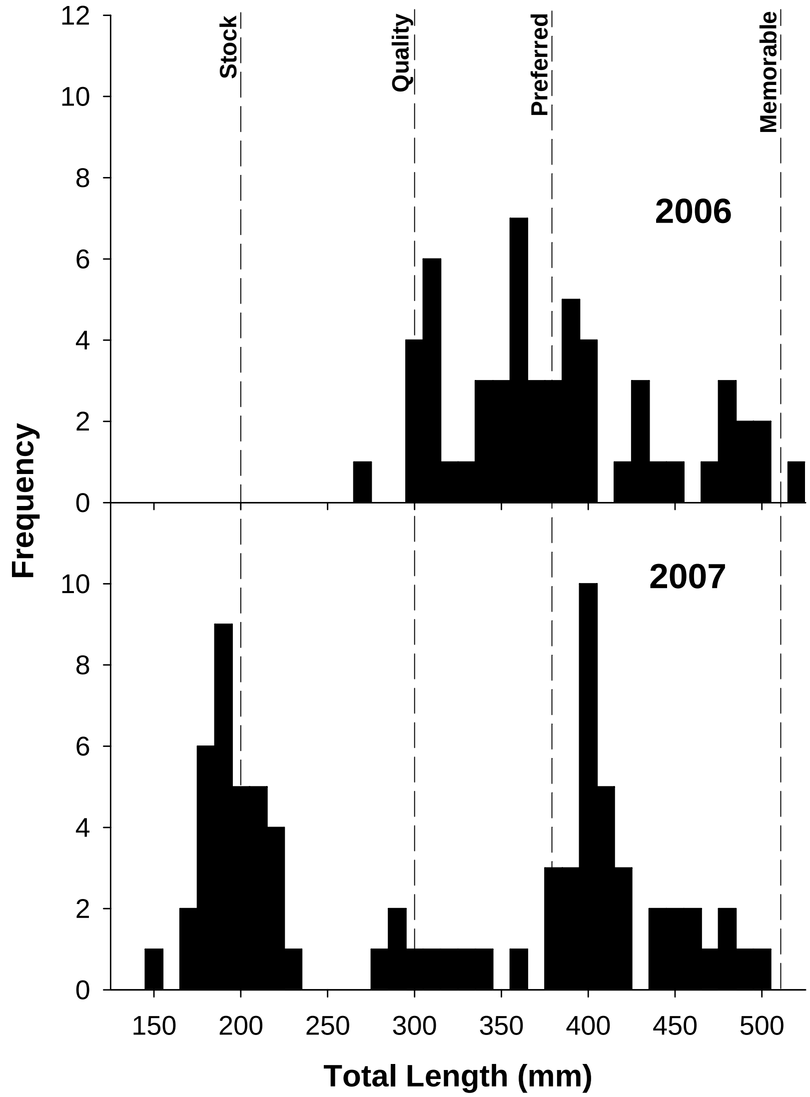

Figure 6. Length frequency for sauger collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2006 and 2007.

Sauger PSD for 2007 was 70 and RSD-P was 59, compared to 98 and 48, respectively, during 2006 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 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, 2002-2007.

Year	PSD	RSD-P	RSD-M	Sample Size
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
2007	70	59	0	77

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 remained similar to 2006 (Table 12). Age-2 sauger were the most prevalent sampled age class in 2006 and were evident again as age-3 in 2007. Sauger generally grow slower than walleye (Malison et al. 1990); however, growth rates of Lewis and Clark Lake sauger and walleye are both similar to the SD Missouri River walleye average (Figure 7). Increased sauger growth may 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, 2002-2007. 80% confidence interval (±) in parenthesis.

Year	**Stock-quality**	**Quality-preferred**	**Preferred-memorable**	**N**
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
2007	83 (1.8)	84 (2.7)	85 (1.1)	76

Table 12. Age distribution of sauger collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2002-2007, as determined from otoliths. Mean age excludes age-0 fish.

Year	**Age**									
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Mean**
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
2007	33	8	3	24	6	2	0	0	0	2.8

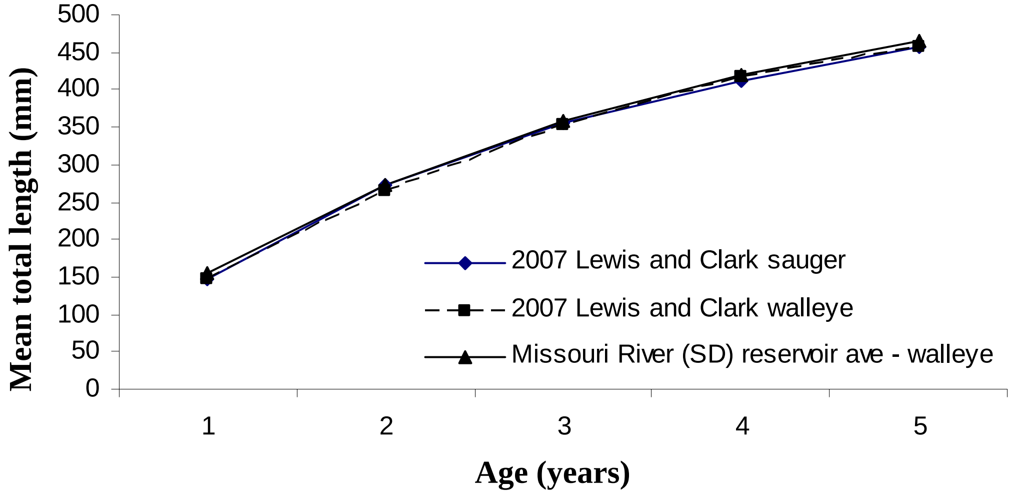

Figure 7. Mean back-calculated length at age for sauger and walleye collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2007, as determined from scales. Missouri River reservoir walleye average-Willis et al. 2005

Annual survival for 2006-2007 pooled sauger data was 53% (Table 13), as estimated from catch curve analysis (Ricker 1975) and excluding age-0 fish. Mortality for sauger in 2006-2007 was higher than that derived from 2005-2006 data at 47% compared to 35%.

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, 2001-2007, as determined from scales.

Years	s	a	-z
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
2006-2007	0.53	0.47	0.633

Channel catfish population parameters

A total of 99 channel catfish were sampled with lengths ranging from 157-781 mm. Mean gill net CPUE for channel catfish increased from 3 fish/net-night in 2006 to 8 fish/net night in 2007. Sixty-one percent of the channel catfish sampled in 2007 were above quality length (Figure 8).

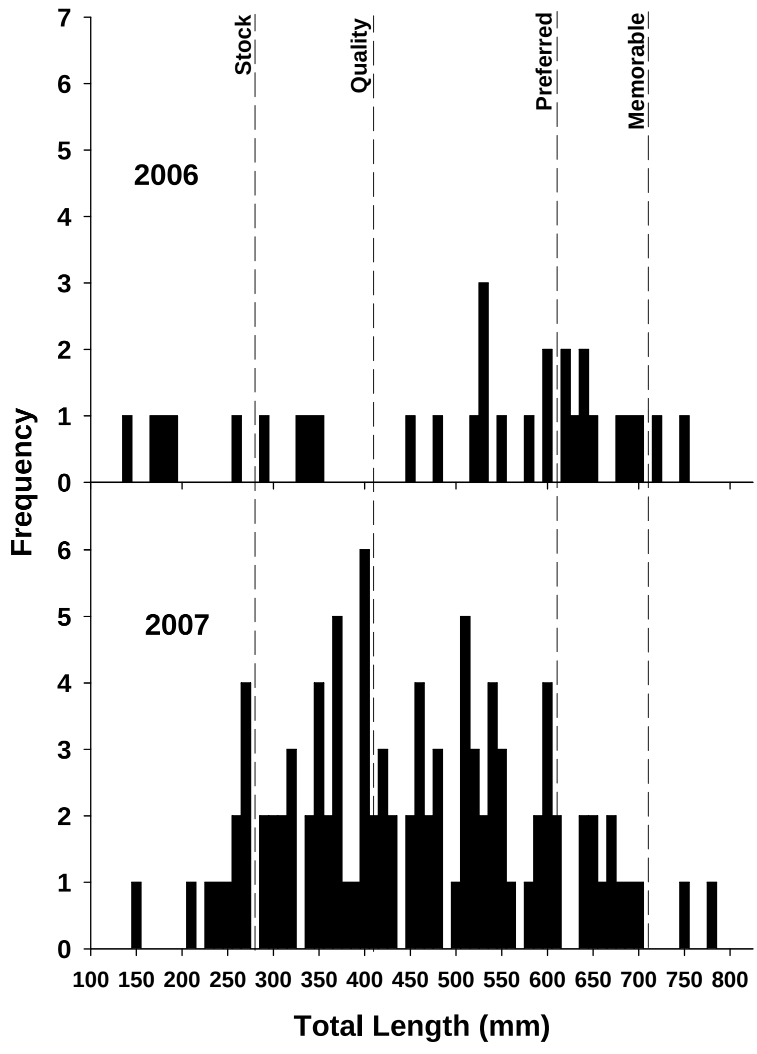

Figure 8. Length frequency for channel catfish collected in standard gill net surveys from Lewis and Clark Lake, South Dakota, 2006 and 2007.

Channel catfish PSD for the 2007 gill net sample was 67 and RSD-P was 16 compared with 84 and 44, respectively, during 2006 sampling (Table 14). Channel catfish PSD and RSD-P in the standard gill net survey have decreased for the first time in two years. In 2006, memorable length channel catfish were captured for the first time since 2003. Memorable length channel catfish were also sampled in 2007, resulting in an RSD-M of 2.

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, 2002-2007.

Year	**PSD**	**RSD-P**	**RSD-M**	**Sample Size**
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
2007	67	16	2	99

Relative weights for channel catfish are generally between 85 and 90. In 2007, mean W_r for quality-to-preferred-length channel catfish was 87 (Table 15). Estimated annual survival for 2006-2007 was 80%, similar to that estimated for 2005-2006 (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, 2002-2007. 80% confidence interval (±) in parenthesis.

Year	**Stock-quality**	**Quality-preferred**	**Preferred-memorable**	**N**
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
2007	86 (1.7)	87 (1.4)	90 (2.3)	88

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, 2002-2007, as determined from pectoral spines.

Years	s	a	-z
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
2006-2007	0.80	0.20	0.218

Electrofishing

<u>*Smallmouth bass population parameters*</u>

A total of 126 smallmouth bass were sampled near Gavins Point Dam with lengths ranging from 77-402 mm (Figure 9). Size structure from 2007 sample was similar to that of 2006, with the majority of the smallmouth bass sampled above stock length. Proportional stock density for smallmouth bass in 2007 was 23; up from 19 in 2006, while CPUE was similar to 2004 and 2005 (Table 17). Relative weight for stock to quality length smallmouth bass was 90, similar to 2006, while quality to preferred and preferred length smallmouth bass relative weights were down from 2006. Growth for smallmouth bass sampled near Gavins Point Dam in 2007 was similar to the statewide average for ages 1 to 5 (Figure 10). Age distribution for smallmouth bass was similar to that of 2006 sampling. Smallmouth bass ages ranged from age 1 to age 7, with age-2 fish comprising 50% of the sample (Table 18).

Smallmouth bass annual survival, as estimated from catch curve analysis (Ricker 1975) of 2006-2007 pooled data, was 45%, with a –z value of 0.79. 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. In 2007, 16% 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).

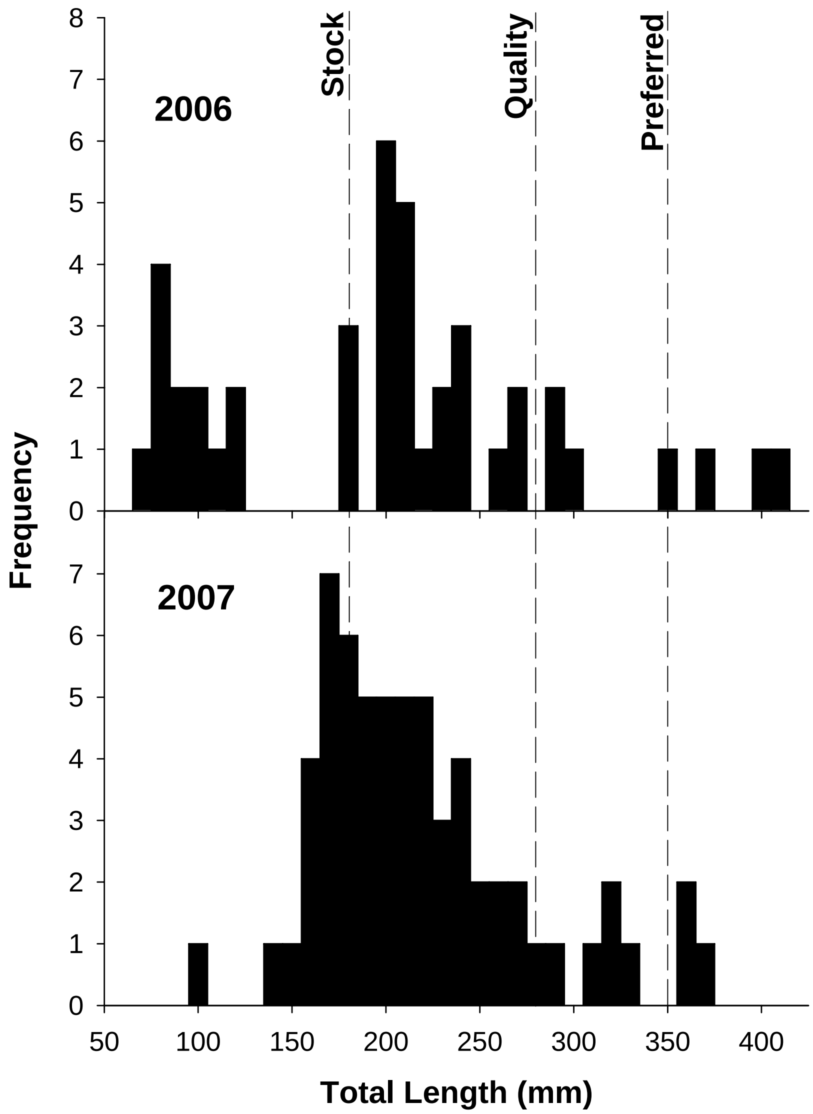

Figure 9. Length frequency for smallmouth bass sampled by nighttime electrofishing near Gavins Point Dam in Lewis and Clark Lake, South Dakota, 2006 and 2007.

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, 2002-2007. 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-M**	**N**
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
2007	42 (26)	23	13	0	90 (2.2)	83 (3)	74 (1.5)	42

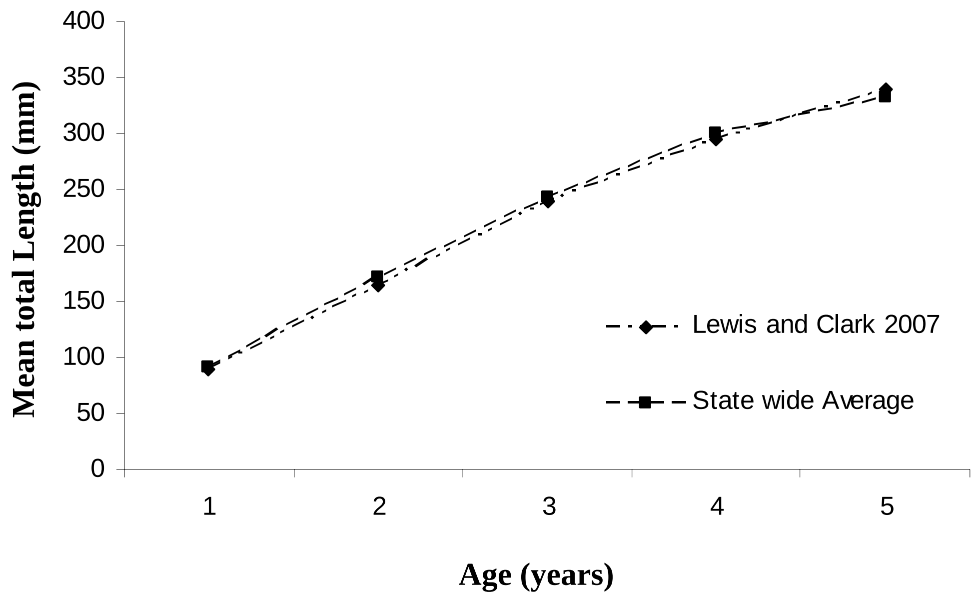

Figure 10. Mean back-calculated length at age for smallmouth bass sampled near the Gavins Point Dam face, Lewis and Clark Lake, South Dakota, 2007, as determined from scales. Statewide smallmouth bass average-Willis et al. 2005

Table 18. Age distribution of smallmouth bass collected by electrofishing Lewis and Clark Lake near Gavins Point Dam, 2002-2007, as determined from scales. Mean age excludes age-0 fish.

Year	**Age**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Mean**
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
2007	5	15	7	3	2	1	2	2.8

Flathead catfish population parameters

Forty-five flathead catfish were sampled by daytime electrofishing along the south shore of Lewis and Clark Lake during June 2007. Catch per unit effort values for 2007 were higher than 2005 and 2006 values (Table 19). Proportional stock density for the electrofishing sample in 2007 was 24, up from 10 in 2006. Flathead catfish lengths ranged from 49 to 602 mm. Size structure showed a similar distribution as 2006, with 77% of flathead catfish sampled below stock length (Figure 11). Relative weight for stock-to-quality-length flathead catfish was 86, similar to the six year average (Table 19).

Flathead catfish captured by electrofishing in 2007 ranged in age from 1 to 8, with a mean age of 2.4 (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 2006-2007 pooled catch data, was 71% with an –z value of 0.3.

First year growth of flathead catfish in Lewis and Clark Lake is higher than observed in the Des Moines River, Iowa (Mayhew 1969). However, after the first year, growth rates were similar out to age 6. Thus, mean length at age is consistently higher in Lewis and Clark Lake (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, 2002-2007. 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**
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 (--)	-
2007	69 (29.1)	24	0	0	86 (2.5)	91 (0.8)	-

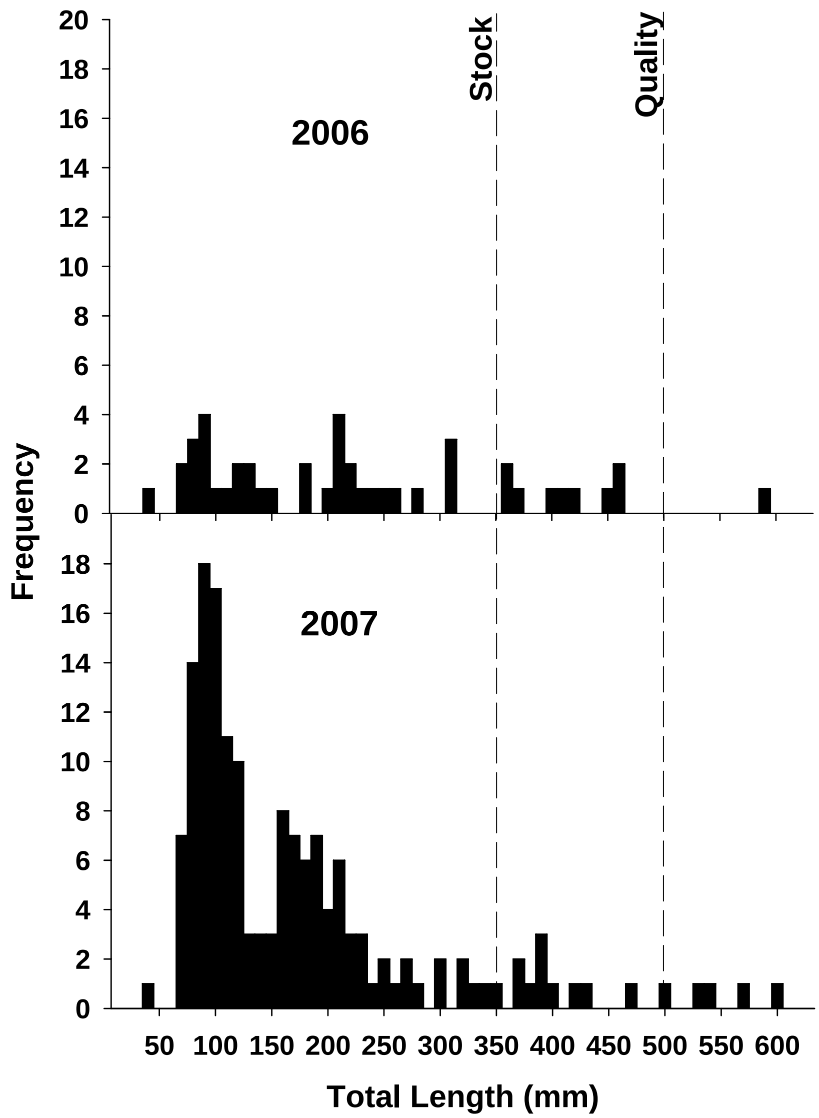

Figure 11. Length frequency of flathead catfish sampled by electrofishing Lewis and Clark Lake during June 2006 and 2007.

Table 20. Age distribution of flathead catfish sampled by electrofishing Lewis and Clark Lake during 2002-2007, as determined from pectoral spines.

Year class	**Age**										
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
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
2007	35	10	7	5	3	1	2	4	0	0	2.4

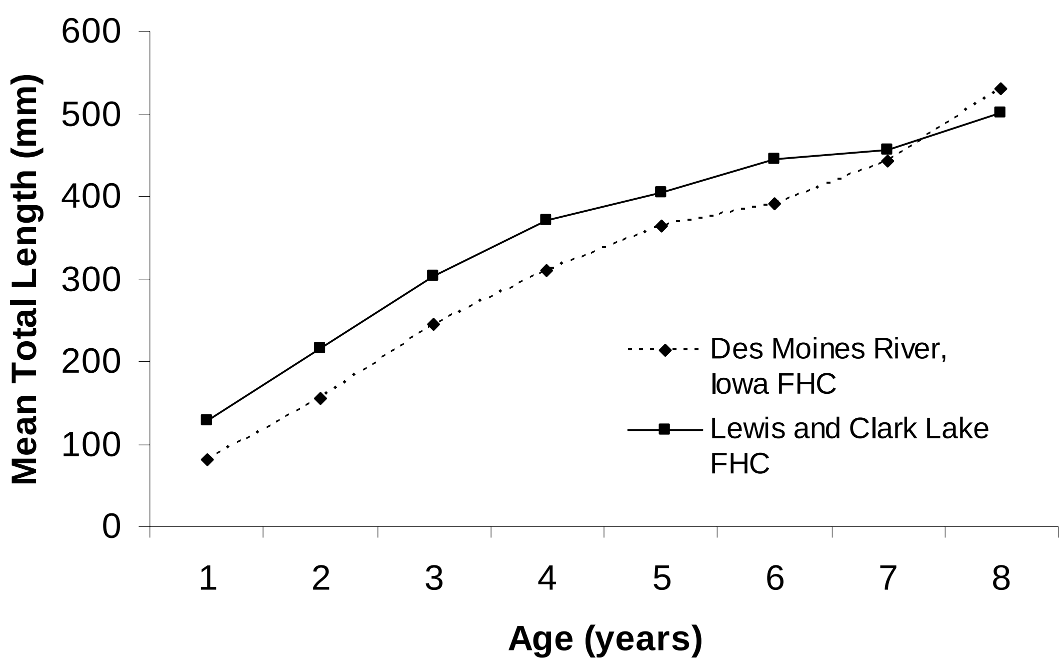

Figure 12. Mean back-calculated length at age for flathead catfish sampled from Lewis and Clark Lake, South Dakota, 2007, and the Des Moines River, Iowa, as determined from pectoral spines. Des Moines River Iowa- Mayhew 1969.

Missouri River

Electrofishing

<u>*Smallmouth bass population parameters*</u>

A total of 68 smallmouth bass were sampled in the Gavins Point Dam tail water area with lengths ranging from 84-441 mm. Mean CPUE for smallmouth bass was 56 fish/h; up from 35 fish/h in 2006 (Table 21). Smallmouth bass PSD decreased from 2006 to 2007, however, RSD-P increased in 2007. Length frequency for smallmouth bass is shown in Figure 13. A large year class was sampled below 150 mm. Relative weight for stock to quality and quality to preferred-length smallmouth bass in 2007 were similar to 2006 (Table 21).

Age distribution for smallmouth bass ages-1 through age-7 is depicted in Table 22. Smallmouth bass collected in 2007 ranged in age from 1 to 7, with a mean age of 2.2. Age-1 and age-2 smallmouth bass comprised 66% of smallmouth bass aged in 2007.

Smallmouth bass annual survival, as estimated from catch curve analysis (Ricker 1975) of 2006-2007 pooled data was 54%, with an –z value of 0.60. Estimated annual survival is generally 20-30%.

Table 21. 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, 2002-2007. 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**
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
2007	56 (19)	21	8	3	94 (1.5)	92 (1.6)	91 (7.8)	67

Table 22. Age distribution of smallmouth bass sampled by electrofishing the Missouri River below Gavins Point Dam, 2002-2007, as determined from scales.

Year	**Age**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**Mean**
2002	13	18	4	0	0	0	0	1.7
2003	3	24	5	0	1	0	0	2.2
2004	1	29	10	3	0	0	0	2.3
2005	1	50	24	2	0	0	0	2.4
2006	7	18	3	3	2	0	0	2.2
2007	26	19	13	8	1	0	1	2.2

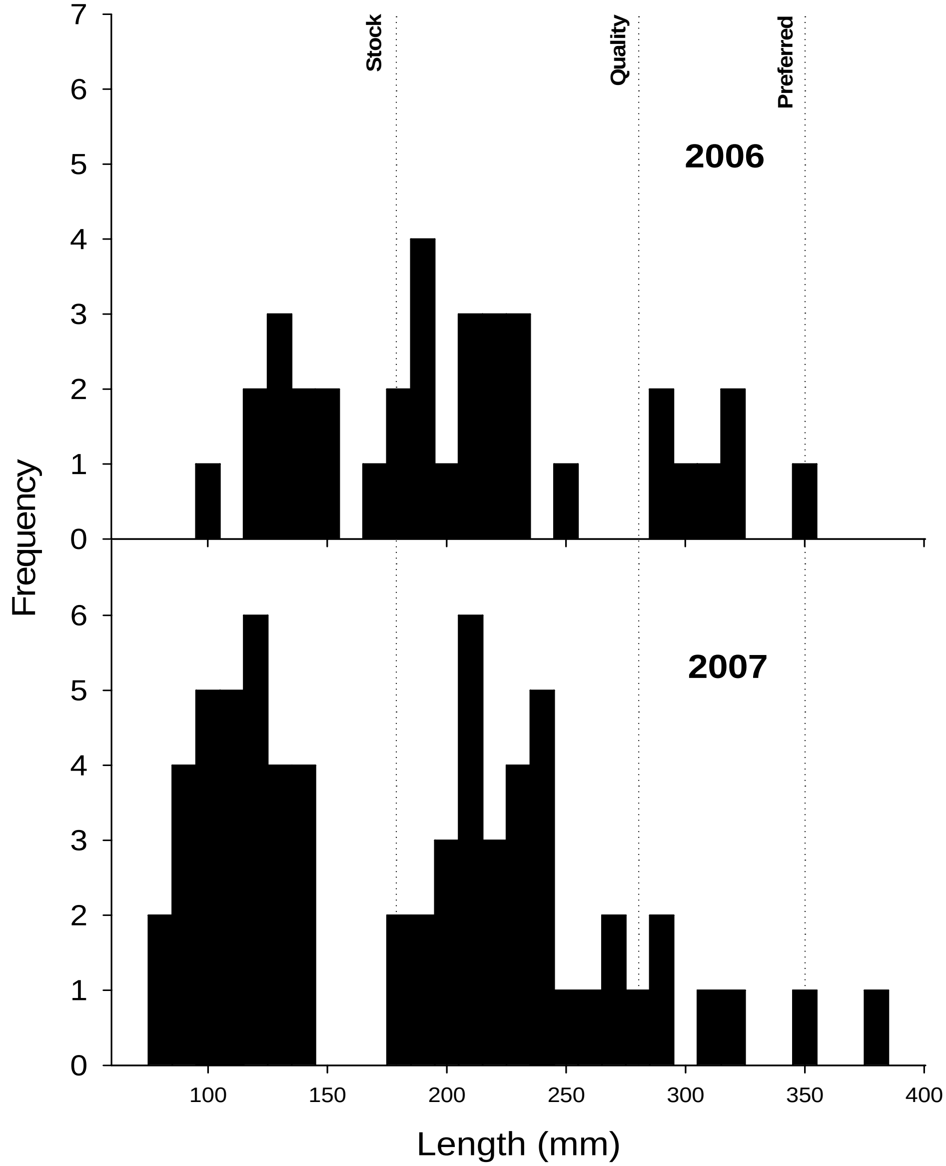

Figure 13. Length frequency of smallmouth bass sampled by electrofishing the Missouri River below Gavins Point Dam in May 2006 and 2007

Hoop Nets

<u>*Channel catfish population parameters*</u>

A total of 21 channel catfish were sampled from the Niobrara River delta area with hoop nets during 2007. Lengths of channel catfish collected ranged from 170-723 mm (Figure 14). Mean CPUE for channel catfish in 2007 was 0.1 fish/net night; down for the second consecutive year (Table 23).

Table 23. Total annual hoop net catches (CPUE) of channel catfish from the Missouri River near Springfield, SD, 2001-2004 and 2006-2007. 80% confidence interval (±) in parenthesis

Year	**Number of fish**	**Net-nights**	**CPUE**	**Mean length (mm)**
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)
2004	81	82	1.0 (1.2)	314 (12.8)
2006	36	80	0.5 (0.2)	287 (19)
2007	21	78	0.1 (0.3)	335 (43)

Channel catfish PSD in 2007 was similar to 2006, while RSD-P increased in 2007 to 25 compared to 9 in 2006. RSD-M in 2007 was 8; however, these size structure indices are based on a low sample size (N=21). Length frequency indicates the majority (86%) of the channel catfish sampled with hoop nets were below quality length (Figure 14). Relative weights for stock-to-quality and quality-to-preferred-length channel catfish were similar to previous years (between 80 and 90) (Table 24).

Table 24. 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, 2001-2004 and 2006-2007. N is sample size.

Year	**PSD**	**RSD-P**	**RSD-M**	**Relative weight**			**N**
				S-Q	**Q-P**	**P**	
2001	27	7	0	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 (9.4)	84
2004	30	12	2	86 (0.4)	80 (3.2)	81 (1.9)	43
2006	27	9	0	81 (9.2)	84 (13)	75 (--)	36
2007	25	25	8	94 (4.8)	81 (--)	78 (--)	21

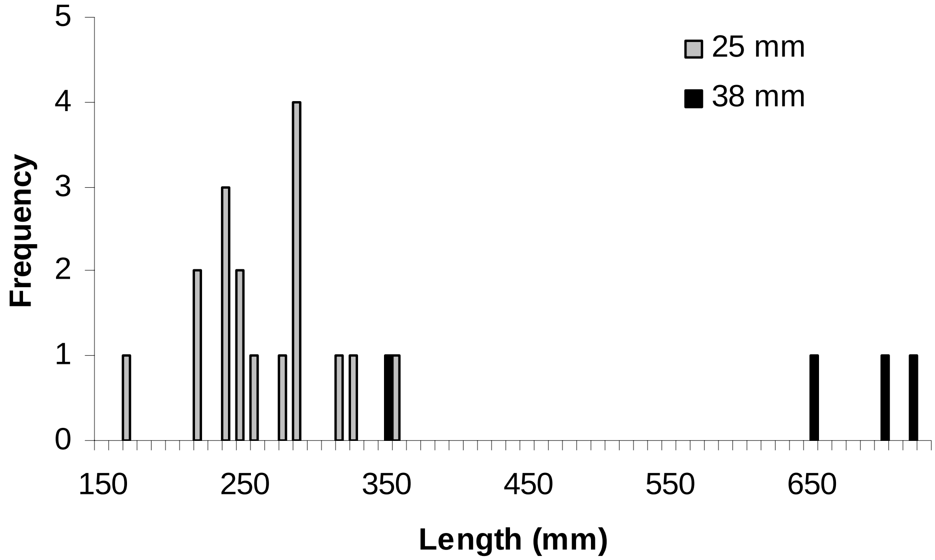

Figure 14. Length frequency of channel catfish sampled in hoop nets from the Missouri River in August of 2007.

Lewis and Clark Lake channel catfish from 2007 sampling grew faster than that of channel catfish from Lake Francis Case, 2007, for all ages (Figure 15).

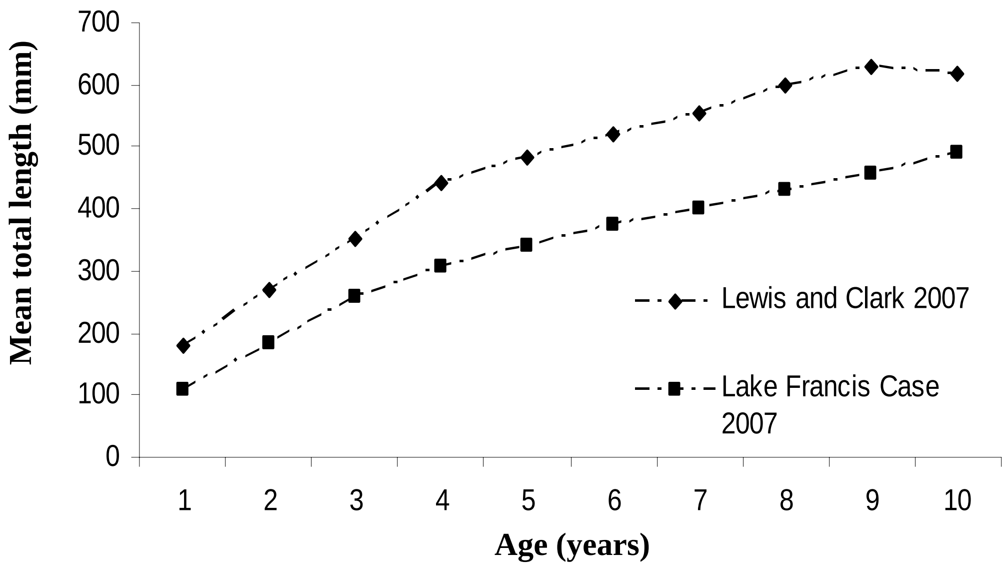

Figure 15. Mean back-calculated length at age for channel catfish sampled in hoop nets from Lewis and Clark Lake, South Dakota, 2007, and Lake Francis Case, 2007, as determined from pectoral spines.

Age distribution for channel catfish is depicted in Table 25. Channel catfish ages ranged from 1 to 11, with a mean age of 1.5. Age-1 through age 3 channel catfish comprised 85% of channel catfish in the 2007 sample.

Table 25. Age distribution of channel catfish sampled in hoop nets from the Missouri River, 2001-2002, 2004, and 2006-2007, as determined from pectoral spines.

Year	**Age**														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**Mean**
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
2007	7	8	2	0	0	0	0	0	1	0	2	0	0	0	1.5

Channel catfish annual survival, as estimated from catch curve analysis (Ricker 1975) of 2006-2007 pooled data was 17%, with an –z value of 0.19. 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

Ten species of age-0 fishes and adult littoral species were collected with seines near Springfield, SD during July of 2007 (Table 26). All species sampled have been previously reported from Lewis and Clark Lake. Gizzard shad and red shiner were the most abundant species sampled during 2007.

Table 26. Catch per unit effort (fish/seine haul) for seining surveys in the Missouri River near Springfield, South Dakota, 2003-2007. Standard error is in parenthesis. *includes both age-0 and adults.

Species	2003	2004	2005	2006	2007
Bigmouth buffalo	-	-	-	-	-
Black crappie	-	-	-	t	-
Bluegill	-	-	0.2(0.1)	-	t
Bluntnose minnow*	-	-	0.2(0.1)	-	-
Emerald shiner*	1.3(0.4)	4.0(2.9)	0.9(0.2)	0.6 (0.4)	1.1 (1.0)
Common carp	-	-	-	-	
Gizzard shad	-	t	3.1(2.5)	0.55 (0.3)	13 (0.9)
Hybognathus sp.	-	-	-	-	-
Johnny darter*	0.1(0.1)	-	-	-	t
Largemouth bass	0.8(0.4)	0.4(0.2)	0.80 (0.3)	t	-
Rock bass	-	t	-	-	-
Red shiner*	-	-	0.1(0.1)	-	26 (0.9)
River carpsucker	0.1(0.1)	t	0.4(0.2)	0.1 (0.1)	5 (1.0)
Sauger	-	-	-	-	t
Shorthead redhorse	-	-	-	-	-
Smallmouth bass	0.4(0.2)	0.1(0.1)	0.4(0.2)	-	t
Smallmouth buffalo	-	-	-	-	-
Spotfin shiner	0.7(0.3)	0.3(0.1)	0.4(0.2)	-	-
Spottail shiner*	-	-	-	-	-
Walleye	0.2(0.1)	t	0.2(0.1)	-	-
White bass	-	t	0.2(0.1)	-	t
White crappie	0.1(0.1)	-	0.2(0.1)	-	t
Yellow perch	-	t	-	-	-

Experimental Missouri River Sampling

Electrofishing

A total of sixteen species were sampled in the fall using electrofishing near Springfield, SD in 2007. Gizzard shad exhibited the highest CPUE at 346 fish/hr followed by emerald shiner, largemouth bass and common carp, respectively. Seven other game species were sampled including; sauger, white bass, smallmouth bass, and flathead catfish, channel catfish, bluegill, and black crappie (Table 27).

Table 27. Catch per unit effort (fish/hr) for fall electrofishing on the Missouri River near Springfield, SD area 2007.

Species	CPUE	SE
Bigmouth buffalo	1.6	1.6
Black crappie	0.8	0.1
Blue sucker	0.8	0.1
Bluegill	6.8	3.2
Channel catfish	2.4	0.4
Common carp	12.4	2.9
Emerald shiner	70	25.7
Flathead catfish	0.8	0.1
Freshwater drum	4.4	1.8
Gizzard shad	346	62.0
Largemouth bass	14	6.9
River carpsucker	12.4	3.9
Sauger	6	2.9
Shorthead redhorse	4.8	2.3
Smallmouth bass	2.4	1.8
Smallmouth buffalo	1.6	0.6
White bass	8	3.4

Gill Nets

Twenty species were sampled with gill nets in the Missouri River below Fort Randall Dam in 2007, with a total of 222 fish sampled. Channel catfish were the most abundant species (5.8/net night) making up 31% of the total sample followed by shorthead redhorse, walleye and shovelnose sturgeon, respectively (Table 28). A total of 69 channel catfish were sampled ranging in length from 241-735 mm. A total of 21 walleye (1.8/net night) were sampled in the Missouri River using gill nets in 2007. Lengths of walleye collected ranged from 258-497 mm. Mean CPUE for walleye was 1.8 fish/net night.

Table 28. Catch per unit effort (fish/net night) for gill nets in the Missouri River below Fort Randall Dam in September 2007.

Species	CPUE	SE
Black bullhead	0.1	0.03
Blue sucker	0.1	0.03
Channel catfish	5.8	1.67
Common carp	0.2	0.06
Freshwater drum	0.2	0.06
Gizzard shad	0.2	0.06
Goldeye	0.3	0.09
Northern pike	0.1	0.03
River carpsucker	1.1	0.32
Rock bass	0.1	0.03
Sauger	0.2	0.06
Shorthead redhorse	4.7	1.36
Shortnose gar	1.3	0.38
Shovelnose sturgeon	1.4	0.40
Smallmouth bass	0.6	0.17
Smallmouth buffalo	0.2	0.06
Walleye	1.8	0.52
White bass	0.2	0.06
White sucker	0.1	0.03
Yellow perch	0.3	0.09

Push Trawl

A push trawl was used to sample littoral fish species in the Missouri River near Springfield, SD on September 17, 2007. Equipment failure resulted in minimal data collection.

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).

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 2007.

CONCLUSIONS

Many species-specific management objectives were met during 2007. Three mature year classes of walleye were present (2001-2004). Proportional stock density was above the management objective range of 30 to 60, and RSD-P was higher than the management objective of 10. Walleye CPUE for fall gill netting efforts was also above the management objective of 4.0 fish/net night. Relative weights in 2007 were within the average range for walleye in this reservoir (80-90).

Age-0 walleye production is currently indexed through standard fall gill net assessments; however, fall night electrofishing in the lake portion of the reservoir could provide a useful index of age-0 and age-1 walleye abundance (Serns 1982, 1983). Conversely, 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 sampled during 2007. 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 met 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.

Although, channel catfish were not the most abundant species during fall gill netting efforts in 2007, they continue to be one of the most common over the years. 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.

Smallmouth bass CPUE continues to be well above the management objective of 10 fish/h, while PSD was below the management objective range of 30 to 60 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 2007 was higher than that of 2006, while PSD also increased from 10 in 2006 to 24 in 2007. Condition of flathead catfish was similar to previous years with relative weight values between 85 and 95.

Experimental fall electrofishing, gill nets, and the use of a push trawl near Springfield, SD, were used to evaluate species abundance and diversity. Electrofishing sampling caught mostly forage species and few game fish. Catch rates were also low in the gill nets. Although gill net catches were low, future sampling may yield different results because the Missouri River continues to change along with habitat use by fish (Graeb 2006). As a result, further information in this area is needed to identify the usage of these habitats.

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	$Log_{10}(Ws)= 3.082*Log_{10}(TL)-5.156$
Sauger	$Log_{10}(Ws)= 3.187*Log_{10}(TL)-5.492$
Smallmouth bass	$Log_{10}(Ws)= 3.200*Log_{10}(TL)-5.329$
Walleye	$Log_{10}(Ws)= 3.180*Log_{10}(TL)-5.453$