Bitter Lake, South Dakota
Angler Use and Harvest Surveys
December 2004 - August 2006

by

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Preface

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Executive Summary

Bitter Lake is currently an important sport fishery in northeast South Dakota. Prior to the 1990's, Bitter Lake was a shallow saline basin not conducive to sport fisheries management, but above normal precipitation during the 1990's increased the water level allowing for long-term sport fish survival. The South Dakota Department of Game, Fish and Parks first stocked walleye and yellow perch into Bitter Lake during 1997. Walleye, yellow perch, and northern pike are the primary sport fish present in Bitter Lake. A fish consumption advisory was issued in 2000 for all sizes of Bitter Lake walleyes and northern pike greater than 76 cm (30 inches) because of elevated mercury (Hg) levels. Information concerning angler use and harvest is important in the ongoing fisheries management of the Bitter Lake fishery. This report summarizes angler use and harvest surveys that were completed between December 2004 and August 2006.

Greater than 95% of interviewed Bitter Lake anglers targeted walleyes during the 2005 and 2006 summers. Sixty-two percent of interviewed anglers targeted walleyes during the 2004-05 winter, but only 26% of interviewed anglers indicated they were targeting walleyes during the 2005-06 winter. A higher percentage of anglers sought northern pike and yellow perch during the winter months than the summer months of this survey.

The 2005 and 2006 summers represented two extremes for Bitter Lake in terms of fishing pressure. The highest recorded amount of angler hours occurred during the 2005 summer when an estimated 65,927 hours were spent fishing at Bitter Lake and the 2006 summer was the lowest recorded summertime fishing pressure at 31,115 hours. Winter fishing pressure during the 2004-05 and 2005-06 winters was similar to that measured in previous winter surveys. The potential economic impact of the Bitter Lake fishery on local economies during the winter and summer periods ranged from $190,824 to $846,427.

South Dakota residents represented approximately half of the anglers fishing at Bitter Lake during the summer months and greater than 60% of the anglers during the winters. Resident anglers at Bitter Lake often originated from Brown, Codington, Day, Grant, and Minnehaha Counties. Nonresident anglers were most likely to come from Minnesota.

Angler catches of northern pike were down from previous surveys. The decrease in northern pike catches is likely the result of fewer northern pike being present in Bitter Lake. The highest angler catch rates for northern pike occurred during December and May. During the 2005-06 winter, anglers harvested northern pike at a rate of 0.19 pike per hour fished when 2,740 pike were harvested. This represented the highest observed harvest during the current survey period. Anglers catching northern pike during the winter were more likely to harvest their fish than those catching pike in the summer. Anglers were almost evenly divided on their views concerning a possible reduction of the northern pike daily limit from six to three fish.

Yellow perch were rare in the summer surveys, but common during the winter months when in excess of 2,500 perch were caught during each of the 2004-05 and 2005-06 winters. Catch and harvest rates during the 2004-05 and 2005-06 winters were similar to that of past

winter surveys. Anglers harvested greater than 85% of the yellow perch caught during the winter months. The average yellow perch in the winter creel was greater than 28 cm (11 inches).

Summertime walleye catch rates decreased from that observed in previous summer surveys when anglers generally caught one walleye per hour fished. In the 2005 summer, anglers averaged 0.58 walleyes per hour fished and 0.32 walleyes were caught per hour fished during the 2006 summer. Although catch rates during the 2005 and 2006 summers were lower than previous summers they continue to represent what would be considered high walleye catch rates for most walleye fisheries. Anglers caught in excess of 30,000 walleyes during the 2005 summer, but the 2006 summer catch was less than 10,000 walleyes and represented the lowest recorded angler walleye catch during a summer at Bitter Lake. The reduced catch during the 2006 summer was likely related to increased walleye food availability during the 2006 summer. The walleye catch and harvest during the 2005-06 winter was the lowest recorded for a winter at Bitter Lake. Fewer anglers indicated that they were targeting walleyes during the 2005-06 winter than in previous winters. Sub-legal walleyes comprised less than 1% of the 1,294 walleyes measured during this survey.

Greater than 83% of interviewed anglers were in favor of making the one walleye over 508 mm (20 inches) a statewide regulation. Anglers were mixed in their views on potentially reducing the walleye daily limit from four to three fish. Over 70% of interviewed anglers were supportive of the reduction in panfish daily limits from 25 to 10 fish. Angler satisfaction at Bitter Lake was high and anglers indicated that relaxation, catching fish, and being with others were important factors in determining a successful fishing trip.

Historic fishing pressure, catch and harvest rates and numbers of fish caught and harvested at Bitter Lake can be found in the appendices of this report.

Table of Contents

Preface ii

Executive Summary iii

Table of Contents v

List of Tables vi

List of Figures viii

Study Site 1

Methods 1

Results and Discussion 2
- Fishing Pressure 2
- Angler Demographics 3
- Angler Catch and Harvest 4
  - Northern Pike 4
  - Yellow Perch 5
  - Walleye 5
  - Other Species 6
- Angler Opinions 6

References 18

Appendices 19

List of Tables

Table 1. Angler primary target species (percentage) by month and combined winter (December – March) and summer (May – August) for anglers fishing at Bitter Lake, South Dakota between December 2004 and August 2006. Any = anything, NOP = northern pike, YEP = yellow perch, and WAE = walleye.....8

Table 2. Winter monthly (December – March), summer monthly (May – August) and total winter and summer, number of angler interviews (# Int), estimated angling hours, estimated angler days, estimated economic value (Eco Value; $), estimated trip length (h), average party size, percent (%) of interviewed anglers that were South Dakota residents, percent (%) of angling activity by boat and percent (%) of angling activity that occurred during weekend/holidays (WE/H) at Bitter Lake, South Dakota between December 2004 and August 2006. One standard error is provided in parentheses when calculated.....9

Table 3. Home state residence (percentage) of anglers fishing Bitter Lake, South Dakota during the winters (December – March) and summers (May – August) between December 2004 and August 2006.....10

Table 4. Estimated winter monthly (December – March), summer monthly (May – August) and overall catch rate per hour fished (C/h) and harvest rate per hour fished (H/h) for northern pike (NOP), yellow perch (YEP), walleye (WAE), and other species (Others) at Bitter Lake, South Dakota between December 2004 and August 2006. One standard error is provided in parentheses when calculated. 11

Table 5. Estimated winter monthly (December – March), summer monthly (May – August), and overall angler catch and harvest of northern pike (NOP), yellow perch (YEP), walleye (WAE), and other species (Others) at Bitter Lake, South Dakota between December 2004 and August 2006. One standard error is provided in parentheses when calculated.....12

Table 6. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on making the one walleye over 508 mm (20 inches) a statewide restriction?" n is the number of responses. 13

Table 7. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on reducing the statewide daily walleye limit from four to three?" n is the number of responses.....13

Table 8. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on reducing the panfish limit from 25 to 10?" n is the number of responses. 13

Table 9. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on reducing the statewide daily northern pike limit from six to three?" n is the number of responses.....14

Table 10. Bitter Lake, South Dakota angler responses, during the 2004-05 winter and 2006 summer, to the question: "Considering all factors, how satisfied are you with your fishing trip today?" n is the number of responses. 14

Table 11. Bitter Lake, South Dakota angler responses, during the 2004-05 winter and 2006 summer, to the question: "What is the most important factor to you in defining a successful fishing trip?" n is the number of responses. 14

List of Figures

Figure 1. South Dakota county of residence for winter (December – March) and summer (May - August) resident anglers fishing Bitter Lake, South Dakota between December 2004 and August 2006. 15

Figure 2. Length frequency histograms of northern pike harvested by anglers fishing Bitter Lake, South Dakota during winter (December – March) and summer (May – August) periods between December 2004 and August 2006, N is the total number of fish measured and the mean total length (TL; mm) is provided for each survey period. 16

Figure 3. Length frequency histograms of yellow perch harvested by anglers fishing Bitter Lake, South Dakota during winter (December – March) periods between December 2004 and March 2006, N is the total number of fish measured and the mean total length (TL; mm) is provided for each survey period. 16

Figure 4. Length frequency histograms of walleye harvested by anglers fishing Bitter Lake, South Dakota during winter (December – March) and summer (May – August) periods between December 2004 and August 2006, N is the total number of fish measured and the mean total length (TL; mm) is provided for each survey period. 17

Bitter Lake, South Dakota
Angler Use and Harvest Surveys
December 2004 - August 2006

Bitter Lake is a relatively new fishery in northeast South Dakota. Above normal precipitation during the 1990's, transformed Bitter Lake from a shallow saline basin not conducive to sport fisheries management to a productive freshwater fishery. Walleyes and yellow perch were first stocked into Bitter Lake during 1997. In January 1999, a walleye minimum-length restriction of 406 mm (16 inches) with one walleye over 508 mm (20 inches) was enacted. Panfish (yellow perch, bluegill/sunfish, and crappie) daily limits were reduced from 25 to 10 of each species in several northeast South Dakota counties on January 1, 2002.

A fish consumption advisory was issued for Bitter Lake during 2000 because of elevated mercury (Hg) levels in all walleye sizes and northern pike greater than 76 cm (30 inches). Mercury sampling continues to show the presence of elevated mercury levels in walleyes and northern pike.

Bitter Lake was previously surveyed for angler use and harvest during winters and summers between December 1999 and August 2004 (Blackwell 2005). Information concerning angler use and harvest is important in the ongoing fisheries management of the Bitter Lake fishery. This report summarizes angler use and harvest surveys that were completed between December 2004 and August 2006.

Study Site

Bitter Lake is located in Day County, South Dakota adjacent to town of Waubay. The lake has a surface area of 4,010 ha (9,900 acres) and a maximum depth of 7.3 m (24 ft). The lake is considered eutrophic with algae blooms often occurring during the open-water period. A public boat access site is located on the southeast end of the lake and two private access sites are located on the northeast end. Much of the land surrounding the lake currently is private making shore fishing access difficult.

Methods

A roving angler use and harvest survey with two-stage stratification was completed during winter (December – March) and summer (May – August). The first stratification unit was between weekdays and weekend days and the second stratification was for the time periods that the clerk was present. Because weekends typically receive increased fishing pressure most weekend days were represented in the survey. Time periods were randomly assigned to available days with weekdays and weekend/holiday days being treated separately when times were assigned.

The survey utilized instantaneous angler counts combined with angler interviews. Instantaneous angler counts provided fishing pressure estimates and angler interviews provided information necessary for estimating fish species catch rates, mean angler trip length, and mean

party size. Two instantaneous counts of the total number of boats fishing and all shoreline anglers present were made each surveyed day during open-water periods and during ice cover all active ice shacks and open-ice anglers were counted. When counts were not being made, anglers were contacted and interviewed. Angler use and harvest estimates were calculated using Creel Application Software (CAS; Soupir and Brown 2002).

Additional questions asked during interviews were used to obtain angler primary residence, fish species targeted, and angler opinions. Total length (TL; mm) measurements from angler caught fish were recorded during the interview process.

The potential economic value of the Bitter Lake fishery was estimated by multiplying a daily angling expenditure of $61 times the estimated number of angler days. The average daily expenditure of $61 was derived from the reported total expenses of $182,480,000 for anglers fishing South Dakota in 2001 and divided by 2,984,000, the estimated number of days spent fishing in South Dakota in 2001 (U.S. Department of Interior, Fish and Wildlife Service, U.S. Department of Commerce Bureau of Census 2001).

Results and Discussion

Angler use and harvest surveys were completed at Bitter Lake in this survey during two winter (December 2004 - March 2005 and December 2005 – March 2006) and two summer periods (May 2005 – August 2005 and May 2006 – August 2006).

Fishing Pressure

Greater than 95% of interviewed anglers indicated that walleyes were their primary target species during the two surveyed summers (Table 1). This is similar to that observed for Bitter Lake during the summers between 2000 and 2004 when 85 to 99% of interviewed anglers indicated they were targeting walleyes while fishing at Bitter Lake (Blackwell 2005). A small percentage of interviewed anglers indicated that they were targeting anything and a few indicated they were fishing for northern pike during the 2005 and 2006 summers. Yellow perch were not targeted by anglers fishing Bitter Lake during the summer months.

During the 2004-05 winter, 62% of interviewed anglers targeted walleyes but the percentage of anglers targeting walleyes decreased to 26% during the 2005-06 winter (Table 1). The percentage of anglers targeting walleyes during the 2004-05 winter was similar to that observed during the 2003-04 winter when 62% of interviewed anglers indicated they were targeting walleyes (Blackwell 2005). The decrease in anglers targeting walleyes during the 2005-06 winter was offset by an increase in the percentage of anglers pursuing yellow perch and northern pike. Yellow perch were the most targeted species during the 2005-06 winter and the second most during the previous winter (2004-05).

The 2005 summer represented the highest recorded fishing pressure at Bitter Lake and the 2006 summer represented the lowest recorded summertime fishing pressure (Table 2). The lower fishing pressure during 2006 summer likely relates to lower walleye catch rates than during previous summers. A decrease in wintertime fishing pressure was also observed between

the 2004-05 winter (25,146 hours) and 2005-06 (14,238 hours) winter (Table 2). Fishing pressure during the 2005-06 winter was the lowest recorded since the 2000-01 winter when a mere 2,355 angler hours were measured (Blackwell 2005).

Greater than 90% of anglers fished from a boat during the current summer surveys (Table 2) and during previous summer surveys (Blackwell 2005). The limited shore access likely leads to the low percentage of anglers fishing from shore. Approximately 50% of interviewed anglers fished from ice shacks while fishing Bitter Lake during the winter months. Fishing pressure tended to be evenly distributed between weekdays and weekend/holidays with the exception of the 2005 summer when only 33% of angling occurred during the weekend/holiday days (Table 2). Mean party size was slightly greater than two anglers during each summer period and slightly less than two anglers during the winter periods (Table 2). Mean trip length was greatest during the 2004-05 winter when angler trip lengths averaged 5.7 hours and the mean trip length exceeded 4.3 hours during the other survey periods (Table 2).

The Bitter Lake fishery continues to be an important fishery in northeastern South Dakota for anglers and economic interests. The potential economic impact of the Bitter Lake fishery on local economies during the two winter and two summer periods of this survey ranged from $190,824 (2005-06 winter) to $826,427 (2005 summer; Table 2). These values were based on an average South Dakota angling expenditure of $61 per day (U.S. Department of Interior, Fish and Wildlife Service, U.S. Department of Commerce Bureau of Census 2001).

Angler Demographics

Approximately half of the anglers fishing at Bitter Lake were South Dakota residents during the summer months (Table 3). This represents a slight decrease in the percent of resident anglers from that of previous summer surveys when South Dakota residents comprised 60% or greater of the anglers during four of five summer surveys (Blackwell 2005). South Dakota residents made up a higher percentage of anglers during the winters than summers of this survey (Table 3). The percentage of resident anglers during the winter months was similar to that observed in previous winter surveys when South Dakota residents comprised greater than 65% of anglers fishing Bitter Lake during winter months (Blackwell 2005). Nonresident anglers fishing at Bitter Lake were most likely to come from Minnesota during both the winter and summer months; anglers from Minnesota comprised approximately 25% of all anglers during each survey (Table 3). Twelve states in addition to South Dakota were represented during this survey period.

In angler use and harvested surveys completed between December 1999 and August 2004, Codington County was the most common county of residence for resident anglers fishing at Bitter Lake (Blackwell 2005). Codington County continued to be highly represented by anglers fishing Bitter Lake during both winter and summer periods. During the winter months of this survey, most resident anglers originated from four counties. Those counties included, Codington, Day, Grant and Minnehaha (Figure 1). In 2005 summer, resident anglers from Codington County comprised the highest percentage of anglers at Bitter Lake followed by Brown, Day, Grant, and Minnehaha counties (Figure 1). During the 2006 summer, Codington, Grant, and Minnehaha were the most represented counties by anglers fishing at Bitter Lake (Figure 1).

Angler Catch and Harvest

Northern Pike

Wintertime anglers were more likely to pursue northern pike than were anglers fishing during the summer months (Table 1). A decrease in anglers targeting northern pike was apparent between the 2000 summer and 2004 summer (Blackwell 2005). The trend of few anglers targeting northern pike during the summer months continued during the current survey period. A higher percentage of anglers sought northern pike during the winter months than did in the summer. The percentage of wintertime anglers targeting northern pike during the 2004-05 (14.4 %) and 2005-06 (30.0%) winters was similar to that during the previous five winter periods when from 4.2 to 38% of interviewed anglers indicated that they were targeting northern pike (Blackwell 2005).

Angler catch rates were greatest during December and May (Table 4). In previous surveys, the highest northern pike catch rates typically occurred during March (Blackwell 2005). The highest catch rate of this survey occurred during December 2005 when anglers caught and harvested 0.78 northern pike per hour fished. Aside from December and May, monthly angler catch rates did not exceed 0.20 northern pike per hour fished. The highest overall northern pike harvest rate occurred during the 2005-06 winter when anglers harvested 0.19 northern pike per hour fished (Table 4).

More northern pike were caught during the 2005 and 2006 summers than during the 2004-05 and 2005-06 winters (Table 5). Although more northern pike were caught during the summer months, anglers were more likely to harvest northern pike caught during the winter months than pike caught during the summer. Greater than 80% of the northern pike caught during the winter surveys were harvested, but less than 40% of pike caught during the 2005 and 2006 summers were harvested (Table 5). The highest harvest occurred during the 2005-06 winter when an estimated 2,740 northern pike were harvested. In previous Bitter Lake angler use and harvest surveys, anglers harvested less than 25% of the northern pike caught during the summer (Blackwell 2005). Harvested northern pike ranged in length from 46 to 88 cm (18.1 to 34.6 inches; Figure 2).

The number of northern pike caught during this survey represents a substantial decrease from that observed in earlier surveys. In summer surveys between May 2000 and August 2004, anglers caught in excess of 10,000 northern pike each summer and generally greater than 5,000 pike were caught each winter between December 1999 and March 2004 (Blackwell 2005). The Bitter Lake northern pike population benefited from excess runoff flooding terrestrial vegetation during the late 1990's. The northern pike population densities increased while the water levels were increasing, but as water levels at Bitter Lake stabilized and then began to decrease, northern pike recruitment was reduced and the abundance of pike decreased. This change in northern pike abundance likely has resulted in fewer northern pike being caught at Bitter Lake in recent years.

Yellow Perch

Interviewed anglers indicated that they were targeting yellow perch only during the winter months (Table 1). In past years, yellow perch have not been actively pursued during the summer months nor have yellow perch been abundant in the angler creel during the summer months (Blackwell 2005). Angler summertime yellow perch catch and harvest rates averaged less than 0.01 perch per hour fished (Table 4) and anglers caught and harvested less than 100 perch each summer (Table 5).

Bitter Lake anglers had better success for perch during the winter months. Yellow perch catch rates during the 2004-05 winter averaged 0.10 perch per hour fished and 0.19 perch per hour during the 2005-06 winter (Table 4). These catch rates are similar to that experienced by anglers during the four previous winter periods when angler catch rates ranged from 0.07 (2000-01 winter) to 0.19 (2003-04 winter; Blackwell 2005).

In excess of 2,500 yellow perch were caught by anglers during each of the 2004-05 and 2005-06 winters (Table 5). Anglers harvested greater than 85% of the yellow perch that were caught during the winter months. The high proportion of angler catch that was harvested is indicative of the average size of yellow perch that anglers caught. Angler harvested yellow perch during the winter months ranged in size from 20 to 38 cm (7.9 to 15.0 inches; Figure 3) and the average perch in the creel exceeded 28 cm (11 inches). This is similar to winter surveys completed between December 1999 and March 2004 when the average yellow perch in the angler creel exceeded 28 cm (11 in) during each surveyed winter (Blackwell 2005).

Walleye

Walleyes continue to be the most sought after species by anglers fishing Bitter Lake during the summer months and were the most sought species during the 2004-05 winter (Table 1). Walleye catch and harvest rates during this survey were less than that reported in previous winter surveys when anglers caught greater than 0.30 walleyes per hour fished during four of five winters and summer surveys when angler catch rates averaged nearly one walleye per hour fished (Blackwell 2005). In the 2005-06 winter the walleye catch rate was the lowest recorded wintertime average at 0.07 walleyes per hour fished (Table 4). Less than 1,000 walleyes were caught during the 2005-06 winter (Table 5).

During the 2005 summer anglers caught an average of 0.58 walleyes per hour fished and during 2006 summer the average catch rate was 0.32 walleyes per hour (Table 4). Angler harvest rates during the 2005 and 2006 summers were similar to that observed in previous summers. Anglers harvested 0.27 walleyes per hour fished during the 2005 summer and 0.20 during the 2006 summer (Table 4). In the five previous summers, angler harvest rates ranged from 0.23 to 0.32 walleyes per hour fished (Blackwell 2005).

Although summertime walleye catch rates have decreased in recent years they still remain relatively high for a walleye fishery. It is generally believed that an angler catch rate of 0.3 walleyes per hour when anglers target all species is indicative of a good walleye fishery (Colby et al. 1979). The reduced walleye catch rate during the 2006 summer is likely the result of high prey availability as a large common carp year class was available for walleyes to feed on (personal observation).

Anglers caught in excess of 30,000 walleyes during the 2005 summer (Table 5). This is similar to the five previous surveys when anglers caught greater than 30,000 walleyes each summer (Blackwell 2005). In the 2006 summer, anglers caught less than 10,000 walleyes and this represents the lowest number of walleyes caught during the summer from Bitter Lake since angler use and harvest surveys began. Approximately half the angler hours were spent fishing Bitter Lake during the 2006 summer as were spent in 2005 summer (Table 2). The reduction in angler hours was likely because a strong walleye bite did not materialize during the 2006 summer. The reduced catch and harvest during the 2006 summer likely is related to increased walleye food availability. Approximately half the walleyes caught during the 2005 summer were harvested and 63% were harvested during the 2006 summer (Table 5).

An occasional sub-legal walleye was observed in the angler catch (Figure 4). However, it does not appear that harvest of sub-legal walleyes is a large component of the total harvest as less than 1% of the 1,294 walleyes measured between December 2004 and August 2006 were sub-legal. Harvested walleyes ranged in length from 33 to 61 cm (13 to 24 inches) during the most recent four survey periods. The average walleye in the angler creel exceeded 43 cm (17 inches) during the winter and summer periods.

Other Species

Other species were rare in the Bitter Lake angler's creel. An occasional black crappie or white bass was reported as being caught by anglers during the summertime.

Angler Opinions

Most anglers (>83%) were in favor of making the one walleye over 508 mm (20 inches) a statewide regulation when asked during the 2005 summer and 2005-06 winter (Table 6). Anglers were mixed on their views on reducing the walleye daily limit from four to three walleyes when asked during the 2005 summer and 2005-06 winter (Table 7). The percent of anglers favoring a reduction in walleye limit was nearly equal to that opposing a reduction during the 2005 summer, but a substantially higher percentage favored the reduction during the 2005-06 winter. Seventy-eight percent of anglers interviewed at Bitter Lake during the 2003-04 winter believed that four walleyes was an acceptable daily limit (Blackwell 2005).

Few anglers were opposed to the reduction of panfish daily limits from 25 to 10 when asked during the 2005 summer and 2005-06 winter (Table 8). Greater than 70% of interviewed anglers favored the reduction during these two periods. When Bitter Lake anglers were asked a similar question during the 2002-03 winter, 77% of interviewed anglers were supportive of the reduction (Blackwell 2005).

Anglers were asked their opinion on a possible reduction in the statewide daily northern pike limit from six to three fish during the 2005 summer and 2005-06 winter. Thirty-six percent favored a reduction and 30% were against a reduction when asked during the 2005 summer and 45% supported a reduction during the 2005-06 winter while 31% were against (Table 9). The higher percentage supporting a reduction during the winter may be related to the increased percentage of anglers targeting northern pike during the winter months. Approximately one third

of interviewed anglers during each survey period had no opinion on the northern pike daily limit (Table 9).

Angler satisfaction at Bitter Lake continues to generally be high (Table 10). Approximately 75% of interviewed anglers were satisfied with their fishing trip during the 2004-05 winter. Angler satisfaction decreased to 65% and a slight increase in anglers dissatisfied with their fishing trip was observed during the 2006 summer. This decrease in angler satisfaction likely relates to the reduced walleye catch rates observed during the 2006 summer. In three previous winter and three summer surveys, greater than 70% of interviewed anglers indicated that they were slightly satisfied or satisfied with their Bitter Lake fishing trip (Blackwell 2005).

When asked what the most important factor was to having a successful fishing trip - relaxation, catching fish, and being with others were the most common responses provided during the 2004-05 winter and 2006 summer (Table 11). In 2004 summer, anglers indicated that relaxation, catching fish, participating, and being with others were important in defining a successful fishing trip (Blackwell 2005). The percentage of anglers indicating that harvesting fish is necessary for a successful fishing trip was less than five percent during the 2004-05 winter and 2006 summer.

Table 1. Angler primary target species (percentage) by month and combined winter (December – March) and summer (May – August) for anglers fishing at Bitter Lake, South Dakota between December 2004 and August 2006. Any = anything, NOP = northern pike, YEP = yellow perch, and WAE = walleye.

		Percent (%)of Anglers			
Year	Month	Any	NOP	YEP	WAE
2004	December	0.0	34.6	7.7	57.7
2005	January	6.9	13.8	19.0	60.3
	February	2.1	4.2	17.7	76.0
	March	2.2	15.2	45.7	37.0
	Overall	3.1	14.4	22.6	62.0
2005	May	9.1	6.8	0.0	84.1
	June	2.5	3.8	0.0	93.7
	July	1.9	1.9	0.0	96.3
	August	0	2.1	0.0	97.9
	Overall	2.9	3.3	0.0	93.8
2005	December	0.0	15.4	69.2	15.4
2006	January	8.6	32.8	20.7	37.9
	February	6.7	28.9	35.6	28.9
	March	1.9	31.5	53.7	13.0
	Overall	5.3	30.0	38.8	25.9
2006	May	0.0	14.0	0.0	86.1
	June	3.6	1.8	0.0	94.6
	July	2.4	0.0	0.0	97.6
	August	16.7	0.0	0.0	83.3
	Overall	3.8	3.8	0.0	92.5

Table 2. Winter monthly (December – March), summer monthly (May – August) and total winter and summer, number of angler interviews (# Int), estimated angling hours, estimated angler days, estimated economic value (Eco Value; $), estimated trip length (h), average party size, percent (%) of interviewed anglers that were South Dakota residents, percent (%) of angling activity by boat and percent (%) of angling activity that occurred during weekend/holidays (WE/H) at Bitter Lake, South Dakota between December 2004 and August 2006. One standard error is provided in parentheses when calculated.

Year	Month	# Int	Angler hours	Angler days	Eco Value ($)	Trip length (h)	Party size	% SD	% Boat or Shack	% WE/H
2004	December	26	2,246 (760)	645	39,370	3.48 (0.94)	1.56 (0.91)	61.5	62.5	16.0
2005	January	59	8,942 (4,257)	999	60,945	8.95 (0.25)	2.20 (1.23)	65.5	79.2	79.1
	February	96	9,123 (2,318)	2,413	147,223	3.78 (1.97)	1.61 (1.09)	79.0	35.9	54.5
	March	46	4,834 (1,207)	753	45,931	6.42 (0.17)	1.80 (0.19)	73.9	34.4	48.4
	Overall	227	25,146 (5,052)	4,811	293,469	5.70 (0.52)	1.80 (0.47)	72.4	53.4	58.6
2005	May	44	11,033 (3,208)	2,652	161,782	4.16 (0.60)	2.39 (0.37)	40.9	87.2	60.9
	June	81	12,692 (3,395)	2,460	150,041	5.16 (1.56)	2.16 (0.63)	46.8	95.6	60.2
	July	109	32,706 (13,047)	6,489	395,846	5.04 (---)	2.45 (---)	59.1	99.9	11.2
	August	50	9,559 (1,778)	1,947	118,757	4.91 (---)	2.23 (0.18)	68.1	99.2	38.4
	Overall	280	65,927 (13,967)	13,548	826,427	4.82 (0.42)	2.31 (0.19)	53.5	96.8	32.9
2005	December	13	1,031 (528)	168	10,243	6.14 (3.05)	1.78 (0.15)	46.2	34.1	15.3
2006	January	58	4,810 (815)	1,006	61,383	4.78 (1.30)	1.87 (1.44)	63.8	55.6	87.3
	February	45	3,285 (497)	825	50,348	3.98 (0.15)	1.84 (1.38)	68.9	62.5	69.2
	March	54	5,113 (1,066)	1,129	68,851	4.53 (0.20)	2.05 (1.66)	64.8	31.4	42.7
	Overall	170	14,238 (1,525)	3,128	190,824	4.88 (0.85)	1.89 (0.65)	64.1	47.0	61.9
2006	May	46	15,142 (7,317)	3,657	223,107	4.14 (0.85)	2.49 (1.25)	41.9	88.0	35.8
	June	110	11,313 (2,807)	2,601	158,642	4.35 (0.86)	2.45 (0.40)	54.6	97.2	46.8
	July	41	3,611 (1,029)	748	45,605	4.83 (---)	2.13 (0.29)	61.0	98.7	66.9
	August	19	1,050 (323)	257	15,660	4.09 (0.64)	1.97 (0.55)	76.5	90.9	70.4
	Overall	216	31,115 (7,911)	7,263	443,014	4.35 (0.34)	2.26 (0.36)	55.0	92.7	44.6

Table 3. Home state residence (percentage) of anglers fishing Bitter Lake, South Dakota during the winters (December – March) and summers (May – August) between December 2004 and August 2006.

	Percent (%) of anglers			
State	2004-05	2005	2005-06	2006
South Dakota	72.4	53.5	64.1	55.0
Alabama		0.4		
Arizona				0.5
Iowa		11.4	1.8	8.1
Michigan				
Minnesota	24.9	26.9	23.5	25.6
Missouri		1.1		
Montana		0.4		
Nebraska	2.2	2.6	4.7	2.4
Nevada			0.6	
New Hampshire				0.5
North Dakota		2.6	0.6	5.2
Texas				0.5
Wisconsin	0.4	1.1	4.7	2.4

Table 4. Estimated winter monthly (December – March), summer monthly (May – August), and overall catch rate per hour fished (C/h) and harvest rate per hour fished (H/h) for northern pike (NOP), yellow perch (YEP), walleye (WAE), and other species (Others) at Bitter Lake, South Dakota between December 2004 and August 2006. One standard error is provided in parentheses when calculated.

		NOP		YEP		WAE		Others	
Year	Month	C/h	H/h	C/h	H/h	C/h	H/h	C/h	H/h
2004	December	0.21 (---)	0.18 (---)	0.02 (0.02)	0.02 (0.02)	0.21 (0.35)	0.13 (0.21)	0.0	0.0
2005	January	0.05 (0.06)	0.05 (0.05)	0.03 (<0.01)	0.02 (0.02)	0.11 (0.07)	0.06 (0.04)	0.0	0.0
	February	0.01 (<0.01)	<0.01 (0.01)	0.17 (0.12)	0.14 (0.10)	0.33 (0.18)	0.16 (0.10)	0.0	0.0
	March	0.10 (0.06)	0.07 (0.04)	0.16 (0.09)	0.15 (0.09)	0.20 (0.11)	0.09 (0.04)	0.0	0.0
	Overall	0.06 (0.02)	0.05 (0.05)	0.10 (0.05)	0.09 (0.04)	0.21 (0.08)	0.11 (0.04)	0.0	0.0
2005	May	0.22 (0.07)	0.09 (0.04)	0.0	0.0	0.27 (0.19)	0.12 (0.07)	<0.01 (0.01)	0.0
	June	0.05 (0.03)	0.01 (<0.01)	<0.01 (<0.01)	<0.01 (<0.01)	0.36 (0.21)	0.13 (0.08)	0.0	0.0
	July	0.04 (0.03)	<0.01 (<0.01)	<0.01 (<0.01)	<0.01 (0.01)	0.79 (0.65)	0.38 (0.31)	0.0	0.0
	August	0.04 (0.02)	0.02 (0.01)	0.0	0.0	0.52 (0.20)	0.26 (0.09)	0.0	0.0
	Overall	0.07 (0.02)	0.02 (<0.01)	<0.01 (<0.01)	<0.01 (<0.01)	0.58 (0.29)	0.27 (0.14)	<0.01 (<0.01)	0.0
2005	December	0.78 (0.50)	0.78 (0.50)	0.04 (0.05)	0.02 (0.03)	0.10 (0.15)	0.01 (<0.01)	0.0	0.0
2006	January	0.10 (0.04)	0.10 (0.04)	0.31 (0.18)	0.28 (0.17)	0.12 (0.07)	0.05 (0.04)	0.0	0.0
	February	0.16 (0.06)	0.16 (0.06)	0.12 (0.14)	0.09 (0.12)	0.05 (0.03)	0.02 (0.02)	0.0	0.0
	March	0.19 (0.09)	0.19 (0.09)	0.15 (0.05)	0.14 (0.04)	0.02 (0.01)	0.01 (<0.01)	0.0	0.0
	Overall	0.19 (0.05)	0.19 (0.05)	0.19 (0.07)	0.17 (0.06)	0.07 (0.03)	0.03 (0.01)	0.0	0.0
2006	May	0.22 (0.14)	0.10 (0.05)	<0.01 (<0.01)	<0.01 (<0.01)	0.29 (0.22)	0.22 (0.17)	0.0	0.0
	June	0.10 (0.06)	0.03 (0.03)	<0.01 (<0.01)	<0.01 (<0.01)	0.29 (0.15)	0.19 (0.09)	<0.01 (<0.01)	<0.01 (<0.01)
	July	0.04 (0.03)	<0.01 (<0.01)	0.0	0.0	0.47 (0.30)	0.22 (0.14)	<0.01 (<0.01)	<0.01 (<0.01)
	August	0.04 (0.03)	0.01 (0.02)	0.01 (<0.01)	0.01 (<0.01)	0.58 (0.37)	0.07 (0.07)	0.01 (0.01)	0.0
	Overall	0.15 (0.06)	0.06 (0.02)	<0.01 (<0.01)	<0.01 (<0.01)	0.32 (0.13)	0.20 (0.09)	<0.01 (<0.01)	<0.01 (<0.01)

Table 5. Estimated winter monthly (December – March), summer monthly (May – August), and overall angler catch and harvest of northern pike (NOP), yellow perch (YEP), walleye (WAE), and other species (Others) at Bitter Lake, South Dakota between December 2004 and August 2006. One standard error is provided in parentheses when calculated.

		NOP		YEP		WAE		Others	
Year	Month	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest
2004	December	481 (---)	401 (---)	39 (24)	39 (24)	473 (392)	289 (233)	0	0
2005	January	428 (209)	411 (203)	235 (117)	185 (86)	983 (338)	544 (217)	0	0
	February	120 (56)	84 (43)	1,516 (962)	1,305 (803)	2,986 (1,114)	1,482 (605)	0	0
	March	476 (387)	333 (217)	765 (371)	709 (360)	949 (457)	438 (174)	0	0
	Overall	1,505 (359)	1,229 (300)	2,555 (1,037)	2,238 (884)	5,391 (1,311)	2,752 (705)	0	0
2005	May	2,481 (165)	993 (40)	0	0	3,033 (2,398)	1,268 (807)	18 (24)	0
	June	607 (257)	140 (64)	34 (37)	17 (19)	4,613 (2,036)	1,695 (477)	0	0
	July	1,236 (510)	267 (178)	85 (56)	85 (56)	25,774 (11,208)	12,479 (5,316)	0	0
	August	423 (186)	216 (99)	0	0	4,971 (1,086)	2,508 (516)	0	0
	Overall	4,768 (624)	1,628 (218)	85 (56)	85 (56)	38,210 (11,688)	17,947 (5,422)	18 (24)	0
2005	December	806 (315)	806 (315)	38 (17)	25 (14)	98 (49)	12 (10)	0	0
2006	January	474 (170)	468 (170)	1,496 (437)	1,341 (368)	599 (314)	238 (132)	0	0
	February	512 (264)	512 (264)	392 (413)	310 (364)	175 (92)	63 (51)	0	0
	March	963 (358)	953 (362)	786 (75)	736 (75)	78 (44)	52 (41)	0	0
	Overall	2,754 (570)	2,740 (573)	2,711 (607)	2,412 (523)	951 (333)	365 (147)	0	0
2006	May	3,396 (1,111)	1,485 (484)	27 (25)	27 (25)	4,318 (2,442)	3,260 (1,678)	0	0
	June	1,141 (435)	354 (259)	20 (11)	10 (9)	3,256 (850)	2,104 (552)	59 (32)	20 (16)
	July	153 (63)	31 (14)	0	0	1,695 (588)	789 (243)	15 (15)	0
	August	42 (23)	15 (20)	5 (4)	5 (4)	609 (258)	73 (51)	61 (68)	0
	Overall	4,732 (1,195)	1,885 (549)	52 (28)	42 (27)	9,879 (2,664)	6,227 (1,784)	136 (77)	20 (16)

Table 6. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on making the one walleye over 508 mm (20 inches) a statewide restriction?" n is the number of responses.

	Percent (%)	
Response	2005 (n=133)	2005-06 (n=55)
Strongly oppose	1.5	0
Somewhat oppose	2.3	0
Neutral	12.8	3.6
Somewhat favor	29.3	12.7
Strongly favor	54.1	83.6

Table 7. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on reducing the statewide daily walleye limit from four to three?" n is the number of responses.

	Percent (%)	
Response	2005 (n=133)	2005-06 (n=55)
Strongly oppose	26.3	16.4
Somewhat oppose	16.5	12.7
Neutral	17.3	18.2
Somewhat favor	18.0	23.6
Strongly favor	21.8	29.1

Table 8. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on reducing the panfish limit from 25 to 10?" n is the number of responses.

	Percent (%)	
Response	2005 (n=112)	2005-06 (n=72)
Strongly oppose	0.9	2.8
Somewhat oppose	2.7	4.2
Neutral	22.3	20.8
Somewhat favor	21.4	13.9
Strongly favor	52.7	58.3

Table 9. Bitter Lake, South Dakota angler responses, during the 2005 summer and 2005-06 winter, to the question: "What is your opinion on reducing the statewide daily northern pike limit from six to three?" n is the number of responses.

	Percent (%)	
Response	2005 (n=112)	2005-06 (n=72)
Strongly oppose	17.9	25.0
Somewhat oppose	12.5	5.6
Neutral	33.9	25.0
Somewhat favor	8.9	18.1
Strongly favor	26.8	26.4

Table 10. Bitter Lake, South Dakota angler responses, during the 2004-05 winter and 2006 summer, to the question: "Considering all factors, how satisfied are you with your fishing trip today?" n is the number of responses.

	Percent (%)	
Response	2004-05 (n=166)	2006 (n=212)
Satisfied	62.7	42.9
Slightly satisfied	12.0	22.2
Neutral	12.0	12.7
Slightly dissatisfied	6.0	10.8
Dissatisfied	7.2	11.3

Table 11. Bitter Lake, South Dakota angler responses, during the 2004-05 winter and 2006 summer, to the question: "What is the most important factor to you in defining a successful fishing trip?" n is the number of responses.

	Percent (%) by survey period	
Response	2004-05 (n=165)	2006 (n=212)
Relaxation	37.0	29.2
Harvesting fish	4.2	1.9
Participating	15.2	10.8
Catching fish	37.6	32.1
Being with others	37.0	15.6
Other	0.0	10.4

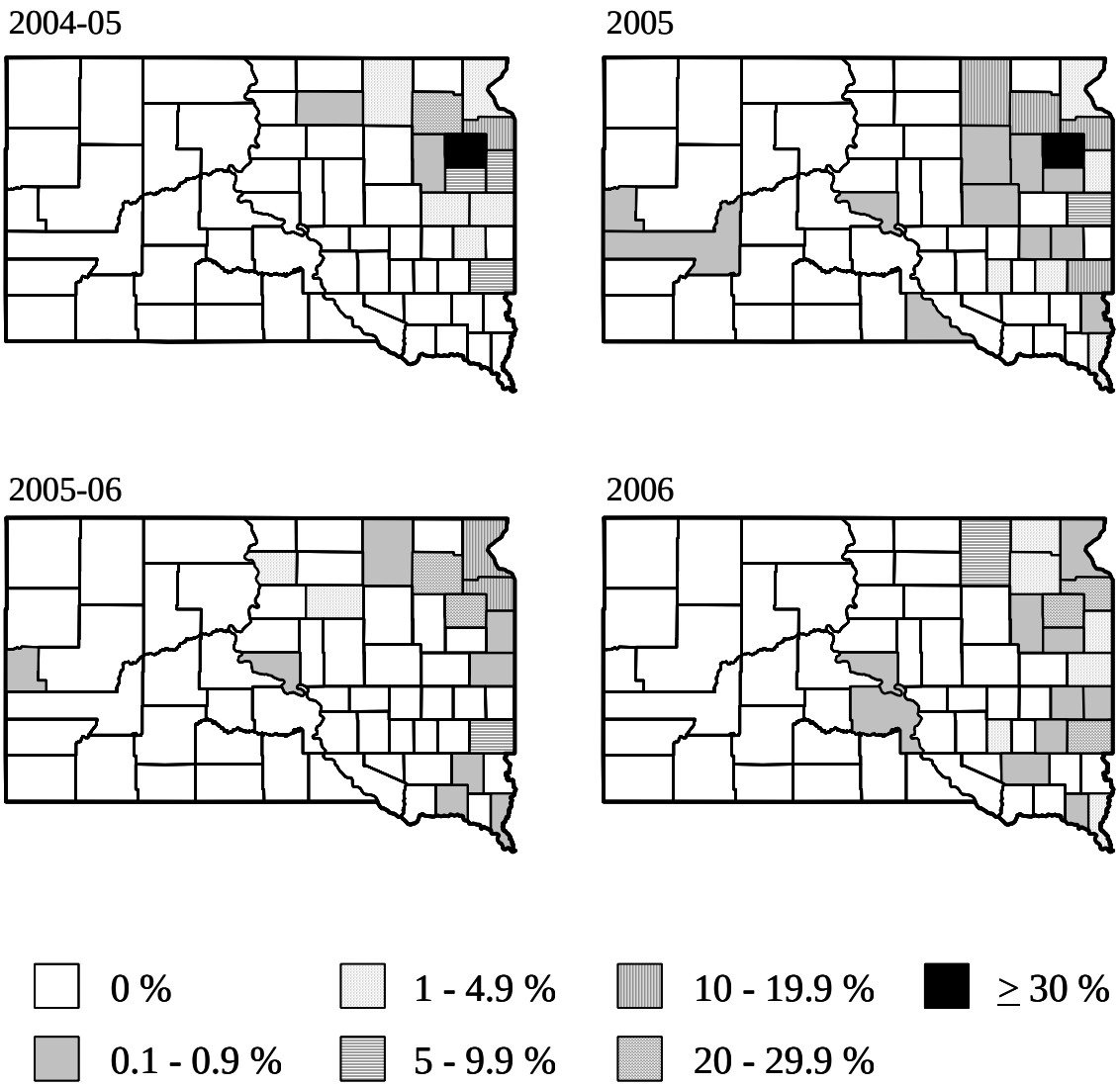

Figure 1. South Dakota county of residence for winter (December – March) and summer (May - August) resident anglers fishing Bitter Lake, South Dakota between December 2004 and August 2006.

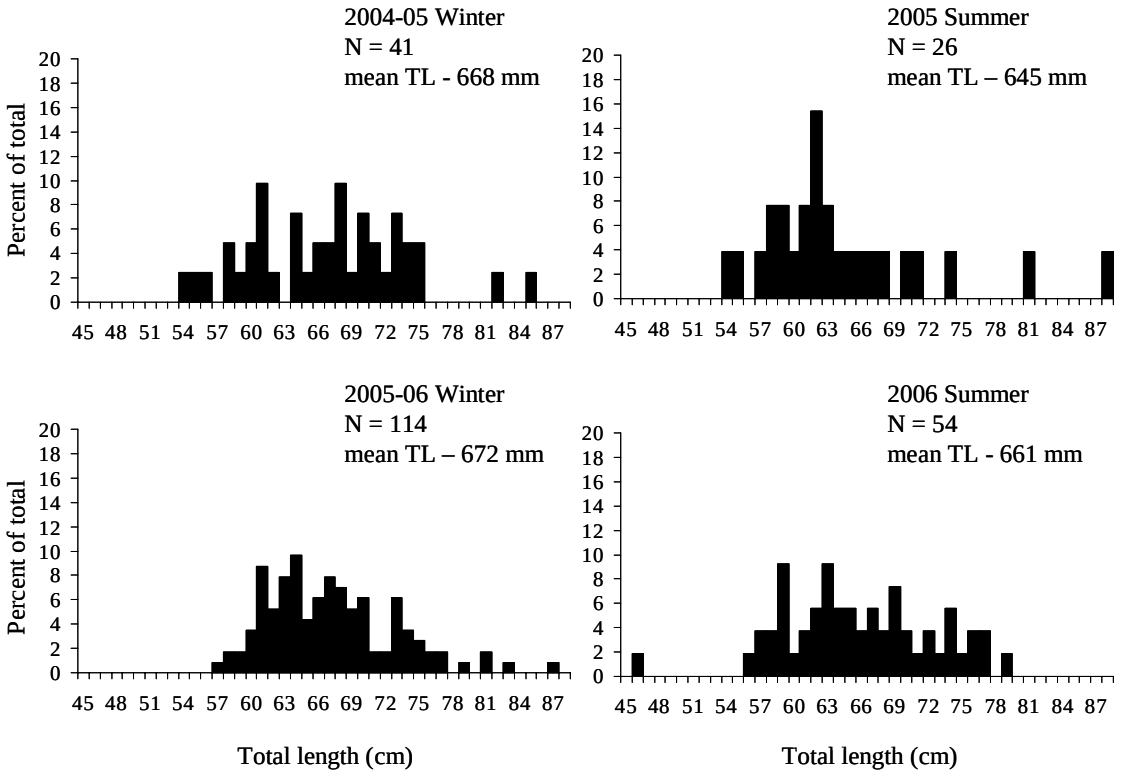

Figure 2. Length frequency histograms of northern pike harvested by anglers fishing Bitter Lake, South Dakota during winter (December – March) and summer (May – August) periods between December 2004 and August 2006, N is the total number of fish measured and the mean total length (TL; mm) is provided for each survey period.

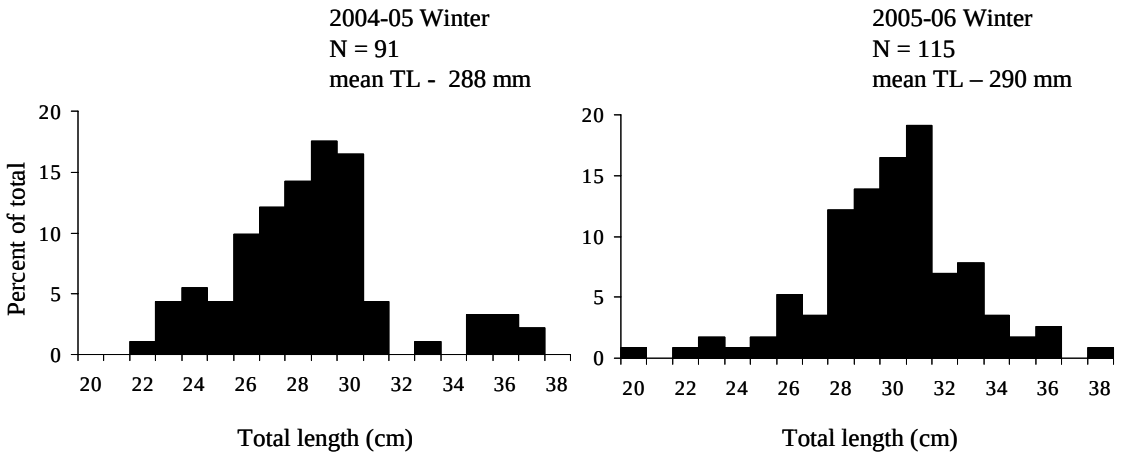

Figure 3. Length frequency histograms of yellow perch harvested by anglers fishing Bitter Lake, South Dakota during winter (December – March) periods between December 2004 and March 2006, N is the total number of fish measured and the mean total length (TL; mm) is provided for each survey period.

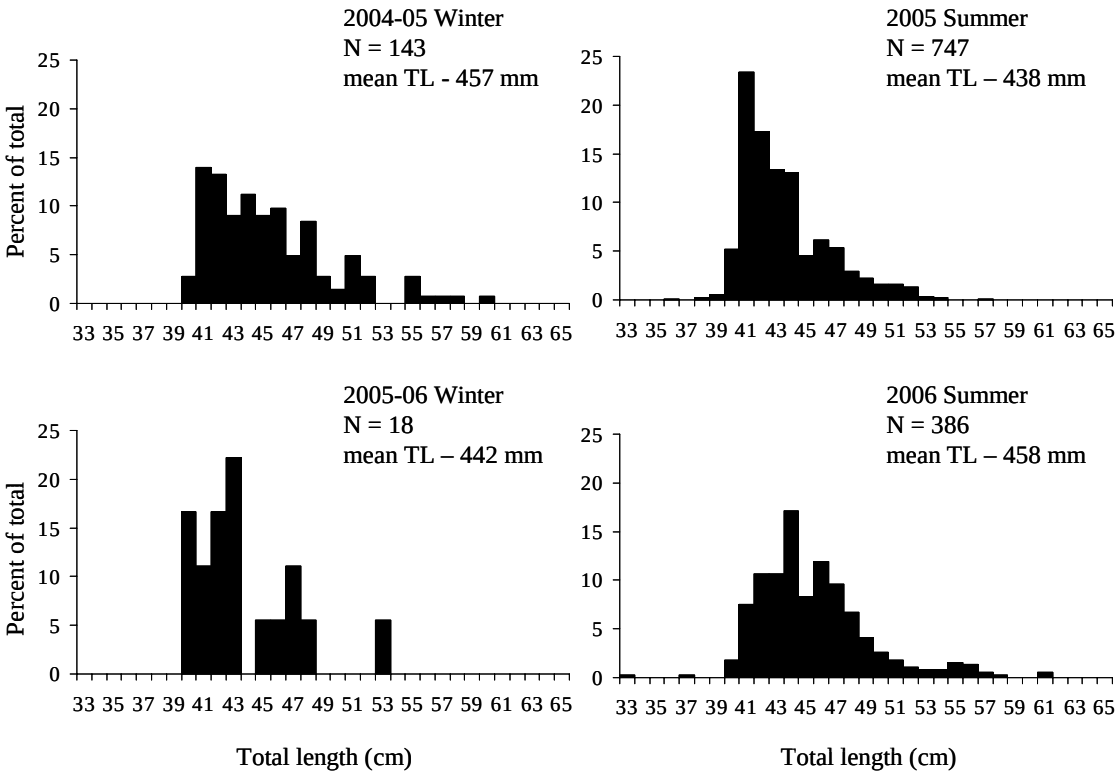

Figure 4. Length frequency histograms of walleye harvested by anglers fishing Bitter Lake, South Dakota during winter (December – March) and summer (May – August) periods between December 2004 and August 2006, N is the total number of fish measured and the mean total length (TL; mm) is provided for each survey period.

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

Common name	Scientific name
Black crappie	*Pomoxis nigromaculatus*
Common carp	*Cyprinus carpio*
Northern pike	*Esox lucius*
Walleye	*Sander vitreus*
White bass	*Morone chrysops*
Yellow perch	*Perca flavescens*

Appendix B. Winter (December – March) and summer (May – August) number of angler interviews (# Int), estimated angling hours, estimated angler days, estimated trip length (h), average party size, percent of interviewed anglers that were South Dakota residents (% SD), percent of angling activity by boat or ice shack (%B or S) and percent of angling activity that occurred during weekend/holidays (%WE/H) at Bitter Lake, South Dakota. One standard error is provided in parentheses when calculated.

Year	Season	# Int	Angler hours	Angler days	Trip length (h)	Party size	% SD	% B or S	% WE/H
1999-00 [a]	Winter	229	14,719	3,967	3.71	2.31	78.6	49.5	34.9
2000-01 [a]	Winter	49	2,355	520	4.53	1.90	82.0	53.2	52.5
2001-02 [a]	Winter	178	26,684 (8,485)	12,203	2.45 (0.30)	1.78 (0.41)	81.4	70.9	58.6
2002-03 [a]	Winter	168	23,241 (9,155)	6,288	3.52 (0.38)	1.81 (0.24)	74.7	64.1	87.4
2003-04 [a]	Winter	335	31,386 (5,773)	7,490	4.25 (1.00)	1.87 (0.74)	82.6	50.7	61.1
2004-05 [b]	Winter	227	25,146 (5,052)	4,811	5.70 (0.52)	1.80 (0.47)	72.4	53.4	58.6
2005-06 [b]	Winter	170	14,238 (1,525)	3,128	4.88 (0.85)	1.89 (0.65)	64.1	47.0	61.9
2000 [a]	Summer	389	48,062	10,882	4.50	2.62	67.2	92.9	50.4
2001 [a]	Summer	298	42,775 (4,847)	8,744	4.93 (0.48)	2.14 (0.39)	68.2	91.6	48.6
2002 [a]	Summer	289	56,655 (11,173)	11,509	5.12 (0.28)	2.38 (0.28)	61.1	97.4	38.3
2003 [a]	Summer	430	50,510 (6,572)	9,503	5.26 (0.32)	2.33 (0.12)	54.9	98.2	46.4
2004 [a]	Summer	408	41,665 (4,989)	9,507	4.24 (0.57)	2.28 (0.39)	60.4	95.1	52.9
2005 [b]	Summer	280	65,927 (13,967)	13,548	4.82 (0.42)	2.31 (0.19)	53.5	96.8	32.9
2006 [b]	Summer	216	31,115 (7,911)	7,263	4.35 (0.34)	2.26 (0.36)	55.0	92.7	44.6

a – Blackwell (2005), b – current study

Appendix C. Estimated winter (December – March) and summer (May – August) angler catch rate per hour fished (C/h) and harvest rate per hour fished (H/h) of northern pike (NOP), yellow perch (YEP), walleye (WAE), and other species (Others) at Bitter Lake, South Dakota. One standard error is provided in parentheses when calculated.

		NOP		YEP		WAE		Others	
Year	Season	C/h	H/h	C/h	H/h	C/h	H/h	C/h	H/h
1999-00 [a]	Winter	0.58	0.27	0.39	0.33	0.43	0.11	0.0	0.0
2000-01 [a]	Winter	0.35	0.26	0.07	0.03	0.12	0.02	0.0	0.0
2001-02 [a]	Winter	0.19 (0.08)	0.08 (0.04)	0.17 (0.13)	0.15 (0.11)	0.34 (0.21)	0.10 (0.06)	0.0	0.0
2002-03 [a]	Winter	0.26 (0.26)	0.14 (0.15)	0.15 (0.16)	0.08 (0.08)	0.34 (0.29)	0.10 (0.09)	0.0	0.0
2003-04 [a]	Winter	0.18 (0.05)	0.12 (0.07)	0.19 (0.08)	0.17 (0.07)	0.46 (0.18)	0.17 (0.06)	0.0	0.0
2004-05 [b]	Winter	0.06 (0.02)	0.05 (0.05)	0.10 (0.05)	0.09 (0.04)	0.21 (0.08)	0.11 (0.04)	0.0	0.0
2005-06 [b]	Winter	0.19 (0.05)	0.19 (0.05)	0.19 (0.07)	0.17 (0.06)	0.07 (0.03)	0.03 (0.01)	0.0	0.0
2000 [a]	Summer	0.44	0.09	0.01	<0.01	1.2	0.32	<0.01 (<0.01)	<0.01 (<0.01)
2001 [a]	Summer	0.38 (0.08)	0.05 (0.02)	<0.01 (<0.01)	<0.01 (<0.01)	1.10 (0.39)	0.27 (0.07)	0.0	0.0
2002 [a]	Summer	0.36 (0.11)	0.05 (0.02)	0.01 (0.01)	<0.01 (<0.01)	0.94 (0.43)	0.25 (0.10)	<0.01 (<0.01)	<0.01 (<0.01)
2003 [a]	Summer	0.22 (0.10)	0.04 (0.01)	0.01 (<0.01)	0.01 (<0.01)	0.95 (0.32)	0.23 (0.07)	<0.01 (<0.01)	<0.01 (<0.01)
2004 [a]	Summer	0.24 (0.06)	0.05 (0.02)	<0.01 (<0.01)	<0.01 (<0.01)	0.79 (0.22)	0.31 (0.09)	<0.01 (<0.01)	<0.01 (<0.01)
2005 [b]	Summer	0.07 (0.02)	0.02 (<0.01)	<0.01 (<0.01)	<0.01 (<0.01)	0.58 (0.29)	0.27 (0.14)	<0.01 (<0.01)	0.0
2006 [b]	Summer	0.15 (0.06)	0.06 (0.02)	<0.01 (<0.01)	<0.01 (<0.01)	0.32 (0.13)	0.20 (0.09)	<0.01 (<0.01)	<0.01 (<0.01)

a – Blackwell (2005), b – current study

Appendix D. Estimated winter (December – March) and summer (May – August) angler catch and harvest of northern pike (NOP), yellow perch (YEP), walleye (WAE), and other species (Others) at Bitter Lake, South Dakota. One standard error is provided in parentheses when calculated.

		NOP		YEP		WAE		Others	
Year	Season	Catch	Harvest	Catch	Harvest	Catch	Harvest	Catch	Harvest
1999-00 [a]	Winter	8,733	3,772	5,777	4,821	6,462	1,475	0	0
2000-01 [a]	Winter	767	572	163	77	267	48	0	0
2001-02 [a]	Winter	5,066 (1,481)	2,243 (744)	4,604 (2,028)	3,993 (1,831)	9,118 (2,631)	2,546 (814)	0	0
2002-03 [a]	Winter	5,994 (3,225)	3,296 (2,061)	3,387 (2,114)	1,907 (1,095)	7,796 (2,798)	2,213 (805)	0	0
2003-04 [a]	Winter	5,597 (2,318)	3,909 (2,043)	6,060 (1,446)	5,278 (1,222)	14,271 (3,151)	5,295 (1,181)	0	0
2004-05 [b]	Winter	1,505 (359)	1,229 (300)	2,555 (1,037)	2,238 (884)	5,391 (1,311)	2,752 (705)	0	0
2005-06 [b]	Winter	2,754 (570)	2,740 (573)	2,711 (607)	2,412 (523)	951 (333)	365 (147)	0	0
2000 [a]	Summer	21,352	4,384	396	31	57,740	15,402	10	10
2001 [a]	Summer	16,328 (3,652)	1,949 (489)	115 (47)	73 (29)	47,141 (10,792)	11,389 (2,054)	0	0
2002 [a]	Summer	20,359 (4,267)	2,828 (722)	435 (241)	266 (167)	53,083 (14,842)	14,268 (3,522)	39 (35)	26 (24)
2003 [a]	Summer	10,891 (3,037)	2,089 (506)	319 (145)	290 (143)	48,111 (7,827)	11,625 (1,734)	28 (12)	13 (12)
2004 [a]	Summer	10,198 (1,435)	2,202 (504)	141 (100)	74 (42)	32,807 (5,079)	12,802 (2,228)	44 (37)	28 (30)
2005 [b]	Summer	4,768 (624)	1,628 (218)	85 (56)	85 (56)	38,210 (11,688)	17,947 (5,422)	18 (24)	0
2006 [b]	Summer	4,732 (1,195)	1,885 (549)	52 (28)	42 (27)	9,879 (2,664)	6,227 (1,784)	136 (77)	20 (16)

a – Blackwell (2005), b – current study