Walleye and Northern Pike Summer Sport Fishery at Lac Ste. Anne, Alberta, 2006

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Bill Patterson
Alberta Conservation Association
101 – 9 Chippewa Road
Sherwood Park, Alberta, Canada
T8A 6J7

Report Editors
PETER AKU
Alberta Conservation Association
#101, 9 Chippewa Rd
Sherwood Park, AB T8A 6J7

KELLEY KISSNER
50 Tuscany Meadows Cres NW
Calgary, AB T3L 2T9

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Fax: (780) 464-0990
Email: info@ab-conservation.com
Website: www.ab-conservation.com

EXECUTIVE SUMMARY

Prior to the mid 1990s, high angling pressure, combined with high fish harvest rates, resulted in the over-harvest of walleye (*Sander vitreus*) and northern pike (*Esox lucius*) populations in Alberta. To aid the recovery of these fisheries, Alberta Sustainable Resource Development (ASRD) implemented two management strategies, the Walleye Management and Recovery Plan (1996; WMRP) and the Northern Pike Management and Recovery Plan (1999; NPMRP). Populations of these two species were assigned to one of three management status categories: 1) collapsed, 2) vulnerable, or 3) stable, according to lake-specific guidelines. Based on criteria in these guidelines, the walleye fishery on Lac Ste. Anne was classified as collapsed in 1997, and angling was restricted to catch-and-release only (i.e., zero bag limit). Similarly, the northern pike fishery on the lake was designated as stable in 1999 and anglers were restricted to a possession limit of three northern pike, each with a minimum size limit of 630 mm TL. This report presents data on angling pressure and population structure of walleye and northern pike in Lac Ste. Anne collected during a creel survey on the lake from 20 May to 20 August 2006. These data will be used to assess the efficacy of these regulation changes in restoring the walleye and northern pike fisheries.

During 2006, angling effort at Lac Ste. Anne was estimated at 7,030 anglers and 20,122 angling-h and angling pressure was 3.4 h/ha. Compared to previous creel surveys, angling pressure during this survey was lower than the mid 1980s but higher than the mid-1990s and early 2000s.

Approximately 30,744 walleye were caught and released by anglers with a yield of 0.219 kg/ha, assuming walleye had an incidental mortality of 5.3%. Anglers reported catching 1.55 walleye/h. The age-class distribution of walleye collected during a recent gillnetting survey included ages-0, 1, and 4 to 10 with ages-6 and 7 dominating the catch. The length distribution from test angling was very similar to the gillnetting sample and both indicated a rather narrow distribution; 370 – 564 mm TL and 376 – 520 mm TL, respectively. Walleye reached 500 mm FL by age-6. The structure and growth rate indicate either a slower growth / higher density population or an altered population caused by excessive mortality of larger fish.

Only two pike were observed harvested by anglers and 3,769 pike were estimated to be released. Yield of pike was 0.062 kg/ha, assuming pike had similar incidental mortality to walleye. Catch rate of pike was reported to be 0.19 pike/h. Test angling samples were used to describe the pike sport fishery. Length of pike caught ranged from 307 to 633 mm TL. Only one legal-length pike was sampled. The age distribution was primarily supported by ages-3 to 5. Pike grew to 630 mm FL by age-5 or 6. The low catch/h and the truncated structure of the population indicates an altered population possibly caused by excessive harvest (primarily incidental mortality).

ACKNOWLEDGEMENTS

The Alberta Conservation Association funded this work. I thank Troy Furukawa and Mike Paplawski for conducting the field component of this work; interviewing anglers on land and water, and test angling. I also thank Alberta Sustainable Resource Development (ASRD), particularly Stephen Spencer and Dr. Michael Sullivan for collaborating on the survey's methods and analysis. I also thank the Summer Village of Alberta Beach and Warwa Estates for their hospitality in conducting creel surveys at their access points. I am also grateful to the anglers who contributed their time and fish to this study. I acknowledge Stephen Spencer, Owen Watkins and Shane Wood for their thorough reviews of this paper.

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1.0 INTRODUCTION

Prior to the mid 1990s, high angling pressure, combined with high fish harvest rates, resulted in the over-harvest of walleye (*Sander vitreus*) and northern pike (*Esox lucius*) populations in several lakes in Alberta (Sullivan 2003). To aid the recovery of these fisheries, Alberta Sustainable Resource Development (ASRD) implemented two new management strategies, Alberta's Walleye Management and Recovery Plan (WMRP) in 1996 and Alberta's Northern Pike Management and Recovery Plan (NPMRP) in 1999 (see Berry 1995, 1999). Through strategies identified in these two recovery plans, the fishery at each lake was assigned one of three management status categories: 1) collapsed, 2) vulnerable, or 3) stable. Sport fishing regulations on individual lakes were then modified according to the status assigned (Sullivan 1998). Using criteria in the WMRP, the walleye sport fishery on Lac Ste. Anne was classified as vulnerable in 1996 and anglers were restricted to a maximum harvest of three walleye (i.e., possession limit), each with a minimum size limit of 500 mm fork length (FL). Based on results of a creel survey conducted in 1997, the walleye sport fishery was re-classified as collapsed and the regulation was changed to a zero possession limit (catch-and-release fishery). Similarly, based on the NPMRP criteria, the northern pike fishery on the lake was designated as a stable-recreational fishery in 1999 and anglers were restricted to a possession limit of three northern pike, each with a minimum size limit of 630 mm total length (TL).

This report presents the results of a creel survey at Lac Ste. Anne conducted during the summer of 2006 using access point and roving surveys. Creel surveys are a non-invasive technique that can effectively estimate parameters required for management of a sport fishery (e.g., angling effort, sport fish yield, and sport fish structure and abundance).

2.0 STUDY AREA

Lac Ste. Anne (E670534, N5953243 UTM, Zone 11, NAD 83) is a 5,600 ha eutrophic lake located approximately 100 km west of Edmonton, Alberta (Government of Alberta Internet Mapping Framework). Lac Ste. Anne has a highly developed shoreline with

several residential developments, including summer villages, campgrounds, day-use areas and boat-launches (Figure 1). The lake is a double-basin lake separated by narrows. The west basin is considerably smaller than the east basin. Lac Ste. Anne is located in the North Saskatchewan River Basin and is fed and drained primarily by the Sturgeon River. A more complete description of the physical, chemical and biological characteristics of Lac Ste. Anne are provided in Mitchell and Prepas (1990).

3.0 METHODS AND MATERIALS

3.1 Study design

The primary purpose of the survey was to conduct a creel survey to assess changes in the sport fishery since the previous survey. Two creel survey technicians conducted access point and roving surveys (Pollock et. al 1994). Surveys were conducted from 20 May to 20 August 2006. Creel survey sites were spatially distributed at boat launches at Alberta Beach and Warwa Estates located in the east and west basins, respectively, and, at the Narrows (i.e., instantaneous counts of anglers were recorded during ratio-of-use (ROU) surveys). Anglers who fished from Alberta Beach or Warwa Estates (i.e., catch rate, angling-trip length) were assumed to be representative of anglers who fished the Narrows and who were counted during ratio-of-use surveys (see Section 3.1.1).

The creel survey activities were temporally distributed between weekend days (i.e., Saturday, Sunday and statutory holidays), weekdays (i.e., Monday – Friday), AM and PM shifts (i.e., 0800 – 1500 h and 1500 – 2300 h, respectively). The creel crew completed 16 shifts. Each shift consisted of five survey days (i.e., Thursday to Monday) and was followed by two days of rest (i.e., Tuesdays and Wednesdays).

Survey technicians collected biological data from fish that were harvested by anglers. Data collected included fork length (FL, ± 1 mm), total length (TL, ± 1 mm), total weight (± 10 g), ageing structures (for pike), sex and state of maturity. Ageing structures included the left cleithrum and the first three rays of the left pelvic fins. Ages of pike were determined according to Mackay et al. (1990). Sex and state of maturity of pike were determined using Duffy et al. (2000).

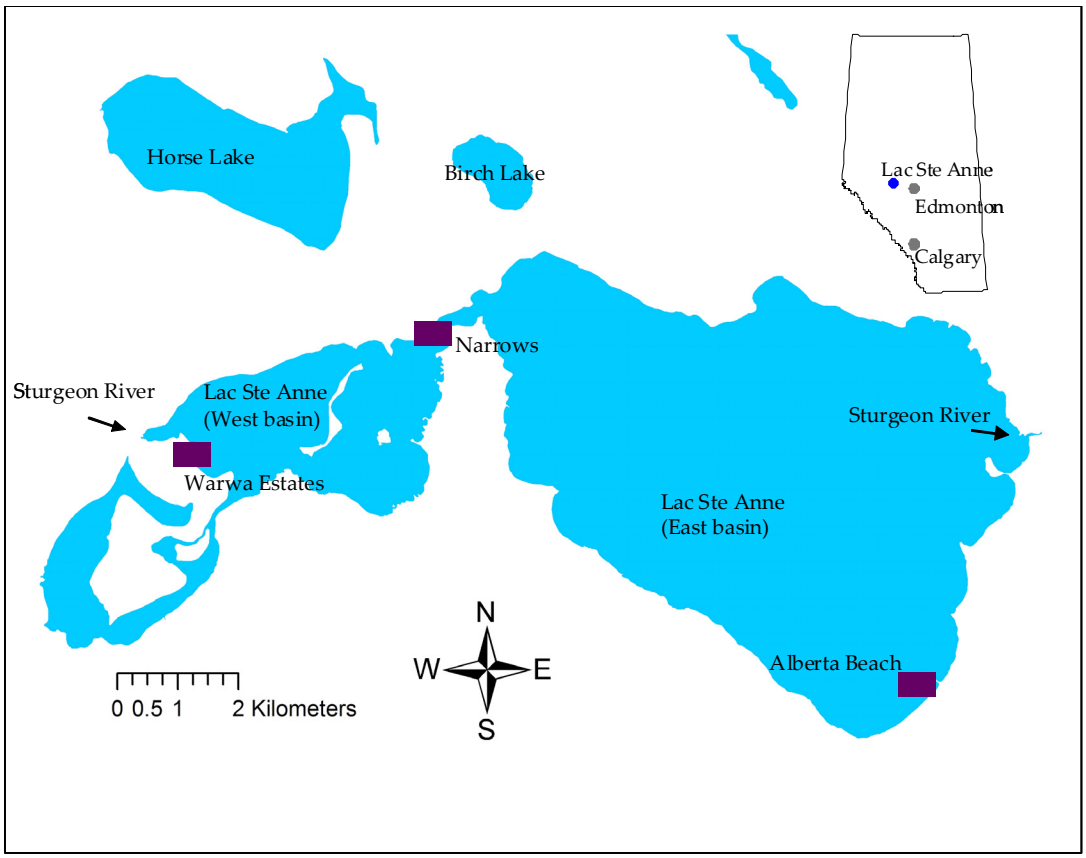

Figure 1. Map of Lac Ste. Anne indicating the Alberta Beach, Warwa Estate and the Narrow's creel survey sites (purple dots). The flow of the Sturgeon River is indicated by black arrows. Inset is a map of Alberta indicating the location of the lake within the province.

3.1.1 Ratio-of-use surveys

Sixteen ROU surveys were conducted during the survey period using a boat. Survey technicians interviewed anglers as they were randomly encountered on the lake. The ROU interview included the same questions (i.e., creel data) as the site access surveys (e.g., catch rate, trip length), but anglers were also asked the location of their angling party's boat landing (i.e., where the boat / angling party would exit the lake at the end of their trip). Data collected from ROU surveys were used to extrapolate data collected from creel survey sites to unsurveyed spatial strata (i.e., other access points). The ROU surveys had the same temporal stratification as the access site creel surveys. For safety reasons, ROU surveys were conducted by two creel technicians.

3.2 Instantaneous counts of anglers at the Narrows

Instantaneous counts of anglers were incorporated into the creel survey design to facilitate estimating angling effort at the Narrows. To calculate effort, instantaneous counts utilize counts of anglers extrapolated to the number of hours in a fishing day. Total catch was not estimated directly, because (incomplete) interviews document only part of the angling trip and therefore are biased toward length-of-stay. Hence, angling effort was calculated as the product of effort or angling-hours and catch rate (fish/h) (i.e., angling-h multiplied by fish/h) following Pollock et. al (1994). To estimate angling effort and catch at the Narrows, the angling day was assumed to be 13 h long. Based on creel data that was collected at Alberta Beach and Warwa Estates, a 13-h angling-day was reasonable; anglers were only observed completing their angling trips from 0900 - 2200 h.

3.3 Analysis

Catch rates were calculated as total ratio estimators following Malvestuto (1983). Specifically, release rates were calculated from the total catch and total number of angler-hours reported by anglers to creel clerks.

Field data were recorded on field data forms (Appendix 1) by creel clerks and then transcribed into Microsoft Excel files by a professional data entry service using double

entry verification. Prior to reporting, frequency distributions of each creel survey parameter were plotted and the original datasheets and creel daily journals used to investigate and verify outliers. Scatterplots of weight-length and length-age were generated to identify outliers. Outliers were identified visually and omitted if measurement or recording error was suspected.

Data collected during the access-site creel surveys were extrapolated using ROU surveys to spatial strata that were not surveyed (e.g., other access sites). Data and estimates were simulated as likelihood profiles, using the procedure described below. Bootstrap techniques were used to estimate mean (and associated uncertainty) angling effort, catch, and yield of walleye and pike, following procedures in Haddon (2001). Bootstrapping is a statistical procedure commonly used to randomly re-sample population data to obtain a new mean. Bootstrap samples are assumed to approximate the distribution of values that would have arisen from repeatedly sampling the original population (Haddon 2001). Repeated sampling thousands of times produces a distribution of possible means that describes the likelihood of the true (population) mean being within that distribution (i.e., likelihood profile). The analyses for this study used 5,000 bootstraps and were done using Microsoft Excel. The distribution of bootstrapped means quantifies the uncertainty around the sample mean (Sullivan 2004). The final proportions (i.e., probability densities) were standardized to range between 0 and 1 (Paul et al. 2003). Empirical confidence intervals (95% CI) were calculated from the bootstrap data following Haddon (2001).

3.3.1 Total estimates excluding the estimates for the Narrows

Parameters (e.g., hours, catch) obtained from the access point creel surveys were extrapolated to include temporal and spatial strata that were not surveyed (Figure 2). Each parameter was represented as a likelihood profile, using the simulation procedure described above. The estimates calculated from each access point were combined and averaged to calculate estimates for both access sites. These combined estimates were then multiplied by the ROU to extrapolate the combined estimates to unsurveyed access points. A flow chart describing this calculation is presented in Figure 2. Estimates of angling effort at the Narrows were added to each estimate.

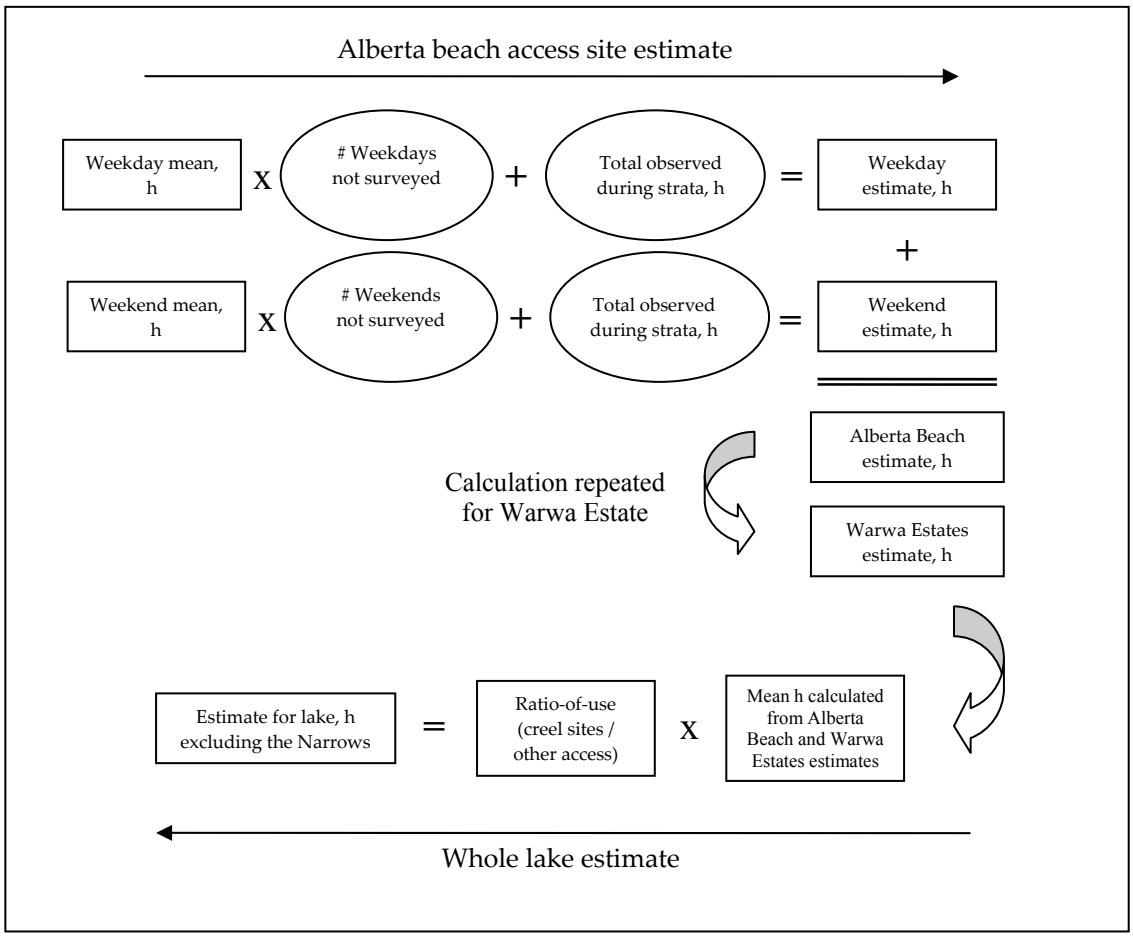

Figure 2. A flow chart outlining the process used for extrapolating parameters (e.g., hours) from the access site surveys and ROU surveys into a whole lake estimate. Circles represent values with no variance (i.e., known values or observed data) and rectangles represent data with variation (i.e., likelihood profiles). The parameter hours was used as an example in the flow chart.

3.3.2 Estimates for the Narrows

Effort at the Narrows was based on counts of anglers extrapolated to the number of hours in a fishing day (Pollock et. al 1994). Anglers at the Narrows were not interviewed because of the unequal probability with which anglers are encountered and the assumptions that underlie estimations of catch. These assumptions apply to the Narrows and include 1) anglers' catch rate is constant and 2) the catch rate of the interviewed anglers is equal to that of non-interviewed anglers (Pollock et al. 1994). These assumptions are vital because related estimates depend on the accuracy of the

catch rate and the calculated effort. To estimate catch (Figure 3), it was assumed the anglers at the Narrows had the same success (i.e., catch rate, fish/h) as the anglers surveyed at the access points. Since the mean trip length (± SE) from the creel sites (2.9 ± 0.09 h, n = 382) was virtually identical to the provincial mean (2.8 ± 0.10 h, n = 47), the survey's mean trip length was used to estimate the number of anglers at the Narrows (i.e., angling effort divided by trip length). These estimates were simulated using the bootstrapping procedure described above.

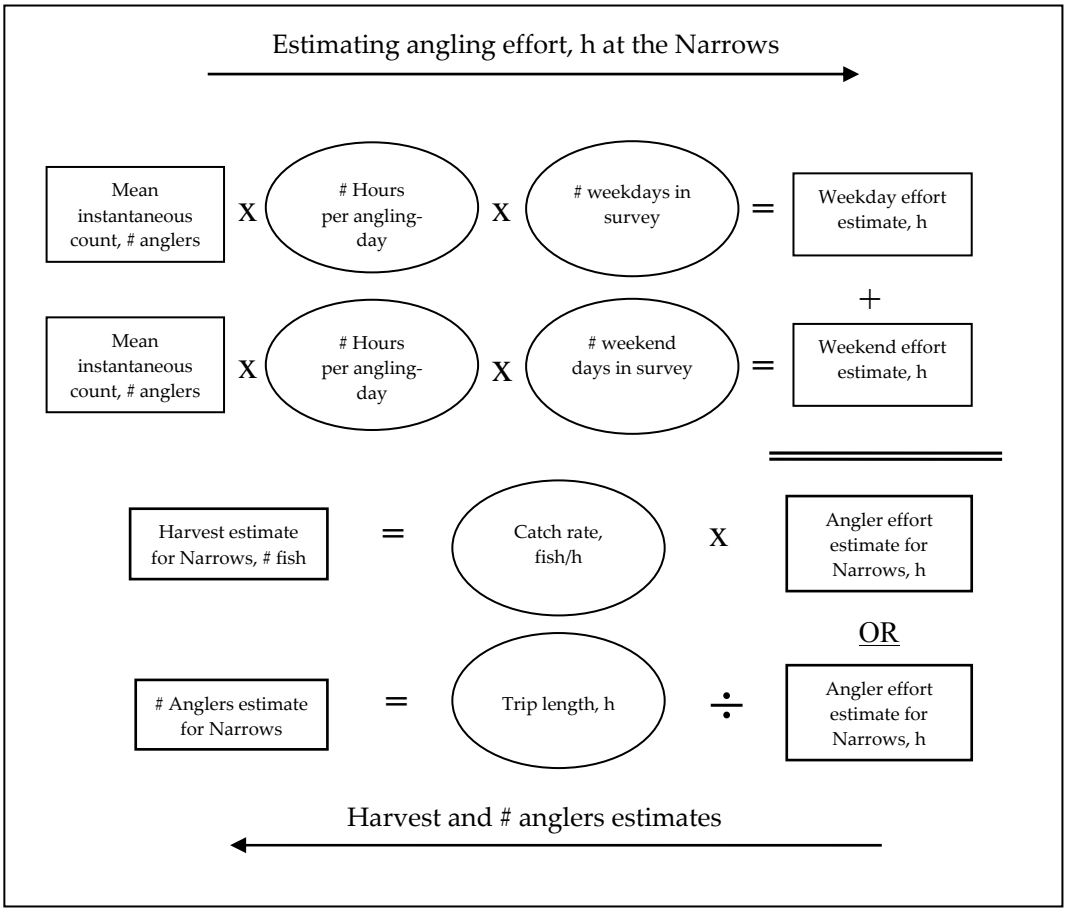

Figure 3. A flow chart outlining the processes for calculating angling effort, harvest and number of anglers at the Narrows. Instantaneous count data collected during ROU surveys were used. Circles represent values with no variance (i.e., known values or observed data) and rectangles represent data with variation (i.e., likelihood profiles).

3.3.3 Total estimates including the Narrows

Whole lake estimates (i.e., from access sites) were combined with estimates from the Narrows to provide total lake estimates (Figure 4).

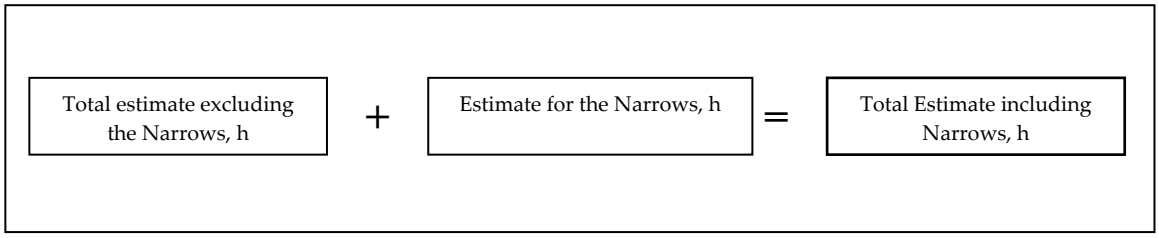

Figure 4. A flow chart outlining the process for calculating total lake estimates on Lac Ste. Anne, 2006. Rectangles represent data with variation (i.e., likelihood profiles).

3.4 Test angling

Since sport anglers were required to release all walleye and also pike that were shorter than the 630 mm TL minimum-size limit, test angling was conducted throughout the survey period to collect additional information from each population. Test anglers consisted of creel clerks, as well as Alberta Conservation Association (ACA) and ASRD staff, all of varying skill level, fishing for walleye and pike using lures, baits, and techniques that would normally be used in the sport fishery. Test anglers recorded the number of hours fished, and the FL (± 1 mm) and TL (± 1 mm) of fish caught. Ageing structures collected included the first three rays of the left pelvic fin for walleye and pike. All test-angled fish were released. To calculate yield (i.e., fish kg/ha), weights of test-angled fish were estimated using the equations below for walleye and pike, respectively. The equation for walleye was derived from a stock assessment for walleye at Lac Ste. Anne (Watkins 2006) and the equation for pike was derived from data collected from creel surveys in 1989 (Archived data). The test angling catch rate was not included in any of the sport angler catch or effort calculations.

Walleye $WT = 6E - 06(FL)^{3.0873}$, $r^2 = 0.99$, $df = 248$, $P < 0.01$, where $6E - 06 = 0.000006$
Northern Pike $WT = 2E - 05(TL)^{2.9762}$, $r^2 = 0.96$, $df = 261$, $P < 0.01$, where $2E - 05 = 0.00002$

With no harvested walleye observed during the survey, the test angling data for both walleye and pike were used to determine length- and age-structure. At the time of this report, the ages from the walleye test angling sample were not determined. Therefore, age of test angled fish was estimated using the following equation derived from data from a recent walleye stock assessment at Lac Ste. Anne (Watkins 2006).

$Age = 6E - 06(FL)^{2.3234}$, $r^2 = 0.76$, df = 226, $P < 0.05$, where 6E – 06 = 0.000006

3.5 Yield

Sport harvest and incidental yield were estimated using calculated weights. For incidental yield (i.e., hooking mortality), it was assumed that the size of fish caught and released were the same as those caught by test angling. Therefore the lengths of walleye and pike measured and released by test angling were converted to weights using the equations in Section 3.4.

Incidental mortality from catch-and-release handling and injuries contributes to the overall yield of sport fish. For walleye, a mean incidental mortality was calculated from incidental mortalities collected from nine previous creel surveys following a multivariate analysis suggested by Reeves (2004). Reeves (2004) used a multiple regression approach to calculate incidental mortality from month of capture, incidental hook location (e.g., stomach, gill, inner mouth), capture depth, water temperature, length category of walleye caught, angling gear (e.g., bobber, crank bait), and hook type (e.g., jig, treble). It seemed reasonable to assume that pike and walleye had similar incidental mortality since pike typically had mortalities under 15% (Muoneke and Childress 1994). Yield estimates were determined by multiplying the incidental mortality estimate by the estimate of fish released and the mean estimate of weight per fish.

All data from the 2006 creel survey were stored in the Fisheries Management Information System (FMIS) database maintained by ASRD.

4.0 RESULTS

During the creel survey, two pike were observed harvested and no walleye were observed harvested. During test angling, 254 walleye and 109 pike were sampled. During the creel survey, a total of 382 anglers were interviewed at both creel access sites and reported fishing for 1,126.5 h (Appendices 2, 3, and 4). These anglers reported releasing 1,747 walleye and 211 pike. Catch rates were 1.55 walleye/h and 0.19 pike/h. In addition, on 21 May 2006, ASRD Fish and Wildlife Division officers collected creel data from 14 anglers on Lac Ste. Anne. Although the ASRD survey was less intensive, the 14 anglers reported similar catches as anglers interviewed during our more intensive creel survey (i.e., 51 walleye and seven pike in 29.5 h or 1.70 walleye/h and 0.24 pike/h).

The angler survey period at Lac Ste. Anne was 92 days from 20 May to 20 August 2006 consisting of 66 weekdays and 26 weekend days. At Alberta Beach, 6 (9%) weekdays and 7 (27%) weekend days were surveyed. At Warwa Estates, 8 (12%) weekdays and 5 (19%) weekend days were surveyed. For ROU surveys, 19% and 31% of weekday surveys were conducted during the AM and PM strata, respectively. Similarly, weekend surveys consisted of 13% and 38% AM and PM strata, respectively. Thirteen instantaneous counts of anglers surveyed 17% (208 hourly strata) of the possible 1,196 hourly strata (i.e., 92 survey days x 13 angling-h per day). The mean number of anglers at the Narrows during weekend days and weekdays was 13.2 (SE = 3.6; n = 5) and 4.8 (SE = 0.8; n = 8), respectively. Even though only 17% of the possible hourly strata were surveyed, the mean number of anglers was fairly consistent. Table 1 provides the instantaneous counts of anglers at the Narrows.

Table 1. Instantaneous counts of anglers at the Narrows collected during ratio-of-use surveys, Lac Ste. Anne, 2006.

Date	Day	Anglers at Narrows
06/02/2006	Friday	2
06/05/2006	Monday	5
06/10/2006	Saturday	16
06/18/2006	Sunday	25
06/19/2006	Monday	8
06/22/2006	Thursday	8
06/23/2006	Friday	3
07/01/2006	Saturday	14
07/03/2006	Monday	11
07/06/2006	Thursday	4
07/09/2006	Sunday	6
07/21/2006	Friday	3
08/19/2006	Saturday	5

The ROU surveys indicated that both creel survey sites provided similar levels of access to the fishery; 27% and 23% of anglers accessed the lake from Alberta Beach and Warwa Estates, respectively (Table 2). A total of 382 anglers were interviewed at both sites. These anglers reported fishing for a total of 1,126.5 h. The mean trip length (h, ± SE) of anglers surveyed at Alberta Beach and Warwa Estates were 2.8 ± 0.11 h (n = 258) and 3.3 ± 0.18 h (n = 124), respectively. The mean trip length for both sites was 2.9 ± 0.09 h (n = 382).

Table 2. Ratio-of-use surveys conducted and the percentage of anglers accessing the lake from Alberta Beach and Warwa Estates creel survey sites, Lac Ste. Anne, 2006.

Date	Ratio-of-use Alberta Beach	Warwa Estates	Other access sites
05/20/2006	6	7	5
05/22/2006	18	5	25
05/28/2006	4	13	9
06/02/2006	1	1	2
06/10/2006	7	6	13
06/18/2006	2	3	5
06/19/2006	4	2	0
06/22/2006		10	6
06/23/2006		2	6
07/01/2006	19	9	27
07/03/2006	8	4	25
07/06/2006	5		1
07/09/2006	6	3	5
07/21/2006	6		8
08/05/2006		8	15
08/19/2006	2		10
Total	88	73	162
Percentage	27	23	
Grand Total			323

4.1 Angling effort and pressure

The estimates of angling effort (i.e., angling-trips and angling-hours) for Alberta Beach and Warwa Estates were similar (Table 3 and Appendices 5 and 6). Based on data from these two sites (excluding the Narrows), the estimated number of angling-trips was 3,914 (95% CI = 2,930 – 5,053 trips, n = 26). The number of angling-hours and the associated angling pressure were 11,445 angling-h (95% CI = 8,161 – 15,180 angling-h, n = 26) and 2.0 h/ha (95% CI = 1.5 – 2.7 h/ha, n = 26), respectively.

Table 3. Observed and estimated angling effort calculated for Alberta Beach and Warwa Estates during the creel survey, Lac Ste. Anne, 2006.

	Observed angling-trips	Observed angling-h	Estimated angling-trips (95% CI)	Estimated angling-h (95% CI)
Alberta Beach	258	720.25	4,384 (3,135 – 5,951)	11,661 (8,062 – 16,043)
Warwa Estates	124	406.25	3,444 (2,039 – 5,176)	11,230 (6,027 – 17,265)
Total [Mean]	382	1,126.50	[3,914] (2,930 – 5053)	[11,445] (8,161 – 15,180)

At the Narrows, the **e**stimated number of angling-trips during the creel survey period was 3,117 (95% CI = 2,264 - 4,095 angling-trips, n = 13, Appendix 7). The number of angling-hours and angling pressure were 8,390 angling-h (95% CI = 6,153 – 10,858 angling-h, n = 13) and 1.5 h/ha (95% CI = 1.1 – 1.9 h/ha, n = 13), respectively. Estimates calculated for the whole lake (including the Narrows) are 7,030 angling-trips (95% CI = 5,713 – 8,551 angling-trips, n = 29, Appendix 8), 20,122 angling-h (95% CI = 15,870 – 24,421 angling-h, n = 29, Appendix 8), and an angling pressure of 3.4 h/ha (95% CI = 2.8 – 4.4 h/ha).

4.2 Walleye yield and population structure

4.2.1 Walleye yield

The entire walleye yield (catch-and-release angling) was estimated at 30,744 walleye (95% CI = 24,599 – 37,853 walleye, n = 29). The estimated mean weight of a walleye caught and released was 0.740 kg/fish (95% CI = 0.688 – 0.796 kg/fish, n = 254). Assuming incidental mortality of walleye was 5.3% (95% CI = 4.2 – 6.6%, n = 9), the estimated number of fish that died as a result of being caught and released was 1,647 (95% CI = 1,036 – 2,498 fish) or a yield of 0.219 kg/ha (95% CI = 0.127 - 0.355 kg/ha).

4.2.2 Walleye population structure

The age-class distribution of walleye in Lac Ste. Anne (Figure 5) indicates recruitment of fish ages-0 and 1. However, when these age–classes were excluded from the distribution (they are not vulnerable to angling), the distribution becomes narrow and represented by ages-4 to 10. The population is primarily supported by walleye age-6 and 7 with a mean age of 6.8 y (SE = 0.14, n = 248)

The length distribution from test angling was similar to the gillnetting sample, excluding the fish < 300 mm TL (Figure 6 and 7). The length-class distribution, as sampled by test angling, was narrow and ranged from 370 – 564 mm TL with a mean length of 443 mm TL (SE = 2.2, n = 254). The length distribution measured from the gill netting project (Watkins 2006), excluding ages-0 and 1, ranged from 376 to 520 mm with a mean TL of 428 mm (SE = 1.8, n = 224).

Walleye reached 500 mm fork length (FL) by age-6 (Figure 8). According to the WMRP, the length-at-age was moderate which may indicate a higher density of walleye. However, with few large walleye (i.e., > 500 mm FL) in the sample, the length-at-age relationship may also indicate an altered population caused by excessive mortality of larger fish from size-selective fishing (Ricker 1969).

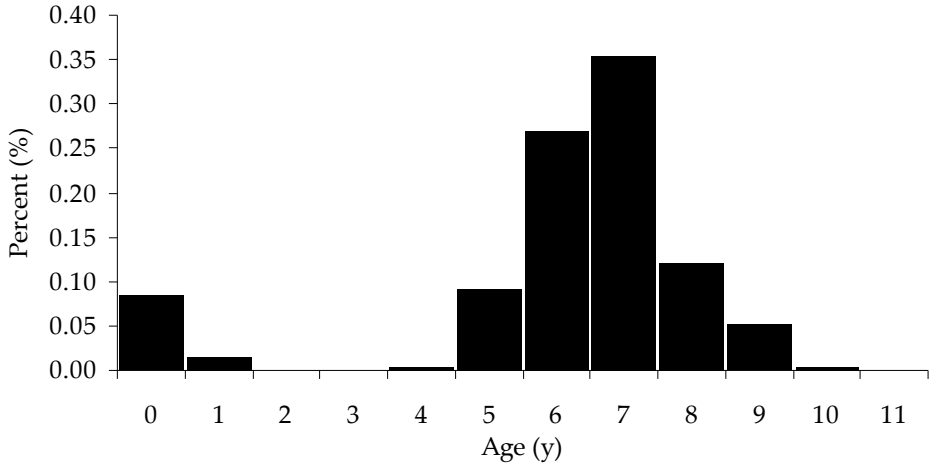

Figure 5. Age-class distribution of walleye sampled during a fall walleye index netting (FWIN) project at Lac Ste. Anne, 2006.

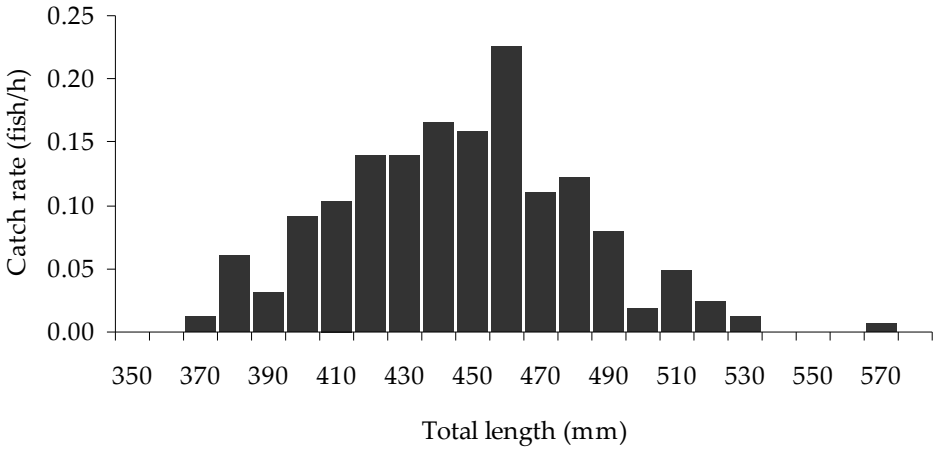

Figure 6. Length-class distribution of walleye sampled using test angling at Lac Ste. Anne, 2006.

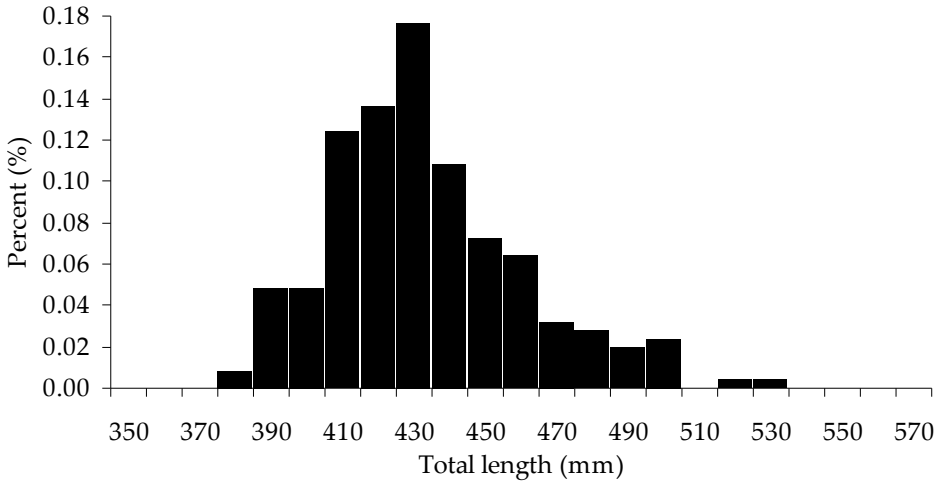

Figure 7. Length-class distribution of walleye sampled during a gillnetting project (Watkins 2006) at Lac Ste. Anne, 2006.

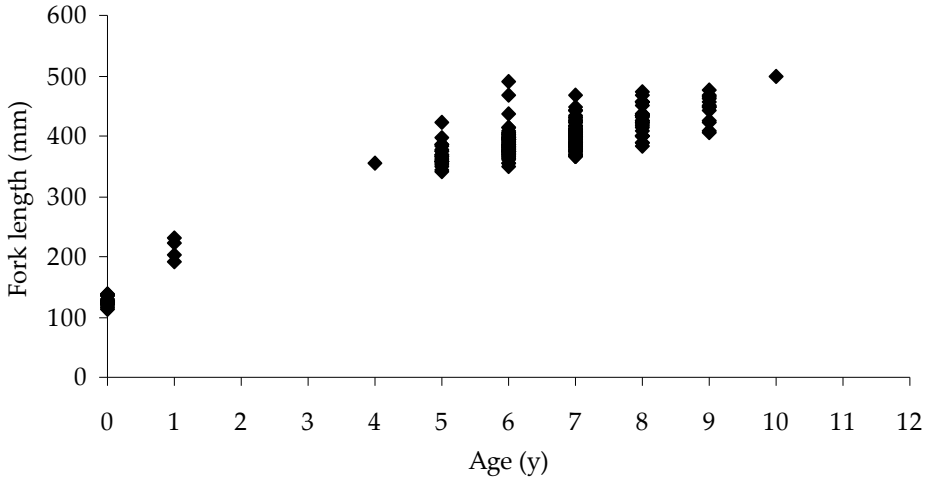

Figure 8. Walleye length-at-age data (Watkins 2006).

4.3 Northern pike yield and population structure

4.3.1 Pike yield

The majority of the pike yield was related to incidental mortality. Only two pike were observed harvested during the creel survey and 211 were reported released, resulting in catch rates of 0.002 kept/h and 0.19 released/h, respectively. Estimated angler harvest during the survey was 40 pike (95% CI = 32 – 49 pike, n = 29). Estimated mean weight of pike larger than 630 mm TL, the minimum harvestable size, was 3.910 kg (95% CI = 1.803 – 6.703 kg, n = 4), resulting in a yield of 0.029 kg/ha (95% CI = 0.010 - 0.058 kg/ha).

Anglers released 3,769 pike (95% CI = 3,015 – 4,640 pike, n = 1,530, n = 29) with an estimated mean weight of 0.991 kg/fish (95% CI = 0.896 – 1.131 kg/fish, n = 109). Assuming pike had the same incidental mortality as walleye (5.3%), the estimated additional number of fish that died as a result of being caught and released was 202 fish (95% CI = 127 – 306 fish) with a yield of 0.036 kg/ha (95% CI = 0.020 - 0.062 kg/ha). Consequently, the estimated total yield of pike was 0.062 kg/ha (95% CI = 0.031 - 0.120 kg/ha).

4.3.2 Pike population structure

As per the NPMRP, the age-class distribution of pike was unstable (i.e., wide ranging densities) and truncated with ages-1 through 6 and age-10 being represented (Figure 9). Pike of ages-3, 4 and 5 supported the fishery. Comparatively, ages-1, 2, 6 and 10 pike were much less abundant (< 0.02 pike/h). The mean age of pike sampled was 4 y (SE = 0.10, n = 108).

The length-class distribution showed pike ranged in size from 307 – 633 mm TL with a mean of 526 mm TL (SE = 5.0, n = 109, Figure 10). Only one legal-size pike was sampled by test angling. Pike in Lac Ste. Anne grew to the minimum harvestable size (630 mm TL) by ages-5 and 6 (Figure 11). According to the NPMRP, this moderate length-at-age indicates a fishery of moderate abundance; however, the low catch rate and the scarcity of pike > 630 mm TL likely indicates excessive harvest.

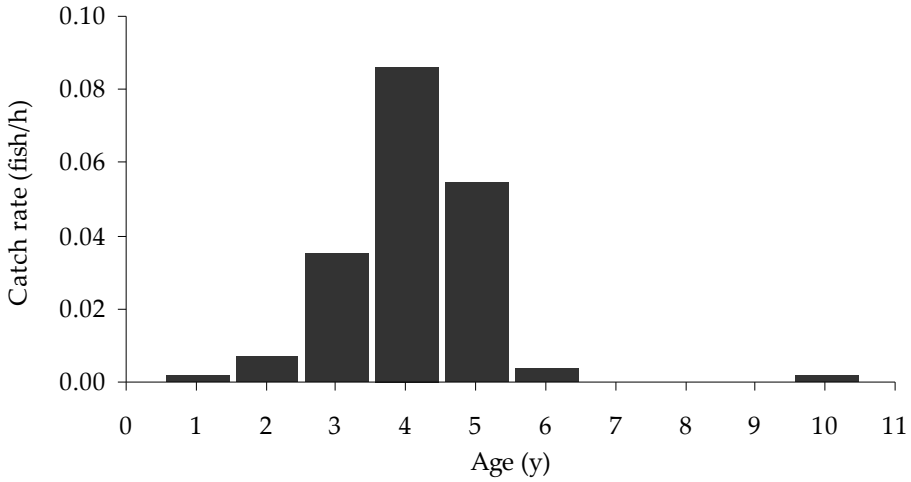

Figure 9. Age-class distribution of pike caught during test angling at Lac Ste. Anne, 2006.

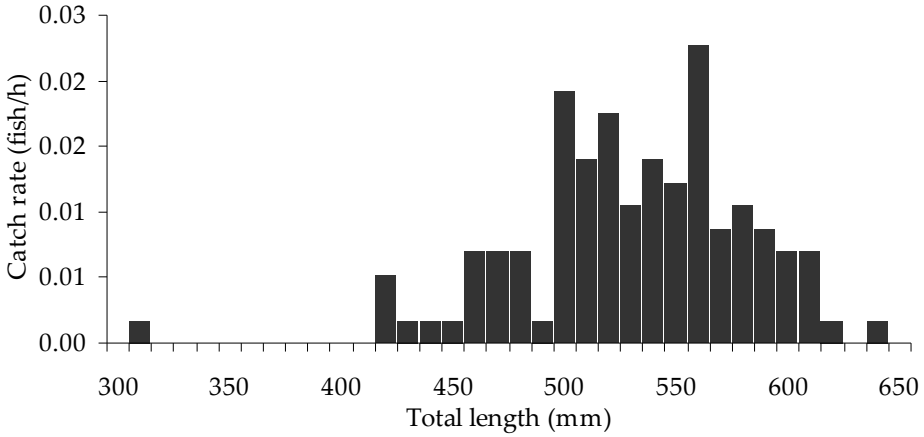

Figure 10. Length-class distribution of pike caught during test angling at Lac Ste. Anne, 2006.

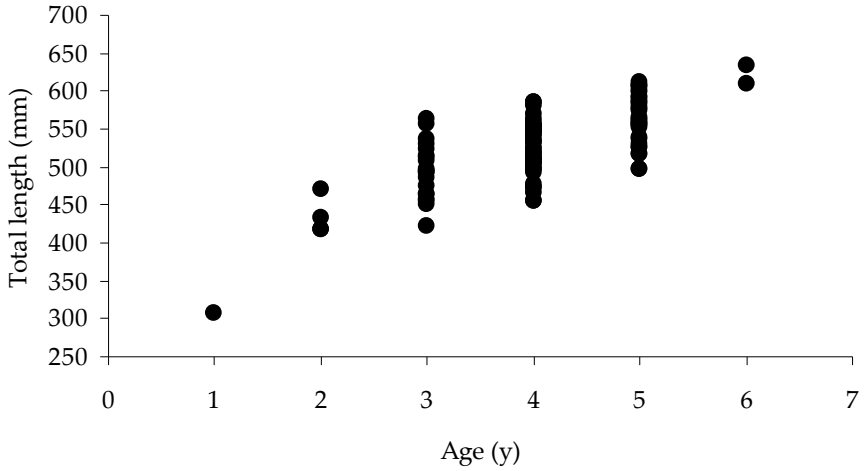

Figure 11. Length-at-age of pike caught by test angling at Lac Ste. Anne, 2006.

4.4 General summary

The characteristics of Lac Ste. Anne and its sport fishery required a complicated creel survey design. The design was successful at quantifying angling pressure and collecting catch data and biological data that described both the walleye and pike sport fisheries.

Both Alberta Beach and Warwa Estates provided similar access to the sport fishery; 27% and 23%, respectively. Overall, angling pressure has declined since the 1984 and 1995

surveys (Figure 12). Conversely, angling pressure estimated from this survey is higher than the 1997 and 2001 surveys. The angling pressure at Lac Ste. Anne is low compared to other lakes in the province (Figure 12). This result is somewhat misleading as fish populations at larger lakes, such as Lac Ste. Anne, are more vulnerable to angling because fish and anglers are concentrated into more productive habitat (Lester et al. 2003) and large increases in angling effort are incremental increases in angling pressure. The increase in pressure may indicate an improvement in the state of the walleye fishery and / or the expanding human population in Alberta.

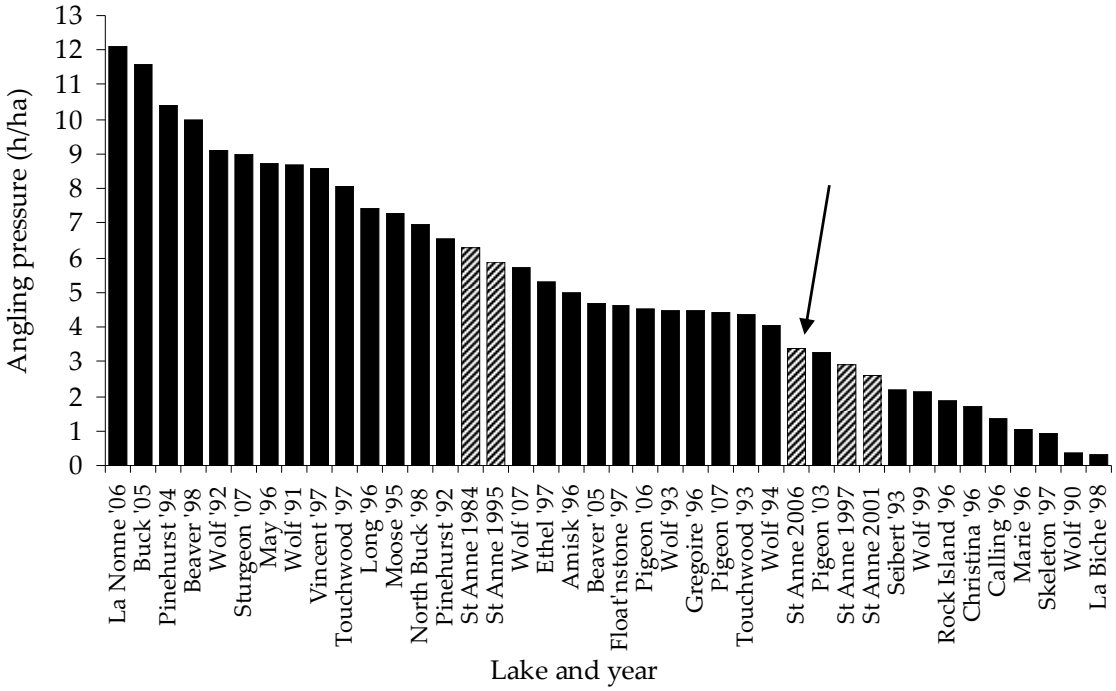

Figure 12. Angling pressure at Alberta lakes from creel surveys conducted from the 1980s to 2000s. Lac Ste. Anne creel surveys are indicated by the hash marks and the 2006 survey is indicated by the arrow. All data points are from creel surveys conducted during the summer from mid-May to late August.

Much of the yield of walleye and pike was related to catch-and-release mortality. Approximately 31,000 walleye and 3,769 pike were caught and released during the survey period. This activity resulted in yields of 0.219 kg/ha and 0.062 kg/ha of walleye and pike, respectively.

Data collected from the sport fishery, test angling and a recent gillnetting survey provided abundance and structure information on the walleye and pike populations. Anglers reported catching 1.55 walleye/h. The age-class distribution was represented by ages-0, 1, and 4 to 10 and primarily supported by walleye of ages-6 and 7. The length distribution from test angling and gillnetting were very similar and both indicated a narrow distribution of sizes; 370 – 564 mm TL and 376 – 520 mm TL, respectively. Walleye length-at-age was moderate according to the WMRP. This length-at-age may indicate a fair density of walleye and / or excessive mortality of larger fish. The higher catch rate supports the notion of a high density of walleye and the truncated length and age distributions indicate an absence of large walleye likely due to excessive mortality from angling.

The catch rate of pike was reported to be 0.19 pike/h and only two pike were observed harvested during the survey. Test angling was used to describe the pike sport fishery. The length of pike caught ranged from 307 – 633 mm TL and only one legal-length pike was sampled. According to the NPMRP, both the age and length distributions were narrow and unstable. The length-at-age of pike indicates a moderate density; however, the altered population structure and the low catch rate indicate an exploited population.

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6.0 APPENDICES

Appendix 1. Field data form used at Lac Ste. Anne, 2006.

Special Harvest License Regulation Monitoring 2006

Creel Data Sheet

Lake (circle one): Pigeon, Lac Ste Anne, Newell, Wolf

Alberta Conservation Association

Alberta SUSTAINABLE RESOURCE DEVELOPMENT

Sheet Rules:
- No blank spaces
- No french 7s
- Print clearly
- Verical lines = As above... be careful with start and end of line
- Horizontal line = Zeros... be careful with start and end of line
- Total each sheet for daily summaries

Field
MM / DD
Day Code
Time of day 24h clock e.g.,3:00pm =15 (i.e., hour + 12)
1/4 hrs = 0, 25, 5, 75
Party # i.e. 017
Angler number (number each angler within each party 1- #
Tag license holder? No=0, <43=1, 43-50=2, >50=3
Did you fish lake last summer? No=0, Yes=1
How many trips this season (including this one)? 0 -##
Hours fished 10's
Hours fished 1's
1/4 hrs fished= 0, 25, 5, 75
Nearest City or Town to residence (POSTAL CODE)?
WALL KEPT
WALL RELEASED <43
WALL RELEASED 43-50
WALL RELEASED >50
WALL RELEASED UNKNOWN SIZE (Non-Tag Anglers)
NRPK KEPT
NRPK RELEASED
YLPR KEPT
YLPR RELEASED
Angling Method
Target
Skill
Electronics
COMMENT
Landing…"At the end of your trip, where is the boat going to touch land?" **ONLY FILL IN DURING ROUS**

TOTALS>>>>>>>

Page: ____

Day Code
1 = Monday
2 = Tuesday
3 = Wednesday
4 = Thursday
5 = Friday
6 = Saturday
7 = Sunday
8 = Holiday

Method
1 = Artificial (plug, spoon, jig)
2 = Leeches
3 = Baitfish
4 = Dewworms
5 = Scentbaits
6 = Other (list in COMMENT)

Target
1 = WALL
2 = NRPK
3 = YLPR
4 = LKWH
5 = BURB
6 = ANYTHING

Skill
1 = Novice
2 = Average
3 = Pro
4 = Guided
5 = Test Angling

Electronics
0 = None
1 = Depth Sounder
2 = Depth Sounder + GPS
3 = GPS
4 = Other (List in COMMENT)

Residence Code
1 = Edmonton Area
2 = Calgary Area
3 = Calgary east Area
4 = Red Deer Area
5 = Lethbridge Area
6 = Medicine Hat Area
7 = Rocky Mtn House / Sundre Area
8 = Stettler / Drumheller Area
9 = Vegreville / Hardisty Area
10 = Hardisty / Hanna Area
11 = Drayton Valley Area
12 = Edson / Hinton Corridor
13 = Mayerthorpe / Whitecourt / Fox Ck Corridor
14 = Grande Prairie / Grande Area
15 = Peace River / Lesser Slave Area
16 = High Level
17 = Smoky Lake / St Paul Area
18 = Lac La Biche Area
19 = Bonnyville / Cold LK Area
20 = Ft McMurray Area
21 = Athabasca / Barrhead Area
22 = Out of Province
23 = USA
24 = Other Country

20 anglers per sheet

Appendix 2. Summary of data collected from the Alberta Beach access site at Lac Ste. Anne, 2006. Species codes: WALL = walleye, NRPK = northern pike, YLPR = yellow perch; Rel = released.

Date	# Anglers	# Hours	WALL Kept	WALL Rel	NRPK Kept	NRPK Rel	YLPR Kept	YLPR Rel
05/21/06	47	159	0	216	0	5	0	0
05/26/06	3	7.5	0	4	0	4	0	0
05/27/06	18	35	0	53	0	3	0	0
06/01/06	8	14	0	2	0	6	0	0
06/03/06	5	24	0	72	0	25	0	0
06/04/06	71	202.25	0	354	0	19	0	0
06/25/06	38	101.5	0	135	0	6	0	0
06/29/06	7	16.5	0	64	0	1	0	0
07/07/06	7	16	0	51	0	4	0	0
07/17/06	5	11.5	0	6	0	2	0	0
07/22/06	24	41	0	64	0	4	0	0
08/13/06	24	90.5	0	120	0	9	0	0
08/18/06	1	1.5	0	0	0	0	0	0

Appendix 3. Summary of data collected from the Warwa Estates access site at Lac Ste. Anne, 2006. Species codes: WALL = walleye, NRPK = northern pike, YLPR = yellow perch; Rel = released.

Date	# Anglers	# Hours	WALL Kept	WALL Rel	NRPK Kept	NRPK Rel	YLPR Kept	YLPR Rel
06/09/06	5	21	0	26	1	35	0	0
06/12/06	2	3.5	0	8	0	0	0	0
06/18/06	2	2	0	20	0	0	0	0
06/24/06	30	119	0	254	0	22	0	0
06/26/06	1	3	0	1	0	5	0	0
07/02/06	35	116.25	0	169	0	19	0	0
07/08/06	6	30	0	28	0	15	0	0
07/10/06	6	11.5	0	13	0	4	0	0
07/20/06	16	51	0	44	0	8	0	0
07/30/06	10	10	0	10	0	4	0	0
08/03/06	8	32	0	18	0	10	0	0
08/04/06	1	0	0	0	0	0	0	0
08/14/06	2	7	0	15	0	1	0	0

Appendix 4. Biological data collected during test angling at Lac Ste. Anne, 2006. Species codes: WALL = walleye, NRPK = northern pike.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
1	WALL	408	439	7
2	WALL	410	434	7
3	WALL	376	402	6
4	WALL	382	409	6
5	WALL	426	454	8
6	WALL	437	466	8
7	WALL	405	433	7
8	WALL	430	465	8
9	WALL	370	400	6
10	WALL	415	447	7
11	WALL	447	477	9
12	WALL	416	443	7
13	WALL	395	420	6
14	WALL	426	454	8
15	WALL	441	473	8
16	WALL	400	430	7
17	WALL	344	406	5
18	WALL	370	397	6
19	WALL	438	458	8
20	WALL	397	435	7
21	WALL	388	417	6
22	WALL	400	429	7
23	WALL	370	395	6
24	WALL	404	431	7
25	WALL	440	468	8
26	WALL	380	400	6
27	WALL	426	456	8
28	WALL	453	489	9
29	WALL	415	444	7
30	WALL	365	393	5
31	WALL	398	424	7
32	WALL	420	449	7

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
33	WALL	377	405	6
34	WALL	365	375	5
35	WALL	423	431	8
36	WALL	423	453	8
37	WALL	369	397	6
38	WALL	369	375	6
39	WALL	419	449	7
40	WALL	423	455	8
41	WALL	413	442	7
42	WALL	410	439	7
43	WALL	410	435	7
44	WALL	461	493	9
45	WALL	407	436	7
46	WALL	390	416	6
47	WALL	349	373	5
48	WALL	410	426	7
49	WALL	371	400	6
50	WALL	385	410	6
51	WALL	350	373	5
52	NRPK	474	509	4
53	NRPK	491	525	5
54	WALL	395	420	6
55	WALL	421	451	8
56	WALL	397	427	7
57	WALL	348	370	5
58	WALL	415	445	7
59	WALL	410	435	7
60	WALL	356	380	5
61	WALL	433	462	8
62	WALL	401	427	7
63	WALL	372	399	6
64	WALL	387	417	6
65	WALL	398	426	7

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
66	WALL	400	428	7
67	NRPK	495	526	5
68	NRPK	440	465	3
69	NRPK	500	530	3
70	NRPK	429	455	3
71	NRPK	471	498	5
72	NRPK	480	517	5
73	NRPK	473	508	4
74	NRPK	567	600	5
75	NRPK	478	512	4
76	NRPK	494	533	4
77	NRPK	460	494	3
78	NRPK	490	524	4
79	NRPK	485	524	3
80	NRPK	461	496	4
81	WALL	392	421	6
82	WALL	434	460	8
83	WALL	350	374	5
84	WALL	435		8
85	WALL	492		11
86	WALL	381		6
87	WALL	403		7
88	WALL	440	461	8
89	WALL	444		8
90	WALL	347	405	5
91	WALL	370		6
92	WALL	405		7
93	WALL	455	485	9
94	WALL	393		6
95	WALL	376		6
96	WALL	437	460	8
97	WALL	372	400	6
98	WALL	426		8

Appendix 4 Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
99	WALL	436		8
100	NRPK	485	512	4
101	NRPK	520		4
102	NRPK	535	560	5
103	NRPK	463	493	4
104	NRPK	488		4
105	WALL	397	423	7
106	WALL	433		8
107	WALL	485		10
108	WALL	435		8
109	WALL	412	438	7
110	WALL	420		7
111	WALL	410		7
112	WALL	450	480	9
113	WALL		457	
114	WALL	478	512	10
115	WALL	352	380	5
116	WALL	400	430	7
117	WALL	425	455	8
118	WALL	385	412	6
119	WALL	437	467	8
120	WALL	470	501	10
121	WALL	415	445	7
122	WALL	395	425	6
123	WALL	430	460	8
124	NRPK	425	455	4
125	NRPK	477	506	4
126	NRPK	537	575	5
127	NRPK	390	418	2
128	NRPK	495	525	4
129	NRPK	466	477	4
130	NRPK	525	557	5
131	NRPK	439	472	4

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
132	NRPK	440	464	3
133	NRPK	544	582	5
134	NRPK	580	610	6
135	NRPK	598	633	6
136	WALL	375	400	6
137	WALL	535	564	13
138	WALL	470	496	10
139	WALL	487	520	11
140	WALL	432	452	8
141	WALL	444	475	8
142	WALL	460	490	9
143	WALL	454	485	9
144	WALL	422	451	8
145	WALL	443	470	8
146	WALL	425	445	8
147	WALL	481	510	10
148	WALL	398	430	7
149	WALL	435	451	8
150	WALL	465	490	9
151	WALL	460	490	9
152	WALL	406	432	7
153	WALL	380	415	6
154	WALL	446	475	9
155	WALL	424	435	8
156	WALL	376	401	6
157	WALL	434	450	8
158	WALL	471	502	10
159	WALL	440	465	8
160	WALL	455	486	9
161	WALL	380	415	6
162	WALL	405	433	7
163	WALL	481	513	10
164	WALL	429	460	8

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
165	WALL	443	469	8
166	WALL	424	451	8
167	WALL	410	441	7
168	WALL	404	430	7
169	WALL	474	505	10
170	WALL	430	455	8
171	WALL	410	435	7
172	WALL	380	405	6
173	WALL	460	487	9
174	WALL	423	450	8
175	WALL	420	440	7
176	WALL	440	475	8
177	WALL	440	475	8
178	WALL	441	470	8
179	WALL	449	475	9
180	WALL	415	448	7
181	WALL	433	460	8
182	WALL	444	470	8
183	WALL	356	383	5
184	WALL	420	447	7
185	WALL	364	381	5
186	WALL	364	392	5
187	WALL	422	449	8
188	WALL	386	415	6
189	WALL	386	420	6
190	NRPK	394	421	3
191	NRPK	515	547	4
192	NRPK	485	517	5
193	NRPK	528	563	4
194	NRPK	540	578	5
195	NRPK	456	493	3
196	NRPK	523	555	4
197	NRPK	552	585	4

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
198	NRPK	524	558	4
199	NRPK	540	556	5
200	NRPK	518	554	5
201	WALL	493	524	11
202	WALL	448	479	9
203	WALL	427	455	8
204	WALL	450	480	9
205	WALL	424	453	8
206	WALL	446	480	9
207	NRPK	495	537	5
208	NRPK	540	576	5
209	NRPK	548	588	5
210	NRPK	442	472	4
211	NRPK	465	497	3
212	NRPK	525	555	4
213	NRPK	420	450	3
214	NRPK	531	553	5
215	NRPK	466	492	
216	NRPK	396	412	
217	WALL	451	478	9
218	WALL	400	436	7
219	WALL	420	452	7
220	WALL	382	410	6
221	WALL	387	411	6
222	NRPK	517	540	5
223	NRPK	516	550	4
224	NRPK	425	455	4
225	NRPK	535	564	5
226	NRPK	440	470	2
227	WALL	435	451	8
228	WALL	400	427	7
229	WALL	429	455	8
230	WALL	425	455	8

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
231	WALL	350	370	5
232	WALL	435	455	8
233	WALL	410	435	7
234	WALL	475	505	10
235	WALL	423	450	8
236	WALL	380	408	6
237	WALL	452	478	9
238	WALL	380	411	6
239	WALL	361	387	5
240	WALL	360	380	5
241	WALL	430	450	8
242	WALL	460	480	9
243	WALL	428	459	8
244	WALL	322	409	4
245	WALL	440	465	8
246	WALL	436	454	8
247	WALL	355	380	5
248	WALL	410	435	7
249	WALL	390	420	6
250	WALL	415	445	7
251	WALL	360	385	5
252	WALL	445	475	9
253	WALL	435	402	8
254	WALL	385	412	6
255	WALL	437	450	8
256	WALL	390	428	6
257	WALL	430	475	8
258	WALL	430	450	8
259	WALL	380	400	6
260	WALL	425	509	8
261	WALL	470	505	10
262	WALL	428	442	8
263	WALL	460	492	9

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
264	WALL	309	420	4
265	WALL	439	457	8
266	WALL	438	436	8
267	WALL	390	410	6
268	WALL	380	420	6
269	WALL	440	470	8
270	WALL	400	420	7
271	WALL	510	530	12
272	WALL	398	429	7
273	WALL	383	411	6
274	WALL	453	483	9
275	WALL	427	458	8
276	WALL	395	423	6
277	WALL	407	436	7
278	WALL	418	446	7
279	WALL	412	441	7
280	WALL	400	439	7
281	WALL	453	485	9
282	WALL	410	442	7
283	WALL	360	400	5
284	WALL	440	450	8
285	WALL	390	410	6
286	WALL	286	400	3
287	WALL	380	410	6
288	WALL	440	457	8
289	WALL	437	467	8
290	WALL	410	430	7
291	WALL	383	406	6
292	WALL	390	410	6
293	WALL	450	470	9
294	WALL	450	470	9
295	WALL	380	420	6
296	WALL	360	382	5

Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
297	WALL	400	427	7
298	WALL	420	452	7
299	WALL	460	480	9
300	WALL	425	452	8
301	WALL	440	475	8
302	WALL	460	490	9
303	WALL	460	480	9
304	WALL	425	457	8
305	WALL	403	439	7
306	WALL	415	445	7
307	WALL	446	479	9
308	WALL	396	423	7
309	WALL	440	460	8
310	NRPK	478	498	5
311	NRPK	568	605	5
312	NRPK	574	608	5
313	NRPK	535	571	
314	NRPK	460	486	3
315	NRPK	505	536	3
316	NRPK	485	517	4
317	NRPK	474	520	4
318	NRPK	535	570	4
319	NRPK	523	551	4
320	NRPK	509	540	4
321	NRPK	537	580	
322	NRPK	544	585	4
323	NRPK	487	520	4
324	WALL	444	464	8
325	NRPK	517	550	4
326	NRPK	497	533	4
327	NRPK	540	564	3
328	NRPK	565	598	5
329	NRPK	536	565	5

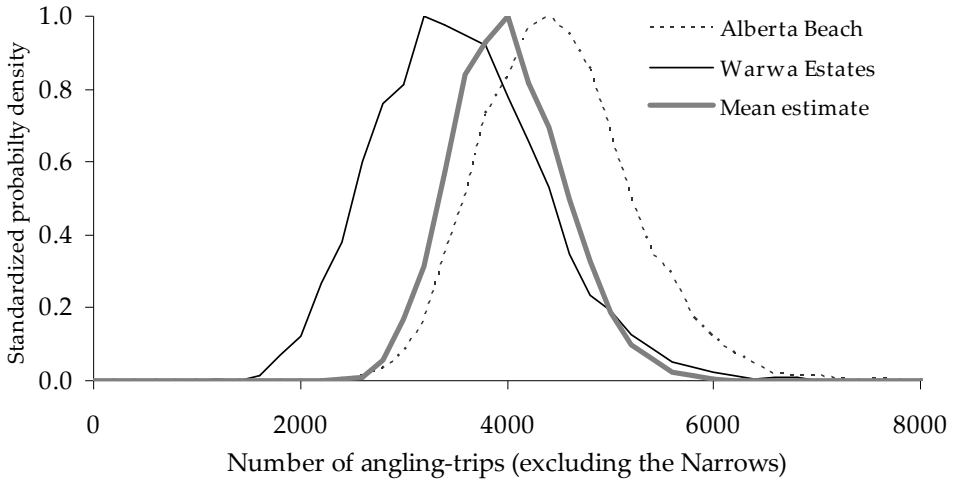
Appendix 4. Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
330	NRPK	536	556	3
331	NRPK	503	535	4
332	WALL	355	378	5
333	WALL	375	400	6
334	WALL	390	416	6
335	NRPK	948		10
336	WALL	472	503	10
337	NRPK	474	505	4
338	WALL	410	440	7
339	WALL	391	417	6
340	WALL	457	483	9
341	WALL	458	485	9
342	NRPK	520	555	4
343	NRPK	546	585	5
344	NRPK	440	476	3
345	NRPK	505	544	4
346	NRPK	550	580	4
347	NRPK	500	531	5
348	NRPK	557	592	5
349	NRPK	467	497	4
350	NRPK	520	544	4
351	NRPK	437	467	4
352	WALL	386	414	6
353	WALL	434	459	8
354	WALL	395	425	6
355	WALL	429	457	8
356	WALL	408	435	7
357	WALL	409	439	7
358	WALL	405	431	7
359	WALL	485	516	10
360	NRPK	480	515	3
361	NRPK	490	511	4
362	NRPK	477	505	4

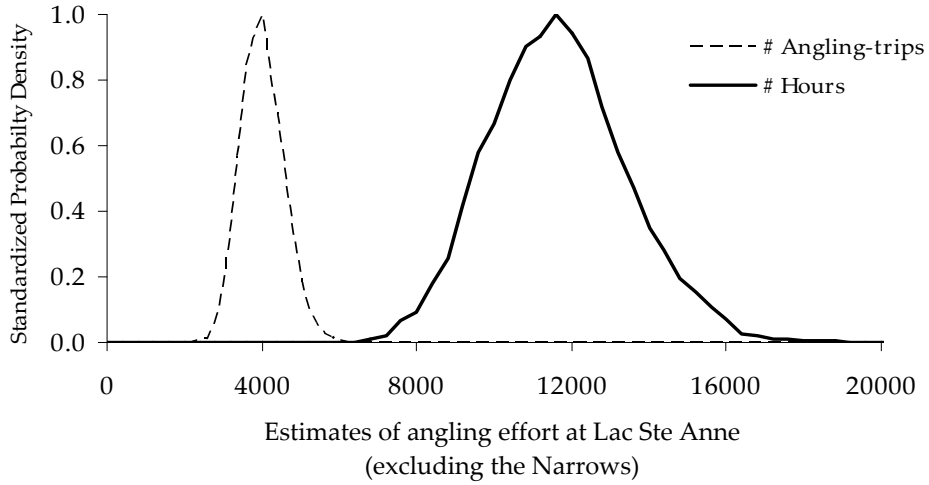
Appendix 4 Continued.

Sample #	Species	Fork Length (mm)	Total Length (mm)	Age (y)
363	NRPK	510	555	4
364	NRPK	285	307	1
365	NRPK	390	417	2
366	NRPK	460	493	3
367	NRPK	469	500	4
368	NRPK	429	457	3
369	NRPK	404	432	2
370	NRPK	478	512	3
371	NRPK	478	509	3
372	NRPK	519	549	4
373	NRPK	547	591	5
374	WALL	390	417	6
375	WALL	406	426	7
376	WALL	435	462	8
377	NRPK	476	509	4
378	NRPK	578	611	5
379	NRPK	520	558	5
380	NRPK	511	545	4
381	NRPK	569	607	5
382	NRPK	463	503	4

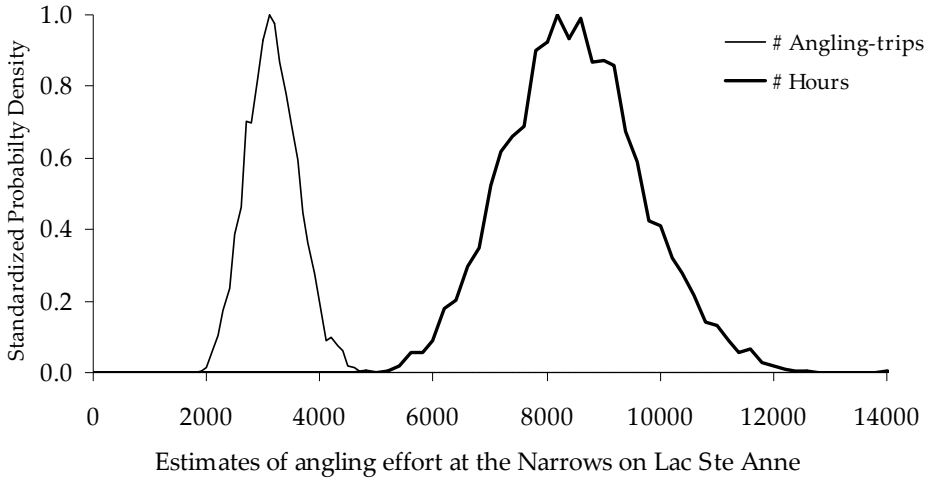
Appendix 5. Estimated number of angling-trips at Lac Ste. Anne in 2006 excluding angling-trips at the Narrows. The mean estimate was 3,914 angling-trips (95% CI = 2,930 – 5,053, n = 26). The estimate was the mean of the bootstrap estimates.



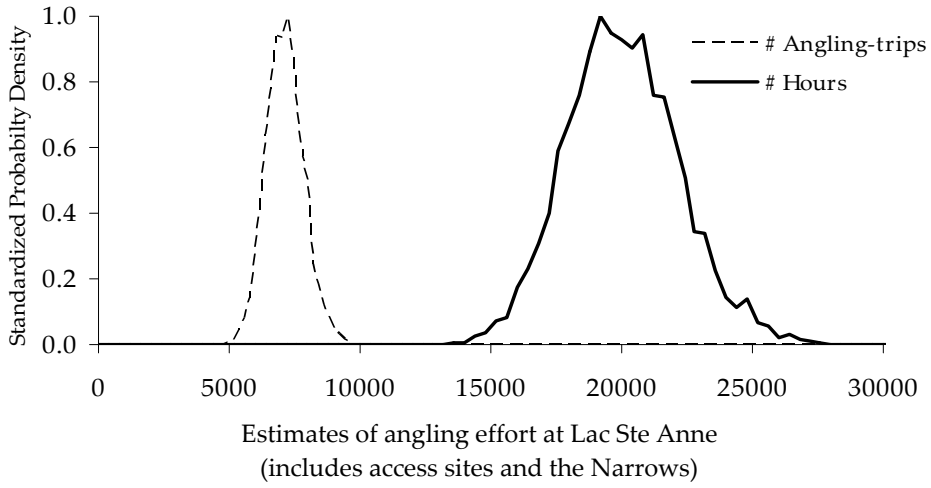
Appendix 6. Estimated number of angling-trips and angling-hours at Lac Ste. Anne (2006) excluding angling effort at the Narrows. The mean estimate was 11,445 angling-h (95% CI = 8,161 – 15,180, n = 26). The estimate was the mean of the bootstrap estimates.



Appendix 7. Estimated number of angling-trips and angling-hours at the Narrows, Lac Ste. Anne, 2006. The mean estimates were 3,117 angling-trips (95% CI = 2,264 = 4,095, n = 13) and 8,390 angling-h (95% CI = 6,153 – 10,858, n = 13), respectively. The estimate was the mean of the bootstrap estimates.



Appendix 8. Estimated number of angling-trips and angling-hours estimated at Lac Ste. Anne, 2006. The mean estimates were 7,030 angling-trips (95% CI = 5,713 – 8,551, n = 29) and 20,122 angling-h (95% CI = 15,870 – 24,421, n = 29), respectively. The estimate was the mean of the bootstrap estimates.



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