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An Assessment of the 2002 Summer Sport Fishery for Walleye (*Sander vitreus*)and Northern Pike (*Esox lucius*) at Winefred Lake, Alberta, 2003

Alberta Conservation Association

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EXECUTIVE SUMMARY

The Province of Alberta implemented new management strategies in 1996 for walleye and in 1999 for pike, in an effort to recover or maintain Alberta's walleye and pike fisheries. In 1996, the walleye fishery at Winefred Lake was classified as a stable fishery, defined using provincial government criteria (Berry 1996), with a 43 cm total length (TL) and 3 walleye daily-bag limit implemented to assist with the recovery of this fishery. Changes to the regulations occurred in 1999, when the pike fishery was classified as vulnerable, defined using Provincial Government criteria (Berry 1998). As a result, a 63 cm total length (TL), 3 fish daily-bag limit for pike was applied. During the same year, the walleye fishery at Winefred Lake was reclassified as vulnerable and the minimum size increased to 50 cm TL. In 2002, the pike fishery was again updated and a 70 cm (TL), 2 fish daily-bag limit was implemented.

A creel survey was used to assess the walleye and northern pike sport fisheries at Winefred Lake between 23 May and 17 August 2003. It was estimated that 3,556 anglers (95% CI = 3,027 - 4,135, n = 828) fished Winefred Lake for 12,351 hours (95% CI = 10,343-14,579, n = 2,878) or 0.98 hours/hectare (95% CI = 0.81-1.15). The sport yield of walleye and pike was 0.10 (95% CI = 0.77-1.27) and 0.16 kg/hectare (95% CI = 0.11-0.22), respectively.

Broad age-class and length frequency distributions and low densities are indicative of an overfished stock, in this case both walleye and pike. When walleye densities are low, it is expected that young walleye will experience increased growth rates as evidenced by this creel survey.

Observed and estimated pike catch rates were very low. Older, larger pike made up the majority of the catch with little evidence of recruitment. Anglers had minimal success catching a legal-size pike and there was a moderate level of inequality in the distribution of catch.

ACKNOWLEDGMENTS

James Witzke, the seasonal crewmember that worked alone at Winefred Lake deserves full credit for the success of this survey. James' perseverance and patience is commendable. Thanks also to lodge owner operators, Paul and Jerelyn Mathias for their hospitality, for the use of a camping site, and for making James' stay very memorable.

The Alberta Conservation Association (ACA) would like to thank: Alberta Fish and Wildlife for project collaboration and for the use of a boat during the survey; Human Resources and Development Canada for seasonal staff funding; and The Fishn' Hole for providing discounts on equipment.

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1.0 INTRODUCTION

1.1 General introduction

Management strategies for walleye (*Sander vitreus*) and northern pike (*Esox lucius*), (hereafter pike) prior to 1996 and 1999 respectively, focused on province-wide regulations designed to manage harvest at average fisheries. Fisheries receiving heavier than average exploitation had not been adequately protected with these regulations and many had declined or collapsed. Prior to 1995, high numbers of anglers per lake (312.5 anglers/ha, mid-1990s) combined with high fish harvests, resulted in the over-harvest of many fish populations in Alberta (Sullivan 2003a). To aid the recovery of these fisheries, two new management strategies were implemented in 1996 (Alberta's Walleye Management Recovery Plan) (Berry 1995) and 1999 (Alberta's Northern Pike Management and Recovery Plan) (Berry 1999). Through the strategies identified in these two recovery plans, the fishery at each lake was assessed and assigned a status category (i.e., collapsed, vulnerable, or stable) based on estimates of angler pressure, yield, and population structure. Alberta Sustainable Resource Development (ASRD) then modified the sport fishing regulation (for walleye or pike) based on the status rating (Sullivan 1998).

In 1996, the Walleye Management and Recovery Plan (WMRP) was implemented and Winefred Lake was subsequently classified as a stable walleye fishery (Berry 1995). This classification resulted in a regulation that permitted anglers to harvest three walleye (daily maximum bag limit) each with a minimum size limit of 43 cm total length (TL) (Table 1). In 1999, the walleye fishery at Winefred Lake was reclassified as vulnerable and the minimum size increased to 50 cm TL.

Based on the 1999 Northern Pike Management and Recovery Plan (NPMRP) a province-wide sport fishing regulation was implemented thereby classifying the majority of pike fisheries, including Winefred Lake, as stable-recreational fisheries (Berry 1999). A stable-recreational classification permitted sport anglers to harvest three pike (daily maximum bag limit) each with a minimum size limit of 63 cm TL (Table 1). In 2002, the pike fishery was updated and a 70 cm total length (TL), two fish daily-bag limit was implemented.

The purpose of this survey was to assess the walleye and northern pike sport fisheries to verify the status of the sport fishery population.

Table 1. Summary of walleye and pike sport fishery regulations for Winefred Lake, Alberta (1984, 1996 – 2003). NA = not applicable, TL = total length. Categories and regulations taken from the Alberta Sportfishing Regulations (1984, 1995-2003).

Year	Regulation category for walleye (WALL) / northern pike (NRPK)	Walleye (TL minimum size, cm / daily bag limit)	Northern pike (TL minimum size, cm / daily bag limit)
1984	NA	38 / 5	No minimum size / 10
1995	NA	38 / 5	No minimum size / 10
1996	Stable / Trophy	43 / 3	No minimum size / 5
1997	Stable / Trophy	43 / 3	No minimum size / 5
1998	Stable / NA	43 / 3	No minimum size / 5
1999	Vulnerable / Vulnerable	50 / 3	63 / 3
2000	Vulnerable / Vulnerable	50 / 3	63 / 3
2001	Vulnerable / Vulnerable	50 / 3	63 / 2
2002	Vulnerable / Vulnerable	50 / 3	70 / 2
2003	Vulnerable / Vulnerable	50 / 3	70 / 2

2.0 STUDY AREA

Winefred Lake (TWP 75, R4, W4) is located approximately 450 km northeast of Edmonton, Alberta. The lake has a surface area of 12,656 hectares (ASRD and Alberta Environment, Unpublished data) and development along its shore includes Winefred Lake Lodge on the lake's southwest shore as well as a camping area and access point on the lake's south shoreline. The Winefred Lake Indian Reserve (#194B) is located on the most northerly shoreline. The lake's main inflows are the Grist and Sandy rivers and the main outflow is the Winefred River, which subsequently flows into the Christina River and finally the Athabasca River.

3.0 MATERIALS AND METHODS

An access site survey (Pollock et. al 1994) was conducted at Winefred Lake Lodge between 23 May and 17 August 2003 to collect sport fishery data for walleye and pike (Figure 1). Survey schedules included 10 survey days (Friday through to the second Sunday of the shift) followed by 4 days of rest, and were repeated 7 times throughout the survey period (Appendix 6.2). Schedules were divided into weekdays (Monday-Thursday) and weekends (Friday-Sunday including statutory holidays) with 2 daily shifts (am = 0800-1530 and pm = 1530-2300). Of the 53 weekdays, surveys were conducted during 10 am shifts (19%) and 24 pm shifts (45%). Surveys were biased towards pm shifts based on the Lodge operator's comments regarding when anglers return from fishing trips most often. Of the 28 weekend survey days, 17 am shifts (61%) and 8 pm shifts (29%) were completed. The lower number of weekend pm shifts is because the 2nd Sunday of each shift was a travel day from the Lodge for the survey technician.

Upon returning to the survey access point, all angling parties were asked a series of questions regarding the number of hours fished, number of each species kept and released, the number of anglers, angling method, targeted species, use of electronics, use of barbless hooks and angler residence. These data were recorded on a creel survey data form (Appendix 6.1). Creel clerks made a subjective evaluation of each angler's skill level. Children and anglers that lacked equipment and knowledge regarding fishing were classified as novice. Anglers that demonstrated clear superiority in equipment and knowledge were classified as professionals. All other anglers were considered to have moderate skill.

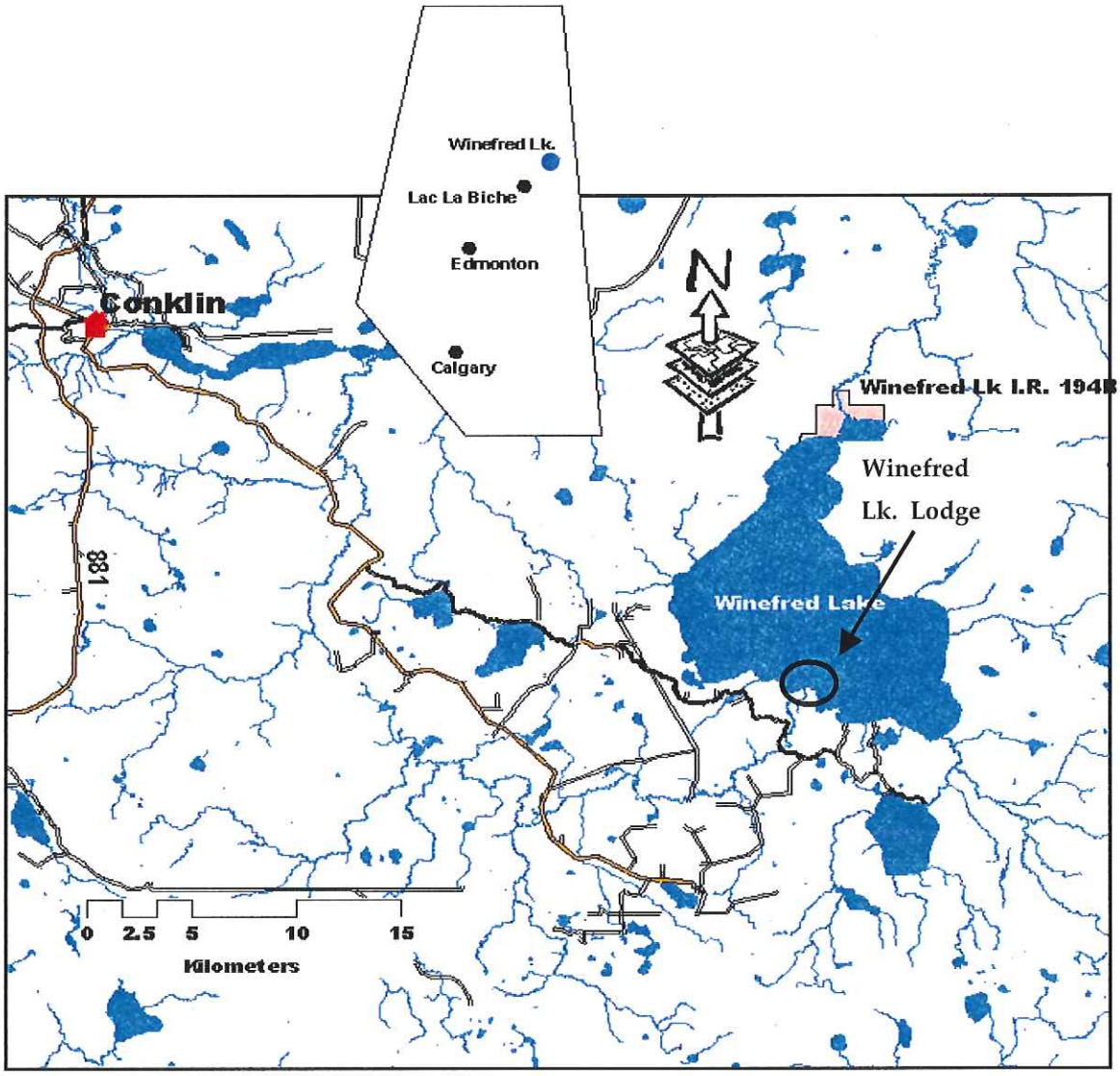

Figure 1. Location of Winefred Lake, Alberta and the 2003 creel survey site. The black circle indicates the location of the Winefred Lake Lodge. Brown, double and black lines indicate roads. Access to the lodge is from the town of Conklin, indicated by the red house symbol.

Since sport anglers were required to release walleye and pike that were shorter than the minimum size limit (walleye 50 cm, pike 70 cm total length), the creel technician could not obtain any information regarding these protected-length fish. Hence, test angling was conducted throughout the survey period to collect additional information on the size frequency distribution of walleye and pike populations. Typically, this was conducted when the creel clerk was not interviewing anglers. Test angling consisted of creel clerks as well as Alberta Conservation Association (ACA) and ASRD fisheries staff, all of varying skill levels, fishing Winefred Lake 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 fork length (±1 mm) of all fish caught. Ageing structures collected included the first three rays of the left pelvic fin for walleye and pike. All fish caught during the test fishery were released. To reduce handling time, weights from test fishery sampled fish were not collected. Therefore, weight was estimated using a length-weight regression ($y=1E\text{-}05x^{2.9641}$, $r^2=0.92$, df=900, $P<0.001$) containing fork length to total length and length to weight conversions (Patterson unpublished data). The ratio of legal-length fish to protected-length fish sampled during the test fishery was assumed to be equal to the corresponding ratio from the sport fishery (Sullivan 2003b). These ratios were compared to determine the angler exaggeration rate, and then estimate the total catch rates for walleye and pike. A calculated weight of fish caught during the test fishery was applied to incidental mortality and total yield calculations. The catch rate calculated from the test fishery was not included in any of the calculations regarding sport angler catch rate, effort (hours) or pressure (hours/hectare; hrs/ha).

Eighteen lake ratio-of-use (ROU) surveys were conducted the survey period. Ratio-of-use surveys provide a site-use ratio (e.g., 178 anglers out of 444 anglers used the access site being surveyed as their landing site; Appendix 6.2) that is used for extrapolating the data to temporal and spatial strata that are not surveyed. Ratio-of-use surveys include interviewing anglers on the lake as they were randomly encountered by boat while test angling. The ROU survey interview was identical to the access site interview but includes the location of each angler party' landing (i.e. where the boat is going to touch shore at the end of the angling trip). The ROU surveys had a temporal stratification of weekdays and weekend days and two shifts (i.e., 08:00 - 15:30 and 15:30

- 23:00) that reflected angler use. For safe practice, the creel technician established a communication plan with the Lodge while conducting ROU surveys and test angling. Creel clerks, when permitted, collected biological data from fish that were harvested by anglers. Data collected included fork length to the nearest millimeter, total weight to the nearest 10 g (0.010 kg), ageing structures, sex and state of maturity. Ageing structures collected included the left operculum and the first three rays of the left pelvic fin for walleye, the left cleithrum and the first three rays of the left pelvic fin for pike, and the left operculum and the anal fin for yellow perch. Sample material and ages were determined according to Mackay et al. (1990). Sex and state of maturity of each fish was determined following Duffy et al. (2000).

Hooking mortality likely contributes to the overall yield of sport fish. Hooking mortality, or incidental mortality, was determined for walleye at Winefred Lake following a multivariate analysis based on Reeves (2004). Reeves' analysis used a linear regression approach that included the covariates; month of capture, hooking location (e.g., stomach, gill, inner mouth), capture depth and water temperature, length category of walleye caught, angling gear (e.g., bobber, crank bait), and hook type (e.g., jig, treble) as explanatory variables. The total harvest estimate was determined by applying the resulting hooking mortality estimate (fish released x 5.6%) to the angler harvest estimate.

I used a bootstrap technique to calculate estimates and confidence intervals for number of anglers, number of hours, angling pressure (hrs/ha), harvest and yield (i.e., kg/ha) of sport fish (i.e., walleye and pike). Sullivan (2004) summarized bootstrapping as a statistical procedure whereby an original sample of the population is subsequently re-sampled and a new mean calculated. Bootstrap samples are assumed to approximate the distribution of values that would have arisen from repeatedly sampling the original population (Haddon 2001). Sullivan (2004) explained that repeating this procedure thousands of times results in a distribution of possible means describing the likelihood of the true (population) mean being within that distribution. This group of means represents the distribution of possible means from data with the same scale of variation as observed in the original data set. Frequentist parameter estimates (e.g., means) are typically equal to maximum-likelihood estimates (MLE) for the parameters of the specified probability density function (Gotelli 2004). Empirical confidence intervals

(95% CI) were calculated following Haddon (2001). The final proportions (i.e., probability densities) were standardized to range between 0 and 1 (Paul et al. 2003). The ROU surveys, as a binomial probability, have a range of variation. I simulated these probabilities (using Microsoft Excel's Random Number Generation), thereby creating a list of possible site-use ratios, with a range of variation that is correlated to the size of the original data sample (Sullivan 2004).

Each parameter that was obtained from creel survey data (e.g., number of anglers, number of hours, number of fish caught, kg/ha) was estimated to include spatial and temporal strata that were not surveyed. Each parameter and estimate is presented as a likelihood profile, using the simulation procedure described above and combined by multiplying the likelihood profiles. A flow chart describing the steps for calculating estimates for each creel site and for the survey is presented in Figure 2.

To quantify catch inequality among anglers for pike, Gini coefficients and angler success rates were calculated for pike (Baccante 1995). A Gini coefficient of 0 indicates all anglers caught an equal amount of fish while a 1 indicates one person captured all fish.

To quantify size-class for pike, proportional stock density (PSD) and relative stock density (RSD) classifications were calculated (Gablehouse 1984). The PSD is the number of pike harvested that are equal to or greater than 530 mm total length (TL), as a proportion of pike that are 350 – 529 mm TL. A high PSD value indicates a larger portion of mature fish, and therefore can be interpreted as reflecting a more stable population. The RSD (stock-quality) is the proportion of pike caught between 350 mm and 529 mm TL relative to the total number of pike greater than or equal to 350 mm TL.

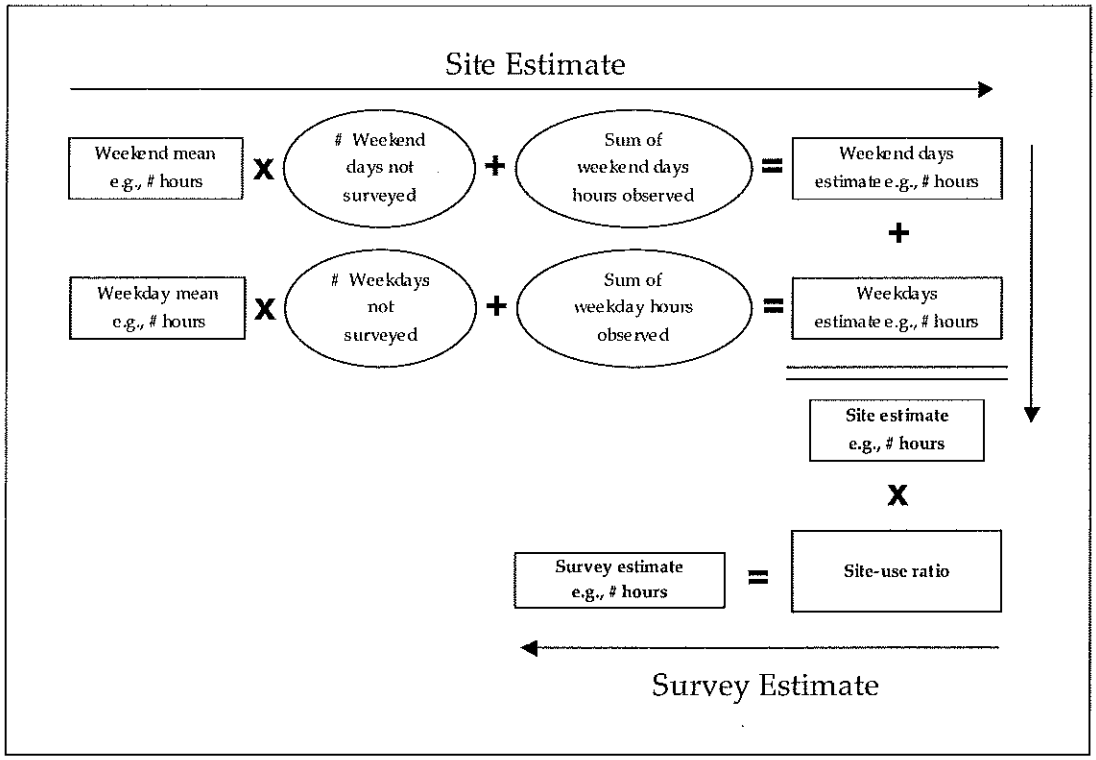

Figure 2. Flow chart outlining the process used for estimating parameters collected from the creel site and extrapolated to a survey estimate for Winefred Lake, 2003. Circles represent values with no variance (i.e., observed data) and rectangles represent data with variation (i.e., likelihood profiles).

Sport anglers were required to release pike less than 63 cm TL (protected-length fish), therefore pike caught and sampled during test angling were used for these calculations.

Field data were recorded on field data forms in pencil by creel clerks and then transcribed into Microsoft Excel files by a professional data entry service using double entry verification. Prior to analysis, frequency distributions of each creel survey parameter were calculated and the original data sheets and creel daily journals used to investigate and verify outliers. Scatter plots of weight-length and length-age were generated to identify outliers. Outliers were investigated and omitted if measurement or recording error was suspected. All data were stored in the Fisheries Management Information System (FMIS) of Alberta Sustainable Resource Development (ASRD).

4.0 RESULTS

4.1. Angler effort

Between 23 May and 17 August 2003, 828 anglers were interviewed (Table 2 and Appendix 6.2). Based on the ROU surveys, the creel survey site recorded 67% (178/266) of the total effort at Winefred Lake. The maximum likelihood estimate (MLE) of the total number of anglers during the survey period was 3,556 (95% CI = 3,027-4,135, n = 828; Figure 3). The MLE of angling effort was 12,351 hours (95% CI = 10,343-14,579, n = 2,878; Figure 4) resulting in an MLE of angling pressure of 0.98 angling-hours / ha (95% CI = 0.81-1.15; Figure 5).

Data were collected from 90 and 103 sport-harvested walleye and pike, respectively. One yellow perch (*Perca flavescens*) was observed in the sport harvest. Twelve walleye and 62 pike were sampled during the test angling in 105.5 hours of angling for catch rates of 0.114 walleye/hr and 0.59 pike/hr.

Table 2. Survey and angler effort and observed, reported and estimated catch rates; Winefred Lake, 1995 and 2003. Refer to Table 1 for size- and daily-bag limits. NA=not applicable.

Creel Data	1995	2003
Number of days surveyed	42	59
Number of anglers interviewed	907	828
Number of angling hours reported	3,172	2,878
Walleye data		
Kept / hour	*0.12	*0.045
Released / hour	0.11	0.073
Total / hour	0.23	0.117
Northern pike data		
Kept / hour	*0.15	*0.055
Released / hour	0.80	0.462
Observed total / hour	0.95	0.517
Estimated release / hour	NA	0.048
Estimated total / hour	NA	0.095

* Refer to Table 1 for specific regulations.

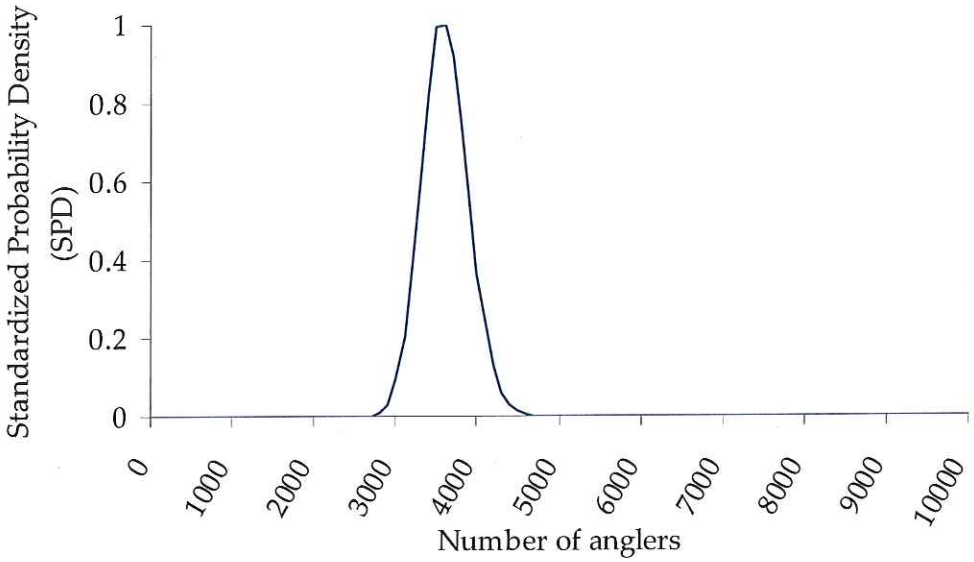

Figure 3. Standardized probability density (SPD) function of anglers at Winefred Lake, 2003. The maximum likelihood estimate of anglers for the survey period was 3,556 (95% CI = 3,027 - 4,135, n = 828).

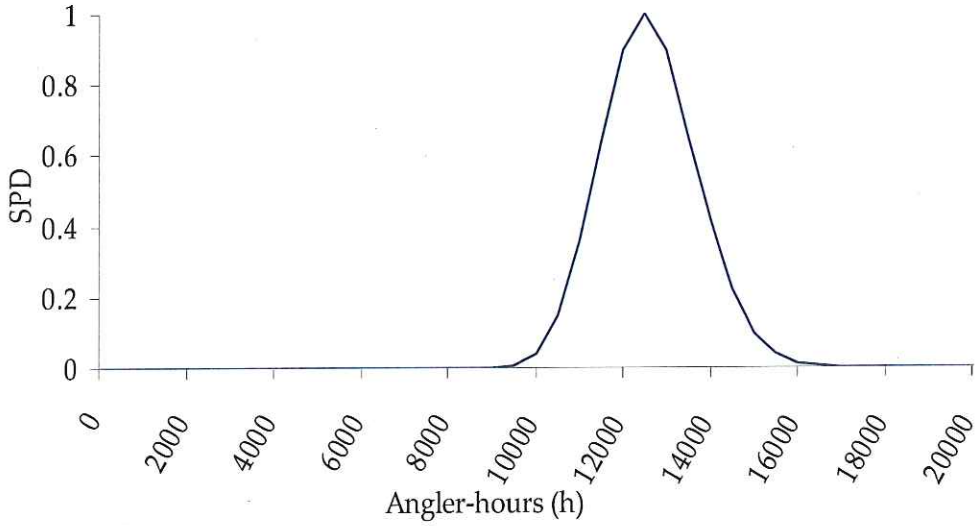

Figure 4. Standardized probability density (SPD) function of angler-hours at Winefred Lake, 2003. The maximum likelihood estimate of angler-hours for the survey period was 12,351 hours (95% CI = 10,343 - 14,579, n = 2,878).

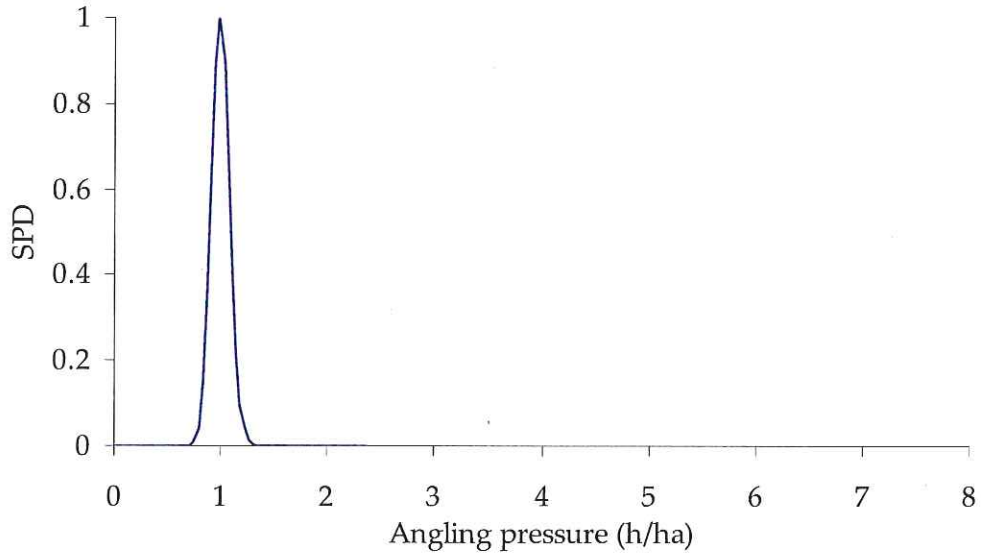

Figure 5. Standardized probability density (SPD) function of angling pressure (hours/hectare) at Winefred Lake, 2003. The maximum likelihood estimate of hours/hectare for the survey period was 0.98 h/ha (95% CI = 0.81 - 1.15).

4.2. Walleye harvest and yield

Walleye harvest MLE was 543 fish (95% CI = 421 - 685, n = 128) (Figure 6). Multiplying the likelihood profile of harvested walleye with the likelihood profile of their mean weight (2324 gm; Figure 7) resulted in a harvest MLE of 1263 kg (95% CI = 971-1601) during the survey period. The MLE of walleye yield was 0.10 kg/ha (95% CI = 0.77 - 1.27; Figure 8).

The present sport yield of walleye (543 fish, mean weight 2,326 gm) would present a low risk to the fishery with potential for recovery if the vulnerable category were an appropriate designation (Sullivan 2004). However, if this fishery is collapsed, the present rate of harvest would likely hinder recovery and, at best result in a population equilibrium (Appendix 6.2).

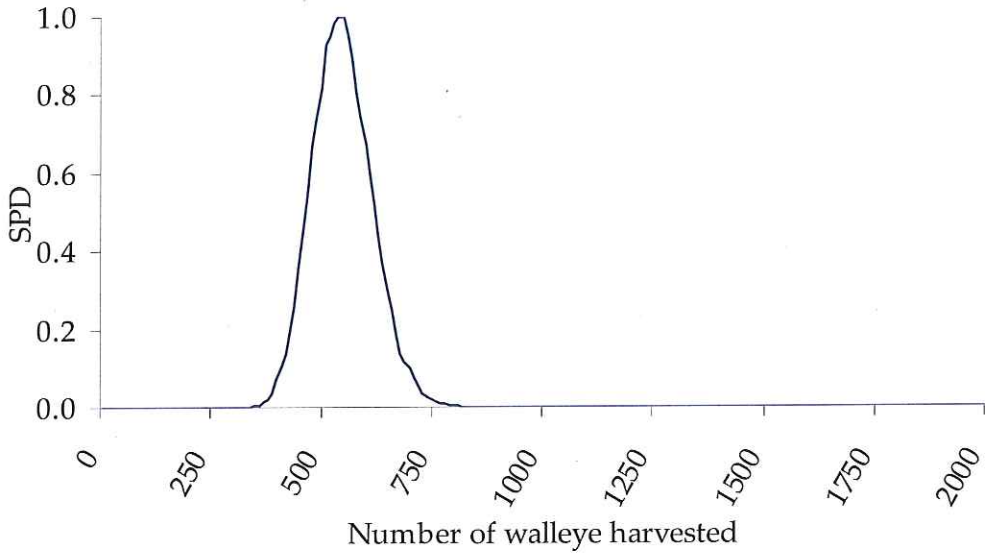

Figure 6. Standardized probability density (SPD) function of the walleye sport fishery harvest from Winefred Lake, 2003. The maximum likelihood estimate of walleye harvest for the survey period was 543 fish (95% CI = 421 - 685, n = 128).

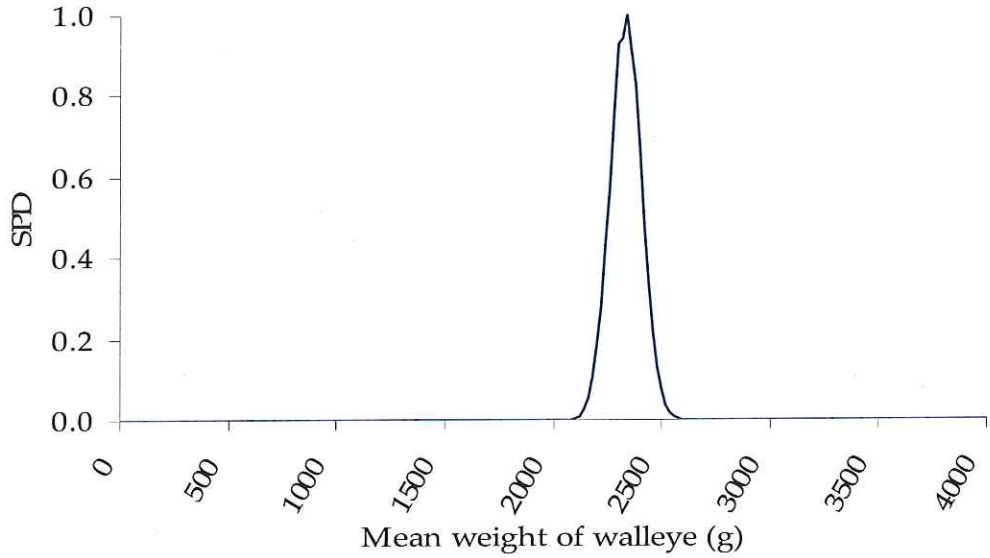

Figure 7. Standardized probability density (SPD) function of the mean weight of walleye harvested by the sport fishery from Winefred Lake, 2003. The maximum likelihood estimate of walleye mean weight for the survey period was 2,324 g (95% CI = 2,183 - 2,466, n = 90).

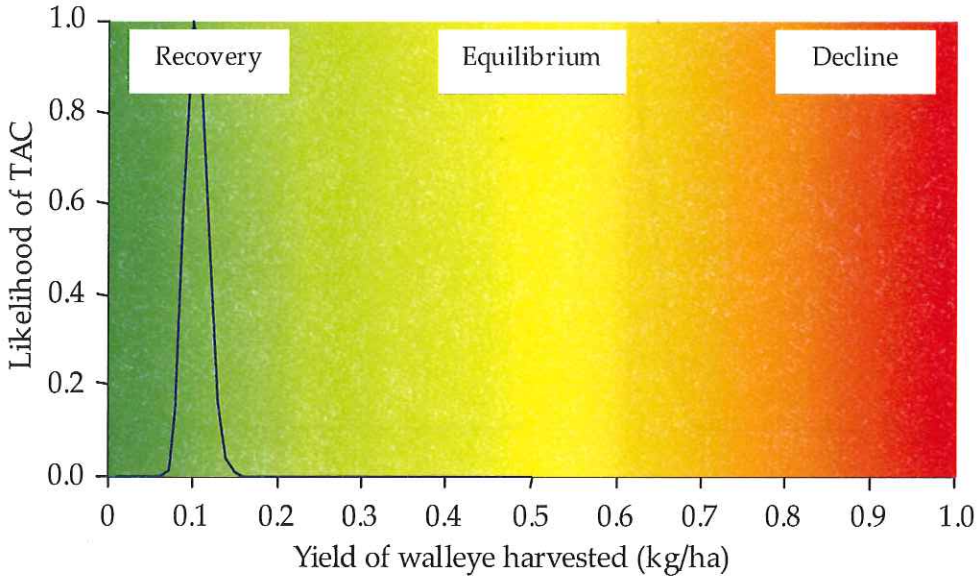

Figure 8. Standardized probability density (SPD) function of the sport fishery yield of walleye from Winefred Lake, 2003. The categories of total allowable catch (TAC) were based on bootstrapped distributions of equilibrium and recovery yields from Alberta walleye fisheries categorized as vulnerable stocks (Sullivan 2004). The maximum likelihood estimate of the yield of walleye for the survey period was 0.10 kg/ha (95% CI = 0.77-0.127).

Walleye harvest yield during the 1995 survey was estimated to be 0.13 kg/ha. Anglers reported release rates of 0.07 walleye/h, resulting in an estimate of 865 released walleye. As the test fishery only sampled 12 walleye in 105.5 hours of angling, an estimated release rate from the protected-length fish to legal-length ratio could not be calculated. However, according to Sullivan (2003), exaggeration in catches is not constant but increases with decreasing catches. Therefore, the actual estimate of released walleye was probably lower than calculated indicating a low abundance of walleye.

By applying an incidental mortality of 5.6% (following in Reese 2004) and a mean weight of 0.95 kg (based on test fishery data) for released walleye, the incidental mortality of walleye released by anglers was 48 or 0.004 kg/ha. Therefore, the total sport yield of walleye (harvest plus incidental mortality) was 591 walleye or 0.10 kg/ha (95% CI = 0.08 - 0.13).

4.3. Pike harvest and yield

The MLE of harvested pike was 609 fish (95% CI = 439-811, n=157; Figure 9). Multiplying the likelihood estimate of the number of pike harvested with the MLE for mean weight of harvested pike (3,289grams; Figure 10) resulted in a MLE of 2,003 kg (95% CI = 1,417-2,719). The MLE of pike yield was 0.16 kg/ha (95% CI = 0.11-0.22) (Figure 11). The sport yield of pike during the 1995 survey was estimated to be 0.32 kg/ha.

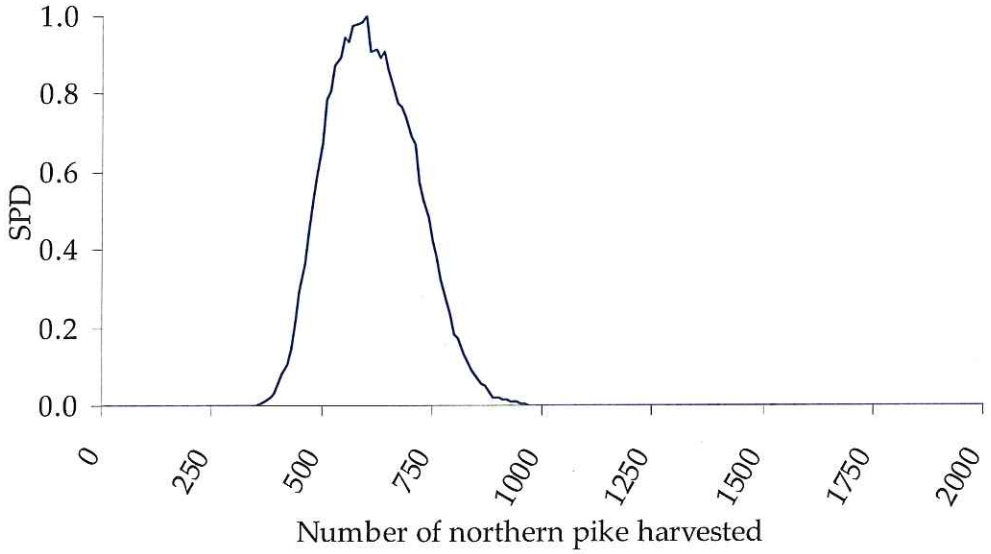

Figure 9. Standardized probability density (SPD) function of the pike sport fishery harvest from Winefred Lake, 2003. The maximum likelihood estimate of pike harvest for the survey period was 609 fish (95% CI = 439-811, n = 157).

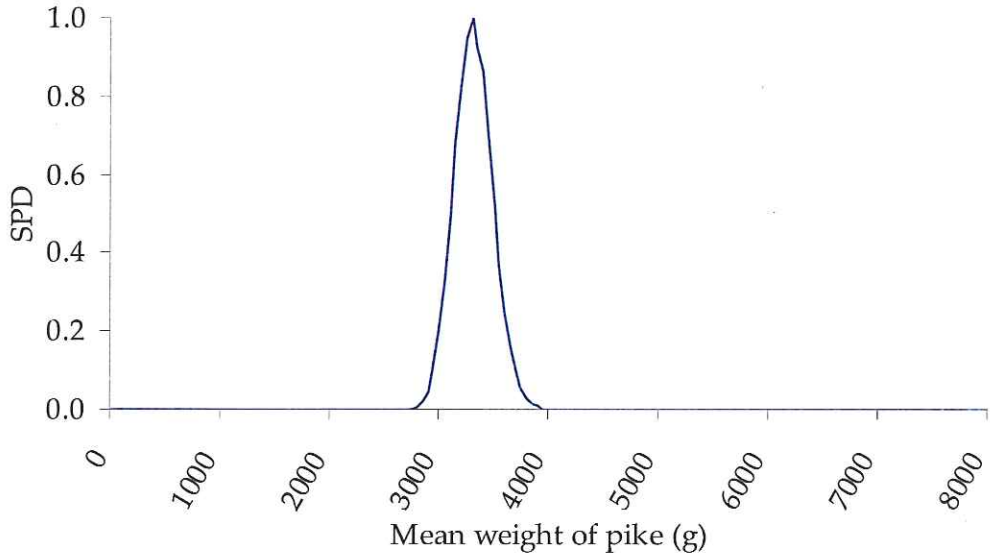

Figure 10. Standardized probability density (SPD) function of the mean weight of pike harvested by the sport fishery from Winefred Lake, 2003. The maximum likelihood estimate of pike mean weight for the survey period was 3,289 g (95% CI = 2,962-3,646, n = 102).

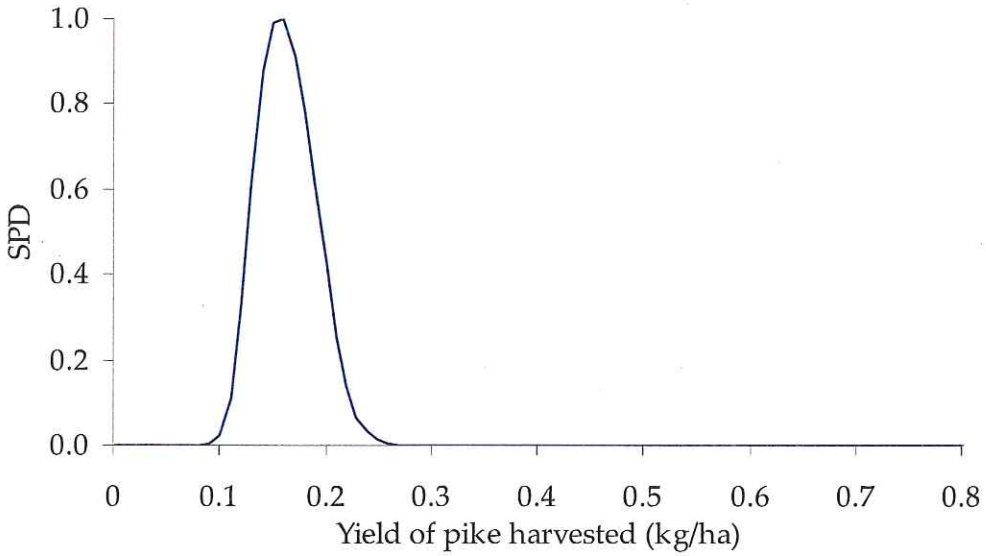

Figure 11. Standardized probability density (SPD) function of the yield of pike harvested by the sport fishery from Winefred Lake, 2003. The maximum likelihood estimate of the yield of pike for the survey period was 0.16 kg/ha (95% CI = 0.11 - 0.22).

Anglers reported a release rate of 0.46 pike/hr, resulting in an estimate of 5,681 released pike. Using the ratio of protected-length (28 pike) to legal-length pike (34 pike) sampled during the test fishery (Sullivan 2003), an estimated release rate of 0.05 pike/hh was calculated, suggesting a nine-fold exaggeration in release rates reported by anglers.

The MLE for the number of pike released was 1,293 (95% CI = 1022 - 1667, n = 322). I assumed that pike released by the sport fishery had the same 5.6% incidental mortality as walleye (following Reese 2004). Based on the mean weight of 1.418 kg per fish (based on the test fishery), the incidental mortality was 46 pike or 0.04 kg/ha. Therefore, the total sport yield of pike during the 2004 survey was estimated to be 152 pike (0.15 kg/ha, 95% CI= 0.11 - 0.22).

4.4. Assessment of the walleye sport fishery

The following subsections are listed according to biological characteristics used by ASRD in the determination of management status categories (i.e., stable, vulnerable, collapsed). These categories are described in ASRDs Walleye Management and Recovery Plan (WMRP; Berry 1995).

4.4.1 Age-class distribution and stability

See comments in Editor's Version

In 2003 at Winefred Lake, the walleye harvested by the sport fishery displayed a wide age-class distribution primarily supported (54% of distribution) by the 1987, 1988 and 1989 year-classes. The harvest rate (0.045 walleye/hr) indicated a very low abundance relative to the previous surveys (1984 and 1995). The mean age of sport harvested walleye was 14 years.

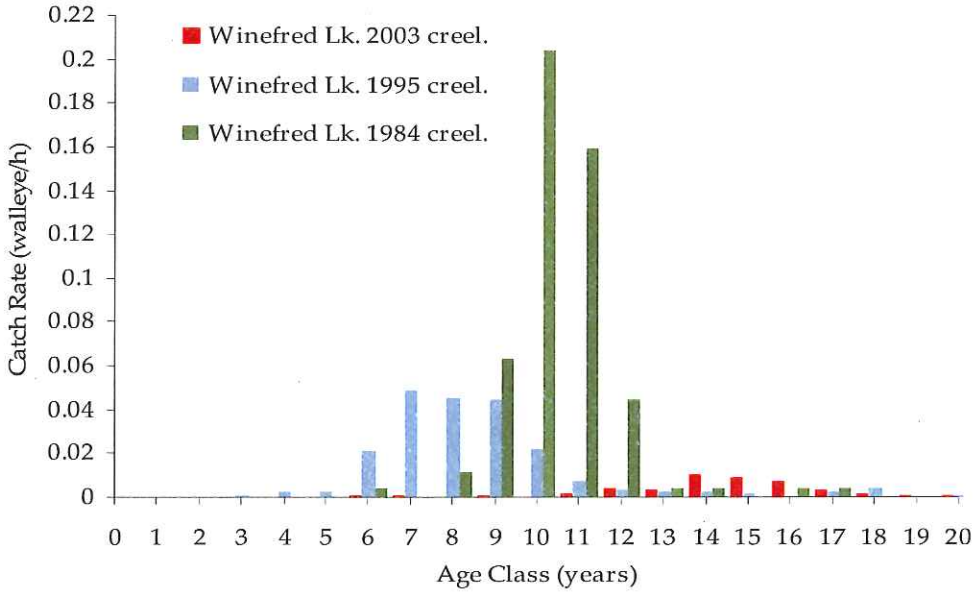

Figure 12. Age-class distributions of walleye sampled during creel surveys at Winefred Lake from 1984, 1995 and 2003. The 1984 and 1995 data come from Herdman (1984) and Walder (1996), respectively.

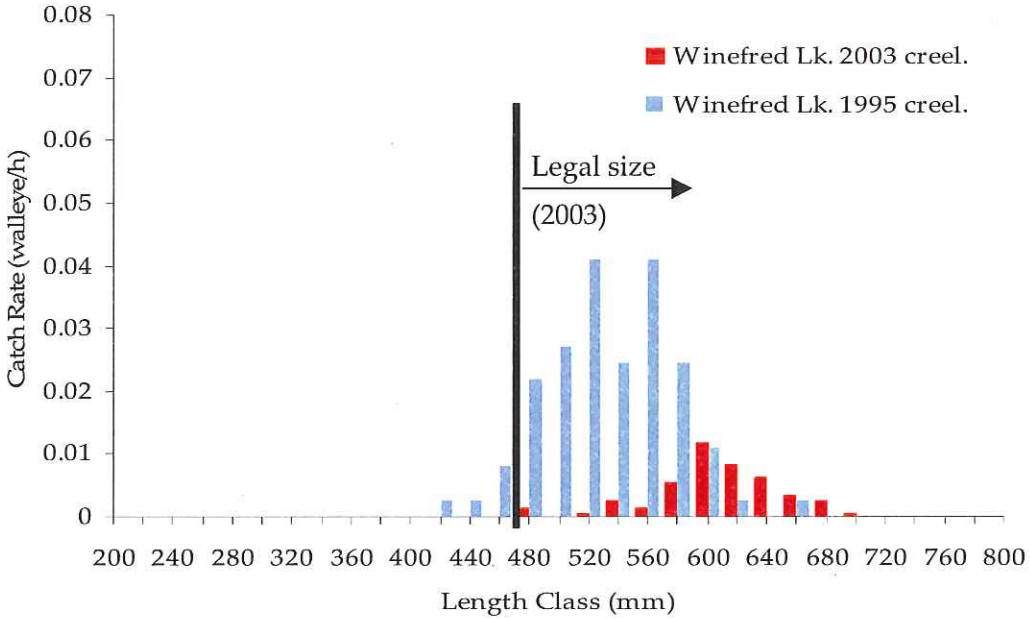

Figure 13. Fork length-frequency distributions of walleye sampled during creel surveys at Winefred Lake from 1995 and 2003. The 1995 data come from Walder (1996).

4.4.2 Length-at-age

The index of growth (i.e., length-at-age) of walleye at Winefred Lake in 2003 was moderately fast, according to the WMRP. Walleye grew to 50 cm (fork length) in six to seven years (Figure 13).

4.4.3 Catch rate

Catch rates for kept walleye and reported released walleye were 0.045/hour and 0.074/hour, respectively. The catch rate of legal-length walleye was 0.044/hour. Sullivan (2003) warns that very low release catch rates reported by anglers are exaggerated and higher than the actual catch rate. Therefore, the catch rate for walleye is likely lower than was reported.

See comments in "edited" version.

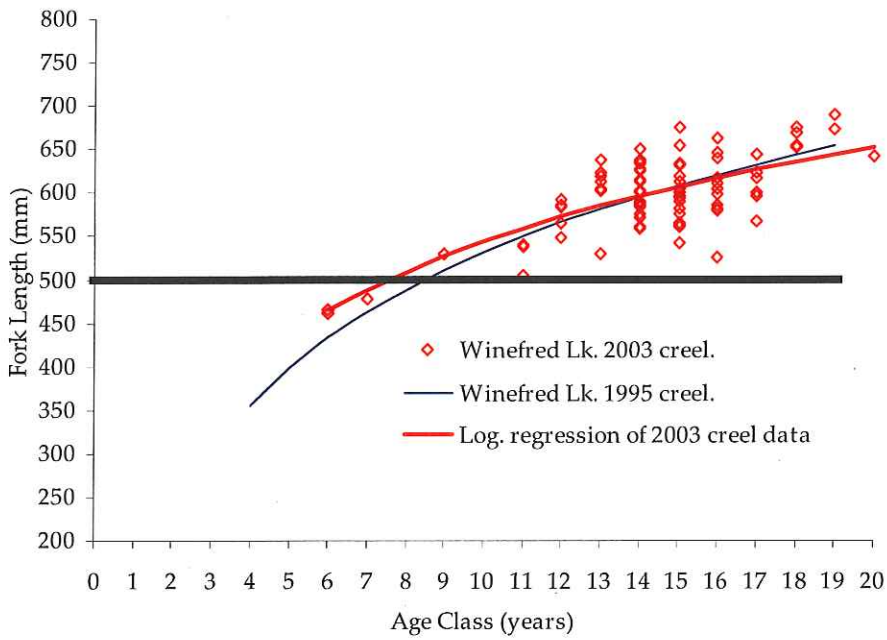

Figure 14. Length-at-age (logarithmic lines-of-best-fit) of sport harvested walleye from Winefred Lake, 1995 ($r^2 = 0.75$, n = 73) and 2003 ($r^2 = 0.51$, n = 89). The 1995 length-at-age data come from Walder (1996).

Based on the scarcity relationship ($y = 1.25x^{-0.84}$, $r^2 = 0.66$, df = 19, $P < 0.01$) between illegal harvest and catch rate of protected-length walleyes (Sullivan 2002), illegal harvest was

estimated to be 17.4% which was similar to the 18.4% based on data from 20 walleye fisheries (Sullivan 2002). Incorporating the illegal harvest, estimates of walleye yield increase from 0.10 kg/ha to 0.12 kg/ha.

Age-at-maturity data were not available from this creel survey to help classify this stock. Of 90 walleye observed harvested and sampled by the creel technician, maturity data were collected from 4 walleye.

4.5 Assessment of the northern pike sport fishery

The status of the pike sport fishery was evaluated using the stock classifications described in the Northern Pike Management and Recovery Plan (NPMRP; Berry 1999) and criteria listed in Sullivan (1998).

4.5.1 Catch rate

The total reported catch rate of pike during the creel survey in 2003 was 0.517 fish/hour. The observed catch rate of the 95 legal-length pike (> 63 cm total length) harvested was 0.052 fish/hr. The reported release rate was 0.462 pike/hr. Sullivan (2003b) warns that very low catch rates reported by anglers are exaggerated. Following Sullivan and using the protected-length to legal-length ratio from test angling (28:34), I estimated a release rate of 0.048/hour. Therefore, the estimated total catch rate for pike was 0.100/hour.

Regional studies of walleye at low catch rate lakes suggest that anglers, on average, exaggerated their catch two-fold (Sullivan, 2003) and thus it may be speculated that anglers at low catch lakes also exaggerated the reported catch of pike. Following Sullivan (2003), pike were released at a rate of 0.048 pike/hr for a total estimated catch rate of 0.100 pike/hr. This calculation assumes that approximately 10% of released fish are legal-sized. If anglers released a larger or smaller proportion of legal-size pike, the estimated catch rate would change. Simulating a proportion of 5%, 20%, 30% and 40% released legal-size pike, the estimated catch rate per hour changes from 0.100 to 0.100, 0.106, 0.111, and 0.116, respectively. Based on this simulation and the NPMRP (Berry 1999), all estimated catch rates are very low.

4.5.2. *Age-class distribution*

The pike harvested from Winefred Lake in 2003 were relatively old and large (Figures 15 and 16). There were notable gaps in age-classes younger than age 4 and no age-classes from the sport fishery had density > 0.01 pike/hr. Since the 1995 creel survey, age-class and length frequency distributions have exhibited a flattening with declining catch rates, which suggests the population is overexploited. The test fishery length distribution (Figure 17) suggests some recruitment to the sport fishery.

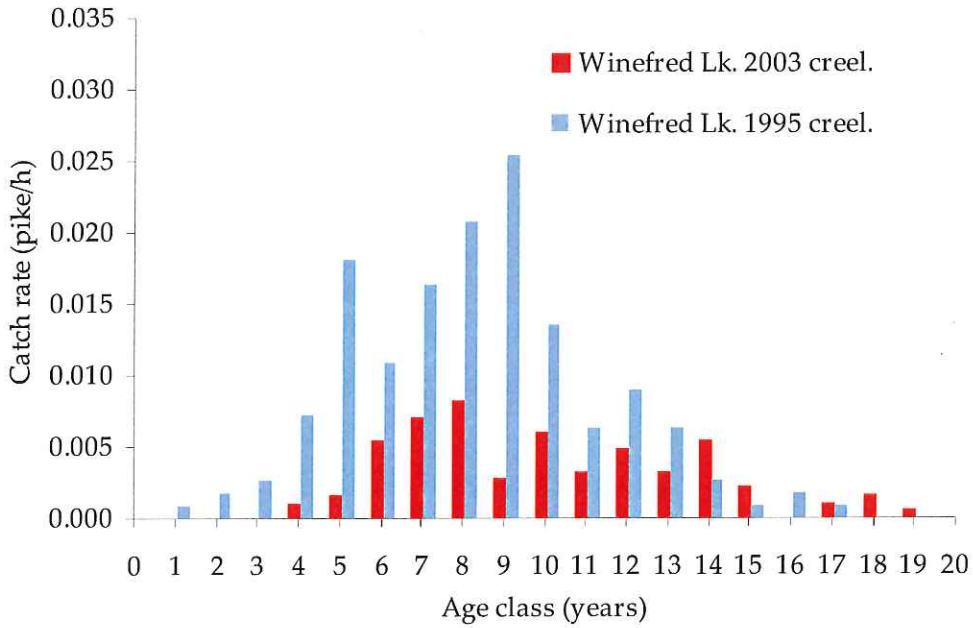

Figure 15. Age-class distributions of sport-harvested pike from Winefred Lake, 1995 and 2003. The 1995 age-class data came from Walder (1996).

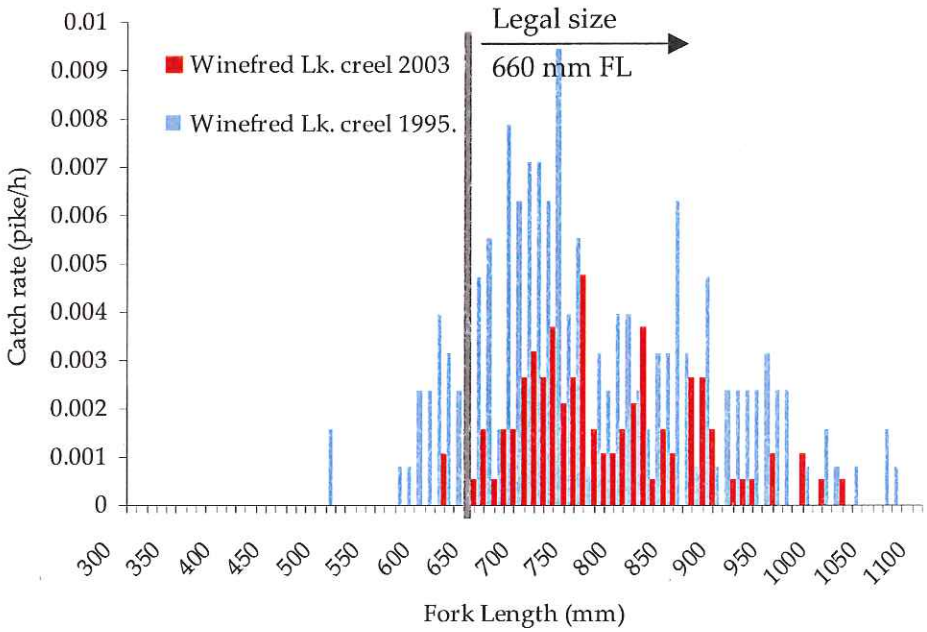

Figure 16. Length frequency distributions of sport-harvested pike from Winefred Lake Alberta, 1995 and 2003. The 1995 length data came from Walder (1996). The solid vertical bar indicates legal size according to 2003 Alberta fishing regulations.

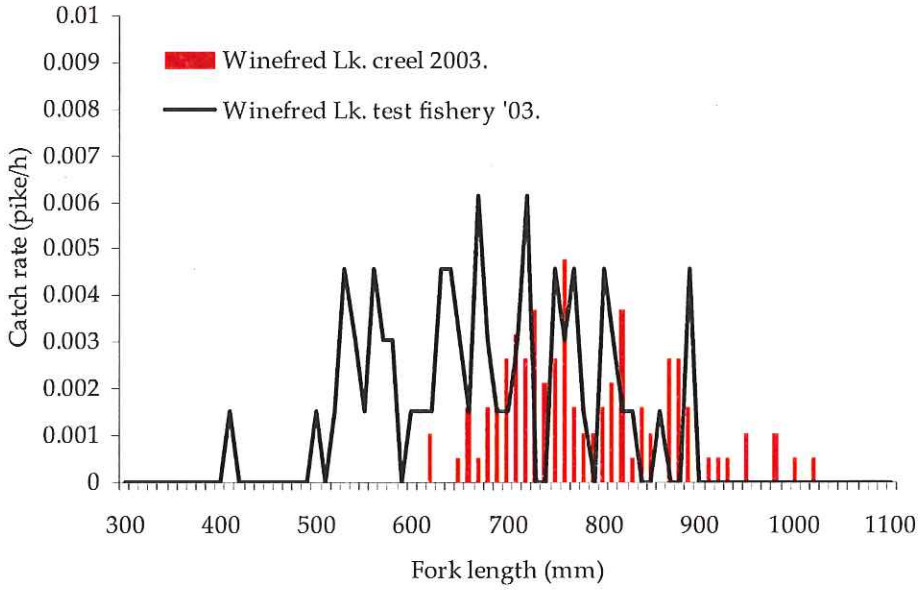

Figure 17. Length frequency distributions of sport harvested and test fishery sampled pike from Winefred Lake, 2003. Test fishery catch rate was estimated following Sullivan (2003).

4.5.3 Length-at-age

Based on the guidelines, length-at-age of pike in Winefred Lake was relatively fast (Figure 18; Berry 1999) but has not changed substantially since the 1995 survey. It is not possible, without smaller and younger pike in the sample, to determine whether the growth trajectory has changed.

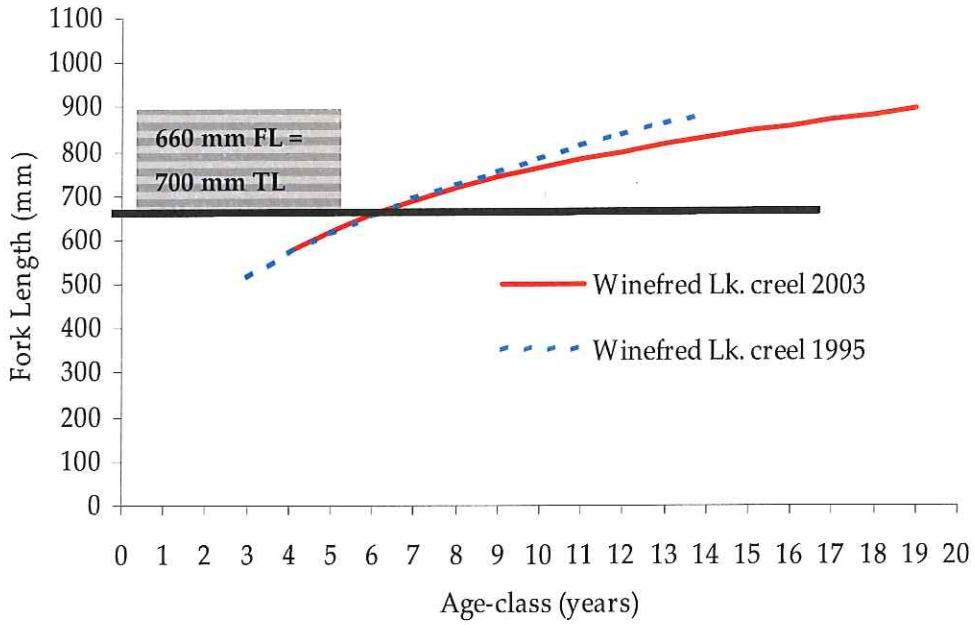

Figure 18. Length-at-age (logarithmic lines-of-best-fit) of sport harvested pike from Winefred Lake, 1995 ($r^2 = 0.95$, n = 190) and 2003 ($r^2 = 0.72$, n = 100). The 1995 length-at-age data came from Walder (1996).

4.5.4 Mean weight

Average pike weight, calculated from the mean fork length of the test fishery sample (>70 cm TL), was 3.37 kg. When mean weights are relatively high, they may indicate either a collapsed or stable population (Sullivan 1998). However, when coupled with very low catch rates, they are likely to indicate an over-exploited fishery.

4.5.5 Proportional and relative stock density

The PSD and RSD (stock-quality) associated with a very low catch rate, indicates an exploited pike fishery: 86% of the pike captured were considered "quality" (53 - 70 cm) and "preferred" (71 - 85 cm) fish, 6.5% were considered memorable (86 - 112 cm) and no fish considered trophy (> 120 cm) were sampled (Gablehouse 1984).

4.5.6 Angler success and GINI coefficient

Sixteen percent of the anglers interviewed during the survey were successful in catching one or more pike > 63 cm total length (length utilized in Berry 1999). The equality of the catch was calculated using a GINI coefficient where 0 indicates all anglers caught equal numbers of fish and a coefficient of 1 indicates that a single angler caught the entire catch. The pike catch at Winefred Lake was moderately unequal with a GINI coefficient of 0.68 (Baccante 1995). Both percent success and Gini coefficient metrics include the anglers' reported released pike that may include some exaggeration. If this was the case then percent success would actually be lower and the GINI coefficient would be higher.

4.6 Stock status summary

4.6.1 Walleye stock classification

In summary, the broad, flat age-class and length distributions from the 2003 survey are indicative of recruitment overfishing (Cushing 1981), where the exploitation of the adult population negatively impacts recruitment of young fish into the fishery. Interestingly, the walleye catch from the 1995 and 2003 creel surveys exhibited the same year-classes. The index-of-growth for younger walleye has increased since the 1995 survey and may indicate low abundance and reduced recruitment. The observed and reported catch rates were very low (0.045/hr and 0.074/hr, respectively) and the estimate of illegal harvest (17.4%) was similar to the Alberta average of 18.4% (Sullivan 2002).

4.6.2 *Pike stock classification*

In summary, based on the NPMRP (Berry 1999) and comparing the previous survey (1995) to the 2003 survey, the pike stock has indications of an exploited population. The estimated harvest rate (for pike >70 cm TL) indicated a very low density of pike. The age and length distributions illustrated a decrease in abundance and the recruitment of fast growing pike into the sportfishery. Length-at-age has not changed substantially since 1995. A relatively high mean weight (3.3 kg) and very low catch rate (estimated total, 0.100/hr), may indicate recruitment overfishing (Sullivan 1998). A high proportion (86%) of the catch was comprised of pike 53 cm to 85 cm TL, however the majority of this range is below the legal size limit of 70 cm TL. If it is to be assumed that release catch rates were exaggerated, percent success is lower than reported and hence relatively few anglers were catching the majority of the fish.

5.0 LITERATURE CITED

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6.0 APPENDICES

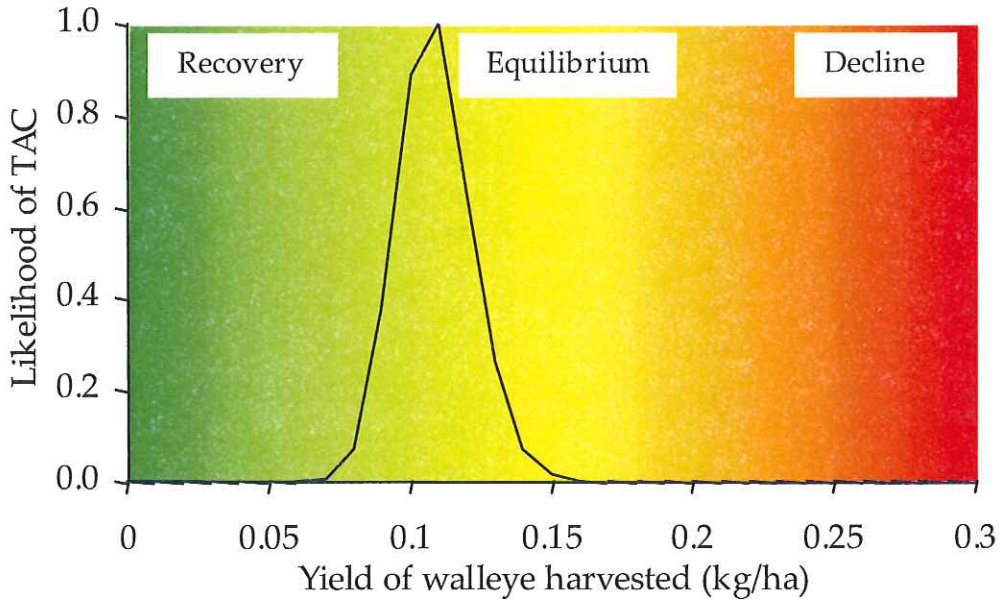
6.1. Appendix 1. Daily summary of angler survey data at Winefred Lake, 2003. Codes are WALL= walleye, NRPK= northern pike, YLPR= yellow perch.

Month	Date	Shift 1=am, 2=pm	# Anglers	# Hours	# WALL kept	#WALL released	#NRPK kept	#NRPK released	#YLPR kept	#YLPR released
5	23	2	15	53	3	3	1	15	0	0
5	24	1	20	68	0	0	8	52	0	0
5	25	1	14	39	10	0	0	5	0	0
5	30	2	36	139	13	16	1	70	0	0
5	31	1	19	77	10	17	9	12	0	0
6	1	1	24	56	3	5	4	16	0	0
6	2	2	4	48	4	1	1	26	0	0
6	3	1	16	55	11	2	8	64	0	0
6	4	2	16	82	0	17	5	47	0	0
6	5	2	1	0	0	0	0	0	0	0
6	6	2	21	78	2	0	5	10	0	0
6	7	1	6	18	3	0	3	2	0	0
6	15	1	22	71	4	4	0	44	0	0
6	16	1	11	27.5	2	0	1	9	0	0
6	17	1	6	19	1	0	1	3	0	0
6	18	2	13	65	0	13	5	25	0	0
6	19	2	17	44	1	1	1	19	0	0
6	20	1	12	35	3	2	0	14	0	0
6	21	2	6	18	0	2	0	4	0	0
6	22	1	2	7	0	0	0	0	0	0
6	27	2	10	52.5	7	0	2	20	0	0
6	28	2	14	54	1	1	4	10	0	0
6	29	1	26	102	2	0	13	28	0	0
6	30	1	7	17	0	0	0	10	0	0
7	1	1	4	8	0	0	0	0	0	0
7	2	1	25	99.5	4	0	5	14	0	0
7	3	1	22	77.5	0	1	2	22	1	0
7	4	2	29	72	1	0	2	13	0	0
7	5	1	14	30	2	0	0	4	0	0
7	10	2	16	50	2	1	5	17	0	0

6.1. Appendix 1. Continued

Month	Date	Shift 1=am, 2=pm	# Anglers	# Hours	# WALL kept	#WALL released	#NRPK kept	#NRPK released	#YLPR kept	#YLPR released
7	11	2	33	118.5	9	3	7	55	0	0
7	12	1	18	66.5	2	3	1	38	0	0
7	13	2	24	104	9	6	9	106	0	0
7	14	2	16	63	3	17	0	26	0	0
7	15	1	6	18	1	0	0	6	0	0
7	16	2	24	87.5	1	39	3	98	0	0
7	17	2	14	25	0	1	0	28	0	0
7	18	2	24	76	0	0	4	10	0	0
7	19	2	30	89.5	0	1	8	8	0	0
7	20	1	5	15	0	0	3	0	0	0
7	26	2	6	17	0	15	0	76	0	0
7	27	1	13	44	1	19	1	7	0	0
7	28	2	23	97.5	8	11	6	98	0	0
7	29	2	2	4	0	0	1	0	0	0
7	30	2	2	1	0	0	1	0	0	0
7	31	1	2	4	0	0	0	1	0	0
8	1	2	4	20	0	0	0	0	0	0
8	2	2	35	141	2	4	17	100	0	0
8	3	2	17	79	2	0	4	35	0	0
8	4	1	1	0	0	0	0	0	0	0
8	9	2	4	4	0	0	0	0	0	0
8	10	1	10	36	1	0	1	3	0	0
8	11	2	8	17	0	0	2	9	0	0
8	12	1	2	5	0	0	0	0	0	0
8	13	2	4	10	0	0	0	4	0	0
8	14	2	5	13	0	1	0	5	0	0
8	15	2	28	83.5	0	0	1	22	0	0
8	16	1	16	69	0	4	2	20	0	0
8	17	1	4	8	0	0	0	0	0	0

6.2. **Appendix 2. Standardized probability density (SPD) function of the sport fishery yield of walleye from Winefred Lake, 2003. The total allowable catch (TAC) was based on bootstrapped distributions of equilibrium and recovery yields from Alberta walleye fisheries categorized as collapsed (Sullivan 2004).**



6.3. Appendix 3. Biological data from sport harvested walleye at Winefred Lake, 2003. Codes are g= grams, FL= fork length, mm= millimeters, f= female, m= male, mat= mature, imm= immature.

Sample number	Date	Weight (g)	FL (mm)	Sex	Maturity	Age (years)
	Average=	2324	598			14
1	23-May	2450	627	f		14
2	23-May	1900	564	m		15
3	23-May	2750	647	f		16
4	25-May	1800	576	m		15
5	25-May	2000	586	f		14
6	25-May	3800	568	f		17
7	25-May	2000	570	m		
8	25-May	1900	566	m		12
9	25-May	2200	597	m		17
10	30-May	2100	597	m	mat	15
11	30-May	2300	600	m	mat	17
12	30-May	2400	600	f		14
13	30-May	3600	675	f		15
14	30-May	2800	642	f		20
15	30-May	2000	580	m		16
16	30-May	2200	603	m		14
17	30-May	2400	625	f		14
18	30-May	2900	670	f		18
19	1-Jun	1700	543	f		15
20	31-May	2200	595	m		15
21	31-May	2700	624	m		17
22	31-May	3200	664	f		16
23	31-May	2700	620	f		15
24	1-Jun	2400	615	f		14
25	1-Jun	2300	588	f		14
26	1-Jun	2200	591	f		14
27	3-Jun	2100	585	m		14
28	3-Jun	2200	587	m		16
29	3-Jun	1300	479	m		7
30	3-Jun	2600	617	m		17
31	3-Jun	3000	674	f		19

6.3. Appendix 3. Continued.

Sample number	Date	Weight (g)	FL (mm)	Sex	Maturity	Age (years)
32	3-Jun	2000	587	m		16
33	15-Jun	2100	560	m		14
34	15-Jun	2200	585	m		12
35	15-Jun	3050	645	f		17
36	15-Jun	1900	587	f		12
37	16-Jun	1700	549	m		12
38	17-Jun	1900	561	f		14
39	18-Jun	2600	633	f		14
40	19-Jun	2800	623	f		13
41	20-Jun	1800	571	m		14
42	20-Jun	2400	604	m		16
43	20-Jun	2000	592	m		12
44	27-Jun	2200	582	m		15
45	27-Jun	2500	632	f		15
46	27-Jun	2700	617	f		16
47	27-Jun	2400	614	f		15
48	27-Jun	2600	619	f		13
49	27-Jun	2400	638	f		14
50	28-Jun	2100	613	f		14
51	29-Jun	2500	605	f		13
52	29-Jun	2700	637	f		14
53	2-Jul	2100	581	m		16
54	2-Jul	3100	675	f		18
55	2-Jul	1900	539	m		11
56	4-Jul	2300	575	m		14
57	10-Jul	2300	625	m		14
58	10-Jul	2000	591	m		15
59	11-Jul	3000	633	f		15
60	11-Jul	2200	586	f		12
61	11-Jul	2200	602	m		13
62	11-Jul	2500	614	f		13
63	11-Jul	2400	612	f		16
64	11-Jul	1900	584	f		12

6.3. Appendix 3. Continued.

Sample number	Date	Weight (g)	FL (mm)	Sex	Maturity	Age (years)
65	11-Jul	1000	462	f	imm	6
66	12-Jul	1700	540	m		11
67	12-Jul	1600	505	m		11
68	13-Jul	2200	525			16
69	13-Jul	3600	691	f		19
70	13-Jul	2600	655	f		18
71	13-Jul	2100	598	m		16
72	13-Jul	1500	530	m		13
73	13-Jul	1700	562	m		15
74	13-Jul	2500	640	f		16
75	13-Jul	1900	587	f		14
76	14-Jul	3000	639	f		13
77	14-Jul	2700	651	f		14
78	14-Jul	2800	653	f		18
79	15-Jul	2400	605	f		15
80	16-Jul	1000	466	m	imm	6
81	27-Jul	1600	530	m		9
82	28-Jul	2500	593	m		12
83	28-Jul	2500	627	f		14
84	28-Jul	2700	615	m		14
85	28-Jul	3000	655	f		15
86	28-Jul	2400	600	f		15
87	28-Jul	2100	581	m		16
88	3-Aug	2000	565	m		15
89	3-Aug	3000	620	f		15
90	10-Aug	2500	605	f		16

6.4. Appendix 4. Biological data from test fishery caught walleye at Winefred Lake, 2003. Codes are FL= fork length, mm= millimetres.

Sample number	Date	FL (mm)
1	10-Jul	553
2	13-Jul	385
3	26-Jul	379
4	26-Jul	360
5	30-Jul	670
6	31-Jul	601
7	2-Aug	664
8	3-Aug	410
9	3-Aug	632
10	10-Aug	380
11	12-Aug	408
12	3-Aug	465

6.5. Appendix 5. Biological data from sport harvested pike at Winefred Lake, 2003. Codes are g= grams, FL= fork length, mm= millimeters, f= female, m= male.

Sample number	Date	Weight (g)	FL (mm)	Sex	Age (years)
	Average=	3289	778		10
1	23-May	2750	743	f	7
2	24-May	4500	867	f	10
3	24-May	3800	815	f	8
4	24-May	4000	839	f	12
5	24-May	3700	871	f	12
6	24-May	4700	905	f	13
7	24-May	5000	915	m	15
8	24-May	3000	801	f	12
9	24-May	4200	875	f	14
10	30-May	3600	832	f	14
11	30-May	2900	751	f	11
12	31-May	2400	730	m	8
13	30-May	3300	798	f	14
14	31-May	2100	704	f	8
15	1-Jun	3000	745	f	9
16	1-Jun	3600	843	m	13
17	1-Jun	2700	791	f	13
18	1-Jun	3700	867	f	13
19	1-Jun	6700	974	f	18
20a	3-Jun	4400	846	f	
20b	3-Jun	2000	671	m	
20c	3-Jun	2500	737	f	
21	16-Jun	4200	816	f	10
22	17-Jun	4600	815	f	13
23	18-Jun		755	f	9
24	18-Jun	3500	790	m	11
25	18-Jun	4100	811	f	14
26	18-Jun	2700	736	f	8
27	19-Jun	3000	752	f	8
27a	27-Jun	4600	879	f	14
28	27-Jun	2800	725	m	10
29	27-Jun	2600	711	m	6
30	28-Jun	6400	1015	f	19
31	28-Jun	2300	704	f	8
32	28-Jun	2100	663	f	6

6.5. Appendix 5. Continued.

Sample number	Date	Weight (g)	FL (mm)	Sex	Age (years)
33	28-Jun	2500	703	m	10
34	29-Jun	2500	688	m	8
35	29-Jun	4900	886	f	12
36	29-Jun	2200	689	m	7
37	29-Jun	6400	930	f	14
38	2-Jul	2500	713	f	6
39	2-Jul	2000	685	m	11
40	2-Jul	3300	814	f	8
41	2-Jul	2500	708	m	6
42	2-Jul	2300	727	f	8
43	3-Jul	2100	698	f	5
44	3-Jul	2700	765	f	8
45	4-Jul	3200	770	f	9
46	10-Jul	1900	651	m	7
47	10-Jul	1800	655	f	4
48	11-Jul	3100	752	m	14
49	11-Jul	4400	868		15
50	11-Jul	2700	795	f	8
51	11-Jul	4700	879	f	15
52	12-Jul	3500	788	f	10
53	12-Jul	2200	723	m	6
54	13-Jul	2700	737	f	7
55	13-Jul	8000	1000	f	18
56	13-Jul	2600	745	m	7
57	13-Jul	3200	810	f	10
58	13-Jul	4500	886	f	12
59	13-Jul	3000	771	f	7
60	13-Jul	3000	776	f	10
61	16-Jul	2500	740	f	7
62	16-Jul	3600	825	f	10
63	16-Jul	2600	745	f	6
64	11-Jul	5000	881	f	14
65	18-Jul	4300	861	f	14
66	18-Jul	2400	660	f	6
67	18-Jul	2500	751	f	12

6.5. Appendix 5. Continued.

Sample number	Date	Weight (g)	FL (mm)	Sex	Age (years)
68	18-Jul	1700	643	f	6
69	19-Jul	1700	619	m	5
70	19-Jul	2300	710	m	7
71	19-Jul	1900	619	f	4
72	19-Jul	4100	819	f	9
73	19-Jul	2600	693	m	7
74	19-Jul	2800	752	f	12
75	19-Jul	2600	760	f	10
76	19-Jul	2600	758	f	11
77	20-Jul	2500	703		7
78	20-Jul	3200	741	m	8
79	20-Jul	2700	726	m	10
80	27-Jul	5100	943	m	17
81	28-Jul	2600	759	f	14
82	28-Jul	6600	976		17
83	28-Jul	2700	700	m	7
84	28-Jul	3800	865		13
85	28-Jul	3500	812	f	12
86	28-Jul	3700	810	f	12
87	29-Jul	4700	875	m	11
88	2-Aug	1900	694	m	8
89	2-Aug	2600	720	f	9
90	2-Aug	2300	675	m	6
91	2-Aug	2400	725	f	8
92	2-Aug	2500	729	m	7
93	2-Aug	2200	711	m	10
94	3-Aug	3100	765	f	8
95	3-Aug	3800	810	f	15
96	10-Aug	3600	833	f	11
97	10-Aug	2000	675	f	5
98	11-Aug	6000	946	f	18
99	15-Aug	2400	711	f	7
100	16-Aug	2500	692	f	6

6.6. Appendix 6. Biological data from test fishery caught pike at Winefred Lake, 2003. Codes are FL= fork length, mm= millimetres.

Sample number	Date	FL (mm)
1	17-Jun	546
2	17-Jun	667
3	18-Jun	605
4	1-Jul	620
5	1-Jul	661
6	1-Jul	755
7	1-Jul	890
8	2-Jul	512
9	2-Jul	886
10	10-Jul	525
11	10-Jul	557
12	10-Jul	705
13	10-Jul	720
14	10-Jul	889
15	13-Jul	557
16	13-Jul	860
17	17-Jul	802
18	29-Jul	535
19	30-Jul	410
20	30-Jul	624
21	30-Jul	627
22	30-Jul	645
23	30-Jul	704
24	30-Jul	715
25	30-Jul	741
26	30-Jul	778
27	30-Jul	815
28	31-Jul	636
29	31-Jul	742
30	31-Jul	752
31	2-Aug	491
32	2-Aug	680

6.6. Appendix 6. Continued.

Sample number	Date	FL (mm)
33	2-Aug	685
34	2-Aug	712
35	2-Aug	761
36	2-Aug	770
37	2-Aug	770
38	3-Aug	530
39	3-Aug	537
40	3-Aug	572
41	3-Aug	641
42	3-Aug	680
43	3-Aug	700
44	3-Aug	830
45	11-Aug	565
46	11-Aug	627
47	11-Aug	796
48	12-Aug	524
49	12-Aug	664
50	14-Aug	562
51	14-Aug	574
52	14-Aug	640
53	15-Aug	560
54	15-Aug	599
55	15-Aug	636
56	15-Aug	795
57	15-Aug	809
58	16-Aug	655
59	16-Aug	668
60	16-Aug	720
61	16-Aug	742
62	16-Aug	797

6.7 Appendix 7. Creel survey field data form from Winefred Lake, 2003.

Page # ________

Crew ______________________

2003 FISHERIES ASSESSMENT

Winefred Lake or Pigeon Lake (circle one?)

Alberta Conservation Association

Date		Day	Time			Interview UTM (NAD 83)		Anglers							Appendices					Interview			Species Caught					
Month	Date	Day Code	Time of day (10s)	Time of day (1s)	Time of day (1/4 hrs = 0, 25, 5, 75)	UTM Easting (roving creel)	UTM Northing (roving creel)	100s	10s Party # e.g. 017	1s	Landing At the end of your trip, where is the boat going to touch land? Coded during entry	Time spent fishing (10s)	Time spent fishing (1s)	Time spent fishing (1/4 hrs = 0, 25, 5, 75)	Target	Method	Electronics	Skill	Residence nearest town or city...coded during entry	Baited hooks? 1 = Yes or 2 = No	1 = complete trip interview or 2 = incompleted trip interview	2 = shore/dock angler during roving creel or 1 = all others	# WALL kept	# WALL released	# NRPK kept	# NRPK released	# YLPR kept	# YLPR released
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20 interviews/page							Sheet totals >>							.														

USE THESE SHEETS FOR BOAT COUNTS ON WINEFRED LAKE

Fill in Date, Day, Time, #Anglers per boat and Landing

SHEET RULES

- NO blank spaces
- ALL [illegible]
- NO [illegible]
- NO [illegible]
- Landing and Residence will be numerically coded during data entry... write the place

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

TARGET
1 = WALL
2 = NRPK
3 = YLPR
4 = LKWH
5 = BRBT
6 = ANYTHING

METHOD
1 = Artificial
2 = Leeches
3 = Commercial Baitfish
4 = Salted Baitfish
5 = Dewworms
6 = Scent Baits
7 = Miscellaneous

ELECTRONICS
1 = Depth Sounder
2 = Depth Sounder + GPS
3 = GPS
4 = None
5 = Other

SKILL
1 = Novice
2 = Average
3 = Professional
4 = Tech angling

The Alberta Conservation Association acknowledges the following partners for their generous support of this project

Alberta

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