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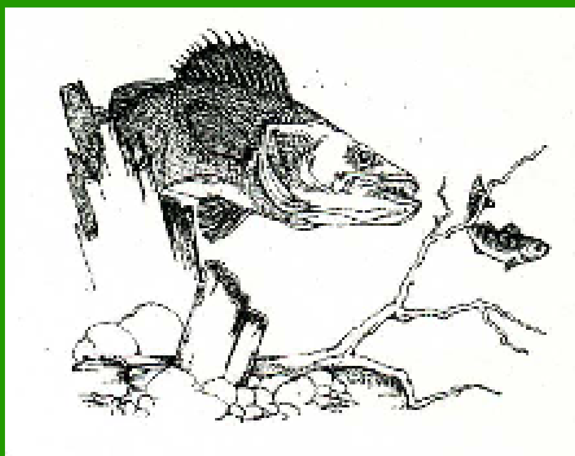
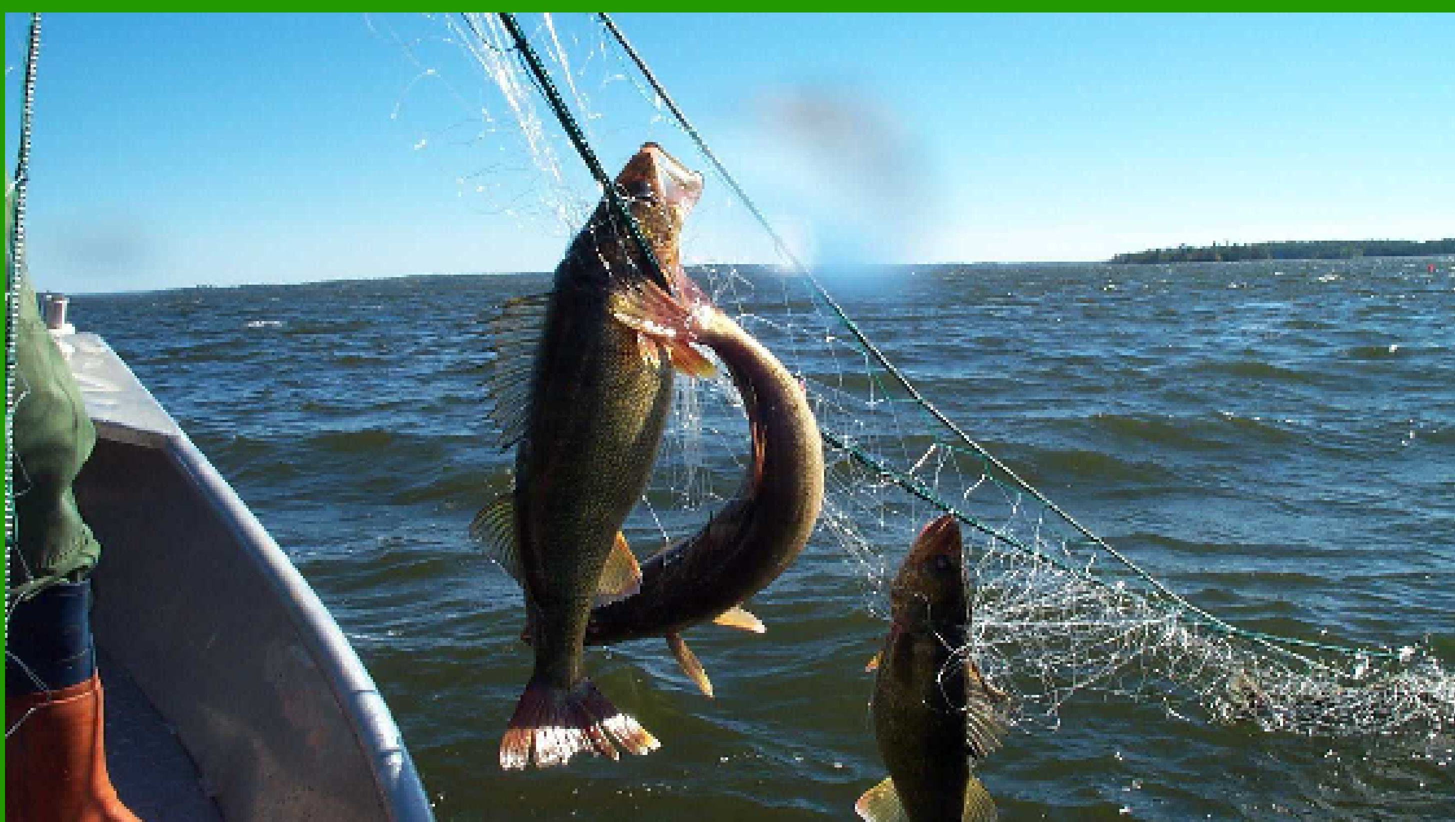


Fort Frances District – Northwest Region

Fall Walleye Index Netting on the North Arm of Rainy Lake, Ontario 2007

Darryl McLeod and Alyson Rob



Fall Walleye Index Netting on the North Arm of Rainy Lake, Ontario, 2007

Darryl McLeod and Alyson Rob
Ontario Ministry of Natural Resources
Fort Frances, Ontario

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SUMMARY

Fall Walleye Index Netting (FWIN) was conducted in 2007 on the North Arm of Rainy Lake, located directly north of Fort Frances, Ontario. The lake is situated on the international border between Ontario and Minnesota; however the North Arm lies entirely in Ontario. A diversity of fish species were captured in gill nets, and detailed biological data relating to walleye were obtained. In general, the walleye population in the North Arm appeared to be recovering since 1965, with most life history parameters showing improvement. Current management strategies appear to be having the desired affect of improving population structure and abundance, as reflected by the 'above average' catch per unit effort of 14.6 walleye/net (geometric mean of 12.5 walleye/net). The geometric mean catch of walleye greater than 450 mm total length was high at 7.9 walleye/net, and the Shannon Diversity Index for adult females was 0.72. A total of 17 age classes (15 with n>1) were captured, with a maximum age of 19 years and a mean age of 4.39 years. Comparison of walleye population structure (e.g. geometric mean CUE ≥ 450 mm, number of age classes, maximum age, Shannon Diversity Index, length at 50% maturity and annual mortality) to NW Regional benchmarks indicate a 'healthy' fishery. Growth of walleye in the North Arm is very rapid with mean total length at age two reaching 411 mm, and remains higher than other populations in the South Arm and Redgut Bay. Fishing Quality Index and mean total length indicate the walleye population is providing high quality angling opportunities.

TABLE OF CONTENTS

LIST OF FIGURES

List of Tables

INTRODUCTION

Rainy Lake is situated on the international border between Ontario and Minnesota, and is divided into three geographically distinct basins; the North Arm and Redgut Bay which lie entirely in Ontario, and the South Arm which lies nearly equally in Minnesota and Ontario (Figure 1). Water levels are regulated by the International Rainy Lake Board of Control (IRLBC) through the International Joint Commission (IJC). The outlet into the Rainy River is controlled by a hydroelectric dam at Fort Frances-International Falls. Inflows are regulated by a hydroelectric dam at Sturgeon Falls (Crilly) on the Seine River system, and by control dams at the outlet of Namakan Lake at Kettle Falls and Squirrel Falls. Three additional water control structures are located at Big Canoe, Footprint, and Manitou Rivers, and provide a minor contribution to water level regulation.

Water levels are regulated based on the "rule curve." The first order of regulation for Rainy Lake and the Namakan Reservoir was established in 1949, and supplementary orders were issued in 1957 and 1970. Dissatisfaction with the 1970 order led to changes in the rule curve which were put in place in January 2000. The new curve consists of virtually identical spring refill patterns, with a period of stable water levels in the summer and gradual, earlier draw down in the fall. The new curve was intended to improve fish populations that spawn in both fall (e.g. lake whitefish, *Coregonus clupeaformis*) and spring (e.g. walleye, *Sander vitreus,* and northern pike, *Esox lucius)*. The changes to the rule curve involve a monitoring strategy to evaluate long term impacts, in which Fall Walleye Index Netting (FWIN) was included (IRLBC, 1999; USGS, 2000).

Rainy Lake covers an area of 92,100 ha (212,010 acres), of which 76%, or 70,150 ha (173,000 acres) is in Ontario. The North Arm has a surface area of 34,570 ha (85,400 acres). The lake is located in the southern range of the boreal forest in North America, and is typical of Canadian Shield lakes with soft water and little submerged aquatic vegetation. Characteristics of the three mesotrophic basins have been summarized in Table 1. A diverse, coolwater fish community is present in the lake, including 55 known species (Appendix I). The North Arm was previously assessed using FWIN standards in 1997 and 2002, and will continue to be assessed on a five-year cycle (McLeod, 2002). Redgut Bay was assessed using FWIN standards in 1998, 2003 and 2008, while the South Arm was sampled in 1999 and 2004. Additional fisheries assessment on the North Arm in the past decade included spring spawning assessment (1997), annual monitoring of commercial harvests, roving creel survey (2002), aerial effort survey(SOR – 2000/01), and annual smallmouth bass (*Micropterus dolomieu*) sampling through the Fort Frances Canadian Bass Championship. Previous index netting from 1965 to 1999 was conducted in early September and utilized multifilament gill nets at fixed sample sites (Mcleod at al., 2004), similar to standards used by the Minnesota Department of Natural Resources (MDNR).

Approximately 26,600 people closely divided between Minnesota and Ontario, permanently resided in the area of Rainy Lake and upper Rainy River in 2001. Of the Ontario population, 61% live in the town of Fort Frances (OMNR and MDNR, 2004). In addition, ten of the twenty-two Ontario commercial tourist establishments on Rainy Lake are located on the North Arm.

Table 1: Physical and chemical characteristics of the Rainy Lake basins (Ontario waters only).

Parameter	North Arm	Redgut Bay	South Arm	Rainy Lake, Ontario
Surface Area - Ontario (ha)	**34,570**	8,320	27,260	70,150
Mean Depth (m)	**8.0**	6.9	11.5	9.3
Maximum Depth (m)	**41.0**	31.2	49.1	49.1
Mean Summer Secchi Depth (m)	**3.3**	2.1	2.7	2.7
Perimeter Shoreline (km)	**583**	276	439	1,298
Island Shoreline (km)	**440**	55	396	891
T.D.S. (mg/L)	**55**	35	43	53
M.E.I.	**6.9**	5.1	3.7	5.7

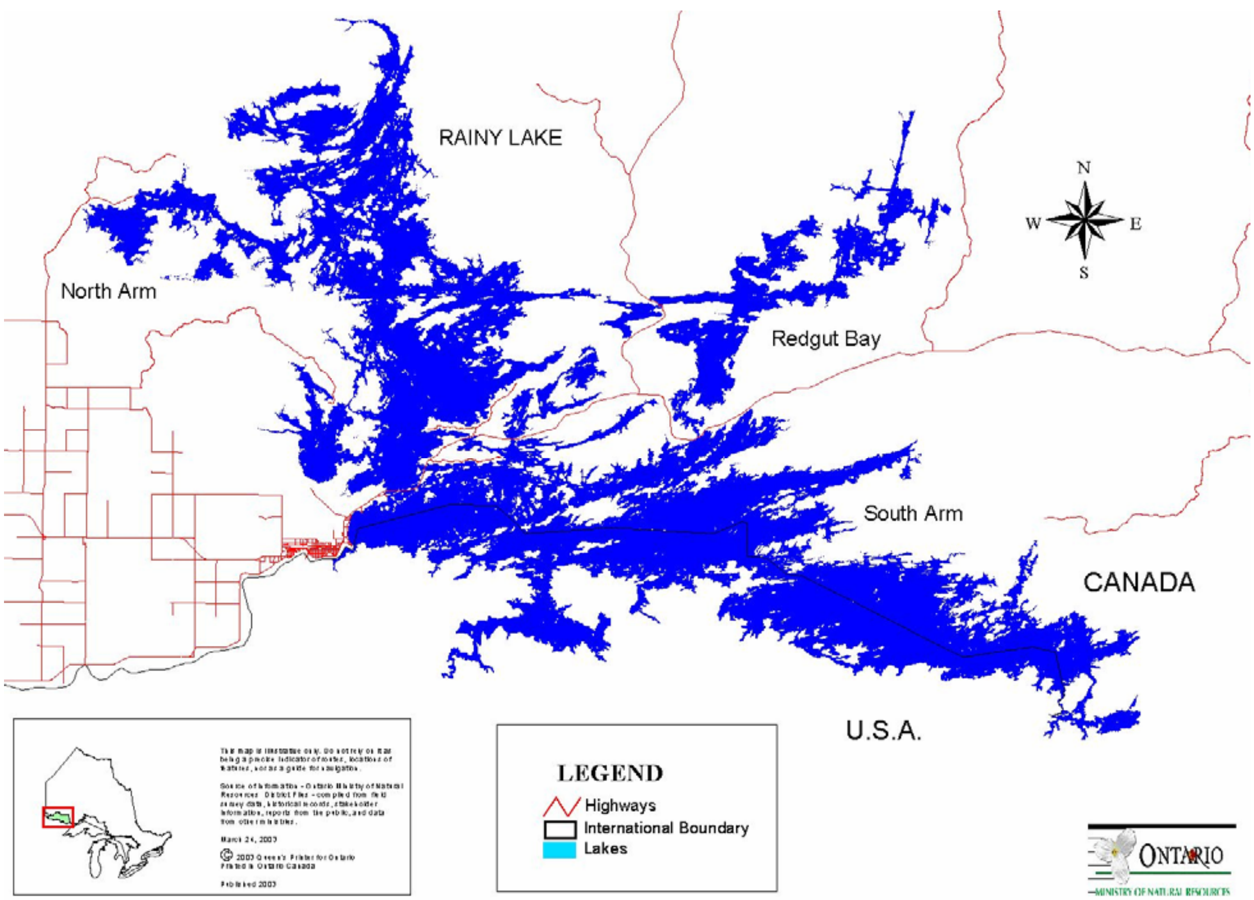

Figure 1: Location of Rainy Lake, Ontario.

Commercial fishing on Rainy Lake dates back prior to the 1890s for lake sturgeon (*Acipenser fulvescens)* and lake whitefish (Pearson, 1963). Commercial fishing since the 1920s was primarily for whitefish, northern pike, walleye and more recently black crappie (*Pomoxis nigromaculatus*). Quota management has been in place for walleye since 1978 and for all other species since 1984. The commercial walleye fishery was reduced by 97% between 1986-2002 by government buy-outs and trades for individual species quotas (OMNR and MDNR, 2004). In 2007, there were four commercial fishing operations and six commercial licenses remaining on the Ontario waters of Rainy Lake. Currently, commercial harvest on the North Arm is limited to two licences, with only one allowing incidental harvests of walleye.

A roving creel survey on the North Arm in 2002 indicated that the majority (86%) of fishing pressure is from non-resident (U.S.) anglers with 83% based in Ontario and 3% from Minnesota. Based on surveys in 2001/02, overall angling effort was lowest on the North Arm (2.9 rod-hrs/ha), and highest on Redgut Bay (8.9 rod-hrs/ha) (M^{c}Leod, 2003).

Angling on Rainy Lake is generally highest for walleye, accounting for 59% of the total effort. The North Arm deviates from the rest of the lake, as angler effort was highest for northern pike (65%) and smallmouth bass (56%). The lower effort directed at walleye (26%) may be attributed to low catch rates relative to other basins (0.25 walleye/rod-hr on the North Arm compared to 1.00 walleye/rod-hr and 1.37 walleye/rod-hr on the South Arm and Redgut Bay respectively). Angler creel surveys in 2001/02 indicated that an estimated 87% of walleye were released in Rainy Lake, and was lowest in the North Arm (70%). The majority of walleye being released is attributed to the restrictive harvest slot and trophy size limits introduced in 1994, and lower daily limits for non-resident anglers introduced in 2000 (M^cLeod, 2003).

Exploited walleye populations often exhibit characteristics associated with over-harvest in many fisheries. These include reductions in numbers, changes in population structure, and physiological (life history) changes (OMNR, 1983). Exploited walleye populations often exhibit inconsistent recruitment and a population structure dominated by younger fish (Morgan et al., 2003). Life history adaptations observed in exploited walleye populations can also include increased juvenile (pre-maturation) growth rates, earlier age at maturity and high investment in reproduction, which are viewed as compensatory mechanisms (Lester et al., 2000).

Historically, walleye populations on Rainy Lake, in particular the North Arm, have fallen below expected and desired levels. Walleye in the North Arm collapsed in the 1960's primarily due to over-fishing. Following that period, the population appeared to be in equilibrium at depressed levels, with both angler and index net catches showing little variation between 1965 and 1990. Initial attempts to rehabilitate the fishery included stocking, spawning habitat creation, angling regulation changes and sanctuaries adjacent to known spawning sites. However, these actions did little to reduce harvest and initiate recovery. In order to allow the walleye population to recover, recommended harvest levels for the North Arm were set at zero beginning in 1992 (MDNR et al., 1992). In 2004, the potential yield of walleye was revised to 33,800 kg/yr, and recommended harvest levels were adjusted to 6,800 kg/yr to reflect recent improvements in the population while supporting continued stock recovery (OMNR and MDNR, 2004).
Since 1994, walleye harvest, particularly by non-resident anglers was restricted to those based in Ontario. Pending a NAFTA trade challenge by the U.S., more general regulations were put in

place in 2000 to limit harvest by all non-resident anglers. The daily catch limit for non-resident anglers of one walleye or sauger per day, with a possession limit of four (walleye and sauger in combination) was introduced. Harvest by anglers was previously limited by the 1994 regulation which allowed a possession limit of three walleye and sauger in combination. All anglers have been regulated by a harvest slot and trophy size limit, whereby only walleye between 35 cm and 45 cm (13.75 to 17.75") with only one walleye greater than 70 cm (27.5") could be legally harvested. Consistent with the entire Northwest (NW) Region, the daily catch and possession limit was increased from three to four walleye in 2000. In order to evaluate the effectiveness of these regulation changes, assessment programs including Fall Walleye Index Netting (FWIN) on each basin of Rainy Lake were initiated (McLeod, 2002). The FWIN program will also provide data for the evaluation and monitoring of water level changes initiated by the IRLBC (USGS, 2000).

METHODS

Standard FWIN gillnetting was conducted on the North Arm between September 4 and September 20, 2007 following the Manual of Instructions: Fall Walleye Index Netting Surveys (Morgan, 2002). Gear consisted of standard OMNR FWIN gillnets constructed of clear monofilament, and made up of eight 7.6 m panels with stretched mesh sizes of 25 mm, 38 mm, 51 mm, 64 mm, 76 mm, 102 mm, 127 mm, and 152 mm (made by *Les Industries Fipec Inc*., Quebec, catalog #FEX-03). Nets were set as close to perpendicular (90°) from shore as each net site would allow.

In 2007, twenty-five net sites were selected using the same fixed locations used in 1997 and 2002. Sites were based on historical net locations, with some adjustments to depth strata (shallow =2-5 m, deep=5-15m) as outlined in the FWIN manual (Morgan, 2002). Sampling intensity in each stratum was determined by the relative amount of shallow versus deep areas of the lake. As a result, 56% (14/25) of nets were deep, and 44% (11/25) were shallow. The timing of the project coincides with historical index netting, and with similar efforts on the South Arm by the Minnesota Department of Natural Resources (MDNR).

All walleye, northern pike and smallmouth bass were sexed and sampled for maturity by comparing gonad development (Duffy et al., 1999), and aging structures were taken (otoliths for walleye >30 cm, scales for walleye <30 cm. 4th dorsal spine for smallmouth bass; and cleithra for pike). All aging structures were assessed by the OMNR Northwest Regional Aging Facility in Dryden, Ontario. All other fish species were measured for fork and total length and weighed, but no aging structures were taken. Data were compiled and analyzed using FISHNET2 (Lester and Korver, 1996) and Fishnet Lite for walleye as part of the Ontario Fisheries Information System (OFIS). The health of the North Arm fishery was also evaluated through comparisons to the NW Regional means for walleye life history (Lester et al., 2000) and population structure (Morgan et al., 2003), and to provincial means for northern pike life history (Malette and Morgan, 2005).

RESULTS

A total of 16 species were captured in 25 gill net sets on the North Arm. Surface water temperatures were warmer than desired during the sampling, and ranged from 17 to 20^{o}C with thermal stratification present throughout the survey. Yellow perch (*Perca flavescens*) were the most abundant species representing 46% of the catch by number with an arithmetic mean catch of 42.4 fish/net. Brown bullheads (*Ictaluus nebulosus*) were the second most abundant species, with an arithmetic mean of 21.6 fish/net, representing 23% of the catch. Walleye were the next most abundant species at 14.6 fish/net, representing 16% of the catch. The total percid composition (walleye, sauger and yellow perch) was 62% of the catch by number. No other single fish species comprised greater than 5% of the total catch, as indicated in a summary of catch data for all species (Table 2). The FWIN efforts on the North Arm produced a fish community with a Simpson's Diversity Index value of 3.30.

Table 2: Summary of catch data from Fall Walleye Index Netting (FWIN) in Rainy Lake North Arm (25 net sets), 2007.

Species	# Nets Captured In	Total # Caught	Mean (#/net)	Standard Error (SE)	% Relative Standard Error	% of Total Catch
Lake Whitefish	16	48	1.92	0.39	20.0	2.1
Lake Herring	10	13	0.52	0.14	27.5	0.6
Northern Pike	25	88	3.52	0.33	9.3	3.8
White Sucker	14	28	1.12	0.28	24.9	1.2
Golden Shiner	1	10	0.40	0.40	100.0	0.4
Spot tail Shiner	7	12	0.48	0.17	36.3	0.5
Brown Bullhead	22	541	21.64	7.18	33.2	23.4
Burbot	1	1	0.04	0.04	100.0	0.0
Trout Perch	2	2	0.08	0.06	69.2	0.1
Rock Bass	14	47	1.88	0.60	31.7	2.0
Pumpkinseed	5	12	0.48	0.24	49.8	0.5
Smallmouth Bass	13	36	1.44	0.39	27.2	1.6
Black Crappie	16	44	1.76	0.38	21.6	1.9
Yellow Perch	22	1060	42.40	12.68	29.9	45.9
Sauger	1	1	0.04	0.04	100.0	0.0
Walleye	24	366	14.64	1.40	9.5	15.9
TOTAL	**25**	**2309**	**92.36**	**-**	**-**	**100.0**

WALLEYE

The catch of walleye in fall index netting on the North Arm of Rainy Lake for the period of 1964-2007 is illustrated in Figure 2. In 1997, provincial FWIN standards were first used in a detailed comparison with historical index netting techniques. Walleye abundance prior to the 1990s was extremely low and varied little within or among sampling years. The long-term arithmetic mean from 1965 to 1993 was only 2.7 walleye/net (SE=0.5). Catch per unit effort (CUE) of walleye had increased dramatically during the late 1990's, from an arithmetic mean of 16.5 walleye/net in 1997 to an historical high of 28.1 walleye/net in 2002. A significant decline in CUE to 14.6 walleye/net was observed in 2007. The catch of spawning stock walleye ≥450 mm is represented in Figure 3, and suggests a dramatic increase in abundance since 1993.

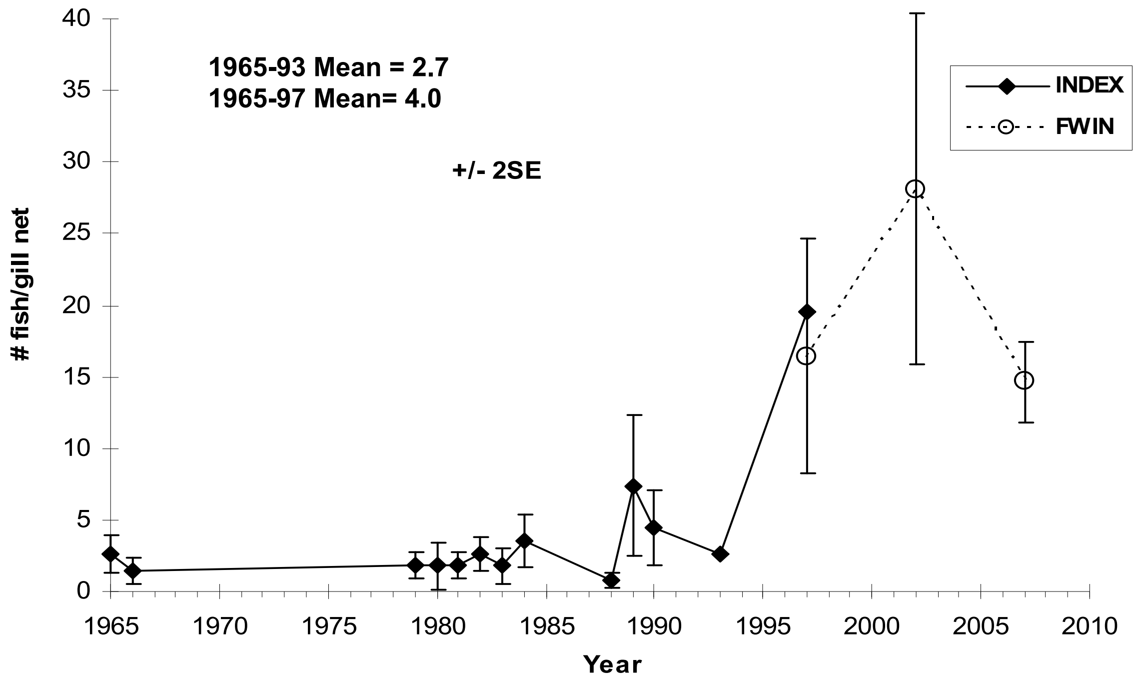

Figure 2: Historical abundance of walleye based on catch-per-unit-effort from index netting (1965-1997) and Fall Walleye Index Netting (1997, 2002 and 2007).

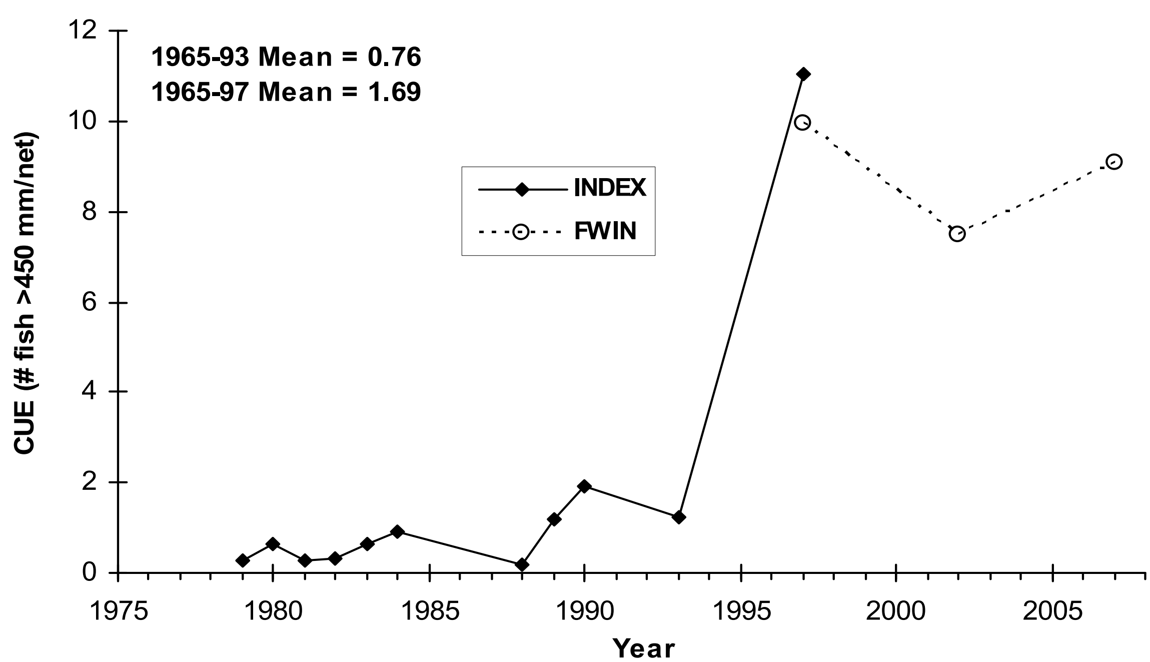

Figure 3: Historical abundance of walleye ≥450mm TL based on catch-per-unit-effort from index netting (1979- 1997) and Fall Walleye Index Netting (1997, 2002 and 2007).

The geometric mean catch was 9.4 walleye/net in 1997 and increased to 15.7 walleye/net in 2002. The geometric mean catch declined slightly to 12.5 walleye/net in 2007, but remains above the NW Region mean of 10.7 walleye/net (Figure 4). The geometric mean CUE (walleye ≥450 mm) was estimated at 7.9 in 2007, compared to 5.0 in 2002 and 6.2 in 1997 (Figure 5).

Despite dramatic increases in the number and size of walleye, the CUE by weight remained relatively stable in 2007 at 20.51 kg/net, compared to 20.22 kg/net in 1997 and 21.62 kg/net in 2002. The mean weight of walleye sampled in 2007 was 1,400 g which was significantly higher than the 775 g observed in the 2002 FWIN, and higher than the long term (1979-1997) mean of 775 g.

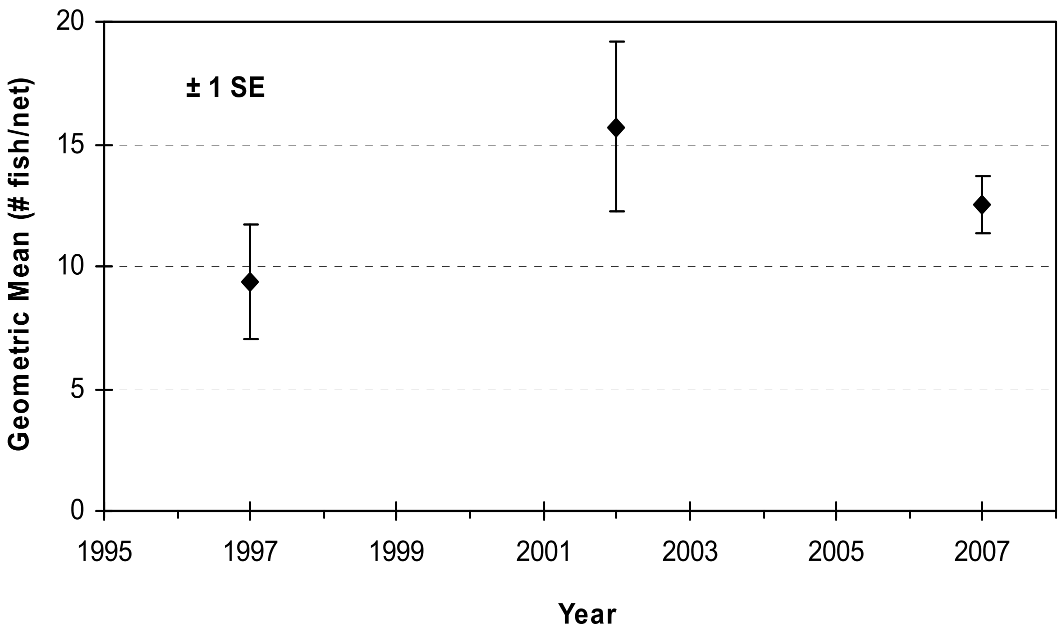

Figure 4: Geometric mean catch of walleye in the North Arm of Rainy Lake based on 1997, 2002 and 2007 Fall Walleye Index Netting (FWIN).

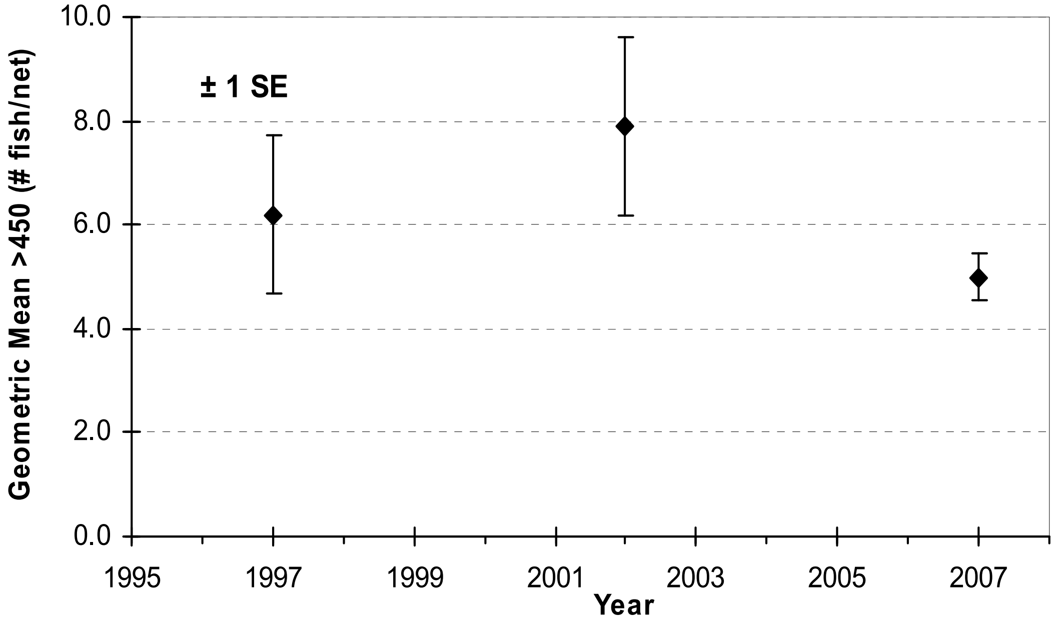

Figure 5: Geometric mean catch of walleye ≥450mm TL in the North Arm of Rainy Lake based on 1997, 2002 and 2007 Fall Walleye Index Netting (FWIN).

Age six (2001 year class) walleye represented the highest proportion of the catch at 20%, followed by age 3 and 2 (2004 and 2005 year classes) at 15% of the catch (Figure 6). As a result, the mean age of catch increased to 4.39 years, with a total of 17 age classes (15 with n>1) present to a maximum age of 19 years. A total of 47 young-of-year (age 0) walleye were collected and were well represented in the age composition. The high abundance of age 6 (2001 year class) and age 13 (1994 year class) reflects the two strongest year classes ever observed in past netting studies across the Fort Frances District. Similarly, the absence of age 7 walleye reflects the very weak year class produced in 2000. Total annual mortality (sexes combined) was 27%, and was estimated at 29% for males (5+ years) and 26% for females (5+ years).

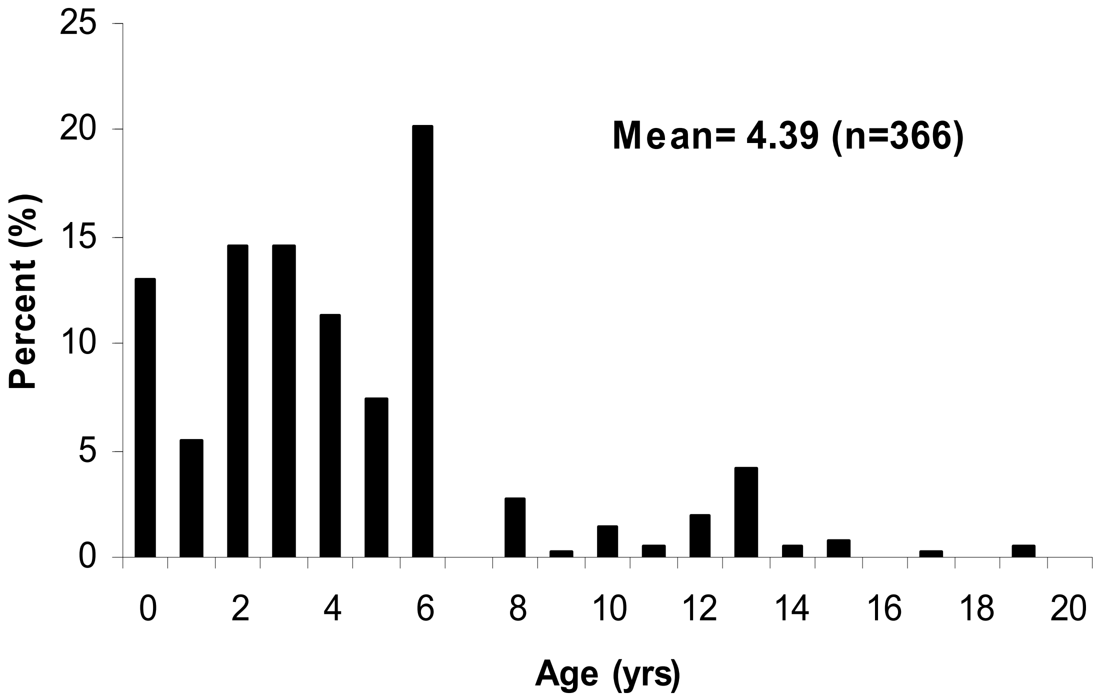

Figure 6: Walleye age composition for the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

The age composition of the catch was also compared to the 2002 FWIN (Figure 7) and to the long-term mean (1970-1997) from previous index netting efforts (Figure 8). The mean age of 4.39 years for the 2007 FWIN was higher than both the 2002 mean of 2.55 years and the 1997 mean of 3.45 years. This increase reflects the variability in year class strengths observed since 2000, along with the shift to older fish to a maximum of 19 years of age. Similarly, the mean age in 2007 was higher than the long-term mean of 3.5 years, even though there were minor differences in gear type.

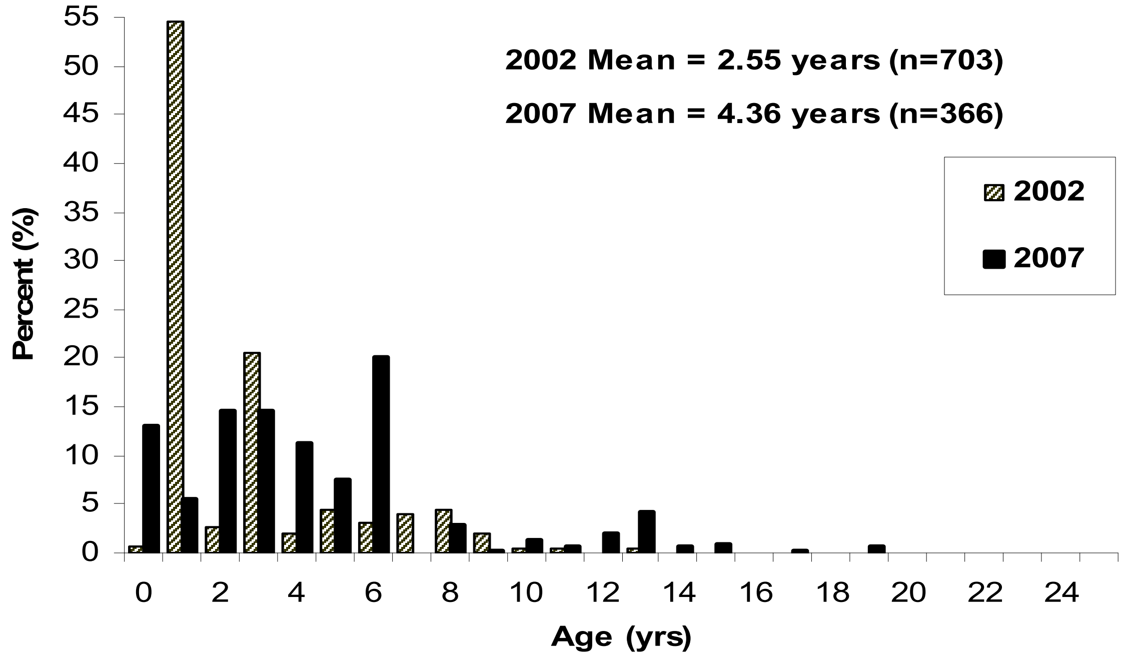

Figure 7: Age composition of walleye in the North Arm of Rainy Lake based on the 2002 and 2007 Fall Walleye Index Netting (FWIN).

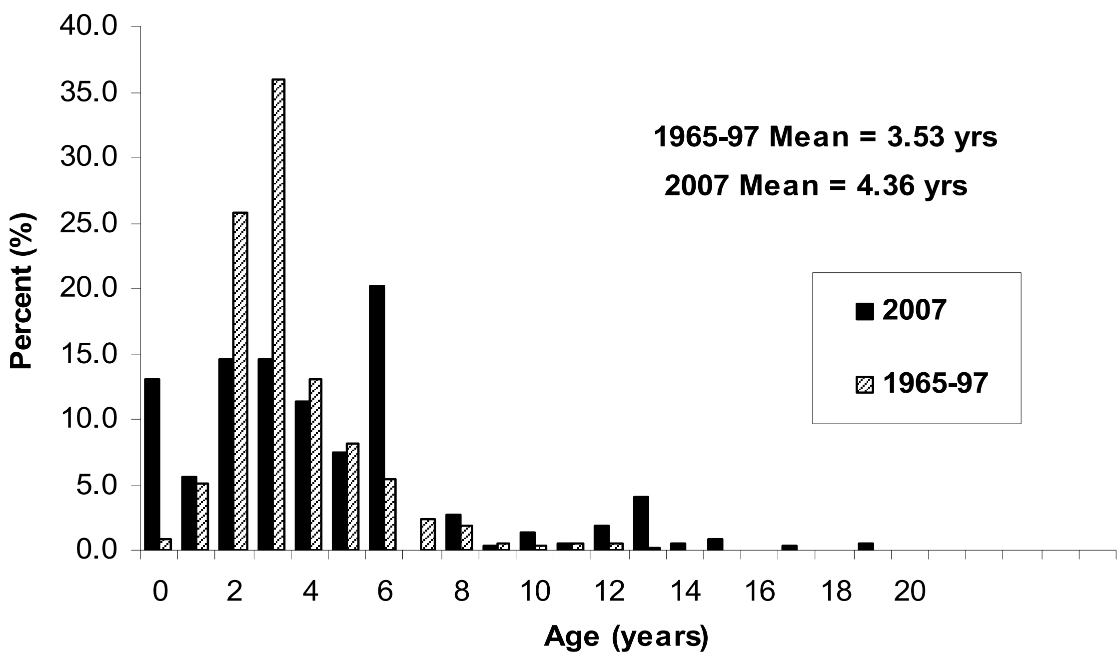

Figure 8: Age composition of walleye in the North Arm of Rainy Lake based on 2007 Fall Walleye Index Netting (FWIN) compared to long-term index netting (1965-1997).

Mean total length of walleye (sexes combined) was 460 mm, with good representation of size classes greater than 400 mm. However, there appears to be very poor representation of smaller fish from 200 to 360 mm, and is cause for some concern. The largest walleye sampled had a total length of 763 mm. The length distribution of walleye captured in the North Arm is illustrated in Figure 9.

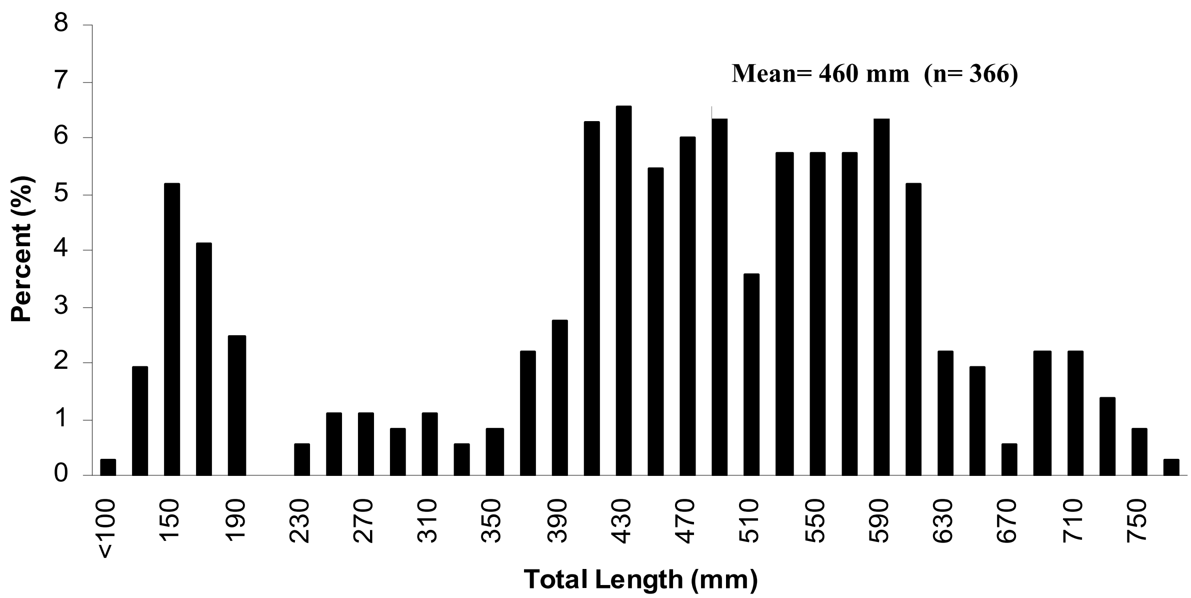

Figure 9: Length composition of walleye for the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

North Arm walleye exhibited typically sexually dimorphic growth patterns, with males and females growing at a very similar rate during the first 2 years, with male growth leveling off and females continuing to grow larger in terms of both length (Figure 10) and weight (Figure 11). Differences were more obvious when considering body weight, as expected given the differences in gonad weight between the two sexes.

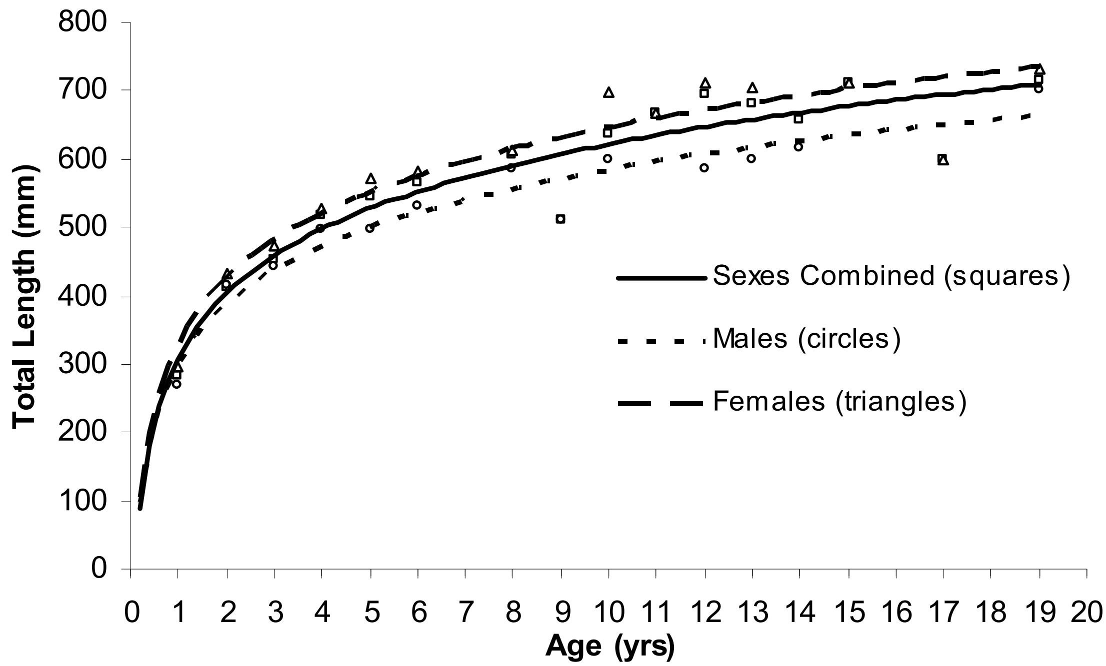

Figure 10: Walleye growth (total length at age) for males, females, and sexes combined in the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

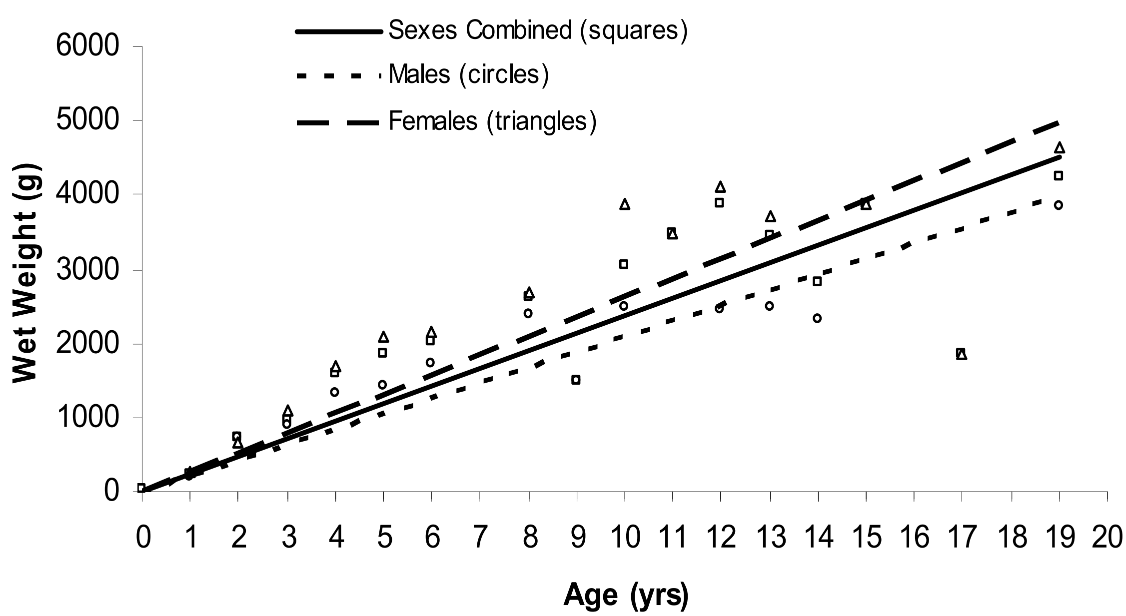

Figure 11: Walleye growth (weight at age) for males, females, and combined sexes in the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

Growth of young walleye (age 1 to 4) remains high and has varied little between 1965 and 2002 (Figure 12), except for a modest increase in the mean length at age for age 2 and 4 fish in 2007. Comparison of mean total length at age through time may help evaluate the response of walleye to increased abundance or invasions of exotic species (e.g. rainbow smelt *Osmerus mordax* in 1991; spiny water flea *Bythotrephes longimanus* in 2006).

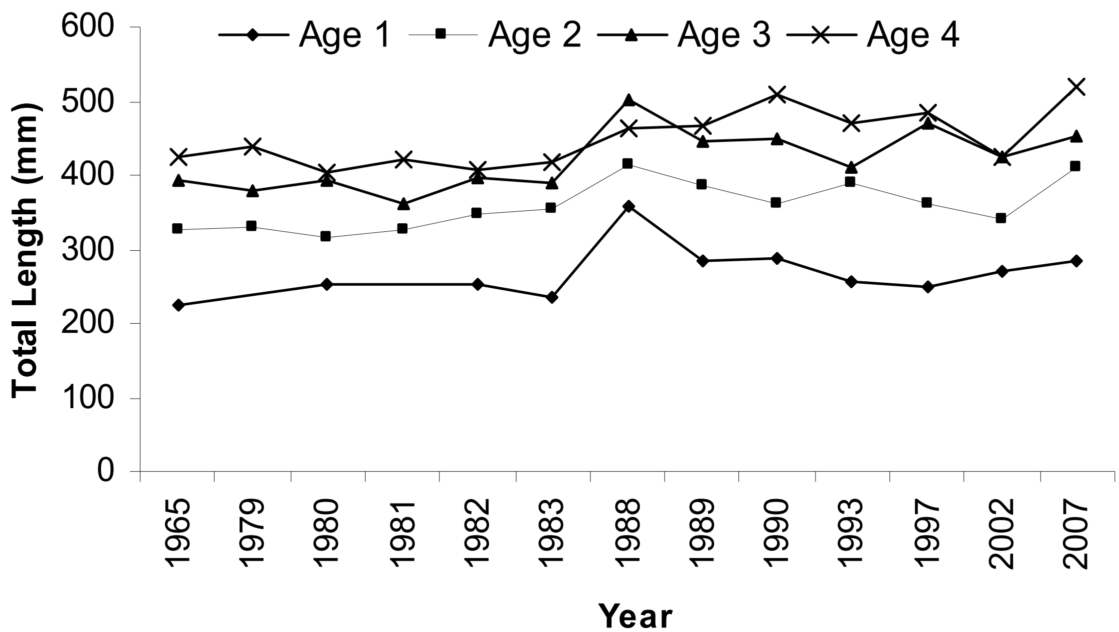

Figure 12: Mean length at age of juvenile (age 1-4) walleye in the North Arm of Rainy Lake, 1965-2007.

The growth of walleye clearly differs between the populations or basins of Rainy Lake. Mean length at age is consistently higher in the North Arm, than in the South Arm or Redgut Bay (Figure 13). Differences in mean length at age remain are evident during the first 8 years, after which North Arm walleye exhibit more typical growth patterns that exist in the other populations.

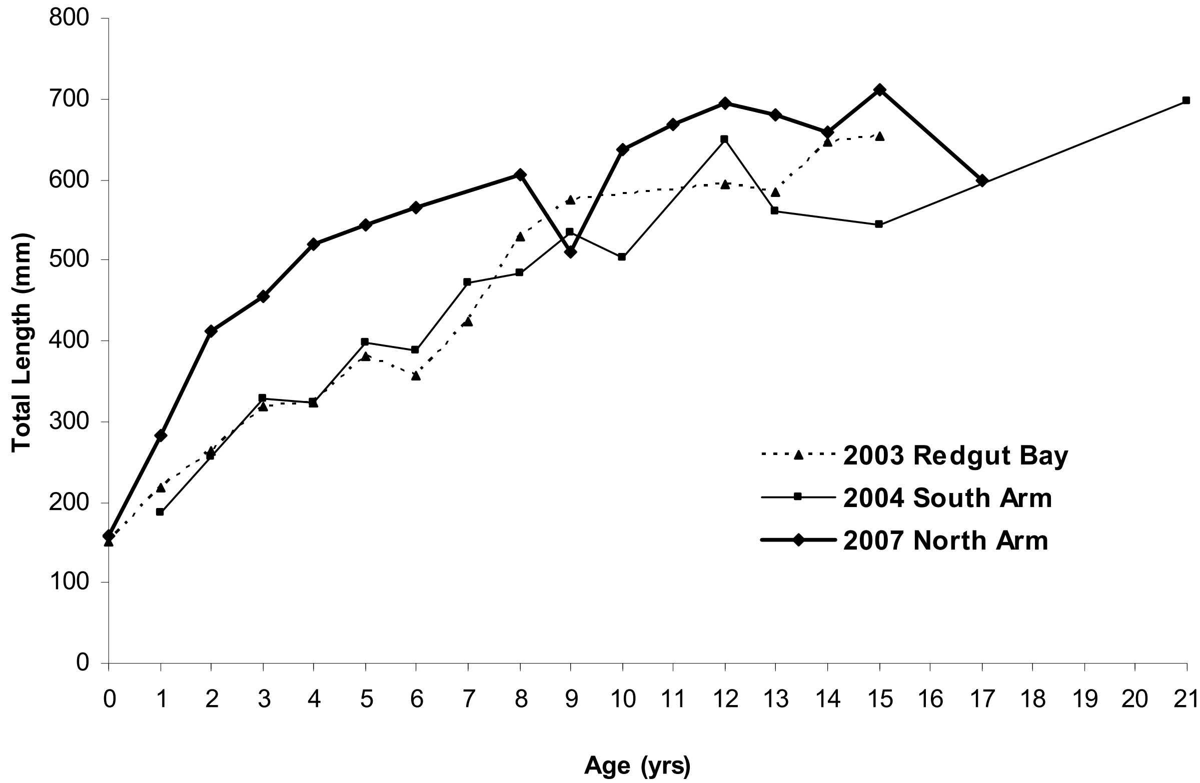

Figure 13: Mean length at age of walleye captured in index netting for each basin of Rainy Lake, 2003-2007.

The sex ratio of walleye (Figure 14) captured in FWIN sampling varied with age. Female composition remained consistent except in the old age classes (>6 years) where sample sizes were limiting. Males were dominant and exceeded 50% of the catch at age 2 and 3. Normally males are more abundant than females in the younger age classes, with females gradually making up a greater proportion of the population as age increases. Shannon Diversity Index for adult females (age ≥5 years) was high at 0.72, and is indicative of healthy walleye populations in Ontario (>0.66).

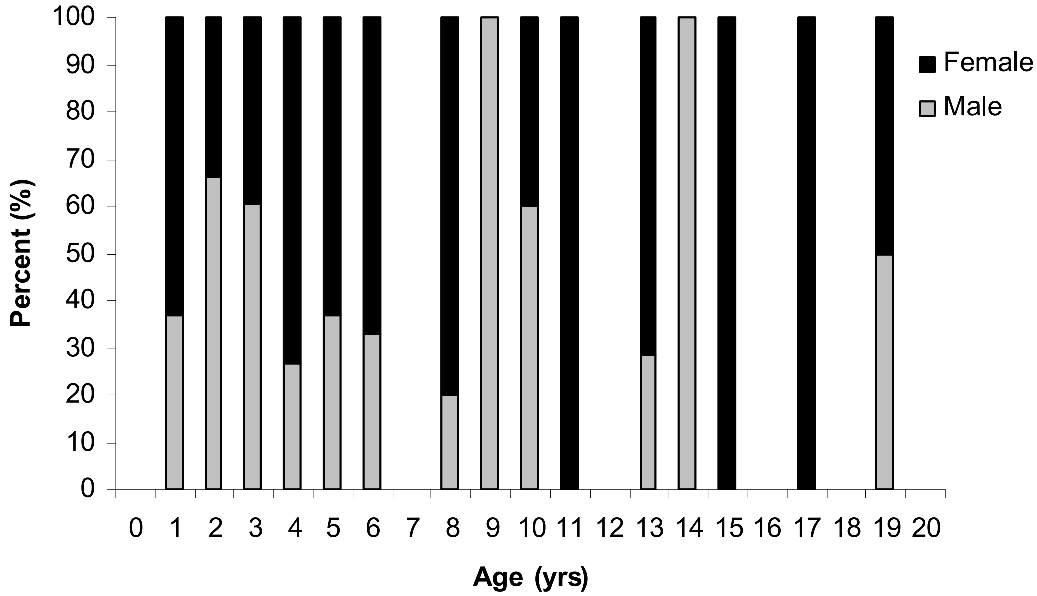

Figure 14: Walleye sex ratio for the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

Maturity schedules for walleye in the North Arm of Rainy Lake were similar between the sexes, with females maturing at a slightly larger size and age than males. Differences between the sexes were more apparent when comparing total length at maturity (Figure 15) than age at maturity (Figure 16). Age at 50% maturity was very low at 1.53 years for males and 3.31 years for females, and might suggest some sampling or recording errors for younger fish. The total length at 50% maturity was 375 mm for males and 486 mm for females. These values suggest that North Arm walleye, particularly males, are maturing at an earlier age but at larger lengths than the NW Region average for all lakes and large lakes.

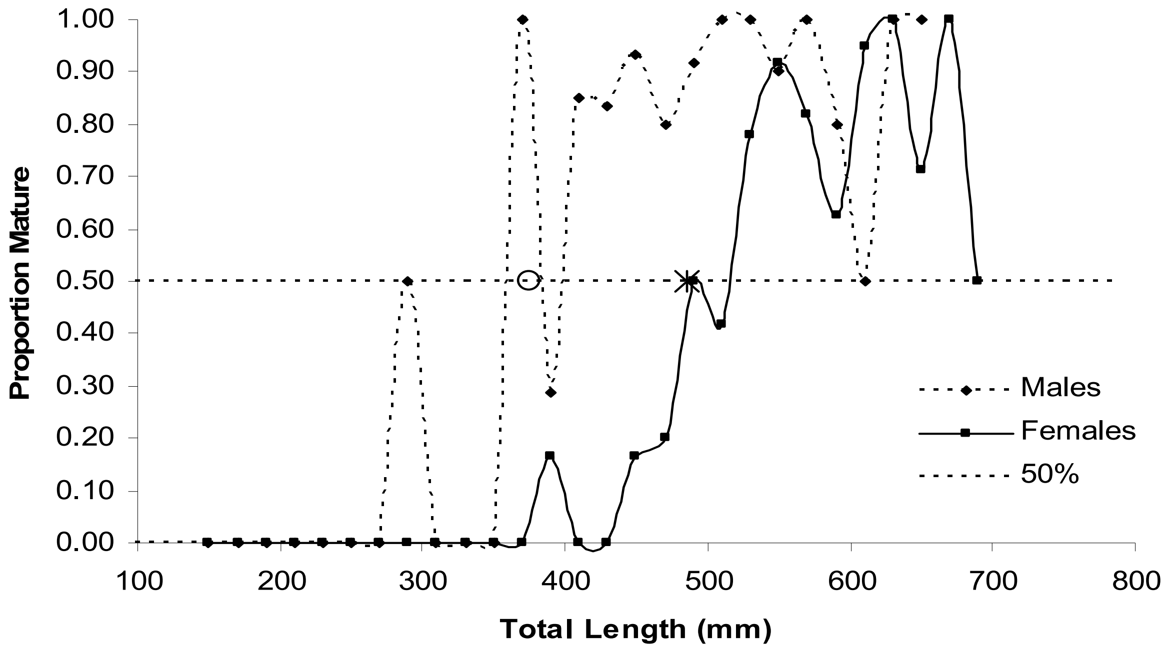

Figure 15: Walleye maturity schedule (total length at maturity) for Rainy Lake North Arm based on Fall Walleye Index Netting (FWIN), 2007. Calculated length at 50% maturity is indicated by (o) for males and (*) for females.

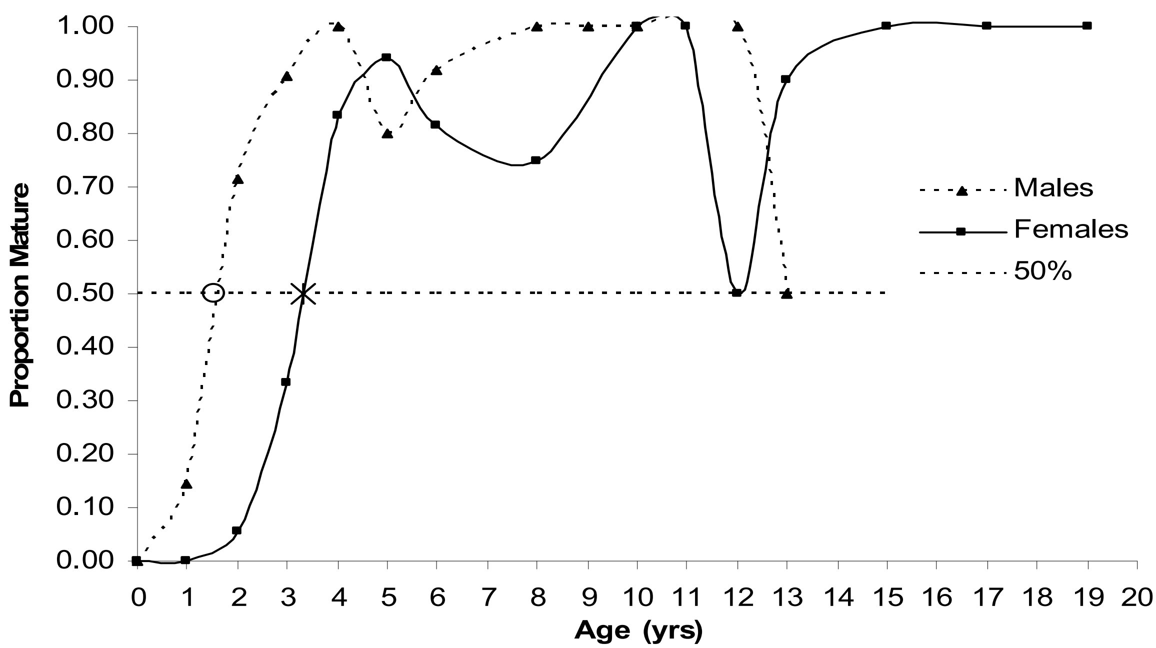

Figure 16: Walleye maturity schedule (age at maturity) for Rainy Lake North Arm based on Fall Walleye Index Netting (FWIN), 2007. Calculated age at 50% maturity is indicated by (o) for males and (*) for females.

Fishing Quality Index (FQI) values based on Relative Stock Density (RSD) (Gabelhouse, 1984) were high for the North Arm of Rainy Lake at 153 in 2007, and increased from 73 in 2002. The RSD values for 'quality' walleye (380-510 mm), doubled from 2002 to 2007. 'Memorable' walleye (630-760 mm) increased since 2002, but still account for only a small portion of the catch. A summary of the RSD values for walleye FWIN catches in 1997, 2002 and 2007 has been included in Table 3.

Table 3: Relative Stock Density (RSD) values for walleye in the North Arm of Rainy Lake based on Fall Walleye Index Netting (1997, 2002 and 2007).

Category (Total Length)	1997	2002	2007
Quality (380-510 mm)	0.823	0.423	0.916
Preferred (510-630 mm)	0.311	0.232	0.495
Memorable (630-760 mm)	0.034	0.079	0.113
Trophy (≥760 mm)	0.000	0.000	0.003
FQI	**117**	**73**	**153**

Comparison to Northwest Ontario Walleye Benchmarks

Walleye catch per unit effort in Rainy Lake fell into the high abundance category and was the 19th highest value in comparison to other Fort Frances District lakes using FWIN standards (Figure 17). The arithmetic mean catch-per-unit-effort (14.6 walleye/net) was slightly above the Fort Frances District average (12.5 walleye/net) and the NW Region average for all lakes (14.1 walleye/net), but below the NW Region large lake average (17.9 walleye/net).

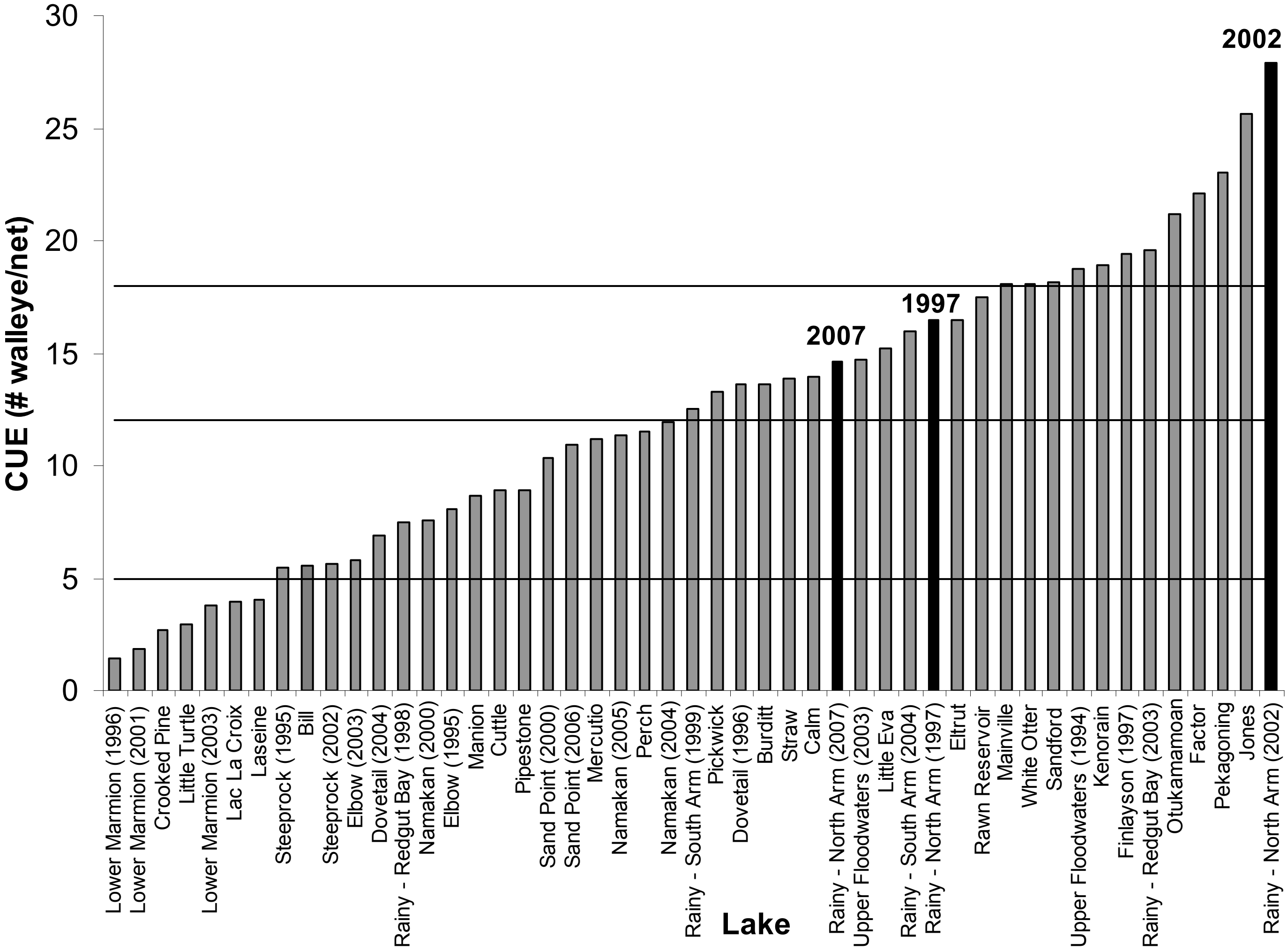

Figure 17: Comparison of walleye abundance on the North Arm of Rainy Lake with other Fort Frances District lakes using FWIN standards, 1994-2007. Arithmetic mean catch-per-unit-effort (CUE) values between 0-5 are considered low, 5-12 below average, 12-18 above average, and >18 high walleye abundance.

The geometric mean CUE of 12.7 walleye/net was similar to the NW Region large lake mean of 13.1 walleye/net, but exceeded the mean of 10.7 walleye/net for all lakes. More importantly, the geometric mean of catch ≥ 450 mm TL was 7.9 walleye/net, and considerably higher than the large lake average of 2.5 walleye/net for the NW Region. Relative to other Ontario waterbodies (Figure 18), this would characterize the population as “healthy”. The Shannon Diversity Index value of 0.72 indicated sufficient age diversity in adult females to be considered a healthy population (>0.66). As well, the mean age (4.39 years) exceeded the average for healthy populations of 4.20 years and greater. A summary of the 1997, 2002 and 2007 FWIN assessments on the North Arm is provided in Table 4, with a detailed comparison of walleye population and life history parameters for the NW Region.

Walleye life history characteristics in the North Arm were largely consistent with NW Region averages. The population shows a fast juvenile growth rate, and early maturation as indicated by the mean age at maturity for both sexes (Table 4). Prematuration growth rate (h) was high at 151 mm/yr in 2007, which is above the NW Region benchmark value of 89 mm/yr and the 2002 value of 110 mm/yr.

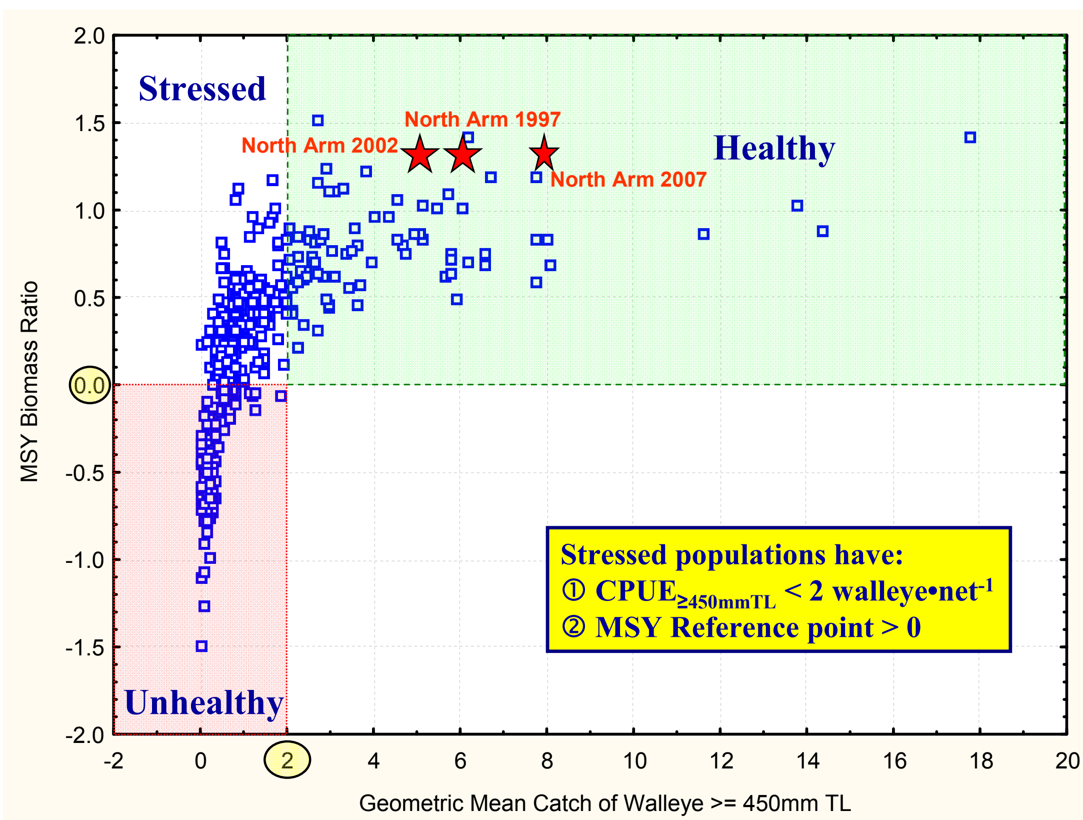

Figure 18: Comparison of walleye abundance (geometric mean catch of walleye ≥450mm TL) in the North Arm of Rainy Lake to other Ontario lakes using FWIN standards, 1994-2007.

Table 4: Summary of North Arm walleye population parameters based on FWIN standards relative to NW Region benchmarks.

VARIABLE	NW MEAN (all lakes)	NW MEAN (large lakes)	NORTH ARM (2007)	NORTH ARM (2002)	NORTH ARM (1997)
SECCHI (m)	3.0	2.7	3.3	3.3	3.3
MEI	8.7	6.4	6.9	6.9	6.9
MSY (kg/ha/yr)	-	-	1.04	1.04	1.04
MSY Ref. (log_{10} FWIN/MSY)	-	-	1.29	1.32	1.29
DEGREE DAYS (GDD> 5C)	1415	1432	1646	1646	1646
MEAN CUE (kg/net)	-	-	20.5	21.62	20.22
MEAN CUE (#/net)	**14.1**	**17.9**	**14.6**	**28.1**	**16.5**
CUE ≤300 mm	4.1	5.9	2.6	12.0	2.3
CUE ≥350 mm	7.5	8.0	11.8	10.8	12.9
CUE ≥450 mm	3.1	3.5	9.1	7.5	9.3
MEAN CUE (WALLEYE & SAUGER)	-	20.3	14.68	28.1	16.6
MEAN CUE (GEO) (#/net)	**10.7**	**13.1**	**12.5**	**15.7**	**9.4**
CUE ≥450 mm (GEO) (#/net)	**2.3**	**2.5**	**7.9**	**5.0**	**6.2**
TL @ 50% MATURITY ♀ (mm)	441	458	486	481	460
AGE @ 50% MATURITY ♀ (yrs)	4.80	5.24	3.31	4.15	2.84
TL @ 50% MATURITY ♂ (mm)	**360**	**369**	**375**	**392**	**341**
AGE @ 50% MATURITY ♂ (yrs)	3.49	3.81	1.53	2.77	2.52
MALE MORTALITY (5+ yrs)	0.30	0.29	0.29	0.34	0.30
FEMALE MORTALITY (5+ yrs)	0.28	0.30	0.26	0.31	0.33
MORTALITY >300 mm	-	0.34	0.23	0.26	0.35
TOTAL MORTALITY (A)	-	-	0.27	0.37	0.39
NUMBER OF AGE CLASSES (all)	-	14	17	13	13
NUMBER OF AGE CLASSES (n>1)	**10**	**13**	**15**	**13**	**11**
MEAN AGE (yrs)	**4.20**	**3.89**	**4.39**	**2.55**	**3.45**
MAXIMUM AGE (yrs)	**16**	**18**	**19**	**13**	**12**
AGE CLASSES >8	5	8	9	4	4
AGE CLASSES >10	4	6	7	2	2
SHANNON INDEX (mature females)	**0.65**	**0.79**	**0.72**	**0.89**	**0.75**
PRE-MATURATION GROWTH ♀ (h)	89	90	151	110	120
FEMALE BRODY COEFFICIENT (K)	**0.155**	**0.158**	**0.165**	**0.179**	**0.177**
FEMALE TL inf (mm)	**733**	**741**	**841**	**791**	**756**
MALE TL inf (mm)	**613**	**635**	**765**	**716**	**703**
FISHING QUALITY INDEX (FQI)	-	-	153	73	117
MEAN TOTAL LENGTH (mm)	**376**	**351**	**460**	**357**	**436**
MEAN ROUND WEIGHT (grams)	705	-	1207	775	1125
TL @ AGE 2 (mm)	302	293	411	340	359

HEALTHY
STRESSED
UNHEALTHY

OTHER FISH SPECIES

Northern pike were captured at an average of 3.5 fish/net on the North Arm (n=88), which is similar to values observed in 1997 and 2002. Although direct comparisons are invalid (McLeod et al., 2004), the average number of pike caught in FWIN gill nets was lower than previous index netting efforts (Figure 19). The long-term mean CUE from index netting (1965-97) was higher at 5.1 pike/net (SE=0.6).

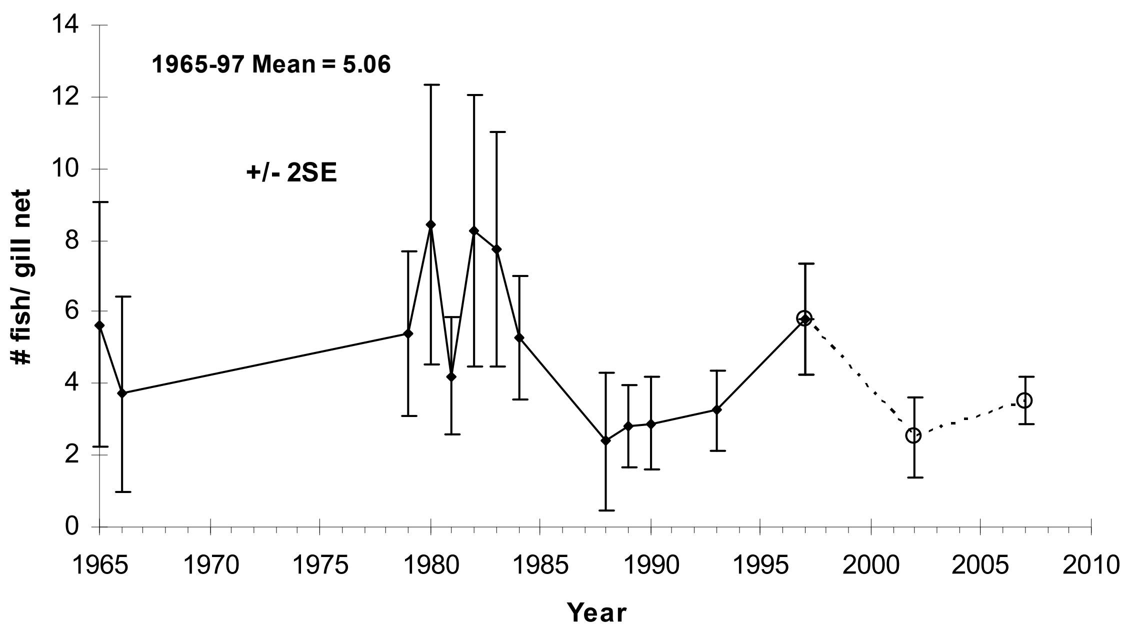

Figure 19: Historical abundance of northern pike based on catch-per-unit-effort from index netting (1964-1997) and Fall Walleye Index Netting (1997, 2002, and 2007).

Pike captured in the 2007 FWIN ranged in age from 0-12 years, with representation in most age classes except age 1 (Figure 20). Catch was dominated by age 3 fish (2004 year class), which accounted for 19.3% of the total catch. The mean age of catch in the 2007 FWIN was 4.99 years (SE=0.27). The good representation of ages is consistent with the total length distribution, which was relatively evenly distributed after 420 mm (Figure 21). There was an absence of fish in total length categories from 260 to 420 mm. Although no fish greater than 1,000 mm were captured, eight fish were observed from the ‘trophy’ size class (>900 mm TL).

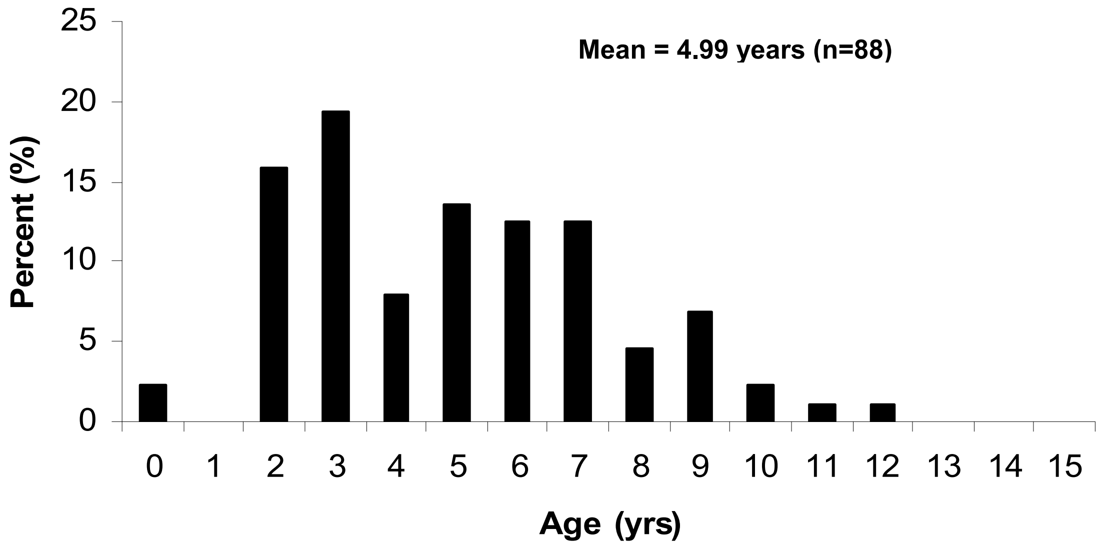

Figure 20: Age composition of northern pike from the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

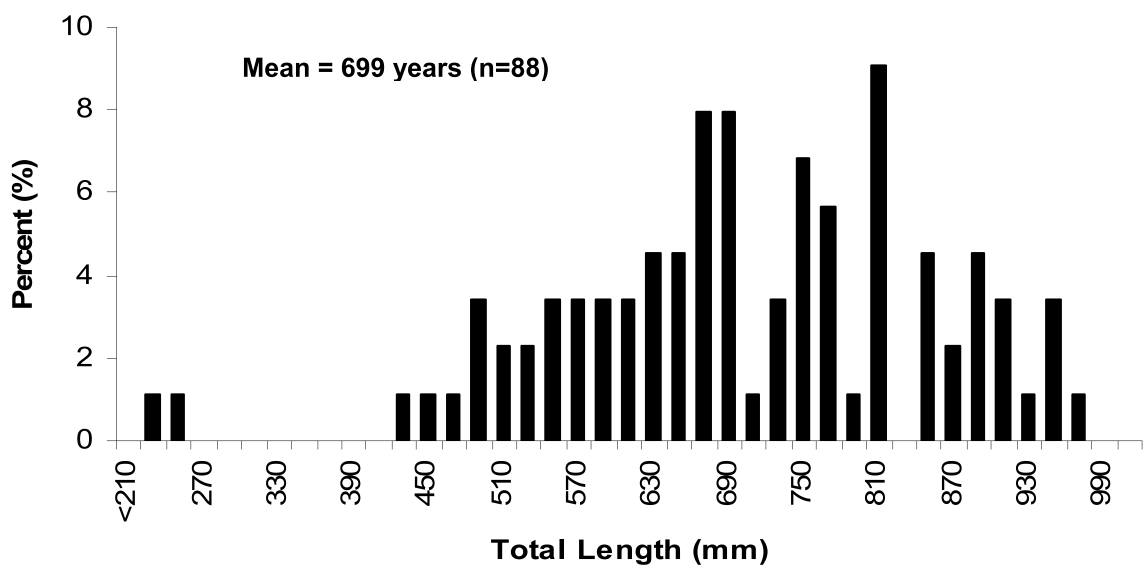

Figure 21: Length distribution of northern pike from the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

The mean weight of northern pike sampled was relatively high at 2,480 g, but the largest fish captured had a round weight of 6,670g (14.7 lbs). Growth of northern pike in the North Arm was rapid during the first two years; with the mean length of age 2 fish exceeding 550 mm. Growth increments in subsequent years were relatively consistent, with an overall decrease in growth rate as age increases (Figure 22).

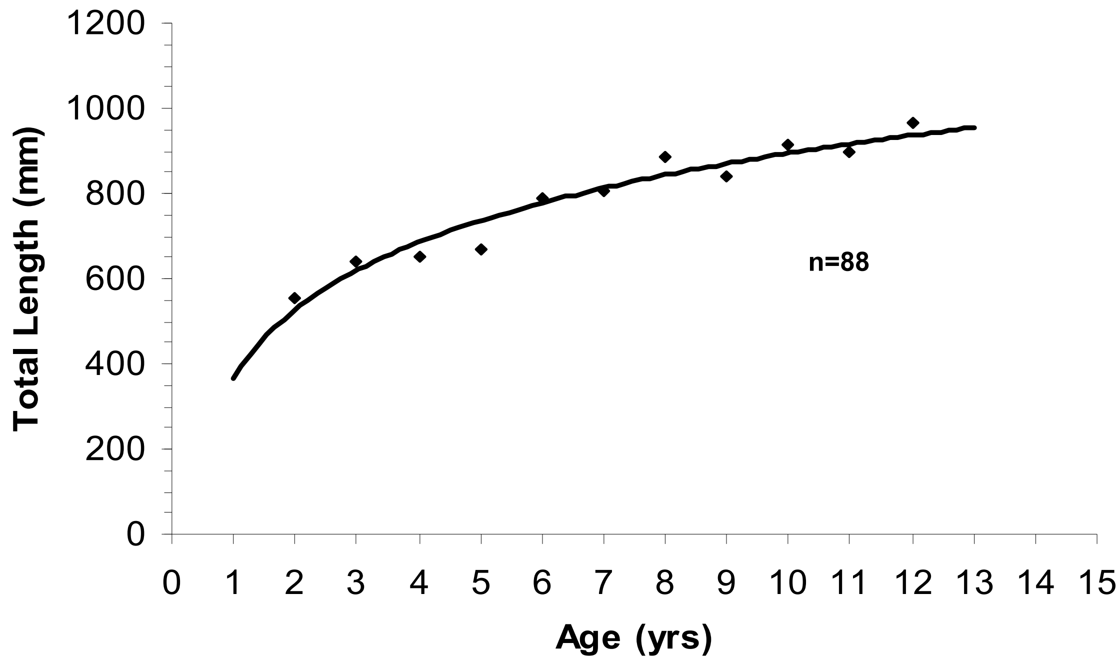

Figure 22: Growth (mean total length at age) of northern pike from the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

A smallmouth bass CUE of 1.4 fish/net (SE= 0.4) in 2007 FWIN was very similar to the 1.5 fish/net (SE= 0.4) observed in the 1997 and 2002 FWIN. In general, smallmouth bass catch has increased through the 1980's and 1990's on the North Arm, and stable since 1997 (Figure 23). The long-term (1965-1997) mean CUE from index nets was 1.1 bass/net (SE=0.2).

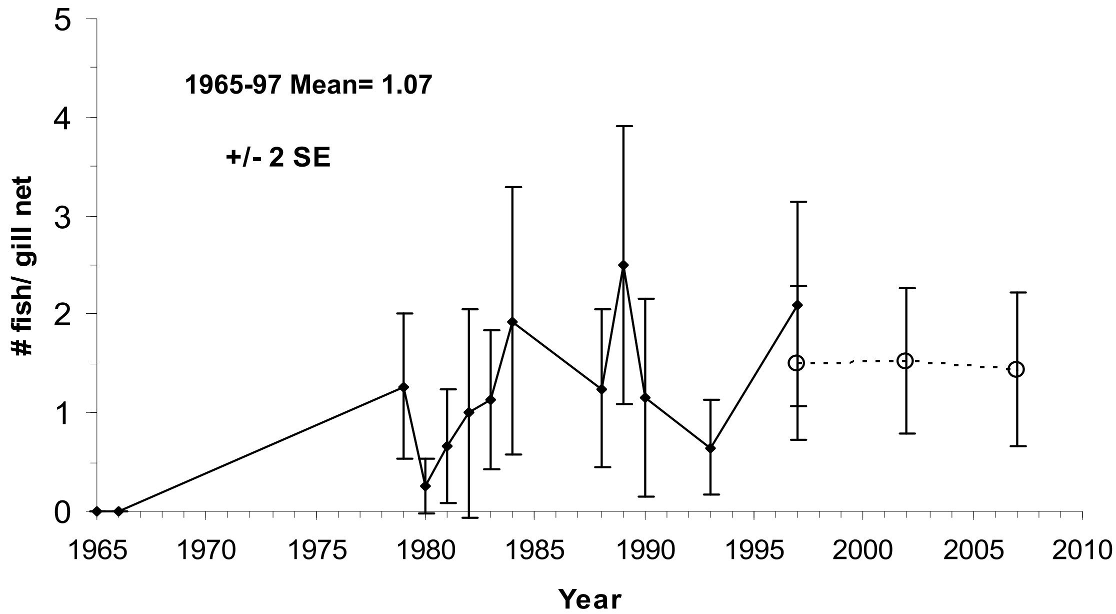

Figure 23: Historical abundance of smallmouth bass based on catch-per-unit-effort from index netting (1965-1997) and Fall Walleye Index Netting (1997, 2002, and 2007).

Smallmouth bass ranged in age from 0-14 years, although a number of age classes were missing due to the small sample size. Only single fish were observed in ages 4, 8 and 14 years. Smallmouth bass catch was dominated by age two fish (2005 year class) at 30% of the catch (Figure 24). The mean age of smallmouth bass in the sample was 4.65 years (SE= 0.76).

The length composition of smallmouth bass is reflective of the age distribution and the rather small sample size (n=36). The catch was poorly distributed among few length classes, with most fish less than 240 mm (Figure 25). The largest bass had a total length of 487 mm. A length frequency distribution for all fish species sampled has also been provided in Appendix II.

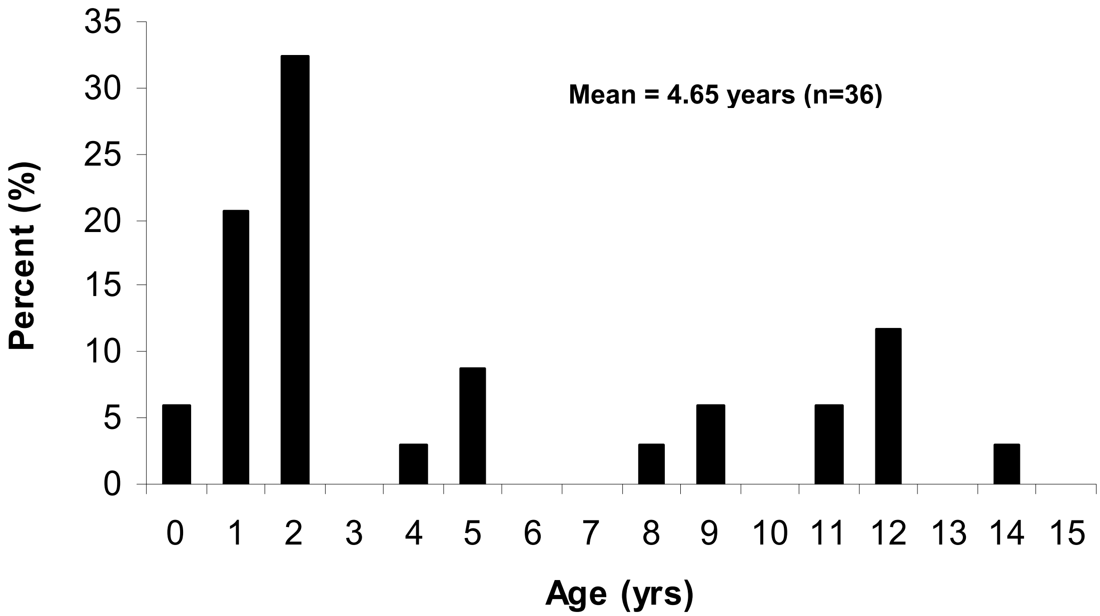

Figure 24: Age composition of smallmouth bass from the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

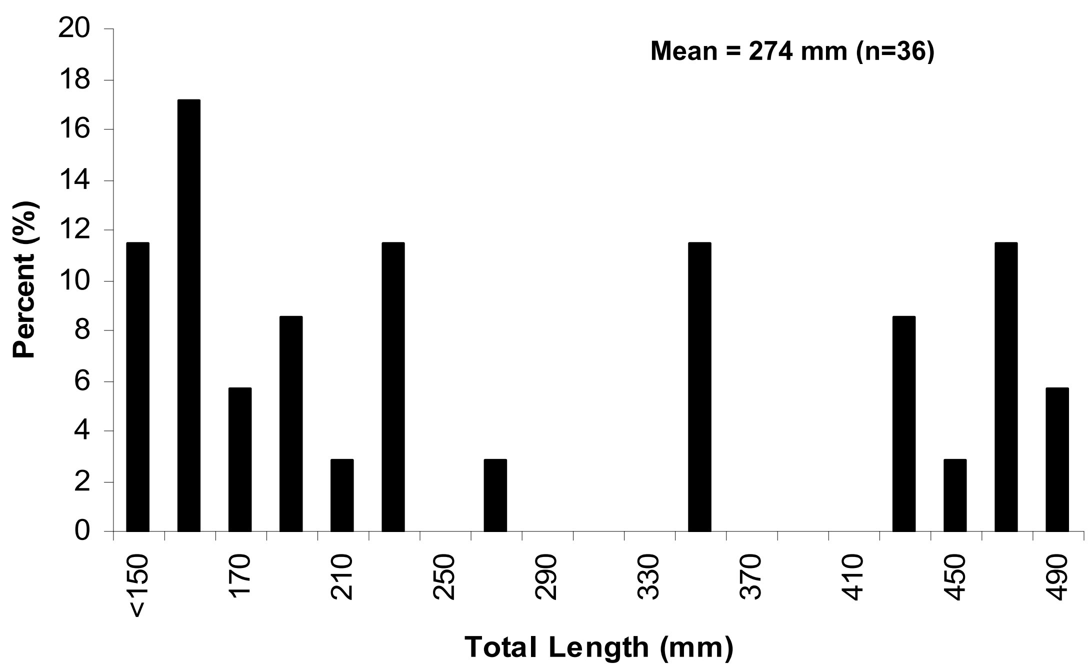

Figure 25: Length distribution of smallmouth bass from the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

The growth rate of smallmouth bass on the North Arm shows a trend similar to other fish species. Growth is rapid during the first few years, with a gradual leveling off beyond age 5 (Figure 26), as adult bass presumably begin to invest more heavily in reproduction rather than growth.

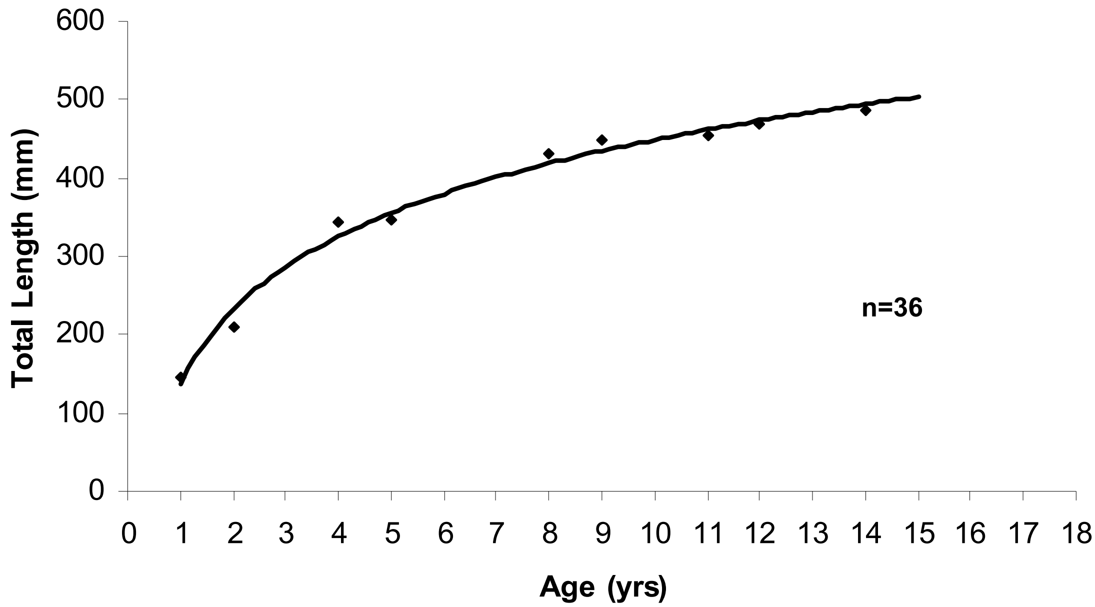

Figure 26: Growth (mean total length at age) of smallmouth bass from the North Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2007.

The North Arm also provides a fishery for other fish species including sauger, whitefish and black crappie. Sauger were poorly represented with only one fish in the FWIN catch, or an arithmetic mean CUE of >0.1 fish/net. Although reported to be present, no muskellunge or lake sturgeon were captured in FWIN nets or any index netting efforts since 1965. Black crappie were better represented with a total of 44 fish, for a mean CUE of 1.8 fish/net. Whitefish are commercially and recreationally fished in the North Arm and showed good representation in the FWIN catch with a mean CUE of 1.9 fish/net. From this small sample of 48 fish, mean total length was estimated at 429 mm (276-612 mm) with a mean round weight of 932 g (180-2,840g). A summary of total length composition for all remaining fish species sampled has been provided in Appendix II.

DISCUSSION

A diverse fish community was sampled in the North Arm of Rainy Lake, with a number of prey and predator species, although catch by number was dominated by three species (yellow perch, walleye, and brown bullhead). Other species known to compete with walleye such as northern pike, smallmouth bass, rock bass, lake whitefish, and black crappie were also present. The high abundance of yellow perch likely provides an important prey resource for adult walleye (Scott and Crossman, 1998). A total of 16 different species were captured, with a Simpson's Diversity Index value of 3.30.

The initiation of the fisheries assessment program on five-year rotation (McLeod, 2002) provides an excellent opportunity to monitor changes in population structure and life history parameters over time. Data from the 2007 FWIN project on the North Arm can be compared to data from other lakes and basins using standardized methodology, and most importantly to previous index netting efforts on the North Arm.

Twenty-five nets were set in the North Arm in 2007 and 2002, which represents an increase of 5 net sites from the 1997 FWIN. This increased sample size lowered the percent relative standard error (%RSE) for walleye from 24.8% in 1997 to 22.1% in 2002 and 9.5% in 2007. Precision targets of <20 %RSE for the walleye were met in 2007 with the modest increase in sample size and reduced abundance. The 2007 catch of 366 walleye was lower than the 703 observed in 2002, and slightly exceeded the provincial recommendation of 200-250 walleye (Morgan, 2002). Although currently not an issue, higher sampling mortality may become more important in future FWIN studies if abundance and size structure continues to improve.

Rapid early growth and early maturity are often characteristic of exploited fish populations (Lester et al., 2000). Generally, the life history characteristics of the North Arm walleye population did not deviate from NW Region means, and continue to show improvements compared to the 1997 and 2002 FWIN studies (Table 4). Walleye in the North Arm continue to show greater ultimate body size ($L\infty$) for both sexes and increased size at maturity relative to NW Region averages. However, age at maturity for both sexes has decreased relative to the 2002 FWIN and continues to be much younger than expected. These low values in 2007 may also indicate some inconsistencies in the field determination or recording of sexual maturity in the younger ages. Shannon Diversity Index values have decreased slightly from 2002, but still indicate a healthy diversity of adult females and presumably a more stable spawning population. This data suggests that regulation changes made to improve walleye populations, and/or environmental variables are providing the North Arm walleye population with the opportunity to recover from historical low levels of abundance. However, the absence of data associated with fecundity and relative condition pose limitations on the ability to draw definitive conclusions regarding reproductive investment of walleye populations in either 2002 or 2007.

The most positive signs regarding the status of North Arm walleye population are the high FWIN catch rates (CUE) compared to index netting prior to 1997, and to similar studies on Fort Frances

District lakes and the other basins of Rainy Lake. Compared to 2002, the geometric mean CUE had decreased by 20% from 15.7 to 12.5 walleye/net, but remains higher than the NW Region mean of 10.7 walleye/net. Good representation of younger age classes (0 to 6 years) would suggest the recovery of spawning stocks to some degree, and several strong or above-average year classes will provide a foundation for the future walleye production as they reach maturity. Fishing Quality Index values also increased from 73 in 2002 to a high of 153 in 2007 suggesting a vast improvement in the abundance of larger fish.

The 2007 FWIN catch helped confirm the presence of a strong 2001 year class, and poor year classes in 2000 and possibly 2002, which were already evident in the 2002 FWIN (McLeod and Taillon, 2003). The 2000 year class also appeared to be weak on other District lakes including Rainy Lake (McLeod and Taillon, 2004; McLeod, 2005); Little Turtle (Taillon and Fox, 2003); Namakan Reservoir (Taillon, 2003; McLeod and Trembath, 2007); and Little Eva Lake (McLeod and Rob, 2008) suggesting that large scale environmental factors may be limiting recruitment in some years (e.g. spring warming or water levels). The lack of age 7 walleye (2000 year class) in the 2007 FWIN catch was clearly represented in the age composition, and remains a concern for future production. However, the continued high abundance of age 6 walleye from the very strong 2001 year class may help alleviate this concern as these fish continue to mature and contribute to the spawning stock. This strong 2001 year class has also been confirmed in previous FWIN assessments across the Fort Frances District.

Good representation (n=47 or 13%) of young-of-the-year or age 0 walleye in the age composition might indicate high first year survival of the 2007 year class. However, the lower abundance of small fish (200 to 360 mm) in the total length composition is cause for some concern, and might reflect the lower abundance of age 1 walleye from the 2006 year class. Walleye produced in 2007 (age 1) ranged from 230 to 344 mm with a mean total length of 283 mm.

Inconsistent recruitment is characteristic of many walleye populations under various levels of exploitation, and must be considered in the development of future management strategies. Factors known to contribute to low levels of recruitment and/or poor year classes include low abundance of spawning fish (Colby et al., 1979), the absence of suitable spawning habitat (Auer and Auer, 1990), spring warming rate and weather conditions (Busch et al., 1975; Koonce et al., 1977; Madenjian et al., 1996; Hansen et al., 1998), and/or cannibalism by adults (Forney, 1976). A number of fish species known to compete with, or prey upon, larval walleye are present in Rainy Lake, and collectively may limit the reproductive success of individual year classes.

Johnston (1997) also determined that the energetic demands of reproduction are so high that many females are unable to obtain sufficient resources to spawn on consecutive years. The high growth rate of adult walleye in the North Arm suggests that food resources are not likely the limiting factor on recruitment. Walleye fecundity and spawning success is positively related to female body size (Johnston, 1997), and the increasing catch of large fish (particularly females) may help alleviate this inconsistent recruitment in future years. The mechanism for poor year classes is likely dependent on the interaction between the physical, environmental and biological characteristics at a given time. Our current management objective, to increase the abundance of older, larger fish in order to improve recruitment, appears to be appropriate.

The population structure and life history of North Arm walleye continues to show positive improvement since the 1997 and 2002 FWIN studies. Maximum age, mean age and the number of age classes have all increased and are above mean values for the NW Region provided by Morgan et al. (2003). Overall, mean age had increased from 2.55 yrs in 2002 to 4.39 years in 2007, while maximum age increased from 13 to 19 years. The number of age classes (n>1) also continued to increase from 11 in 1997, to 13 in 2002 and 15 in 2007. Mortality rates have historically been very high in the North Arm, averaging 50% between 1979 and 1990, with annual mortality exceeding 70% in both 1980 and 1990 (Wepruk et al., 1992). Total annual mortality rates (sexes combined) have continued to decline from 39% in 1997 to 27% in 2007, and are no longer a concern to overall fishing quality. In 2007, adult mortality by sex (>age 5) also decreased to 26% and 29% for females and males respectively.

Growth curves, particularly those based on weight; do not show definite asymptotic curves typical of many fish populations, including walleye. This may be attributable to the low abundance of older fish (>age 13) in the sample. In addition, the invasion of rainbow smelt into Rainy Lake in the early 1990s (MDNR and OMNR, 1998) may be providing a food resource that allows the larger fish in the sample to maintain a high growth rate (in terms of both length and weight). In addition, pre-maturation growth (h) continued to be higher than the NW Region means, and subsequently age at maturity is very low. The Brody Growth Coefficient (K) remains the only life history parameter that does not reflect a healthy walleye population in 2007.

Comparisons of mean length at age at various sampling periods show that growth rates on the North Arm have remained relative stable for age 1 to 4 walleye over the past four decades and no growth responses were detected since rainbow smelt were confirmed in 1991. The collapse of the walleye fishery in the early 1960's likely resulted in increased growth, a common compensatory mechanism among walleye populations (Lester et al., 2000). Continued monitoring of growth rates as the population recovers will provide information on how life history characteristics respond to increased abundance and reduced prey forage.

The geometric mean CUE of large fish ≥450 mm is significantly higher than the NW Region means for walleye populations, and have increased since 2002 (Table 4). An increase in the number of adult fish enhances the quality of the spawning population and can help reduce recruitment variability. In addition, fishing quality and the economic value of the fishery is greatly enhanced by the presence of large, 'memorable' or 'trophy' class fish. A Fishing Quality Index (FQI) value of 153 in 2007 is reflective of a quality or trophy walleye fishery (OMNR, 1990). The North Arm walleye population is healthy and is showing little or no signs of exploitation stress. A proposed Walleye Benchmark Classification Key would also suggest the population is "healthy/stable" with an overall score of 3.0 in 2007, compared to 2.50 in 2002. In comparison, the other walleye populations in Rainy Lake had overall scores of 2.50 in 2003 and 2.75 in 2004. A score of 2.75 or maximum of 3.0 is deemed to be healthy/stable (G. Morgan, pers. comm.).

Changes to walleye angling regulations on Rainy Lake in 1994 and 2000 appear to be having the desired effect by reducing harvest and protecting larger fish. Reductions in harvest have also been achieved through commercial fishery buy-outs and trades in species quotas since 1986. The combined angler, commercial and subsistence harvest of walleye was estimated at 4,100 kg/yr (1997-2002), and remains below the management objective of 6,800 kg/yr (OMNR and MDNR, 2004).

The recovery of the walleye population in the North Arm of Rainy Lake is especially encouraging, considering that similar fisheries in the NW Region have been slow to recover from collapse. The catch in Shoal Lake (on Lake of the Woods) was dominated by young, fast growing and early maturing fish despite over 20 years of closure to recreational and commercial fishing. Forage for walleye in Shoal Lake was apparently abundant, and the factors inhibiting the recovery were still unclear (Seyler, 2001; Gillies, 2002).

Sauger continue to show poor representation in the fish community of the North Arm, with a catch of only one fish (<0.1 fish/net) in 2007. This is much lower than the 4.0 sauger/net observed in Redgut Bay in 2003 and the 1.3 sauger/net observed in the South Arm in 2004. With a mean summer secchi transparency of 3.3 m, the North Arm appears better suited to walleye production.

Northern pike and smallmouth bass populations on the North Arm appear to be healthy and sustainable at existing harvest levels. Although catch rates of pike were lower than the long-term index netting mean, there was good representation of size and age classes considering the low sample size (n=88). The arithmetic mean CUE for northern pike increased from 2.5 fish/net in 2002 to 3.5 fish/net in 2007. The age composition provides a mean age of 4.99 years with ages 0 to 12 years represented. The absence of age 1 fish might be indicative of poor recruitment to the population in 2006, although the effects of gear selectivity have not been evaluated. The sample size was too small to evaluate life history parameters by sex and make any comparisons to a provincial summary of population characteristics (Malette and Morgan, 2005). Relative abundance, based on a geometric mean CUE of 3.2 fish/net, was above the provincial average of 2.2 fish/net (and above the 75th percentile of 3.0 fish/net). Mean total length (699 mm) and weight (2,480 g) were also well above the Ontario averages of 581 mm and 1,470 g respectively.

The lower abundance of large pike (>1,000 mm) relative to other lakes in the District, for example Little Turtle Lake (Taillon and Fox, 2003) and Lac La Croix (McLeod and Taillon, 2005) might suggest that the pike fishery is still producing a quantity rather than a quality fishery. However, large trophy fishing opportunities still appear to be available, even though the combined angler, commercial and subsistence harvest is high, at an estimated 28,200 kg/yr from 1997 to 2002. Harvest has been increasing over the long-term but remains below the current management objective of 31,800 kg/yr (OMNR and MDNR, 2004). Changes to the pike angling regulations in NW Ontario in 1999 may also be having the desired effect by reducing harvest and protecting larger fish.

Recent FWIN assessments would suggest that smallmouth bass abundance has been stable since 1997. The arithmetic mean CUE remained unchanged from 1.5 bass/net in 1997 and 2002, to 1.4 bass/net in 2007. This value is slightly above the long-term (1965-1997) index netting mean of 1.1 bass/net, considering that smallmouth bass did not appear in the index netting catch on the North Arm until 1978. Based on a very small sample size (n=36), there was representation of 10 age classes ranging from 0 to 14 years, with a low mean age of 4.65 years. Mean total length was small at 240 mm, with a maximum size of 487 mm. Angling for smallmouth bass remains a very important component of the sport fishery in the North Arm, while providing a quality angling experience (OMNR and MDNR, 2004). Annual harvest of bass averaged 2,200 kg/yr from 1997-2002, and is below the management objective of 2,800 kg/yr and the potential yield of 5,600 kg/yr. A complete review of life history parameters for smallmouth bass would likely require combining data from all three lake basins to improve sample size and statistical precision.

CONCLUSIONS

- Overall abundance of walleye is high (above average), with an arithmetic mean CUE of 14.6 fish/net (geometric mean of 12.5 fish/net), but both values represent a decline since 2002. There has been a significant increase in abundance from the long term (1965-93) index netting mean of 2.7 fish/net.
- The FWIN catch is still dominated by younger fish from 0 to 6 years of age; with age 6 fish showing good representation from a very strong, above average year class from 2001. Poor representation of age 7 and age 1 walleye likely reflect weak or below average year classes produced in 2000 and 2006 respectively. Recruitment is variable but may be naturally occurring. Identification of the mechanisms for this recruitment variability will required more detailed studies in the future.
- Catch rates of large adult fish (≥450 mm) increased relative to the 1997 and 2002 FWIN, and are well above the NW Region averages and indicate a "healthy" fishery.
- Most life history parameters, including number of age classes (15), maximum age (19), mean age (4.39 years), Shannon Diversity Index (0.75), Fishing Quality Index (153), maximum attainable length ($L\infty$) for both males (765 mm) and females (841 mm), total length at 50%

maturity for males (375 mm) and mean total length (460 mm) are all indicative of a healthy population, and continue to show improvement since 1997. A proposed Walleye benchmark Classification Key for Ontario suggests the walleye population is "healthy/stable" and improving with a maximum score of 3.0. Previous classification scores were 2.50 in both 1997 and 2002.

- The walleye population in the North Arm of Rainy Lake exhibits above average pre-maturation growth rates, and fish appear to mature at a younger age, but larger length than other populations sampled in NW Region. A Brody Growth Coefficient (K) of 0.165 is above the NW Region mean, and is the only life history parameter that is indicative a stressed/unstable fishery.
- Total annual mortality has steadily declined since 1997 and 2002, and was estimated at 27% in 2007. This mortality is well below the level of 50% which would entail high risk of instability or collapse (OMNR, 1983), and should allow continued improvement in the health and quality of the fishery.
- Current levels of exploitation should be evaluated for all users, including a roving creel survey and continued monitoring of commercial harvests. A review of existing commercial quotas, restrictive size limits and non-resident angling restrictions are also warranted, and could lead to future discussions regarding allocation and management objectives.
- Northern pike and smallmouth bass populations appear healthy from the limited diagnostics available. Further monitoring and interpretation is recommended, along with more detailed investigation of muskellunge and lake sturgeon populations.

ACKNOWLEDGEMENTS

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Appendix I: Fish Species Present in Rainy Lake, Ontario

Common Name	*Scientific Name*	MNR Species Code
Silver Lamprey	*Ichtymyzon unicuspis*	013
Lake Sturgeon	*Acpines fulvescens*	031
Lake Trout	*Salvelinus namaycush*	081
Lake Whitefish	*Coregonus clupeaformis*	091
Cisco (Lake Herring)	*Coregonus artedii*	093
Rainbow Smelt	*Osmerus mordax*	121
Northern pike	*Esox lucius*	131
Muskellunge	*Esox masquinogy*	132
Central Mudminnow	*Umbra limi*	141
Mooneye	*Hiodon tergisus*	152
Longnose Sucker	*Catostomus catostomus*	162
White Sucker	*Catostomus commersoni*	163
Silver Redhorse Sucker	*Moxostoma anisurum*	168
Shorthead Redhorse Sucker	*Moxostoma macrolepidotum*	171
Northern Redbelly Dace	*Phoxinus eos*	182
Finescale Dace	*Phoxinus neogaeus*	183
Lake Chub	*Couesisus plumbeus*	185
Brassy Minnow	*Hybognathus hankinsoni*	189
Golden Shiner	*Notemigonus crysoleucas*	194
Emerald Shiner	*Notropis atherinoides*	196
Common Shiner	*Notropis cornutus*	198
Blackchin Shiner	*Notropis heterodon*	199
Blacknose Shiner	*Notropis herolepis*	200
Spottail Shiner	*Notropis hudsonius*	201
Mimic Shiner	*Notropis volucellus*	206
Bluntnose Minnow	*Pimephales notatus*	208
Fathead Minnow	*Pimephales promelas*	209
Blacknose Dace	*Rhinichthys atratulus*	210
Longnose Dace	*Rhinichthys cataractae*	211
Creek Chub	*Semotilus atrmaculatus*	212
Black Bullhead	*Ictalurus melas*	231
Brown Bullhead	*Ictalurus nebulosus*	233
Tadpole Madtom	*Noturus gyrinus*	236
Burbot	*Lota lota*	271
Brook Stickleback	*Culaea inconstans*	281
Ninespine Stickleback	*Pungituus pungitius*	283
Trout-Perch	*Percopsis omiscomaycus*	291
Rock Bass	*Amboloplites rupestris*	311
Green Sunfish	*Lepomis cyanellus*	312
Pumpkinseed	*Lepomis macrochirus*	313
Bluegill	*Lepomis macrochirus*	314

Appendix I: cont'd

Common Name	Scientific Name	MNR Species Code
Longear Sunfish	*Lepomis megalotis*	315
Smallmouth Bass	*Micropterus dolomieui*	316
Largemouth Bass	*Micropterus salmoides*	317
Black Crappie	*Pomoxis nigromaculatus*	319
Yellow Perch	*Perca flavescens*	331
Sauger	*Sander canadensis*	332
Walleye (Yellow Pickerel)	*Sander vitreus*	334
Rainbow Darter	*Etheostoma caeruleum*	337
Iowa Darter	*Etheostoma exile*	338
Johnny Darter	*Etheostoma nirgrum*	341
Logperch	*Percina caprodes*	442
Brook Silverside	*Labidesthes siculus*	361
Mottled Sculpin	*Cottus bairdi*	381
Slimy Sculpin	*Cottus cognatus*	382

Total Species: 55

Appendix II: Total length frequency distribution of fish species captured in 25 FWIN gill net sets on Rainy Lake North Arm, 2002.

Length (mm)	Walleye	N. Pike	SM Bass	Burbot	Yellow Perch	Lake Herring	Whitefish	Sauger
0 – 99	1		2		1			
100-119			1		96			
120-139	7		1		32			
140-159	19		6		94			
160-179	15		2		57			1
180-199	9		3		29			
200-219			1		11	1		
220-239	2	1	4		18			
240-259	4	1			28			
260-279	4		1		8		2	
280-299	3				6			
300-319	4					2	1	
320-339	2					2	3	
340-359	3		4	1		3	5	
360-379	8					3		
380-399	10					1	7	
400-419	23					1	7	
420-439	24	1	3				5	
440-459	20	1	1				2	
460-479	22	1	4				2	
480-499	24	3	2				1	
500-519	13	2					4	
520-539	21	2					5	
540-559	21	3					1	
560-579	21	3					1	
580-599	25	3					1	
600-619	19	3					1	
620-639	8	4						
640-659	7	4						
660-679	2	7						
680-699	8	7						
700-719	8	1						
720-739	5	3						
740-759	3	6						
760-779	1	5						
780-799		1						
800+		26			1			
Total	**366**	**88**	**35**	**1**	**381**	**13**	**48**	**1**
Mean	**460**	**699**	**274**	**350**	**163**	**342**	**430**	**177**
Min	**153**	**239**	**95**	**350**	**99**	**206**	**276**	**177**
Max	**763**	**968**	**487**	**350**	**990**	**405**	**612**	**177**

Appendix II: (cont'd)

Length (cm)	White Sucker	Golden Shiner	Brown Bullhead	Rock Bass	Pumpkin Seed	Black Crappie	Trout perch	Spottail Shiner
0 – 99				2	6			1
100-119	4	8		16	3	1	2	5
120-139	1	2	21	4	1	12		
140-159			13	8		15		
160-179			61	8		7		
180-199			56	4		4		
200-219	2		69			5		
220-239			32	2				
240-259			31	2				
260-279			7	1				
280-299	5		3	1				
300-319	2		1					
320-339	4		1					
340-359	1							
360-379	2							
380-399								
400-419								
420-439	2							
440-459	2							
460-479	1							
480-499	1							
500-519	1							
520-539								
540-559								
560-579								
580-599								
600-619								
620-639								
640-659								
660-679								
680-699								
700-719								
720-739						1		
740-759								
760-77.9								
780-799								
800+								
Total	**28**	**10**	**295**	**48**	**10**	**45**	**2**	**6**
Mean	**461**	**115**	**198**	**151**	**98**	**169**	**108**	**104**
Min	**105**	**106**	**120**	**69**	**70**	**116**	**107**	**98**
Max	**513**	**124**	**339**	**289**	**121**	**720**	**110**	**108**