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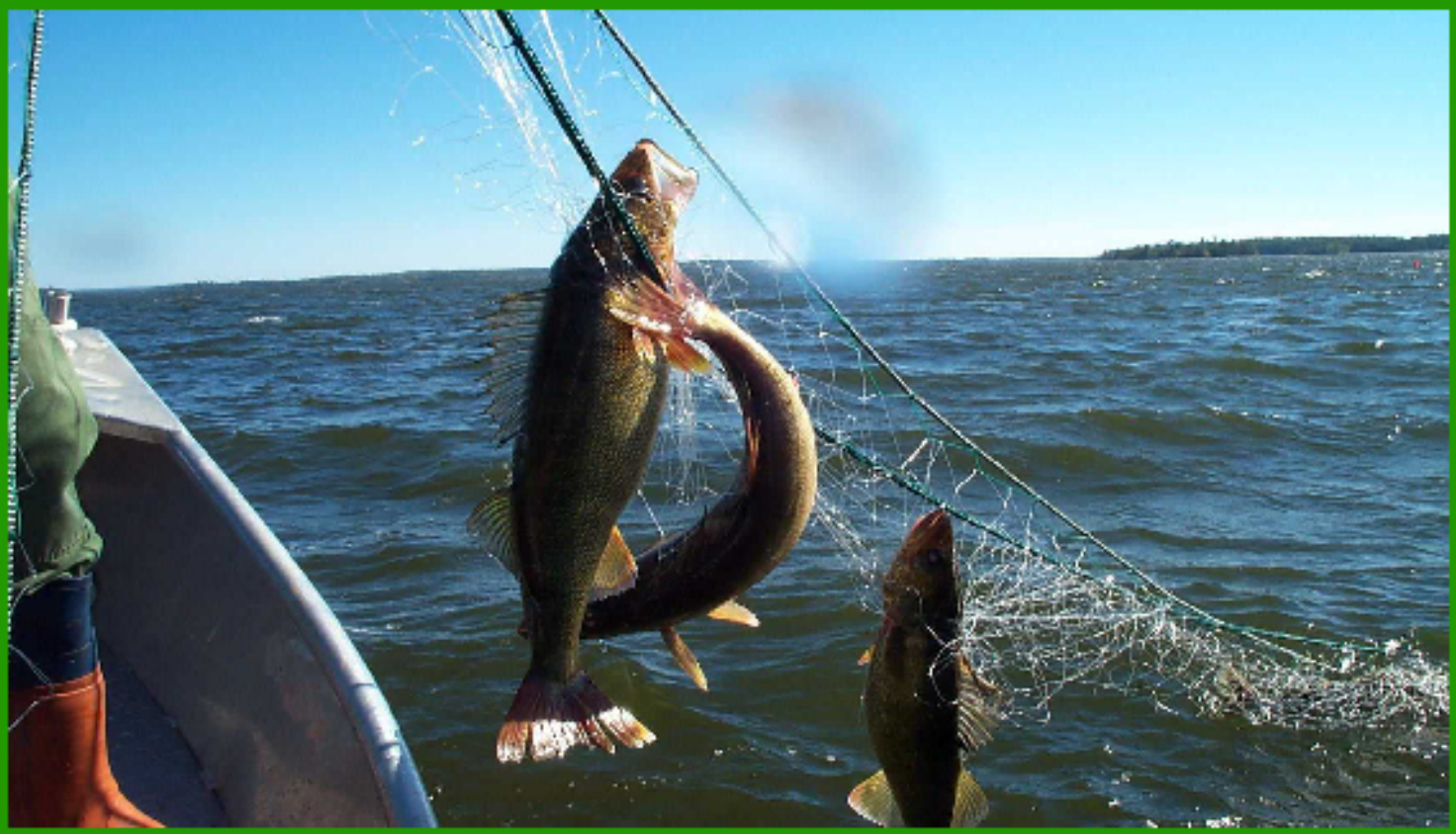
Fall Walleye Index Netting on the South Arm of Rainy Lake, Ontario 2009

Darryl McLeod and David Denyes



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Darryl McLeod and David Denyes
Ontario Ministry of Natural Resources
Fort Frances, Ontario

September, 2011

Fort Frances District Report Series No. 90

SUMMARY

Fall Walleye Index Netting (FWIN) was conducted in 2009 on the South Arm of Rainy Lake, located directly east and southeast of Fort Frances, Ontario. The lake is situated between NW Ontario and Minnesota; with the international border dividing the South Arm basin. A diversity of fish species were captured in gill nets, and detailed biological data relating to walleye, northern pike and smallmouth bass were obtained. In general, walleye populations in the South Arm appeared to be recovering but unstable, with a few life history parameters (age composition, age and length at 50% maturity, mortality, diversity of mature females) showing improvement relative to the previous FWIN projects and long-term index netting since 1965. A total of 17 age classes (16 with n>1) were captured, with a maximum age of 18 years and a mean age of 4.13 years. The Shannon Diversity Index for adult females was high at 0.89. However, there is concern that the geometric mean CUE of walleye ≥450 mm was quite low and declining to only 0.7 walleye/net. Comparisons of walleye population structure (e.g., number of age classes, maximum age and Shannon Diversity Index) to regional benchmarks indicate a "healthy" fishery, although some parameters (geometric mean CUE ≥450 mm, mean age and Fishing Quality Index) still indicate a "stressed" or unstable fishery. The previous improvements in walleye abundance observed in 2004 did not continue in 2009 where a decrease in catch per unit effort from 16.0 walleye/net in 2004 to a low of 10.4 walleye/net was observed (geometric mean decreased from 12.1 to 7.9 walleye/net). Regardless of the recent declining trend in FWIN catch per unit effort, walleye abundance is still higher then the long term index netting mean of 7.1 walleye/net. Harvest restrictions should remain in place until all population parameters indicate a healthy fishery, and fishing quality objectives are achieved.

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INTRODUCTION

Rainy Lake is situated on the international border between Ontario and Minnesota, and is divided into three geographically distinct basins; Redgut Bay and the North Arm which lie entirely in Ontario, and the South Arm which lies nearly equally in Minnesota and Ontario (Figure 1). Water levels in the lake 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 located at Big Canoe, Footprint, and Manitou Rivers, although small, contribute to the regulation of water levels.

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 and earlier drawdown in the fall. The new curve was intended to improve fish stocks that spawn in both fall (e.g. lake whitefish, *Coregonus clupeaformis*) and spring (e.g. walleye, S*ander vitreus,* 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 South Arm basin covers a surface area of 49,200 ha (121,500 acres), of which 27,260 ha (67,400 acres) is in Ontario. 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 1). The South Arm was previously assessed using FWIN standards in 1999 and 2004 (M^{c}Leod, 2005), and will continue to be assessed on a five-year cycle (M^{c}Leod, 2002). The North Arm was assessed using FWIN standards in 1998, 2002, and 2007 (McLeod and Rob, 2009) and Redgut Bay in 1998, 2003 and 2008 (McLeod and Bisson, 2011). Additional fisheries assessment programs also included annual monitoring of commercial harvests, roving creel surveys (2010/11), aerial effort survey (SOR pilot – 2000/01), and annual smallmouth bass (*Micropterus dolomieu*) tagging and sampling through the Fort Frances Canadian Bass Championship. Index netting from 1965 to 1999 was conducted in early September and utilized multifilament gill nets at fixed sites, similar to standards used by the Minnesota Department of Natural Resources (MDNR) (M^{c}Leod at al., 2004).

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, seven of the twenty-two Ontario commercial tourist resorts on Rainy Lake are located in the South Arm.

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

Parameter	Redgut Bay	North Arm	South Arm	Rainy Lake, Ontario
Surface Area - Ontario (ha)	8,300	34,570	**27,260**	70,150
Mean Depth (m)	6.9	8.0	**11.5**	9.3
Maximum Depth (m)	31.2	41.0	**49.1**	49.1
Mean Summer Secchi Depth (m)	2.1	3.3	**2.7**	2.7
Perimeter Shoreline (km)	276	583	**439**	1,298
Island Shoreline (km)	55	440	**396**	891
T.D.S. (mg/L)	35	55	**43**	53
M.E.I.	5.1	6.9	**3.7**	5.7

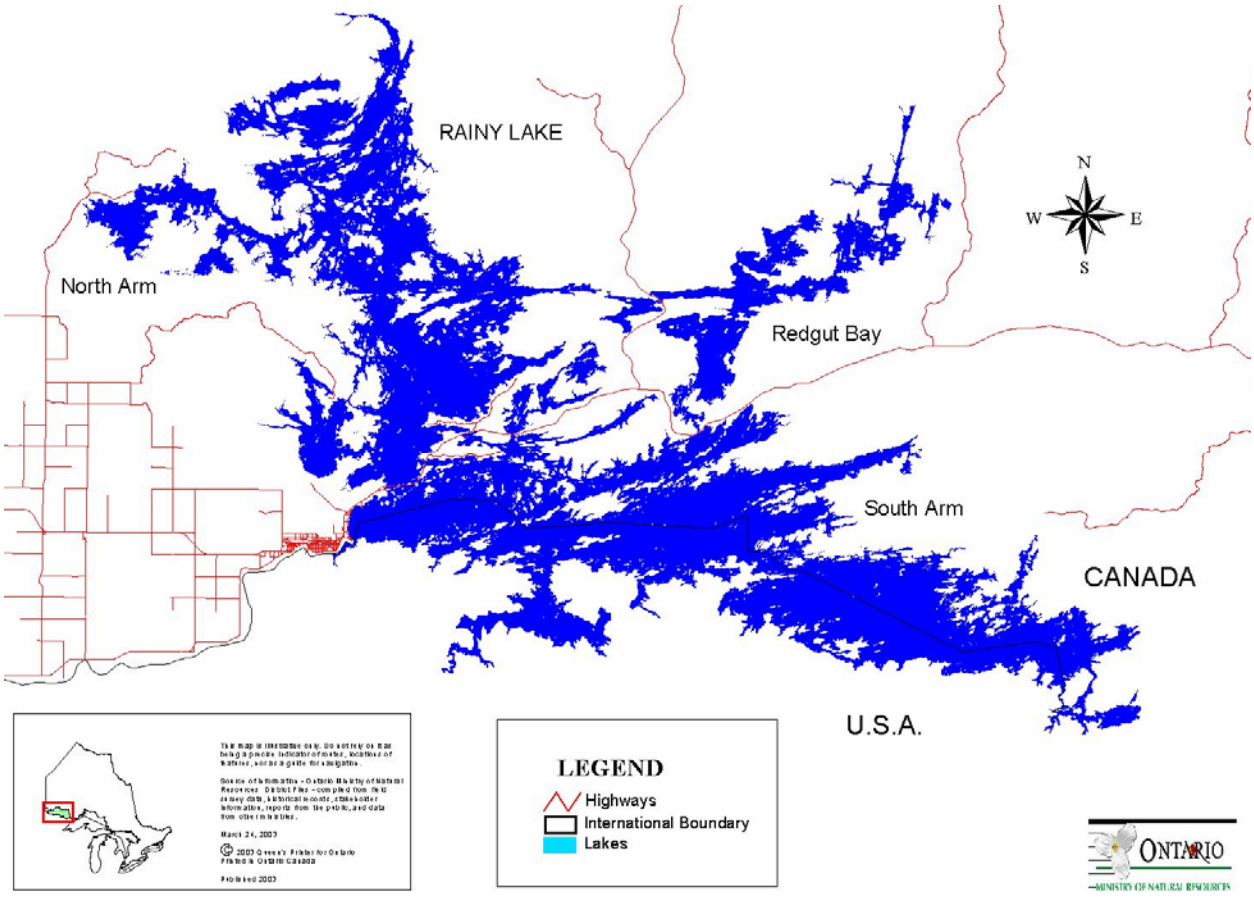

Figure 1: Location of Rainy Lake, Ontario

Commercial fishing on Rainy Lake dates back prior to the 1890s for lake sturgeon (*Acipenser fulvescens)* and lake whitefish. Commercial fishing since the 1920s was primarily for whitefish, northern pike, walleye and more recently black crappie (*Pomoxis nigromaculatus*). The commercial walleye fishery on the South Arm was closed in 1971 due to mercury contamination, and only a small incidental harvest was reported in 1972. Limited commercial walleye harvest occurred on this basin until 1990 under quota management, which was established for walleye in 1978 and for all other species in 1984. In 2004, there were a total of four commercial fishing operations and six commercial licenses remaining on the Ontario waters of Rainy Lake. Currently, commercial harvest on the South Arm is limited to two licences, with species quotas for whitefish only.

A roving creel survey on the South Arm in 2001 indicated that the majority (70%) of fishing pressure is from non-resident (U.S.) anglers, with 43% based in Ontario and 27% from Minnesota. Angling effort based on surveys in 2001/02 revealed that overall angling effort was moderate on the South Arm at 4.7 rod-hrs/ha (127,240 rod-hours) (M^{c}Leod, 2003).

Overall angler effort on Rainy Lake was highest for walleye, accounting for 59% of the total effort. The majority of angler effort on the South Arm is directed at walleye (71%), with lesser effort directed at smallmouth bass (36%), northern pike (27%), and black crappie (2%). Muskellunge (*E. masquinongy*) are also present in the South Arm, and offer limited trophy opportunities for anglers. The high effort directed at walleye may be attributed to the high catch rates (1.00 walleye/rod-hour). Angler creel surveys in

2001/02 indicated that an estimated 87% of walleye were released in Rainy Lake increasing from 82% in 1994/95. Release rate of walleye was 85% on the South Arm, compared to 89% on Redgut Bay and only 70% on the North Arm. The majority of the 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^{c}Leod, 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 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 have fallen below expected and desired levels. The South Arm fishery has shown signs of over-exploitation stress since 1965 (Wepruk et al., 1992). Although population abundance based on index net catches showed a slight increasing trend since 1965, walleye abundance appeared to be declining through the late 1980's while angler exploitation was high. The 1999 FWIN catch of 10.4 walleye/net suggested that abundance was average and dominated primarily by small fish (OMNR and MDNR, 2004). Attempts to rehabilitate the Rainy Lake fishery have included angling regulation changes and sanctuaries adjacent to known spawning sites. In

order to allow the walleye population to fully recover, recommended harvest levels for the Ontario portion of the South Arm were set at 47% of the annual yield or 11,200 kg/yr in 1992 (MDNR et al., 1992), and revised to 85% or 20,500 kg/yr in 2004 (OMNR and MDNR, 2004). The potential yield of walleye is estimated at 23,700 kg/yr, while annual harvests have averaged only 10,500 kg/yr from 1997-2002, compared to previous levels of 12,700 kg/yr from 1990-96. The highest angler harvest was reported at 27,970 kg in 1982, and exceeded the potential yield alone by 18 %.

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 *(S. canadensis)* per day, with a possession limit of four (walleye and sauger in combination) was introduced. Harvest by resident and Ontario-based non-resident 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 since 1994, 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 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 the Rainy Lake were initiated (M^{c}Leod, 2002). The FWIN program will also provide

baseline data for the evaluation and monitoring of water level changes initiated by the IRLBC (USGS, 2000).

METHODS

Standard FWIN gillnetting was conducted on the South Arm between September 8 and September 23, 2009 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 7.6m panels with stretched mesh sizes of 25mm, 38mm, 51mm, 64mm, 76mm, 102mm, 127mm, and 152mm (made by *Les Industries Fipec Inc*., Quebec, catalog #FEX-03). Nets were set as close to perpendicular (90^{o}) from shore as each net site would allow.

Twenty-five net sites were selected using the fixed locations from gill net sampling efforts between 1970 and 2004, with minor adjustments to individual site depths to meet the depth stratification requirements in the FWIN manual (Morgan, 2002). Sampling intensity in each strata (shallow = 2-5 m, deep = 5-15m) was determined by the relative amount of shallow versus deep areas of the lake. As a result, 56 % (14/25) of nets were in the shallow strata, and 44 % (11/25) were in the deep strata. Surface water temperatures were much warmer than desired during the sampling period, and ranged from 19.3°C to 23.5°C with thermal stratification still present. The timing of the project coincided with similar index netting efforts on the South Arm by the Minnesota Department of Natural Resources.

All walleye, northern pike, muskellunge and smallmouth bass were sampled for sex and maturity by comparing gonad development (Duffy et al., 1999), and aging structures were taken (otiliths 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). The health of the South 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 the provincial means for northern pike life history (Malette and Morgan, 2005).

RESULTS

A total of 13 species were captured in 25 gill net sets on the South Arm. Walleye were the most abundant species, representing 46.3% of the catch by number with an arithmetic mean of 10.4 fish/net. Sauger averaged 2.5 fish/net and represented 11.3% of the total number of fish caught. Rock bass (*Ambloplites rupestris*) were the third most abundant species at 2.1 fish/net and 9.5% of the total catch. The total percid composition (walleye, sauger, yellow perch) was 66.2% of the catch by number. Meanwhile, lake herring *(C. artedii)* comprised 2.0 fish/net and 8.8% of the catch and northern pike comprised 1.5 fish/net and 6.8% of the catch. 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 South Arm produced a fish community with a Simpson's Diversity Index value of 3.88.

Table 2: Summary of catch data from Fall Walleye Index Netting (FWIN) in the South Arm of Rainy Lake (25 net sets), 2009.

Species	# Nets Captured In	Total # Caught	Mean (#/net)	Standard Error (SE)	% RSE	% of Total Catch
Lake Whitefish	7	9	0.36	0.14	38.9	1.6
Lake Herring	13	49	1.96	0.67	34.3	8.8
Northern Pike	21	38	1.52	0.27	17.5	6.8
White Sucker	10	13	0.52	0.14	27.5	2.3
Silver Redhorse	2	2	0.08	0.06	69.2	0.4
Shorthead Redhorse	4	5	0.20	0.10	50.0	0.9
Spottail Shiner	1	6	0.24	0.24	100.0	1.1
Rock Bass	10	53	2.12	0.90	42.4	9.5
Smallmouth Bass	8	12	0.48	0.16	34.3	2.1
Black Crappie	2	2	0.08	0.06	69.2	0.4
Yellow Perch	10	48	1.92	1.05	54.6	8.6
Sauger	18	63	2.52	0.74	29.4	11.3
Walleye	25	259	10.36	1.54	14.8	46.3
TOTAL	**25**	**559**	**27.95**	**-**	**-**	**100.0**

WALLEYE

The catch of walleye in index netting programs on the South Arm for the period of 1965-2009 is illustrated in Figure 2. In 1999, provincial FWIN standards were first used in a detailed comparison with historical index netting techniques. Walleye abundance between 1965 and 1990 showed a modest increasing trend, with high levels of variability within sampling years. The long-term arithmetic mean from 1965 to 1999 index netting was 7.1 ± 1.7 walleye per net. The arithmetic mean catch per unit effort (CUE) of walleye declined in the 2009 FWIN to 10.4 walleye/net, after an increase from 12.6 walleye/net in 1999 to 16.0 walleye/net in 2004. The CUE observed in 2004 was the

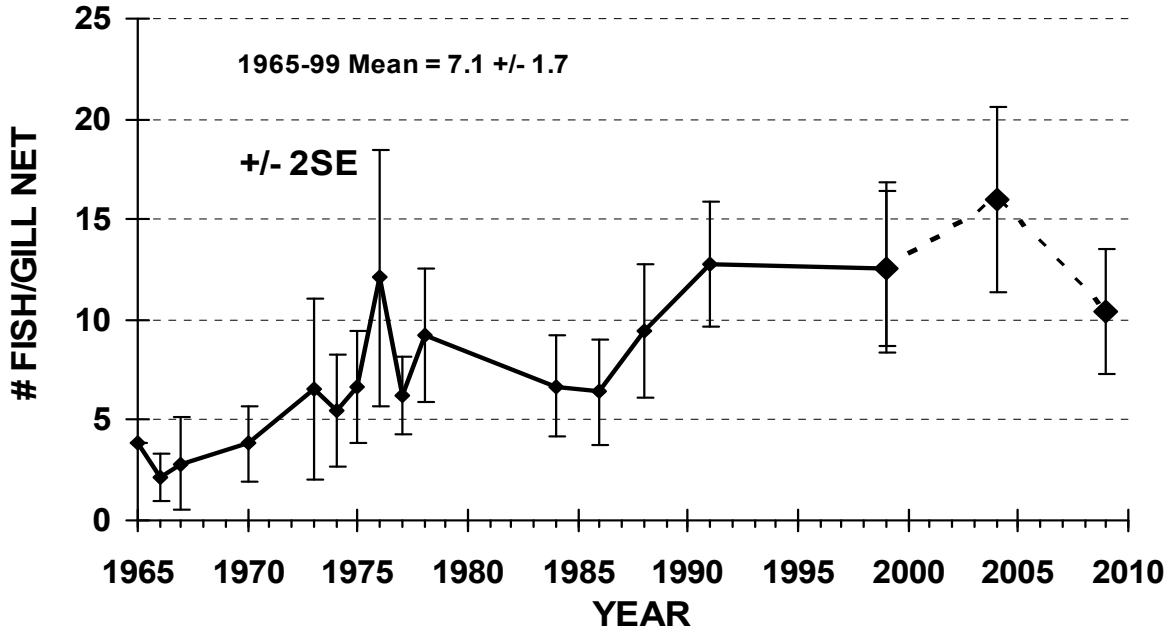

Figure 2: Historical abundance of walleye based on catch-per-unit-effort from index netting (1965-1999) and Fall Walleye Index Netting (1999, 2004 and 2009).

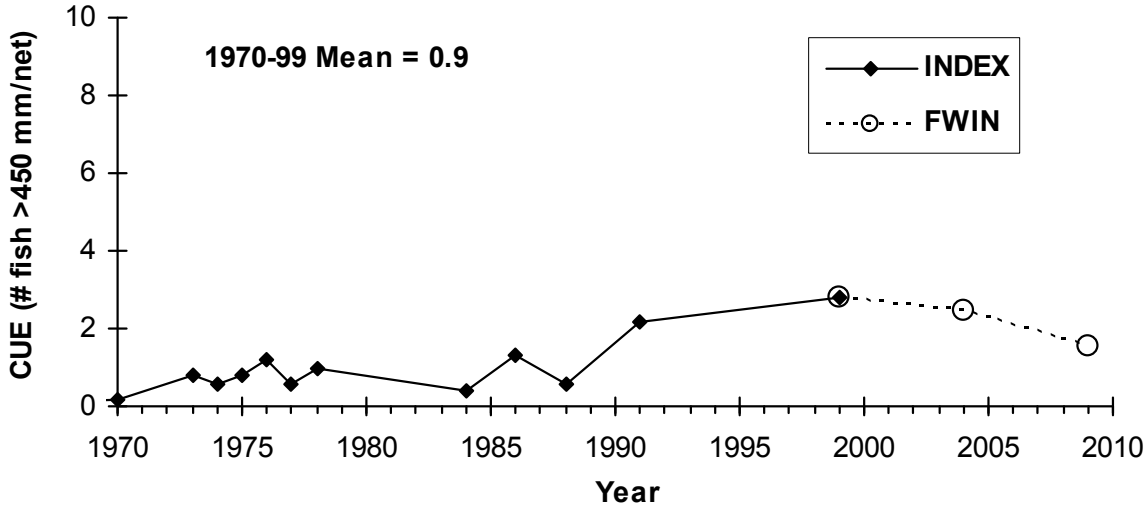

Figure 3: Historical abundance of walleye >450 mm TL based on catch-per-unit-effort from index netting (1970-1999) and Fall Walleye Index Netting (1999, 2004 and 2009).

highest abundance observed since sampling initiated in 1965. The catch of spawning stock walleye ≥450 mm is represented in Figure 3, and would suggest a modest declining trend in abundance after reaching a historical high of 2.7 walleye ≥450 mm/net in 1999. The CUE from historical index netting indicated an increasing trend, averaging 0.9 walleye ≥450 mm /net from 1970-1999, compared to 1.5 observed in 2009. The geometric mean CUE also declined in 2009 to 7.9 walleye/net, compared to 10.0 walleye/net in 1999 and 12.1 walleye/net in 2004 (Figure 4). The geometric mean CUE (walleye ≥450 mm) was estimated at 0.7 in 2009, and reflects a continued decline from 1.9 in 1999 (Figure 5).

The recent decrease in FWIN catch by number coincided with decreases in catch by weight, which declined to 4.01 kg/net in 2009 from 8.62 kg/net in 2004. The mean weight of walleye sampled in 2009 was 0.39 kg (SE = 0.03) down from the average weight of 0.54 kg from 2004 FWIN, and lower than the long term (1965-1999) average of 0.48 kg (SE = 0.03).

Walleye age composition showed a broad distribution in year classes with age three (2006 year class) being most dominant and comprising 23% of the catch. As a result, the mean age of catch was 4.13 years, and a total of 17 age classes (16 age classes n>1) were present with a maximum age of 18 years (Figure 6). This was followed by the 2008 (age 1) and 2007 (age 2) year class, representing 16 and 15% of the catch, respectively. A high proportion (7.8%) of age 8 walleye also reflect the continued contribution of a very strong 2001 year class which had comprised 50% of the total 2004 FWIN catch .

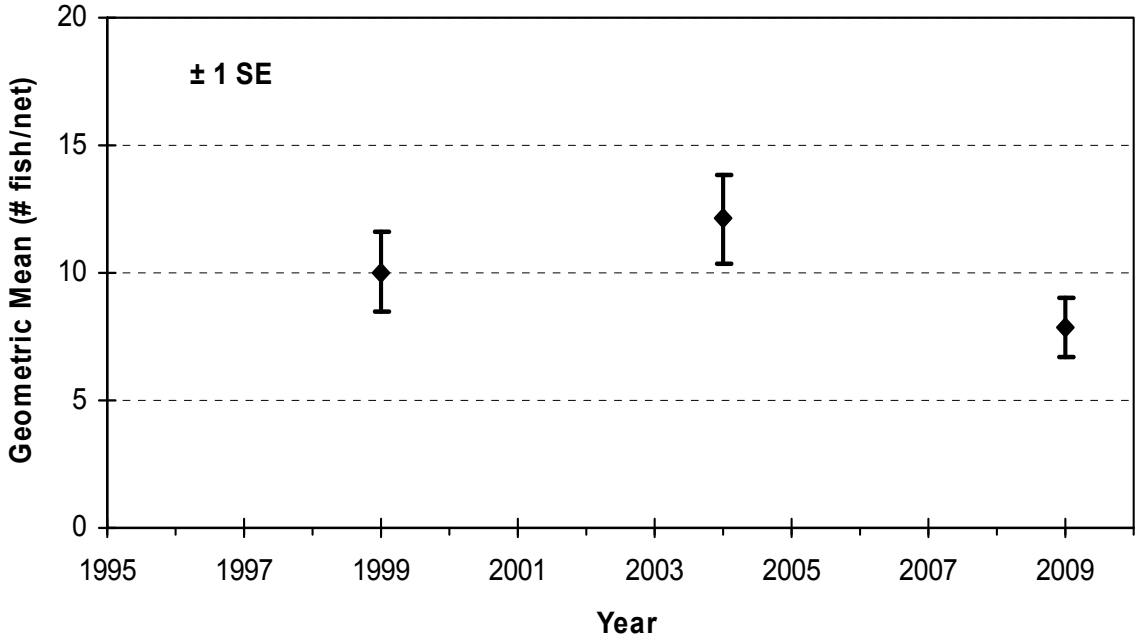

Figure 4: Geometric mean catch of walleye in the South Arm of Rainy Lake based on 1999, 2004 and 2009 Fall Walleye Index netting (FWIN).

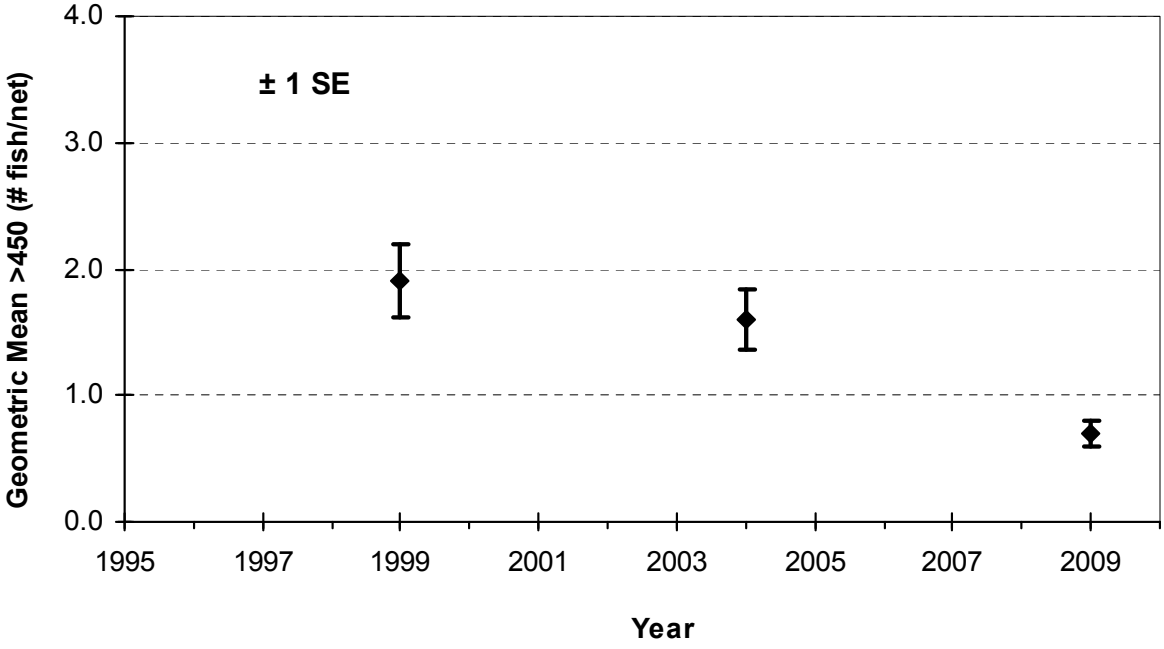

Figure 5: Geometric mean catch of walleye ≥450 mm TL in the South Arm of Rainy Lake based on 1999, 2004 and 2009 Fall Walleye Index Netting (FWIN).

A total of 8 young-of-year (age 0) walleye were collected comprising 3.1% of the catch, suggesting that there may have good initial recruitment of the 2009 year class. Total annual mortality (sexes combined) was estimated at 27%, and was 25% for males (5+ years) and 28% for females (5+ years).

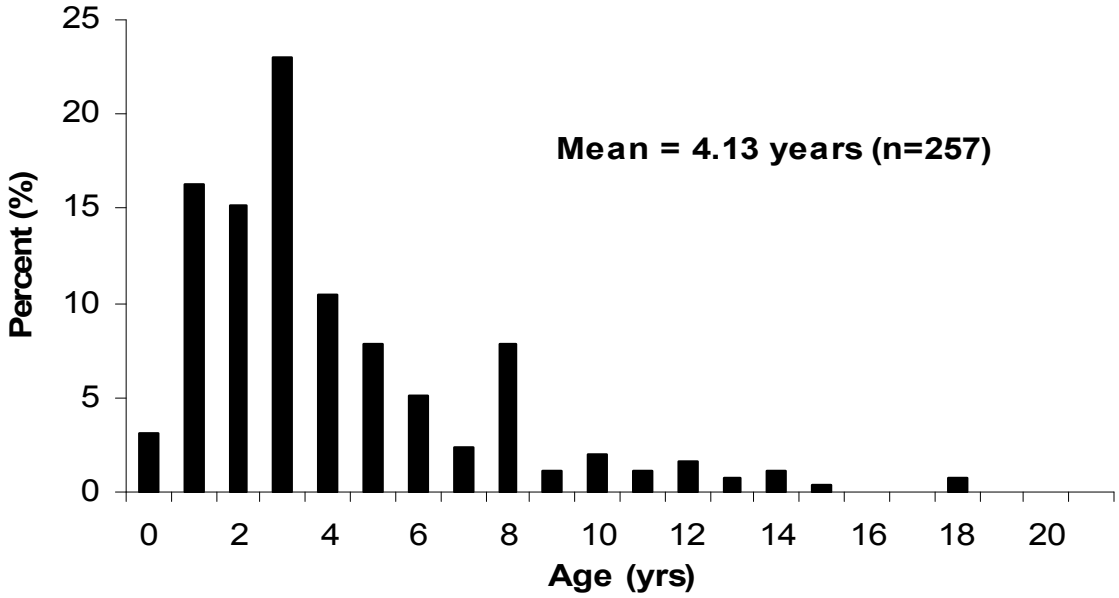

Figure 6: Age composition of walleye in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

The age composition of the catch was also compared to the 2004 FWIN (Figure 7) and to the long-term mean (1970-1999) from previous index netting efforts (Figure 8). The mean age of the 2009 FWIN catch was similar to the long-term mean of 3.97 years, even though there were minor differences in gear type. Walleye age composition in 2009 was comparable to 2004 FWIN and long term index netting means (1970-1999), with a broad representation of year classes. In contrast, 2004 FWIN age composition was dominated by one year class with age 3 walleye from 2001 representing 50% of the total catch. The

2009 FWIN catch continues to provide slightly better representation of older fish (>10 years) compared to previous netting efforts.

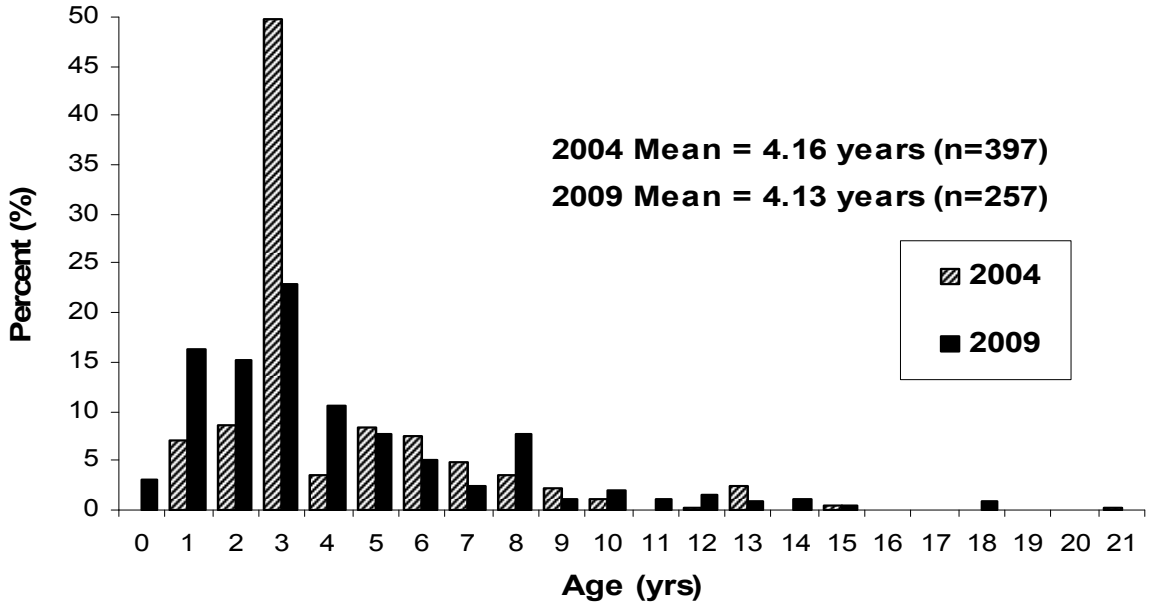

Figure 7: Age composition of walleye in the South Arm of Rainy Lake based on the 2004 and 2009 Fall Walleye Index Netting (FWIN).

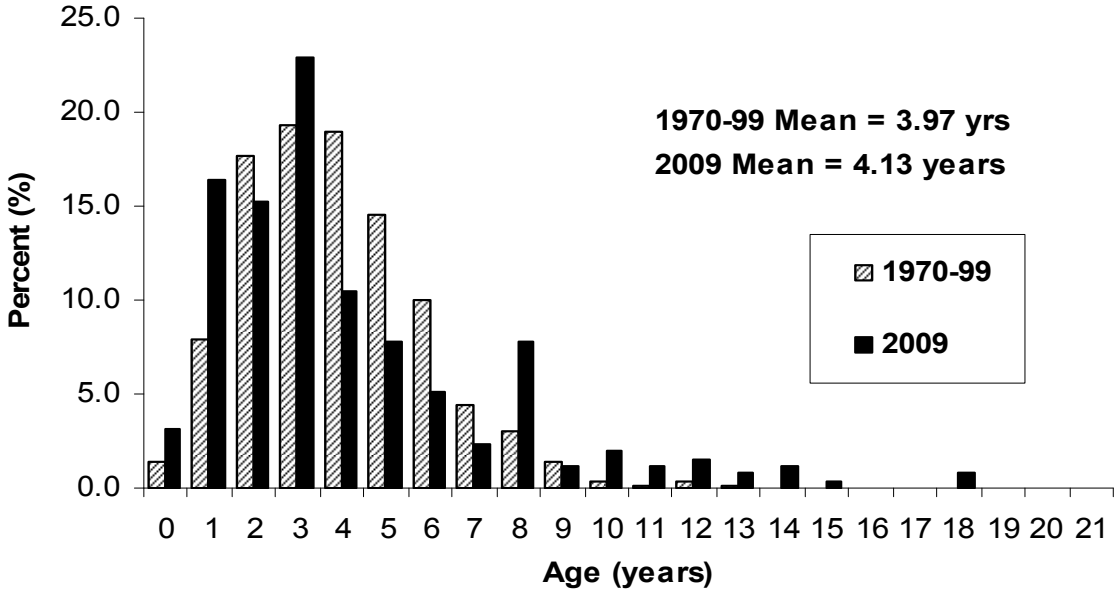

Figure 8: Age composition of walleye in the South Arm of Rainy Lake based on 2009 Fall Walleye Index Netting (FWIN) compared to long-term index netting (1970-1999).

Overall mean total length of walleye (sexes combined) was 308 mm, which represents a decline from 350 mm observed in 2004. Fish in 180 to 410 mm range were dominant, and there was an obvious reduction in the abundance of fish greater than 580 mm. Only one walleye greater than 700 mm was sampled. The length distribution of walleye captured in the South Arm in 2009 is illustrated in Figure 9.

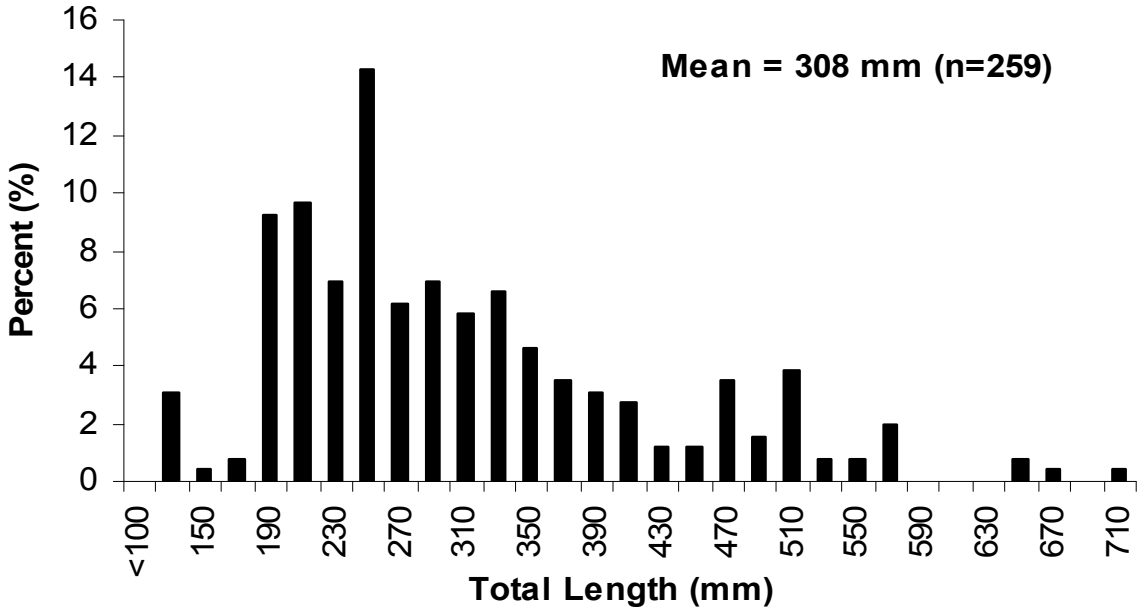

Figure 9: Walleye length composition in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

South Arm walleye exhibited typically sexually dimorphic growth patterns, with males and females growing at a very similar rate during the first 4 years, with male growth levelling 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.

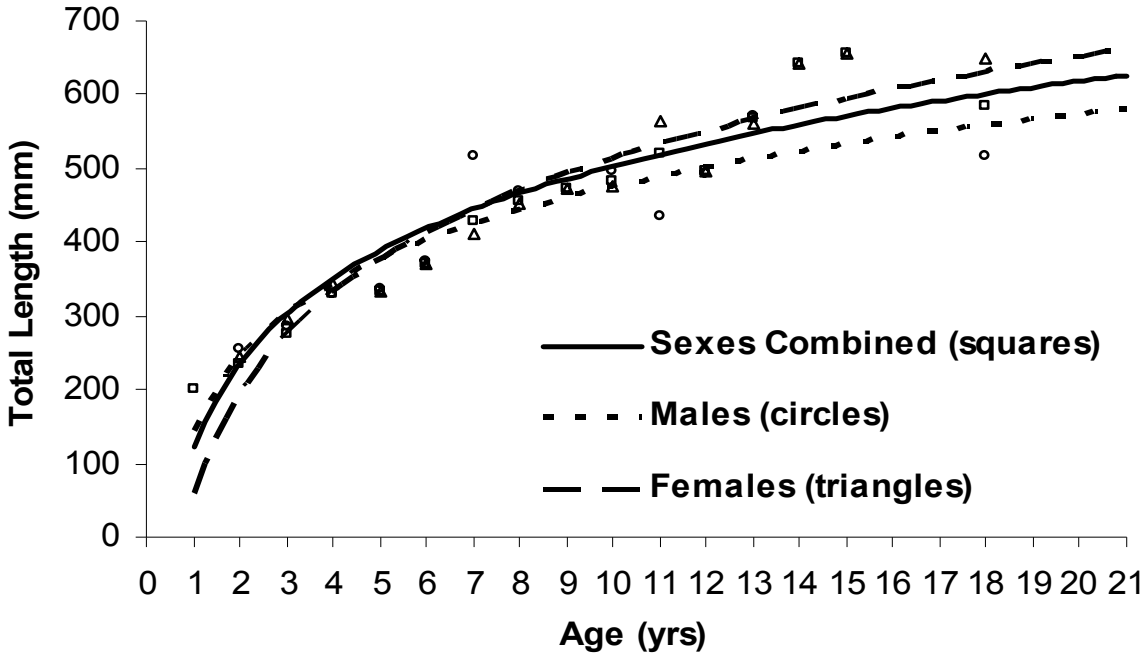

Figure 10: Walleye growth (total length at age) for males, females, and combined sexes in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

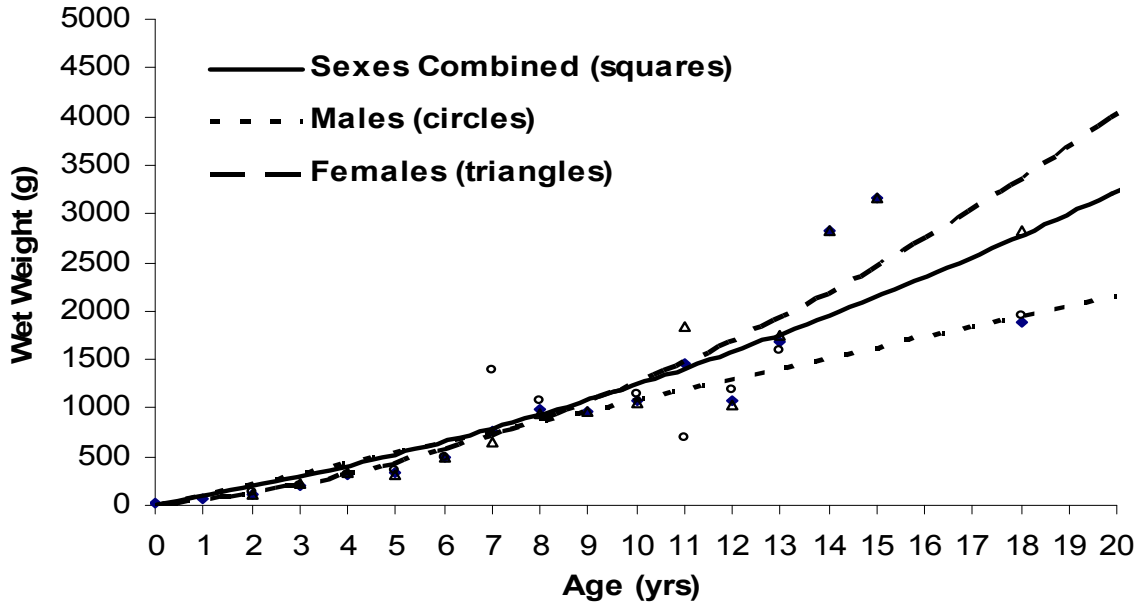

Figure 11: Walleye growth (weight at age) for males, females, and combined sexes in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

Growth of juvenile (age 1 to 4 years) walleye has remained relatively unchanged over the period from 1965 to 1999 (Figure 12), but appears to have declined for age 2, 3 and 4 walleye over the past 10 years. Comparison of mean total length at age through time may help evaluate the response of walleye to increased abundance, harvest restrictions or invasions of exotic species (e.g. rainbow smelt *Osmerus mordax* in 1991; spiny water flea *Bythotrephes longimanus* in 2006).

The growth rate of walleye in Rainy Lake differs among basins. Mean length at age is consistently higher in the North Arm, than the South Arm and Redgut Bay (Figure 13). Although age 0 fish are of similar size, South Arm walleye are slower growing than North Arm fish especially through age classes 2 to 13 years. Walleye in the South Arm also appear to be growing at an identical rate to those sampled in Redgut Bay in 2008.

Shannon Diversity Index for adult females (age ≥5 years) in the South Arm was high (0.89), and above the level indicative of healthy walleye populations in Ontario (≥0.66). Maturity schedules for walleye in the South Arm were clearly different between the sexes, with females maturing at a slightly larger size and age than males. These differences between the sexes were apparent when comparing total length at maturity (Figure 14) than age at maturity (Figure 15). The calculated mean total length at 50 % maturity was 385 mm for males and 425 mm for females. The mean age at 50 % maturity was 6.68 years for males and 7.33 years for females. This age at maturity represents a significant increase from previous sample years and much higher than NW Regional means. This may be due to a slowing of growth rates, or could be indicative of sampling

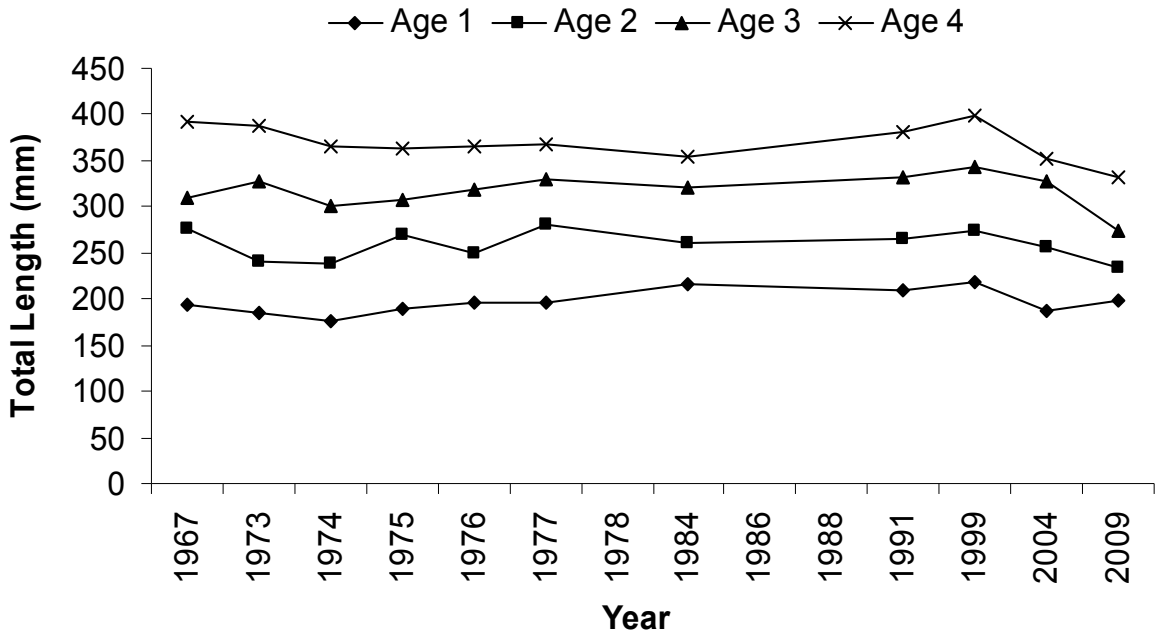

Figure 12: Mean length at age of juvenile (age 1-4) walleye in the South Arm of Rainy Lake, 1974-2009.

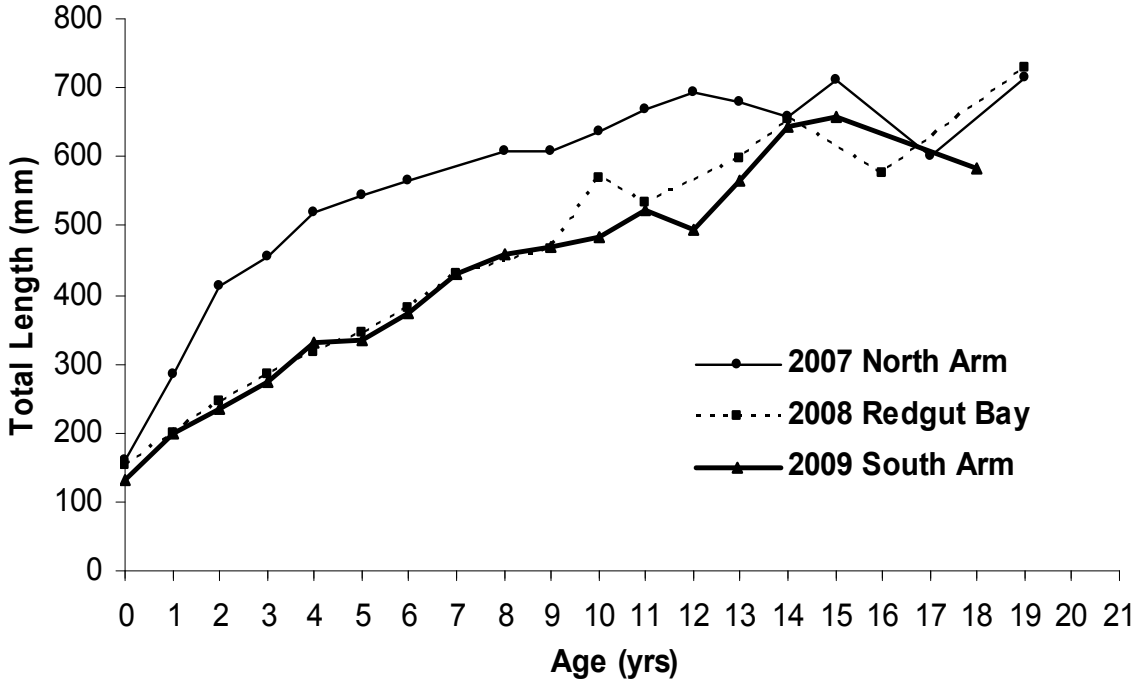

Figure 13: Mean length at age of walleye captured in Fall Walleye Index Netting (FWIN) for each basin of Rainy Lake, 2007-2009.

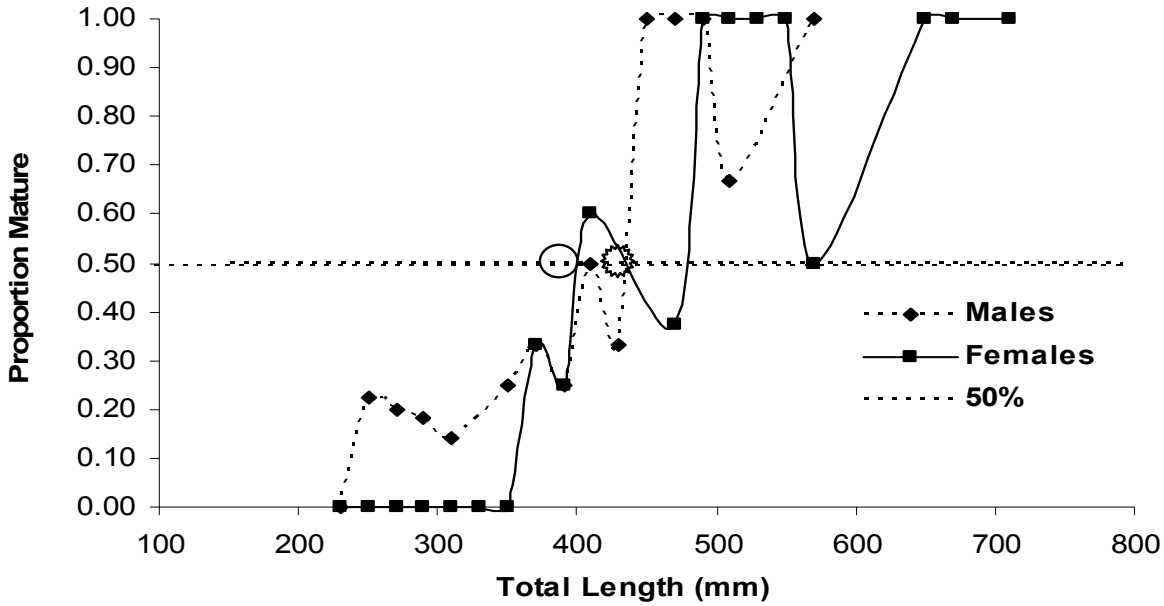

Figure 14: Maturity schedule (total length at maturity) of walleye in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009. Calculated length at 50% maturity is indicated by (O) for males and (☼) for females.

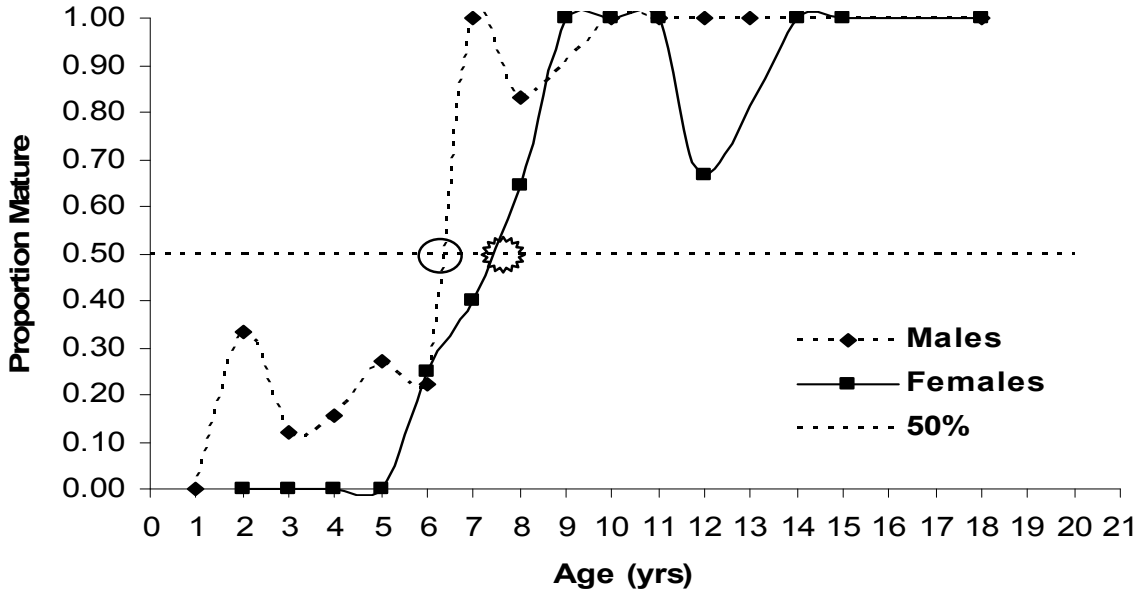

Figure 15: Maturity schedule (age at maturity) for walleye in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009. Calculated age at 50% maturity is indicated by (O) for males and (☼) for females.

error or recording of maturity codes in the field data. Age at maturity results should be interpreted with caution.

Fishing Quality Index (FQI) values based on Relative Stock Density (RSD) (Gabelhouse, 1984) were low with a value of 48 for South Arm walleye in 2009, compared to 56 in 2004 and 54 in 1999. The RSD values for 'quality' walleye (380-510 mm) declined while 'memorable' walleye (630-760 mm) increased from 1999 to 2009. No trophy fish (≥760 mm) were captured in any year based on the size parameters provided. A summary of the RSD values for walleye populations in 1999, 2004 and 2009 have been included in Table 3.

Table 3: Relative Stock Density (RSD) values for walleye in the South Arm of Rainy Lake based on Fall Walleye Index Netting (1999, 2004 and 2009).

Category (Total Length)	1999	2004	2009
Quality (380-510 mm)	.457	.467	.346
Preferred (510-630 mm)	.082	.080	.081
Memorable (630-760 mm)	.000	.012	.015
Trophy (≥760 mm)	.000	.000	.000
FQI	**54**	**56**	**48**

Comparison to Northwest Ontario Walleye Benchmarks

Walleye catch per unit effort in the South Arm of Rainy Lake could be considered in the "low average' abundance category (5-12 walleye/net) and was the 20th lowest value observed in all other FWIN assessments conducted on Fort Frances District lakes since 1994 (Figure 16). The arithmetic mean walleye catch-per-unit-effort (10.4 fish/net) was below the Fort Frances District average (12.1 walleye/net), the Northwest Region average for all lakes (14.1 walleye/net) and the Northwest Region large lake average (17.9

walleye/net). Furthermore, this represented a 21% and 54 % decrease in the number of fish relative to the 1999 and 2004 FWIN respectively. However, a large proportion (50%) of the 2004 catch was from the exceptionally strong 2001 year classes.

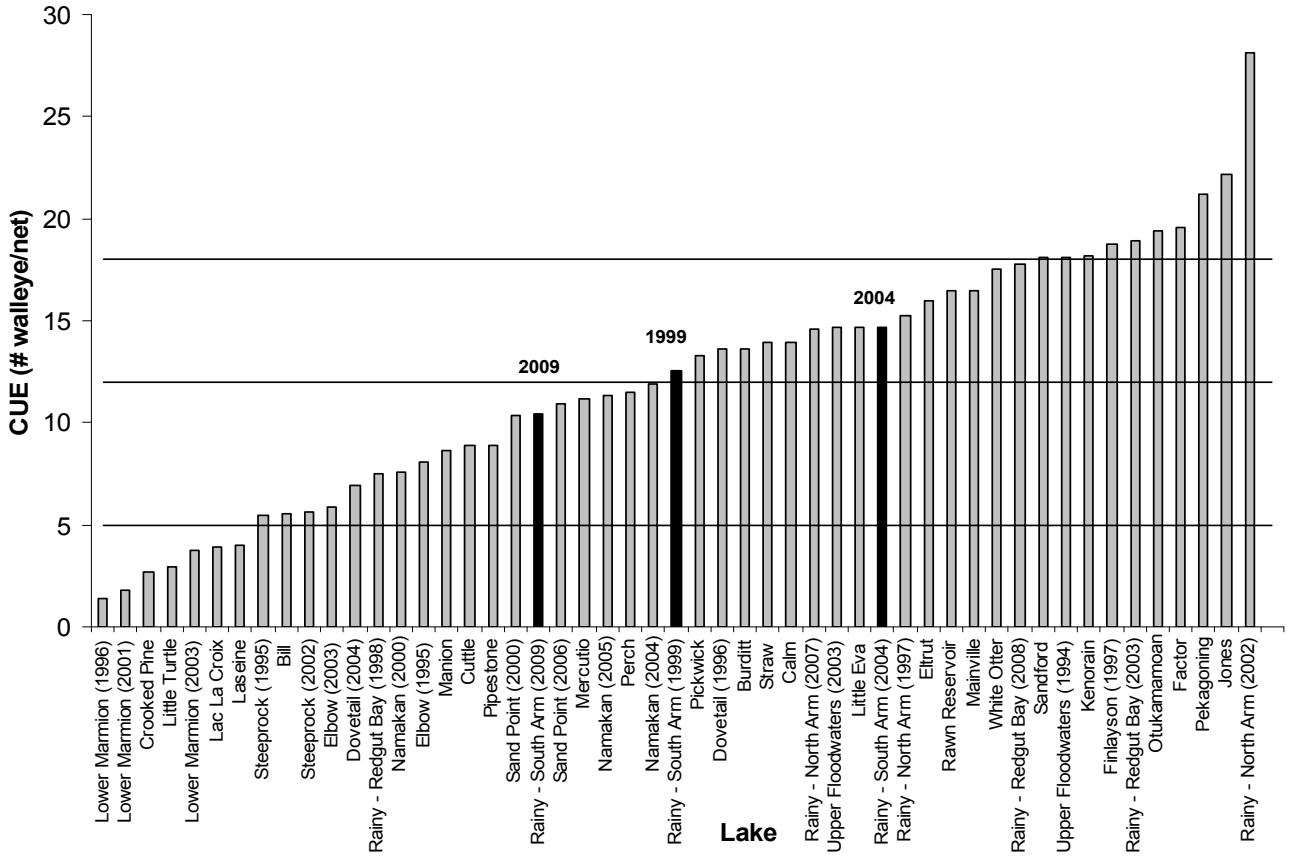

Figure 16: Comparison of walleye abundance in the South Arm of Rainy Lake with other Fort Frances District lakes using FWIN standards, 1994-2009. Walleye catch-per-unit-effort (CUE) between 0-5 are low, 5-12 low-average, 12-18 high average, and >18 high walleye abundance.

The geometric mean CUE for South Arm walleye (7.9 fish/net) was well below the Northwest Region large lake mean of 13.1 fish/net and the mean for all lakes of 10.7 fish/net. The geometric mean of catch of walleye ≥450 mm TL was also low at 0.7

fish/net, and well below the large lake average of 2.5 fish/net for the Northwest Region. Relative to other Ontario waterbodies (Figure 17), this would characterize the population as "stressed" or unstable. The Shannon Diversity Index value of 0.89 indicated sufficient diversity in adult female age classes to be considered a healthy population (>0.66). However, the mean age (4.13 years) is slightly greater then the Northwest Region large lake mean of 3.89 and similar to the mean for all lakes of 4.20. A summary for 1999, 2004 and 2009 FWIN assessments on the South Arm is presented in Table 4, with a detailed comparison of walleye population and life history parameters for the Northwest Region.

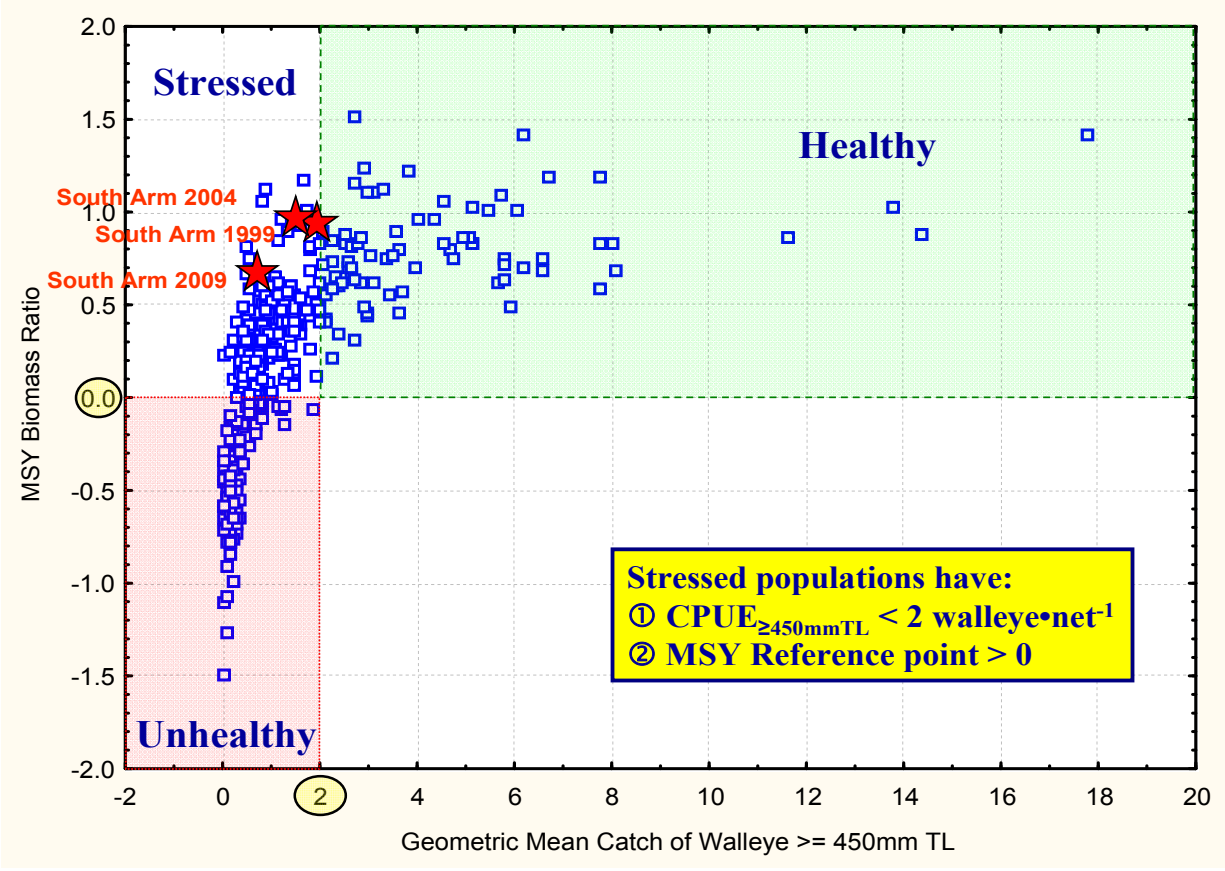

Figure 17: Comparison of walleye abundance (geometric mean catch of walleye >=450mm TL) in the South Arm of Rainy Lake to other Ontario lakes using FWIN standards, 1994-2009.

Table 4: Summary of South Arm walleye population parameters based on FWIN standards, relative to NW Regional benchmarks.

VARIABLE	NW MEAN (all lakes)	NW MEAN (large lakes)	SOUTH ARM (2009)	SOUTH ARM (2004)	SOUTH ARM (1999)
SECCHI (m)	3.0	2.7	2.7	2.7	2.7
MEI	8.7	6.4	3.7	3.7	3.7
MSY (kg/ha/yr)	-	-	0.90	0.90	0.90
MSY Ref. (log_{10} FWIN/MSY)	-	-	0.65	0.98	0.89
DEGREE DAYS (GDD> 5C)	1415	1432	1646	1646	1646
MEAN CUE (kg/net)	-	-	4.01	8.62	6.99
MEAN CUE (#/net)	**14.1**	**17.9**	**10.4**	**16.0**	**12.6**
CUE ≤300 mm	4.1	5.9	6.0	5.3	3.3
CUE ≥350 mm	7.5	8.0	2.9	7.9	6.7
CUE ≥450 mm	3.1	3.5	1.5	2.5	2.7
MEAN CUE (walleye & sauger)	-	20.3	12.9	17.3	14.0
MEAN CUE (GEO) (#/net)	**10.7**	**13.1**	**7.9**	**12.1**	**10.0**
CUE ≥450 mm (GEO) (#/net)	**3.2**	**2.5**	**0.7**	**1.6**	**1.9**
TL @ 50% MATURITY ♀ (mm)	441	458	425	444	450
AGE @ 50% MATURITY ♀ (yrs)	4.80	5.24	7.33	5.91	4.61
TL @ 50% MATURITY ♂ (mm)	**356**	**369**	**385**	**363**	**374**
AGE @ 50% MATURITY ♂ (yrs)	3.49	3.81	6.68	3.87	3.90
MALE MORTALITY (5+ yrs)	0.30	0.29	25	0.29	0.49
FEMALE MORTALITY (5+ yrs)	0.28	0.30	28	0.24	0.45
MORTALITY >300 mm	-	0.34	27	0.29	0.41
TOTAL MORTALITY (A)	-	-	27	0.29	0.40
NUMBER OF AGE CLASSES (all)	-	14	17	14	13
NUMBER OF AGE CLASSES (n>1)	**10**	**13**	**16**	**12**	**9**
MEAN AGE (yrs)	**4.20**	**3.89**	**4.13**	**4.16**	**3.74**
MAXIMUM AGE (yrs)	**16**	**18**	**18**	**21**	**14**
AGE CLASSES >8	5	8	8	6	4
AGE CLASSES >10	4	6	6	4	2
SHANNON INDEX (mature females)	**0.65**	**0.79**	**0.89**	**0.86**	**0.77**
PRE_MATURATION GROWTH (h)	89	90	50	97	84
FEMALE BRODY COEFFICIENT (K)	**0.155**	**0.158**	**0.136**	**0.126**	**0.171**
FEMALE TL inf (mm)	**733**	**741**	**732**	**756**	**697**
MALE TL inf (mm)	**613**	**635**	**624**	**636**	**602**
FISHING QUALITY INDEX (FQI)	-	-	48	56	54
MEAN TOTAL LENGTH (mm)	**376**	**351**	**308**	**350**	**364**
MEAN ROUND WEIGHT (grams)	705	-	387	540	557
TL @ AGE 2 (mm)	302	293	235	257	274

HEALTHY
STRESSED
UNHEALTHY

Walleye life history characteristics in the South Arm for 2009 were largely consistent with the Regional averages. The population is later maturing indicated by the age and length at maturity of both sexes (Table 4). Pre-maturation growth rate (h) was 50 mm/yr, which is lower than the 1999 and 2004 values of 84 and 97 mm/yr and Regional benchmark values (89-90 mm/yr).

OTHER FISH SPECIES

Northern pike were captured at an average of 1.5 fish/net on the South Arm (n = 38), which represents a continued decrease in CUE from the 1999 and 2004 FWIN (2.6 and 1.7 pike/net). Although direct comparisons are invalid (Mcleod et al., 2004), the average number of pike caught in FWIN gillnets was lower than previous index netting efforts (Figure 18). The long-term mean from index netting (1965-99) was slightly higher at 2.7 pike/net.

Pike captured in the 2009 FWIN ranged in age from 0-11 years, and older year classes (>11 years) were absent in the sample (Figure 19). Age 3 (2006 year class) and age 4 fish (2005 year class) were dominant, and accounted for 18% and 21% respectively of the total catch. However, age 6 fish (2003 year class) and age 7 (2002 year class) were poorly represented and each accounted for only 3% of the total catch. The mean age of catch in the 2009 FWIN was 5.08 years (SE=0.47). The poor representation of older age classes is consistent with the length distribution and the small sample size, with few fish greater than 820 mm in total length (Figure 20). Only one fish was captured from the 'trophy' class (>900 mm TL), with the largest fish having a total length of 987 mm. The mean total length was 659 mm (SE = 31) based on the small sample size of 38 fish.

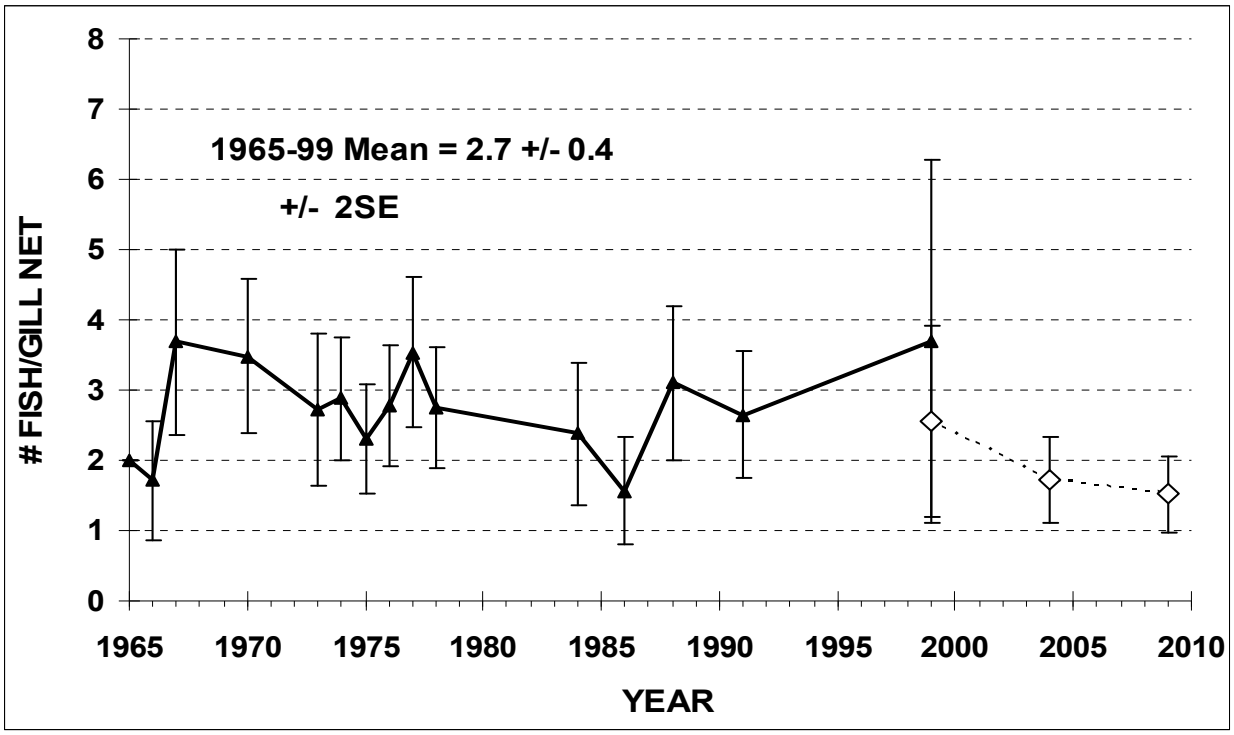

Figure 18: Historical abundance of northern pike based on catch-per-unit-effort from index netting (1965-1999) and Fall Walleye Index Netting (1999, 2004 and 2009).

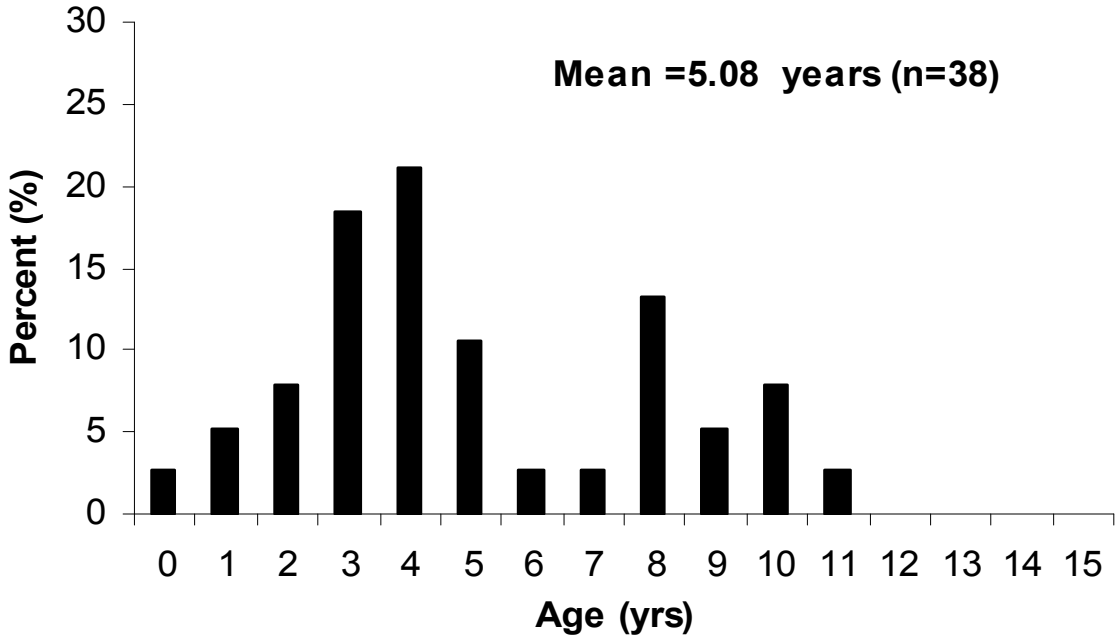

Figure 19: Age composition of northern pike in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

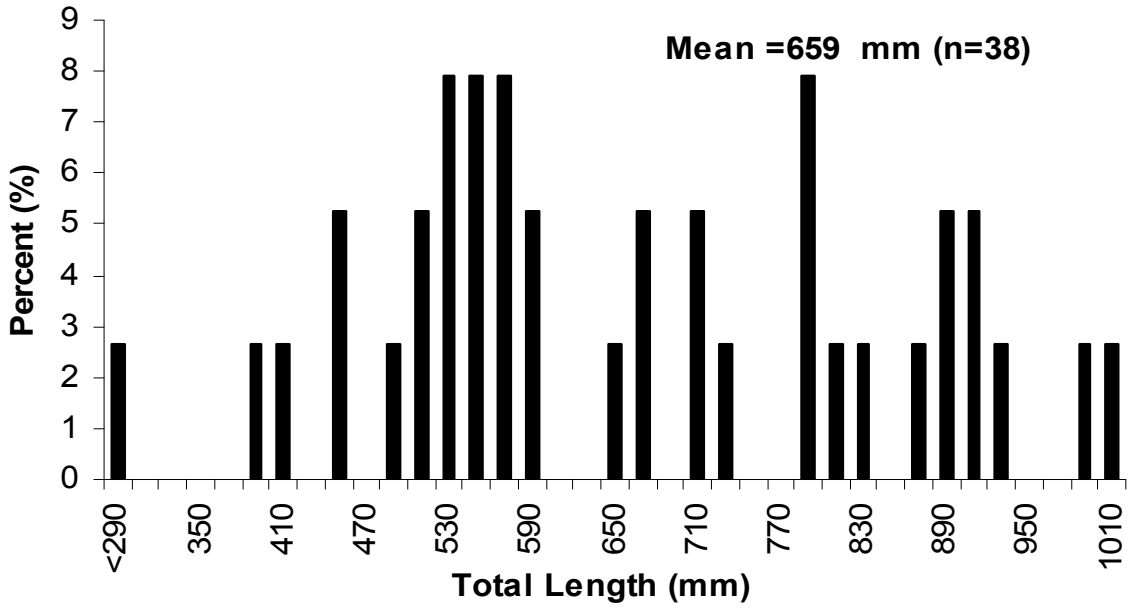

Figure 20: Length composition of northern pike in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

The mean weight of northern pike sampled was relatively high at 2.30 kg (SE = 0.33) compared to only 1.51 kg in 2004. The largest fish caught had around weight of 8.24 kg (18.1 lbs) compared to only 5.88 kg (12.9 lbs) in 2004. The growth rate of northern pike in the South Arm was rapid during the first two years; with age 2 fish exceeding 463 mm in total length. Growth increments in subsequent years were relatively consistent, with an overall decrease in growth rate as age increases (Figure 21).

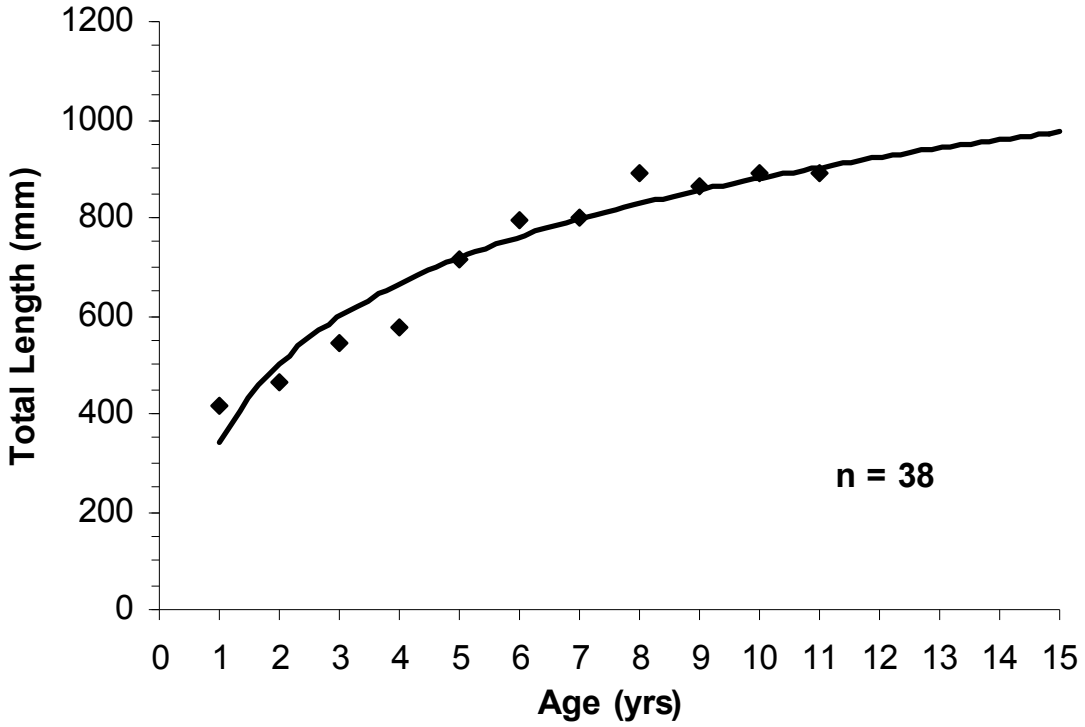

Figure 21: Growth (mean total length at age) of northern pike in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

A smallmouth bass CUE of 0.5 fish/net (SE = 0.2) in the 2009 FWIN was only slightly lower the 0.8 fish/net in the 2004 FWIN and comparable to the 0.6 fish/net observed in the 1999 FWIN. The long-term (1965-1999) average catch per unit effort of smallmouth bass from index nets was 0.8 fish/net, but overall abundance would appear to be to have been gradually increasing since the early 1970s to a peak abundance in 1988 (Figure 22).

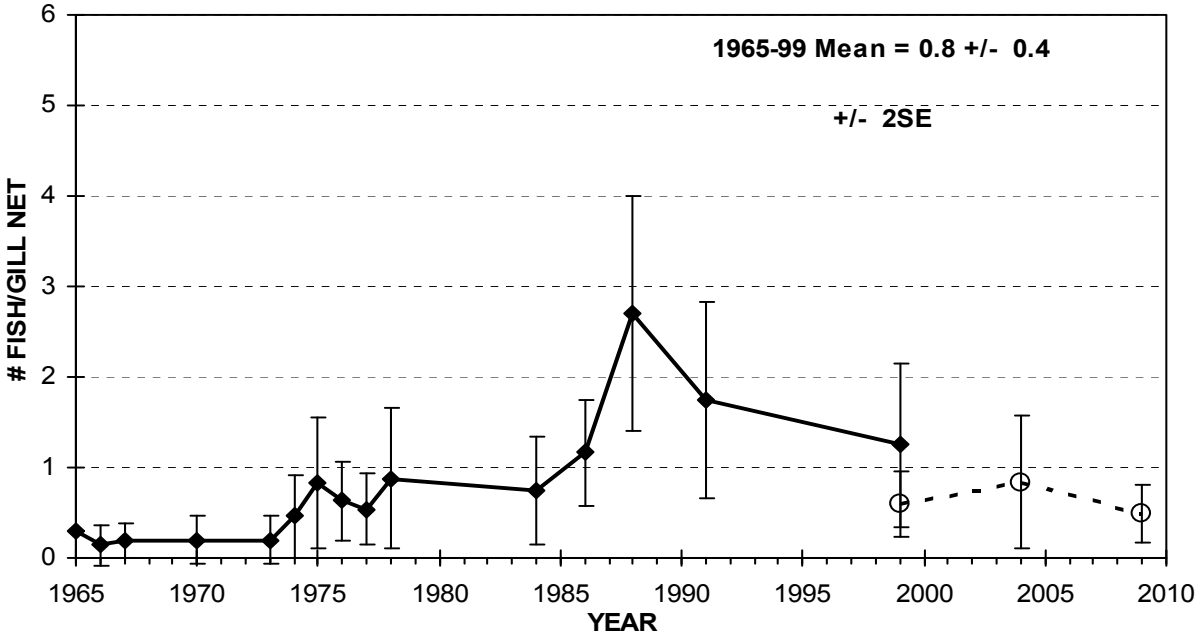

Figure 22: Historical abundance of smallmouth bass based on catch-per-unit-effort from index netting (1965-1999) and Fall Walleye Index Netting (1999, 2004 and 2009).

Smallmouth bass ranged in age from 3-12 years; although sample size was limited to only 12 fish (Figure 23). No smallmouth bass were sampled over 12 years. The mean age of smallmouth bass in the sample was 6.50 years (SE= 0.93). The low sample size precludes any further detailed analysis for this species, however the length composition and growth (total length at age) are presented in Figures 24 and 25 respectively. The length composition of smallmouth bass is reflective of the age distribution and the small sample size. Size distribution was distributed among several length classes, with the largest bass having a total length of 474 mm (Figure 24). Mean total length was 357 mm. A length frequency distribution for all fish species sampled has also been provided in Appendix 2.

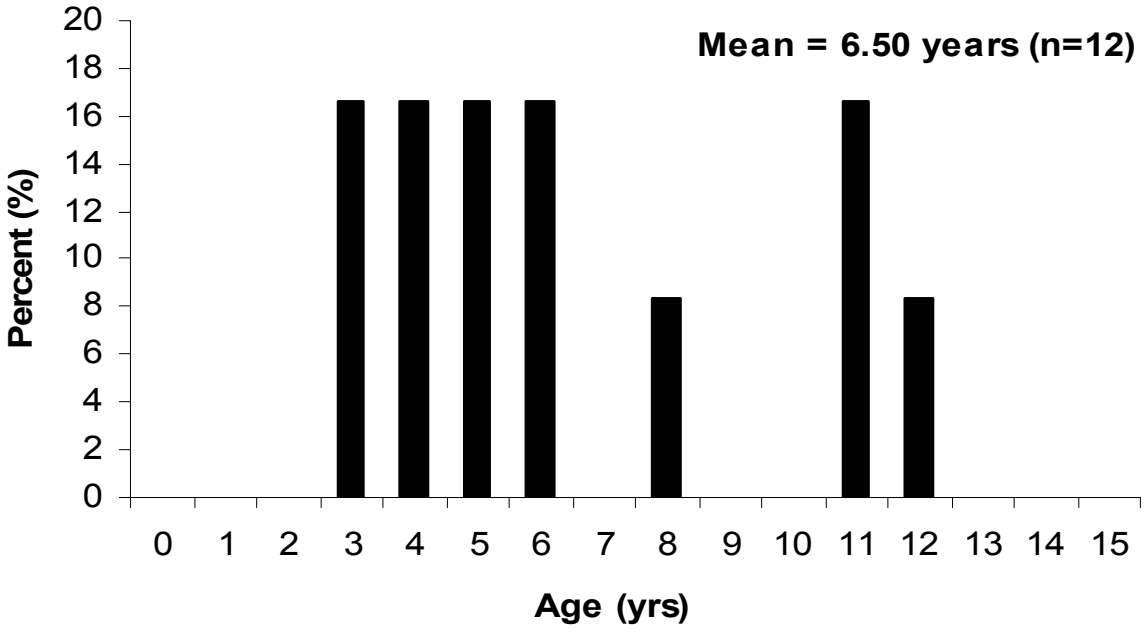

Figure 23: Age composition of smallmouth bass in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

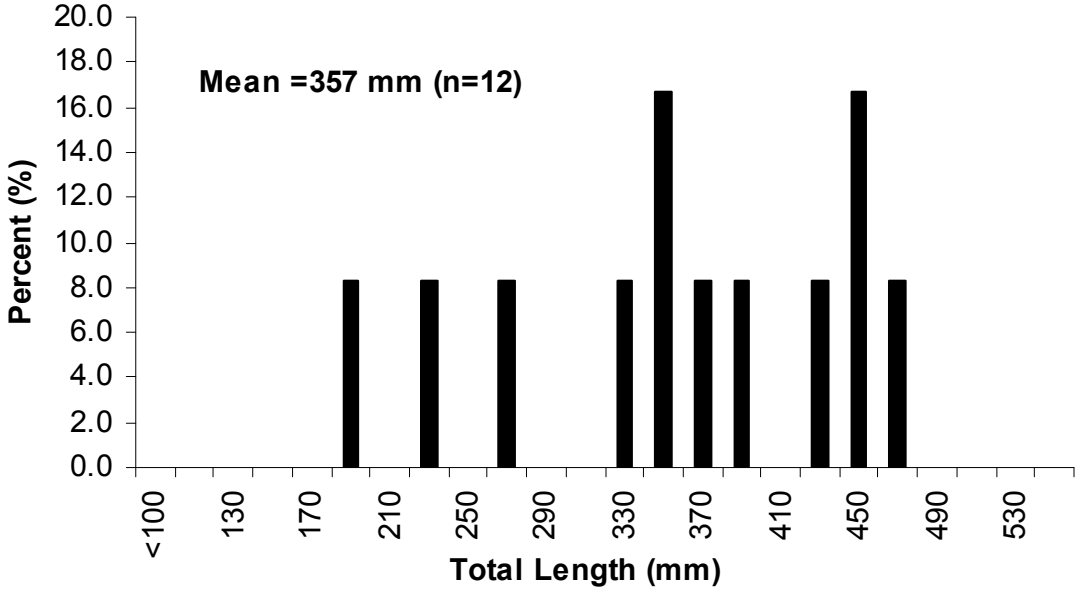

Figure 24: Length composition of smallmouth bass in the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

The growth rate of smallmouth bass in the South Arm shows a trend similar to other fish species. Growth is rapid during the first few years, with a gradual levelling off beyond age 8 (Figure 25), as adult bass presumably begin to invest more heavily in reproduction rather than growth.

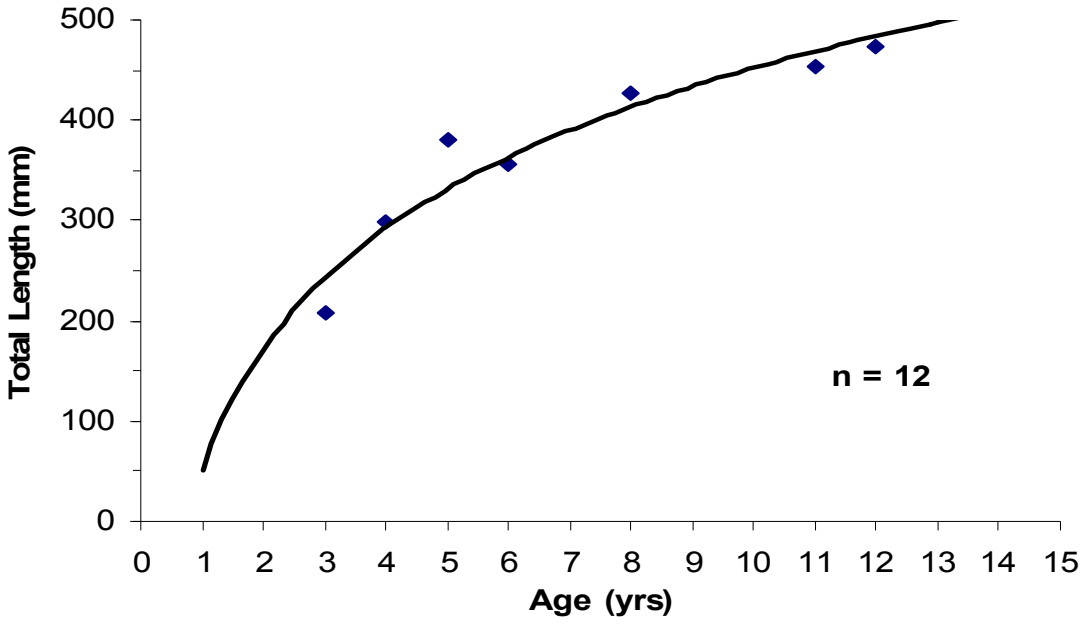

Figure 25: Growth (mean total length at age) of smallmouth bass from the South Arm of Rainy Lake based on Fall Walleye Index Netting (FWIN), 2009.

The South Arm also provides a sport fishery for other fish species including sauger, muskellunge and black crappie. Sauger were well represented in the FWIN catch with a total of 63 fish, or an arithmetic mean CUE of 2.5 fish/net. In combination with walleye, this provides a total CUE of 12.9 fish/net, which is below the Northwest Region large lake average of 20.3 walleye & sauger/net. Sauger were rather small in size with a mean

total length of 200 mm (126-429 mm) and a mean round weight of only 0.07 kg (0.02-0.58 kg).

Although present, no muskellunge were captured in 2009 FWIN nets or any in index netting efforts on the South Arm since 1965. Only two black crappie were captured in gill nets for a mean CUE of 0.1 fish/net. Whitefish are commercially fished in the South Arm and showed limited representation in the FWIN catch with a mean CUE of 0.4 fish/net. From this small sample of 9 fish, mean total length was estimated at 292 mm (103-432 mm) with a mean round weight of 0.39 kg (0.01-1.12 kg). A summary of total length composition for all remaining fish species sampled has been provided in Appendix 2.

DISCUSSION

A diverse fish community was sampled in the South Arm of Rainy Lake, with a number of predator and prey species, although catch by number was dominated by the three percid species (walleye, yellow perch, and sauger). Other species known to compete with walleye such as northern pike, smallmouth bass and black crappie were also present. The abundance of yellow perch was low (1.9 fish/net) but likely provides an important prey resource for adult walleye (Scott and Crossman, 1998). A total of 13 different species were captured in 2009, and did not include any introduced species that were confirmed in previous assessments (e.g. brown bullhead, rainbow smelt and pumpkinseed).

The initiation of the fisheries assessment program on five-year rotation (McLeod, 2002) provides an excellent opportunity to monitor changes in fish population structure and life history parameters over time. Data from the 2009 FWIN project on the South Arm can be compared to previous studies on the other basins using standardized methodology, and most importantly to previous index netting efforts on the South Arm.

In 2009, 25 nets were set at the historical fixed sample sites in the South Arm similar to the 2004 FWIN survey. The percent relative standard error (%RSE) for walleye were comparable between 2004 and 2009, ranging from 14.3% to 14.8% respectively. The desire or target level is typically <20% RSE. The 2009 catch of 259 walleye fell just above the provincial recommendation of 200-250 walleye (Morgan, 2002). The total walleye catch in 2004 was much higher at 399 fish. Although currently not an issue, the increase in sampling mortality may become more important in future FWIN assessments on the South Arm as the abundance and size structure improves.

Rapid early growth and early maturity are often characteristic of exploited fish populations (Lester et al., 2000). These life history parameters are known to act as a compensatory mechanism for exploitation allowing populations to mature earlier and invest more heavily in reproduction as populations decline. Generally, the life history characteristics of the walleye population in the South Arm did not deviate from the Northwest Regional means, and generally show improvements compared to the 1999 FWIN (Table 4). Walleye in the South Arm show similar ultimate body size ($L\infty$) for males and females, but higher age at maturity for both sexes relative to Northwest Region

averages. In addition, the number of age classes and maximum age both increased relative to the 1999 and 2004 FWIN. Shannon Diversity Index values have increased as well, indicating greater diversity of adult females and presumably a more stable spawning population. This data suggests that regulation changes made to improve walleye population structure in both Ontario and Minnesota, and/or environmental variables are providing South Arm walleye populations with the opportunity to recover. However, the absence of data associated with fecundity, gonad weight and relative condition pose limitations on the ability to draw definitive conclusions regarding reproductive investment of walleye populations.

Although the South Arm walleye population structure is improving, there are less positive signs regarding walleye abundance based on the lower catch rates (number of fish per net) relative to 1999 and 2004, and to other Fort Frances District waterbodies. Compared to previous FWIN studies, the arithmetic mean CUE decreased by 35% to 10.4 walleye/net from an historical high of 16.0 walleye/net in 2004. The geometric mean CUE also declined to 7.9 walleye/net which is well below the NW Regional average of 10.7 walleye/net. Similarly, the geometric mean CUE of larger walleye (≥450 mm) declined to 0.7 walleye/net compared to 1.9 in 1999 and a desired level of >2.0. Along with the decrease in the numbers of fish, the catch by weight of walleye also decreased by 53%. The lower abundance observed in 2009 could be related to a number of factors including:

- Higher than expected abundance in 2004 based on the presence of very strong year class in 2001 and several above average year classes in the late 1990's,

- Warmer than desired water temperatures during sampling (19-23.5°C) in 2009. Generally, water temperatures would be cooling closer to 15°C as the lake approaches fall turnover.
- Increases in walleye exploitation in other areas of the basin and affecting a shared walleye population (e.g. lower Seine River, MN waters). Further evaluation of harvest levels will occur upon completion of 2010/11 creel surveys in Ontario and Minnesota waters.

Previous FWIN observations were suggesting the recovery of spawning stocks to some degree, and the strong year classes will continue to provide a foundation for the future walleye production as they reach maturity. In addition to the very strong 2001 year class (which still persists as age 8 fish in 2009), it appears that the 2006 year class (age 3) is above-average and contributing a high proportion of the catch.

Previous FWIN studies had reported poor year classes in 2000 and possibly 2002. Although both were likely naturally occurring, there was some concern as too long-term effects. The 2000 year class continues to show low representation in the 2009 catch. This same year class appeared to be poor on other District lakes including the North Arm and Redgut Bay of Rainy Lake (McLeod and Taillon, 2003; McLeod and Taillon, 2004), Little Turtle Lake (Taillon and Fox, 2003), and Namakan Reservoir (Taillon, 2003), suggesting that large scale environmental factors may be limiting recruitment in some years (e.g. spring warming or water levels). 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). The mechanism for poor year classes is likely dependent on the interaction between the physical, environmental and biological characteristics at a given time. 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 average growth rate of adult walleye in the South 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 continued lower catch of larger and older fish may be contributing to inconsistent recruitment. However, the current age diversity of mature females based on the Shannon Diversity Index of 0.89 appears to be healthy. Our current management objective, to increase the abundance of older, larger fish in order to improve recruitment, appears to be appropriate.

Further comparisons of walleye population structure of South Arm walleye does raise some additional concern. Mean total length and mean CUE of fish ≥450 mm, are well below the mean values for the Northwest Region (Morgan et al., 2003). Other than these parameters, the South Arm walleye population is improving, and showing very few signs of stress. A proposed Walleye Benchmark Classification Key would also suggest the population is healthy/stable with an overall score of 2.75 compared to 2.25 in 1999 (G. Morgan, pers. comm.). By comparison, the North Arm of Rainy Lake had an overall score of 3.0 in 2007 while Redgut Bay was 2.75 in 2008.

Catch rates of large fish ≥450 mm are generally below the Northwest Regional means for walleye populations identified by Morgan et al. (2003), but have decreased significantly since 1999 and 2004. A reduction in the number of adult fish reduces the quality of the spawning population and can contribute to recruitment variability. In addition, fishing quality and the economic value of the fishery is greatly reduced by the absence of large, 'memorable' or 'trophy' class fish. A Fishing Quality Index (FQI) value of 48 in 2009 (compared to 54 in 1999 and 56 in 2004) are still considered low, and reflective of a quantity fishery (OMNR, 1990).

The apparent recovery of walleye stocks that is occurring in all basins of Rainy Lake is still encouraging, especially considering that similar fisheries in the Northwest Region have been slower to recover. The catch in Shoal Lake (Lake of the Woods) has been 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 are still unclear (Seyler, 2001; Gillies, 2002).

Sauger showed increased representation in the fish community of the South Arm, with a catch rate (CUE) of 2.5 fish/net compared to only 1.3 fish/net in 2004. This is still lower than the long-term (1965-1999) index netting mean for South Arm of 4.5 sauger/net, and the 4.3 sauger/net observed in Redgut Bay in 2008. With a mean summer secchi transparency of 2.7 m, the South Arm basin is probably better suited to walleye production. Sauger likely only contributes a small portion of the estimated annual yield of 23,700 kg/year (0.87 kg/ha/yr) for percids. The small average size of sauger (200 mm and 0.07 kg) also provides limited angler harvest opportunities, with only 113 kg harvested lake-wide in 2001 (McLeod, 2003).

Northern pike and bass populations in the South 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 and declining, there was good representation of size and age classes. The age composition of pike suggests total mortality after age 4 could be high, although gear selectivity has not been fully evaluated. The sample size of pike (n=30) was too small to evaluate life history parameters by sex and make any comparisons to a provincial summary of population characteristics (Mallette and Morgan, 2005). Relative abundance, based on a geometric mean CUE of 1.2 fish/net, was below the provincial average of 2.2 fish/net (but above the 25% percentile of 0.9). However,

mean size (659 mm) and weight (2.30 kg) of northern pike in the South Arm exceeded the provincial averages of 581 mm and 1.47 kg respectively.

The lower abundance of large pike relative to other lakes in the District, for example Little Turtle Lake (Taillon and Fox, 2003) and Lac La Croix (McLeod and Taillon, 2005) suggests that the pike fishery is currently producing as a quantity rather than a quality fishery. However, large trophy fishing opportunities are no doubt available, since the combined angler, commercial and subsistence harvest of 8,000 kg/year (1997-2002) has been declining and remains well below the management objective of 15,800 kg/year for Ontario waters (OMNR and MDNR, 2004). Changes to the angling regulations in Northwest Ontario in 1999 may also be helping to improve the protection of large fish, and further evaluation should be part of future monitoring programs.

Although smallmouth bass abundance appeared to increasing in the South Arm from 1965 to 1988, recent index netting and FWIN assessments might suggest that numbers are declining or at least stabilized. Based on a sample of only 12 fish in 2009, there appears to be good representation of age classes, with a high mean age of 6.50 years. The low sample size precluded any further analysis and comparison of population status. Angling for smallmouth bass remains an important component of the sport fishery in the South Arm, while providing a quality angling experience (OMNR and MDNR, 2004). Harvest of bass averaged only 1,600 kg from 1997-2002, and is well below the management objective of 3,000 kg/yr and potential yield of 6,000 kg/yr. A complete

review of life history parameters for smallmouth bass would likely require combining data from all three lakes basins to improve sample size and statistical precision.

CONCLUSIONS

- Overall abundance of walleye is 'low average' with an arithmetic mean CUE of 10.4 fish/net and represents a decrease since 1999. There still has also been a significant increase in abundance from the long term (1965-99) index netting mean of 7.1 walleye/net. A geometric mean CUE of 7.9 fish/net, falls below the NW Region average of 10.7 fish/net. The catch was still largely dominated by small and younger fish, with age three fish showing good representation from an above average 2006 year class. Catch rates of large adult fish (≥450 mm TL) also decreased relative to the 1999 and 2004 FWIN, and are still below the Northwest Region averages and indicate a 'stressed' or unstable fishery.
- Most life history parameters, including number of age classes (16), maximum age (18), Shannon Diversity Index (0.89), and age at 50% maturity (7.33 years ♀) continue to show improvement relative to the 1999 and 2004 FWIN on the South Arm. A proposed Walleye Benchmark Classification Key for Ontario suggests the walleye population is "healthy" and improving, with a score of 2.75 out of 3.
- The walleye population in the South Arm exhibits below average juvenile growth rates, but fish mature at ages that are slightly higher than the North Arm population in Rainy Lake and the Northwest Region.
- Although total mortality rates remain relatively low at 27%, existing levels of exploitation appear to be impacting abundance and the size composition of the

- The 2000 year class (age 9) still appears to be quite weak and the 2001 year class (age 8) appears to be exceptionally strong. This is consistent with previous assessments on the Rainy Lake from 2002-2004 and again from 2007-2009. The 2006 year class (age 3) appears to strong and well represented in the 2009 FWIN catch. Recruitment is still highly variable on Rainy Lake, but may be naturally occurring, or due to continued exploitation. Identification of the mechanisms for this recruitment variability should be the focus of future investigations.
- Existing levels of exploitation and target harvests should be maintained for all users, at least an assessment of the sport fishery is completed in 2010-11. A continuation of the restrictive size limits, fish sanctuaries, non-resident angling restrictions, no commercial quotas, as well as the new water level management regime introduced in 2000 (IRLBC, 1999) should all contribute to the continued improvement and recovery of walleye populations in the South Arm.
- 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

We would like to acknowledge MNR staff of the Fort Frances Area who contributed to the Fall Walleye Index Netting effort, namely Alyson Bisson, Linda Chepil, Tony Elders, Dan Fox, Jessica Hall, Melissa Mosley, Wayne Nixon, and Mary-Beth Tkachuk. Quite some time ago, George Morgan (Cooperative Freshwater Ecology Unit, Sudbury) provided insight and advice into the interpretation of FWIN data and provincial comparisons. In addition, Kim Armstrong (Northwest Science and Information, Thunder Bay) provided the Northwest Region large lake walleye diagnostics which aided in the interpretation of results, and produced the Fishnet Lite outputs for walleye. Finally, we would like to acknowledge Susan Mann and the Northwest Regional Aging Facility for aging all samples that were collected.

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Appendix I: Fish Species Present in Rainy Lake, Ontario

Common Name	Scientific Name	MNR Species Code
Silver Lamprey	*Ichthyomyzon unicuspis*	013
Lake Sturgeon	*Acipenser 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 masquinongy*	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	*Phoximus 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	*Ambloplites 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 dolomieu*	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 the South Arm of Rainy Lake, 2009.

Total Length (mm)	Walleye	N. Pike	SM Bass	Spottail Shiner	Yellow Perch	Lake Herring	Whitefish
0 – 99				1	3		
100-119				5	11	11	1
120-139	8				3		
140-159	1				11	2	
160-179	2				8	1	
180-199	24	1	1		5		
200-219	25				2	4	
220-239	18		1		2	2	1
240-259	37				1		3
260-279	16		1		2	9	
280-299	18					7	
300-319	15					4	
320-339	17		1			2	1
340-359	12		2			1	
360-379	9		1			3	
380-399	8	1	1				2
400-419	7	1				2	
420-439	3		1				1
440-459	3	2	2				
460-479	9		1				
480-499	4	1					
500-519	10	2				1	
520-539	2	3					
540-559	2	3					
560-579	5	3					
580-599		2					
600-619							
620-639							
640-659	2	1					
660-679	1	2					
680-699							
700-719	1	2					
720-739		1					
740-759							
760-779							
780-799		3					
800+		10					
Total	**259**	**38**	**12**	**6**	**48**	**49**	**9**
Mean	**308**	**659**	**357**	**107**	**155**	**247**	**292**
Min	**123**	**198**	**191**	**99**	**97**	**105**	**103**
Max	**703**	**1008**	**474**	**115**	**268**	**517**	**432**

Appendix II: (cont'd)

Total Length (mm)	White Sucker	Silver Redhorse	Shorthead Redhorse	Sauger	Rock Bass	Black Crappie
0 – 99					1	
100-119	1				2	
120-139				8	8	
140-159				11	10	
160-179				3	18	
180-199				8	11	
200-219				16	2	
220-239	1			4	1	
240-259	1			5		
260-279				4		
280-299	1			2		1
300-319				1		1
320-339						
340-359						
360-379	1					
380-399						
400-419						
420-439	1			1		
440-459	1					
460-479	1		2			
480-499	1					
500-519						
520-539	1		1			
540-559		1				
560-579	1					
580-599	1					
600-619						
620-639	1	1	2			
640-659						
660-679						
680-699						
700-719						
720-739						
740-759						
760-779						
780-799						
800+						
Total	**13**	**2**	**5**	**63**	**53**	**2**
Mean	**415**	**587**	**547**	**200**	**162**	**300**
Min	**112**	**552**	**462**	**126**	**94**	**291**
Max	**629**	**621**	**638**	**429**	**231**	**309**