Fall Walleye Index Netting on Namakan Lake, Ontario 2005

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SUMMARY

Fall Walleye Index Netting (FWIN) was conducted in 2005 on Namakan Lake, located approximately 70 km southeast of Fort Frances, Ontario. The lake is situated on the international border between NW Ontario and Minnesota. 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 Namakan Lake appeared to be recovering, with most life history parameters (CUE, age composition, and age at 50% maturity) showing improvement relative to the 2000 FWIN project. A similar FWIN project was also completed in 2004 by Voyageur's National Park and USGS. A total of 12 age classes (12 with n>1) were captured, with a maximum age of 16 years and a mean age of 3.7 years. The geometric mean CUE of walleye ≥450 mm was 1.1 walleye/net, and the Shannon Diversity Index for adult females was 0.86. Comparisons of walleye population structure (e.g. number of age classes, Shannon Diversity Index) to regional benchmarks indicate a "healthy" fishery, however some parameters (geometric mean CUE ≥450 mm , mean age and Fishing Quality Index) still indicate a "stressed" or recovering fishery. Current management strategies appear to be having the desired affect of improving abundance and structure as reflected by an increase in the geometric mean catch per unit effort from 5.4 walleye/net in 2000 to 7.9 walleye/net in 2004 and 7.8 walleye/net in 2005 (arithmetic mean increased from 7.6 to 11.3 walleye/net). Walleye abundance remains below the NW Region geometric mean of 10.7 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

Namakan Lake is located approximately 70 km southeast of Fort Frances, Ontario, and forms part of the Namakan Reservoir which also includes Sand Point, Kabetogama, Crane, and Little Vermillion Lakes (Figure 1). Water levels in the reservoir are regulated by the International Joint Commission (IJC) through the International Rainy Lake Board of Control (IRLBC). Two water control dams at Kettle and Squirrel Falls regulate water levels based on a "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, involved a decrease in the over-winter draw down by approximately 1 m (3 ft) along with earlier spring refill and a gradual summer draw down. The new rule curve was intended to improve fish stocks that spawn in both spring (e.g. walleye, *Sander vitreus;* northern pike, *Esox lucius)* and fall (e.g. lake whitefish, *Coregonus clupeaformis*). Changes to water regulation will involve a monitoring strategy to evaluate long term impacts, in which the Fall Walleye Index Netting (FWIN) program was included (IRLBC, 1999; USGS, 2000).

Namakan Lake is located on the International border, with 51% (5,150 ha) of the 10,100 ha surface area in Ontario (MDNR and OMNR, 1998). 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 lake are summarized in Table 1. A diverse coolwater fish community is present in the reservoir, including 43 known species (Appendix 1). The Ontario waters have been previously

Table 1: Physical and chemical characteristics of Namakan Lake, Ontario.

Parameter	Namakan Lake
Surface Area (ha)	5,150
Littoral Zone (%)	20
Mean Depth (m)	13.6
Maximum Depth (m)	45.7
Mean Summer Secchi Depth (m)	2.6
Greatest Length (km)	31
Perimeter Shoreline (km)	235
Island Shoreline (km)	75
T.D.S. (mg/L)	44
M.E.I.	2.8
Alkalinity (mg/l)	14

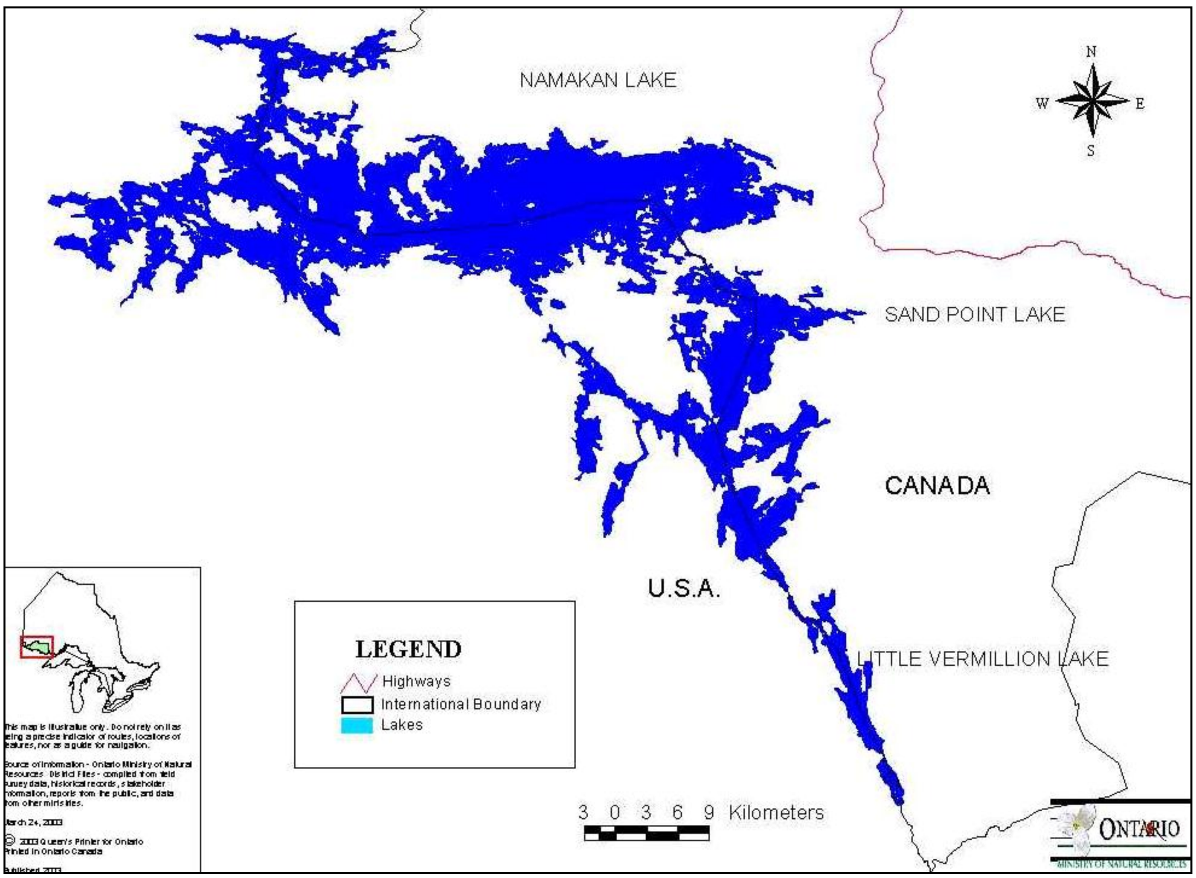

Figure 1: Location of the Namakan Reservoir; including Namakan, Sand Point, and Little Vermilion Lakes in Ontario.

assessed in 1994, however provincial FWIN standards were not utilized (Van den Broeck, 1995).

Development on the Ontario shoreline of Namakan Lake consists of one tourist establishment, a single recreational cottage site and a number of cottages on 37 patent properties. A Canada Customs/Immigration point of entry, a tourist lodge, a store, a boy scout camp and approximately 38 cottages are also located on the adjoining waters of Sand Point Lake, Ontario. Voyageurs National Park borders the Reservoir on the Minnesota side, where development is limited to 20 cabins and 35 campsites. There is an old logging camp on Namakan Lake and three privately developed tracts, in addition to 21 use and occupancy tracts and 7 campsites on Sand Point Lake (MDNR and OMNR, 1998).

Commercial fishing on Namakan Lake began in 1916-17, however the commercial walleye and northern pike fishery was eliminated in Minnesota waters in 1946. Currently, a single lake whitefish operator exists on the Minnesota side. Quotas existed in Ontario for lake whitefish, lake sturgeon (*Acipenser fulvescens)*, black crappie, walleye and northern pike from 1984 until the commercial fishery was eliminated in 2001.

Creel surveys indicated that the vast majority (99%) of fishing pressure was from non-resident anglers (Elder, 2001; Jackson, 1994). Nearly two-thirds (65%) of anglers on Namakan Lake were based out of Minnesota in 1998, with the remainder camping on Crown Land in Ontario (3%), guests at Ontario resorts (21%), or owners of cottages in Ontario (11%). Creel surveys on Minnesota waters conducted in 1999 were designed to monitor a regulation change which limited walleye harvest to fish between 286 mm and 374 mm (13-17"), with only one fish exceeding 506 mm (23"). Overall, angler effort throughout most of the reservoir remained consistent from 1985 to 1999 (Burri, 2000).

The majority of angler effort on Namakan Lake is directed at walleye (85 %), with lesser effort directed at smallmouth bass (*Micropterus dolomieu*) (38 %) and northern pike (27 %). Overall, angling pressure on Ontario waters was 3.6 hours/ha (18,780 rod-hours) in 1998 (Elder, 2001). The lack of resident anglers has been attributed to the low quality of the walleye fishery relative to a number of more accessible lakes in the Fort Frances District. Angler catch rates were also low, averaging only 0.49 fish caught/angler-hour with very few fish captured over 46 cm. Release rates were estimated at 47% in 1998.

Historically, walleye populations on Namakan Lake have fallen below desired levels, and have shown signs of over-exploitation stress since the early 1990s (MDNR and OMNR, 1998). Walleye abundance and fishing quality indicators appeared to be low, while angler exploitation was reported to be high. The 2000 FWIN catch provided a geometric mean CUE of 5.4 walleye/net, suggesting that walleye abundance was below-average and dominated primarily by small fish (Taillon, 2003).

Attempts to rehabilitate the Namakan Lake fishery have included commercial fish buy-outs and angling regulation changes in both Ontario and Minnesota. In order to allow the walleye population to fully recover, the recommended target harvest level for Ontario waters was reduced to 3,500 kg/yr, or 85% of the annual potential yield in 2004 (OMNR and MDNR, 2004). Previous target levels for Ontario were as high as 5,800 kg/yr (MDNR and OMNR, 1998). The potential yield of walleye is estimated at 4,100 kg/yr, while annual harvests averaged only 2,900 kg/yr from 1997-2002, compared to previous levels of 5,200 kg/yr from 1990-1996. The highest angler harvest was reported at 2,600 kg in 1993, with the remainder taken by the commercial fishery.

In 1994, non-resident anglers were restricted to catch and release angling only for all species, unless staying overnight at an Ontario tourist establishment, houseboat, recreational fishing site, parcel of land or provincial park as described in the regulations. Pending a NAFTA trade challenge by the U.S., more general regulations were put in place across the border waters area in 2000 to limit harvest by all non-resident anglers. The daily catch limit for non-resident anglers of two walleye or sauger *(S. canadensis)* per day, with a possession limit of four (two for conservation licenses) was introduced. Walleye harvest had also been regulated since 1989 by a maximum size limit, whereby only one walleye greater than 50 cm (19.5”). This maximum size limit was changed in 1999 to one greater than 46 cm (18.1”), in conjunction with a number of fisheries regulation changes for the Northwest Region.

Exploited walleye populations often exhibit characteristics associated with the 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 are viewed as compensatory mechanisms, and often include: increased juvenile (pre-maturation) growth rates, earlier age at maturity and high investment in reproduction (Lester et al., 2000).

In order to obtain more detailed biological information and to evaluate management strategies for Namakan Lake, a Fall Walleye Index Netting study was conducted in 2000 and again in 2005, consistent with the proposed fisheries assessment strategy (McLeod, 2002). The FWIN program will also provide data for the evaluation and monitoring of water level changes initiated by the IRLBC (IRLBC, 1999; USGS, 2000) and contributes to long-term monitoring efforts of the Ontario-Minnesota Fisheries Committee (MDNR and OMNR, 1998). Consistent with this monitoring effort, one additional FWIN survey was completed in Ontario waters in 2004 by Voyageur's National Park and USGS staff.

METHODS

Standard FWIN gillnetting was conducted on Namakan Lake between September 8 and September 15, 2005 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-four net sites were selected using random locations, with minor adjustments to selected sites to meet the depth stratification requirements in the FWIN manual (Morgan, 2002). Sampling intensity in each strata (shallow = 2-5 m, deep = 5-15 m) was determined by the relative amount of shallow versus deep areas of the lake. As a result, 42 % (10/24) of nets were in the shallow strata, and 58 % (14/24) were in the deep strata. Surface water temperatures were much warmer than desired during the sampling period, and ranged from 18.9 to 20.9°C. Thermal stratification was present on September 11th and likely persisted throughout the survey. Thermocline depth was estimated at 17-19 m. However, timing of the project coincided with previous index netting efforts on the Namakan Reservoir and on the South Arm of Rainy Lake by the MDNR, VNP and OMNR.

All walleye, northern pike, smallmouth bass and lake sturgeon were measured for fork and total length and weighed. These species were also biologically sampled for sex and maturity by comparing gonad development (Duffy et al., 1999) (excluding sturgeon), and aging structures were taken (otiliths for walleye >30 cm; scales for walleye <30 cm; cleithra for pike; 4th dorsal spine for smallmouth bass; and large pectoral fin ray for sturgeon). All lake sturgeon were live released and not sampled for sex and maturity. All aging structures were assessed by the OMNR Northwest Regional Aging Facility in Dryden, Ontario. All other fish species were measured for 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 Namakan Lake 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 14 species were captured in 24 gill net sets on Namakan Lake. Walleye were the most abundant species, representing 45.3 % of the catch by number with an arithmetic mean of 11.3 fish/net. They were the only species to be caught in all 24 net sets. Rock bass (*Ambloplites rupestris*) averaged 4.0 fish/net and represented 15.8 % of the total number of fish caught. Yellow perch (*Perca flavescens*) were the third most abundant species at 3.2 fish/net and 12.7 % of the total catch, while sauger followed at 2.1 fish/net and 8.5% of the catch. The total percid composition (walleye, sauger & yellow perch) was 66.5 % of the catch by number. Meanwhile, northern pike comprised 1.3 fish/net and 5.2 % of the catch. Other than white sucker, no other single fish species comprised greater than 5 % of the total catch, as indicated in a summary of catch data by species (Table 2). A total of 3 lake sturgeon were captured for a arithmetic mean CUE of 0.l1 fish/net, which was lower than the 8 sturgeon (0.3 fish/net) captured in 2000. The FWIN efforts on Namakan Lake produced a fish community with a Simpson's Diversity Index value of 3.81. Table 3 provides a summary of the catch data from 2004 for comparison purposes.

Table 2: Summary of catch data from Fall Walleye Index Netting (FWIN) in Namakan Lake (24 net sets), 2005.

Species	# Nets Captured In	Total # Caught	Mean (#/net)	Standard Error (SE)	% RSE	% of Total Catch
Lake Sturgeon	3	3	0.13	0.07	55.2	0.5
Lake Whitefish	3	5	0.21	0.12	57.6	0.8
Lake Herring	2	2	0.08	0.06	69.2	0.3
Northern Pike	16	31	1.29	0.23	17.7	5.2
Mooneye	2	2	0.08	0.06	69.2	0.3
White Sucker	17	30	1.25	0.28	22.7	5.0
Silver Redhorse	5	6	0.25	0.11	43.4	1.0
Shorthead Redhorse	2	3	0.13	0.09	73.2	0.5
Rock Bass	18	95	3.96	1.02	25.9	15.8
Smallmouth Bass	13	22	0.92	0.21	22.7	3.7
Black Crappie	3	3	0.13	0.07	55.2	0.5
Yellow Perch	11	76	3.17	1.46	46.2	12.7
Sauger	14	51	2.13	0.54	25.5	8.5
Walleye	24	272	11.33	2.31	20.4	45.3
TOTAL	**24**	**601**	**25.04**	**-**	**-**	**100.0**

Table 3: Summary of catch data from Fall Walleye Index Netting (FWIN) in Namakan Lake (24 net sets), 2004.

Species	# Nets Captured In	Total # Caught	Mean (#/net)	Standard Error (SE)	% RSE	% of Total Catch
Lake Sturgeon	1	1	0.04	0.04	100.0	0.1
Lake Whitefish	8	19	0.79	0.31	38.8	1.4
Lake Herring	13	45	1.88	0.61	32.3	1.2
Northern Pike	17	39	1.63	0.43	26.4	2.8
Mooneye	1	2	0.08	0.08	100.0	0.1
White Sucker	16	44	1.83	0.39	21.4	3.2
Silver Redhorse	4	9	0.38	0.22	59.7	0.7
Shorthead Redhorse	1	1	0.04	0.04	100.0	0.1
Brown Bullhead	2	2	0.08	0.06	69.2	0.1
Rock Bass	9	34	1.42	0.63	44.1	2.4
Smallmouth Bass	15	28	1.17	0.25	21.1	2.0
Black Crappie	3	3	0.13	0.07	55.2	0.2
Yellow Perch	16	827	34.46	15.91	46.2	59.4
Sauger	18	52	2.17	0.44	20.2	3.7
Walleye	22	287	11.96	2.23	18.6	20.6
TOTAL	**24**	**1393**	**58.04**	**-**	**-**	**100.0**

WALLEYE

The FWIN catch per unit effort (CUE) of walleye increased from an arithmetic mean of 7.6 walleye/net in 2000, to 12.0 walleye/net in 2004 and 11.3 walleye/net in 2005. The target precision for the mean CUE was a relative standard error (RSE) of 20 % or less. The desired %RSE was obtained in 2005 at 20.4 %, as well as in 2004 (18.6 %) and in 2000 (18.1 %). The geometric mean CUE also increased from 5.4 walleye/net in 2000, to 7.9 in 2004 and 7.8 in 2005 (Figure 2). The geometric mean CUE (walleye ≥450 mm) was estimated at 1.1 in 2005 compared to 1.4 in 2004 and only 0.3 in 2000 (Figure 3).

The increases in FWIN catch by number coincided with the catch by weight, which increased from 2.69 kg/net in 2000 to 4.25 kg/net in 2005. The mean weight of walleye sampled in 2005 was 375 g, which was only slightly higher than the 354 g observed in 2000 and lower than the 508 g observed in 2004.

Age two (2003 year class) walleye comprised the majority of the catch at 28 %, while age four (2001 year class) walleye contributed 21 % of the total catch in 2005. As a result, the mean age of catch was only 3.73 years, with a total of 12 age classes (12 age classes n>1) present to a maximum age of 16 years (Figure 4). The 2002 (age 3) and 2000 (age 5) year classes were especially weak and poorly represented in the catch at only 6 % and 4 % respectively. Similarly, the absence of age 12 and age 13 walleye also reflects the very poor 1993 and 1992 year classes previously observed across a broad area of the Northwest Region. No young-of-year (age 0) walleye were collected suggesting that

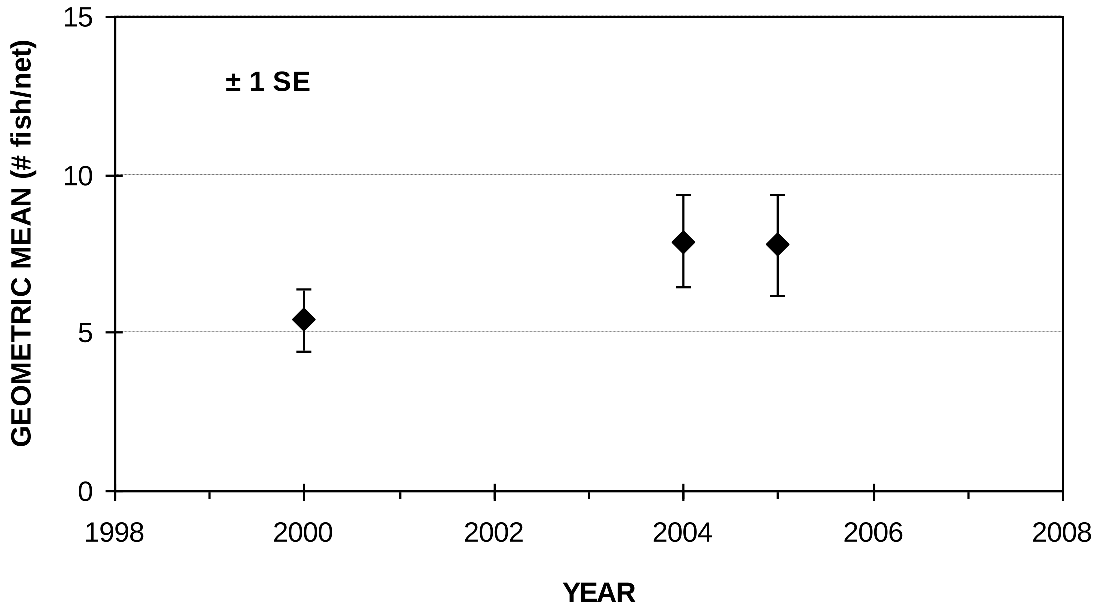

Figure 2: **Geometric mean catch of walleye in Namakan Lake based on 2000, 2004 and 2005 Fall Walleye Index Netting (FWIN).**

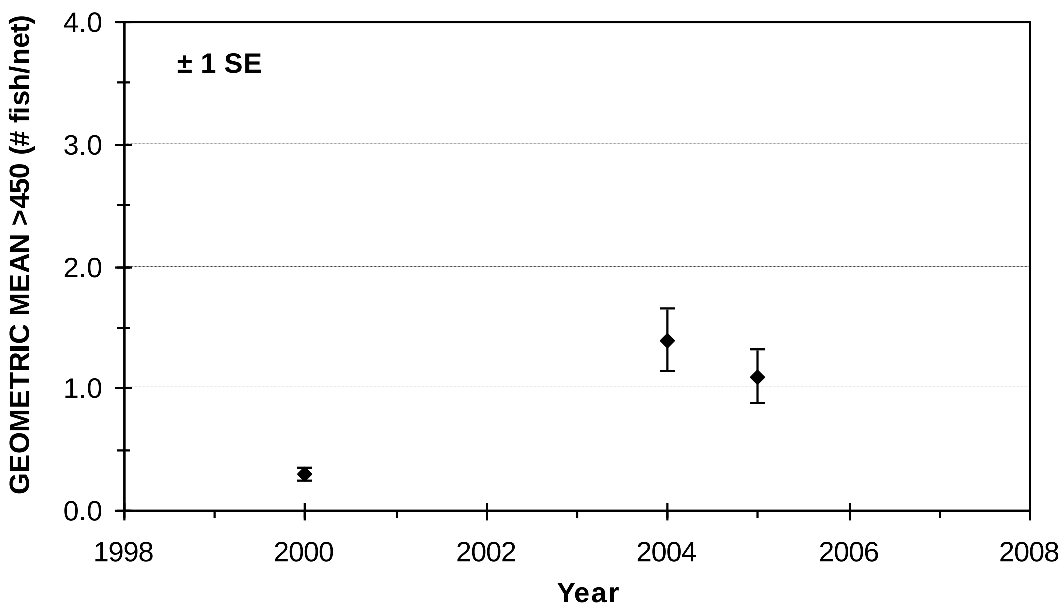

Figure 3: **Geometric mean catch of walleye >450 mm in Namakan Lake based on the 2000, 2004 and 2005 Fall Walleye Index Netting (FWIN).**

there may have been poor recruitment of the 2005 year class. Total annual mortality (sexes combined) was estimated at 29 %, and was 29 % for males (5+ years) and 28 % for females (5+ years).

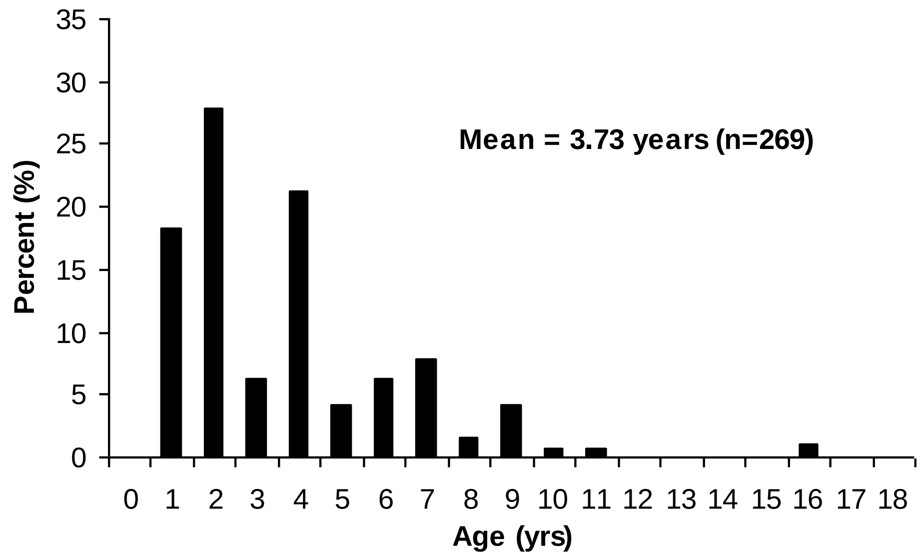

Figure 4: Age composition of walleye in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

The age composition of the catch was also compared to the 2000 FWIN (Figure 5). The mean age of 3.73 years for the 2005 FWIN catch was similar to 2000 mean of 3.44 years, but slightly lower than the 4.48 years observed in 2004. Although the age compositions were similar, there were obvious differences based on year class strengths (e.g. 2001 and 2003), and relatively few older fish sampled (>10 years).

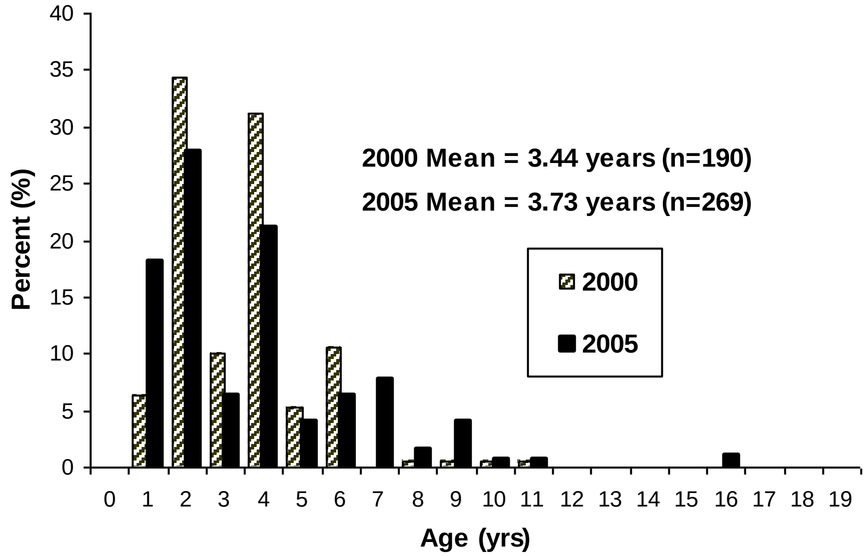

Figure 5: Age composition of walleye in Namakan Lake based on the 2000 and 2005 Fall Walleye Index Netting (FWIN).

Overall mean total length of walleye (sexes combined) was 350 mm, with good representation of fish from 180 to 540 mm. No walleye greater than 700 mm were sampled and there was an obvious reduction in the abundance of fish greater than 540 mm. The length distribution of walleye captured in the Namakan Lake in 2005 is illustrated in Figure 6.

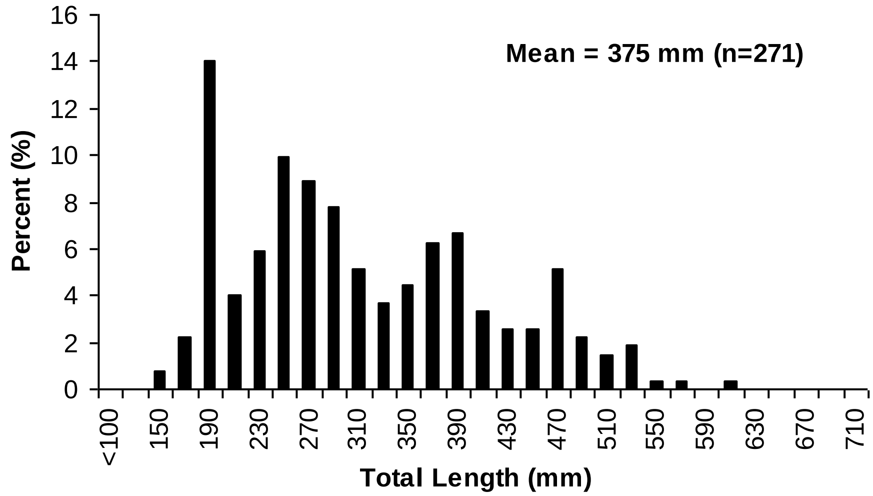

Figure 6: Walleye length composition in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

Namakan Lake 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 7) and weight (Figure 8). Differences were more obvious when considering body weight, as expected given the differences in gonad weight between the two sexes. Figure 9 provides a comparison of growth rates observed for walleye from 2000, 2004 and 2005 sampling. Although sampling of older age classes (>10 years) is limited, the comparison suggests a very modest reduction in growth rates since 2000, especially for fish older than 4 years of age.

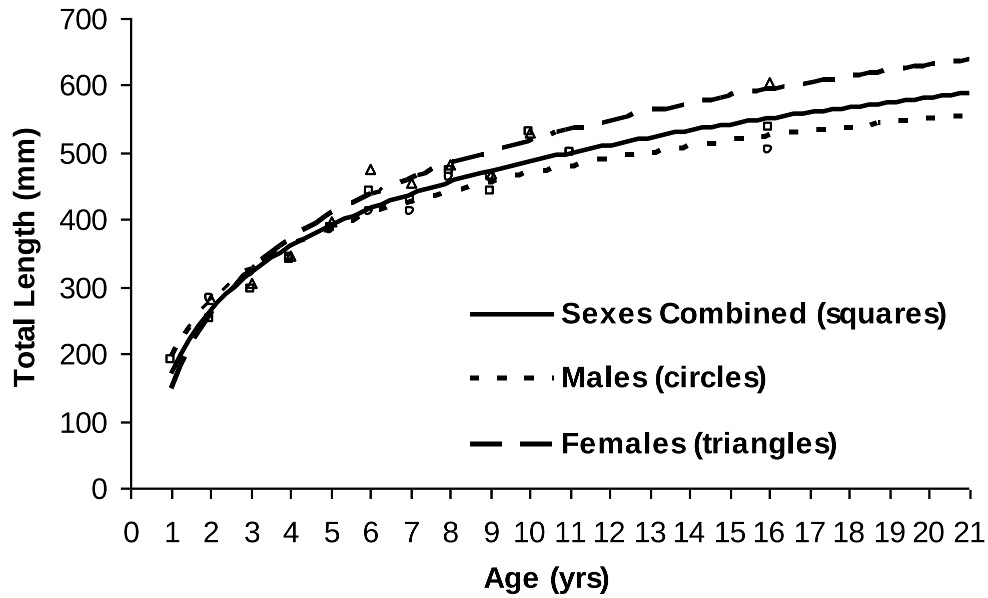

Figure 7: Walleye growth (total length at age) for males, females, and combined sexes in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

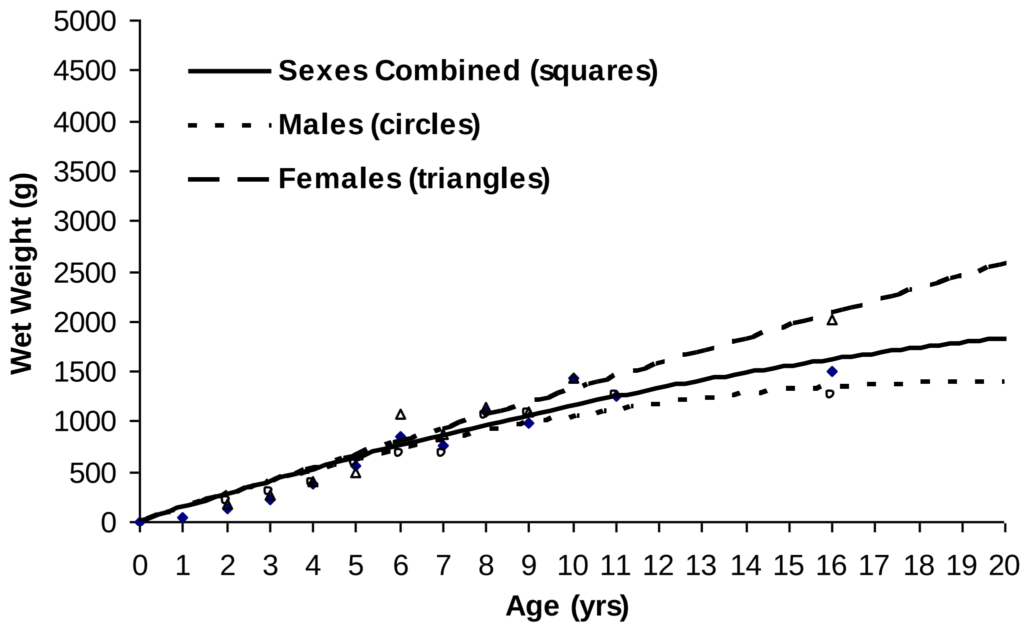

Figure 8: Walleye growth (weight at age) for males, females, and combined sexes in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

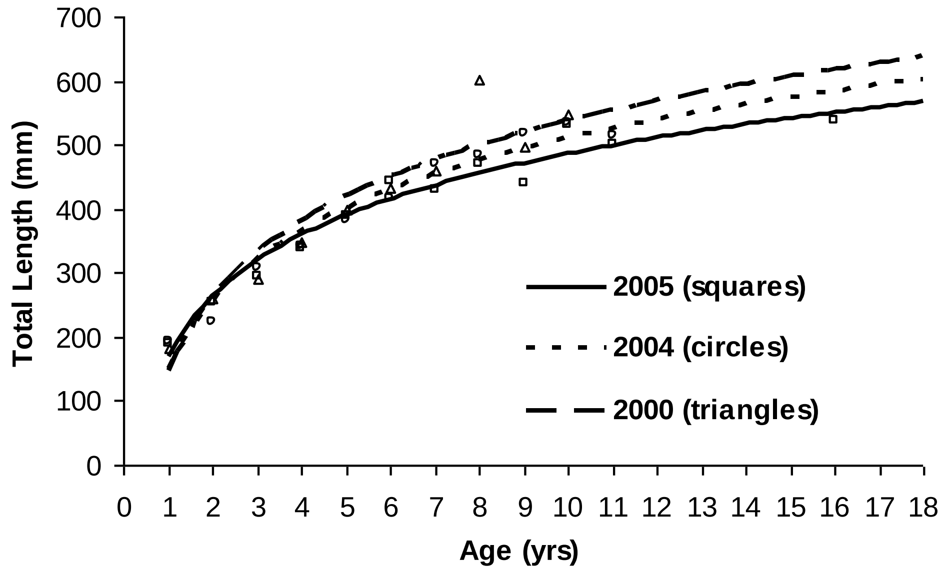

Figure 9: Mean length at age of walleye captured in Fall Walleye Index Netting (FWIN) for Namakan Lake in 2000, 2004 and 2005.

The sex ratio of walleye (Figure 10) captured in FWIN sampling varied with age. Males comprised the majority of most age classes, however sample size declined to very low levels beyond age 9 (n=7). Normally, males are more abundant than females in the younger age classes, with females gradually making up a greater portion of the population as age increases. Shannon Diversity Index for adult females (age ≥5 years) in Namakan Lake was high (0.86), and above the level indicative of healthy walleye populations in Ontario (≥0.66).

Maturity schedules for walleye in Namakan Lake were clearly different between the sexes, with females maturing at a slightly larger size and age than males. These differences between the sexes were more apparent when comparing total length at maturity (Figure 11) than age at maturity (Figure 12). The calculated mean total length at

50 % maturity was 370 mm for males and 409 mm for females. The mean age at 50 % maturity was 4.78 years for males compared to 5.29 years for females.

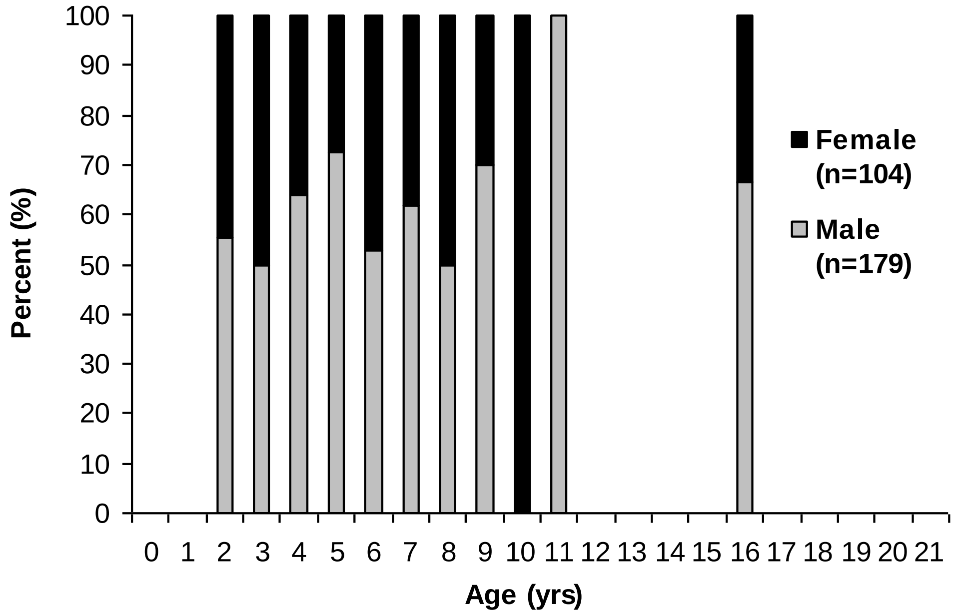

Figure 10: Sex ratio of walleye in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

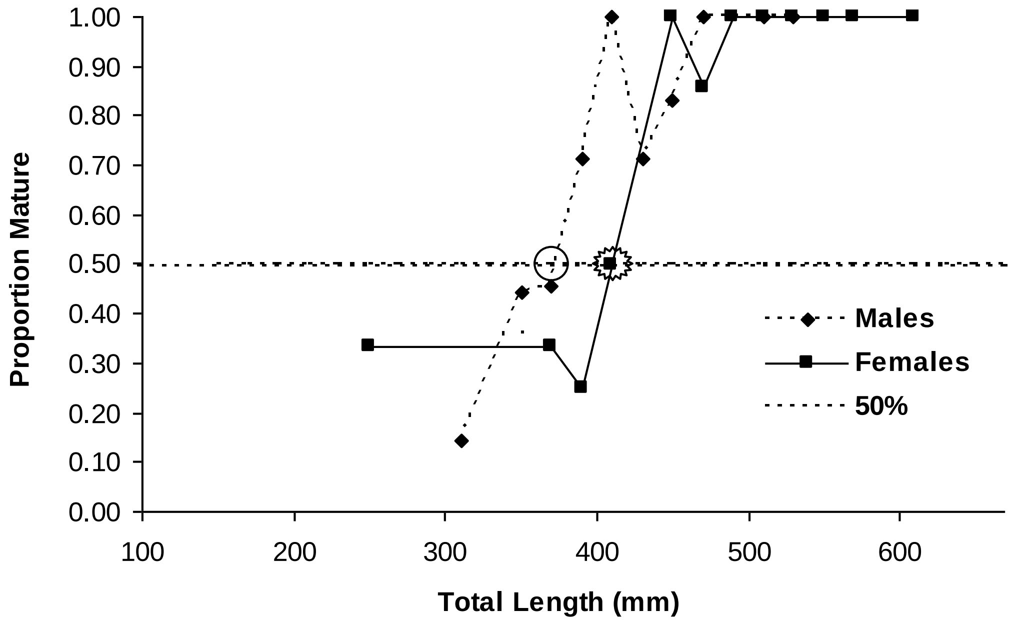

Figure 11: Maturity schedule (total length at maturity) of walleye in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005. Calculated length at 50% maturity is indicated by (O) for males and (☼) for females.

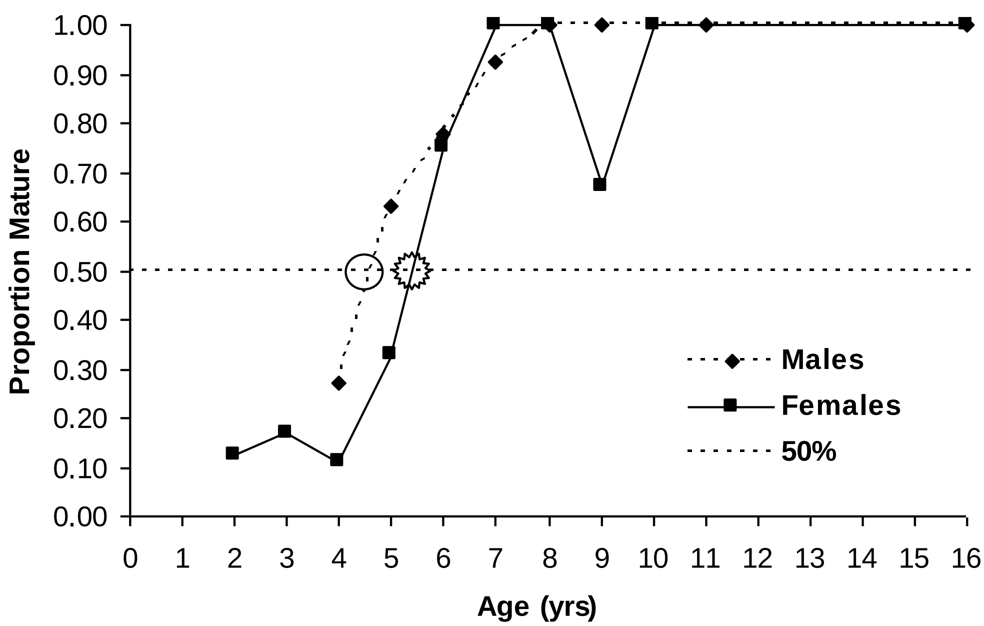

Figure 12: Maturity schedule (age at maturity) for walleye in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005. Calculated age at 50% maturity is indicated by (O) for males and (☼) for females.

Fishing Quality Index (FQI) values based on Relative Stock Density (RSD) (Gabelhouse, 1984) were quite low with a value of 45 for Namakan walleye in 2005, compared to 57 in 2004 and 35 in 2000. The RSD values for 'quality' walleye (380-510 mm) and 'preferred' walleye (510-630 mm) increased slightly from 2000 to 2005. No memorable (630-760 mm) or 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 2000, 2004 and 2005 have been included in Table 4.

Table 4: Relative Stock Density (RSD) values for walleye in Namakan Lake based on Fall Walleye Index Netting (2000, 2004 and 2005).

Category (Total Length)	2000	2004	2005
Quality (380-510 mm)	.320	.427	.369
Preferred (510-630 mm)	.014	.071	.040
Memorable (630-760 mm)	.000	.000	.000
Trophy (≥760 mm)	.000	.000	.000
FQI	**35**	**57**	**45**

Comparison to Northwest Ontario Walleye Benchmarks

Walleye catch per unit effort in Namakan Lake would still be considered in the 'below average' abundance category (5-12 walleye/net), and below the median catch from all other FWIN assessments conducted on Fort Frances District lakes since 1994 (Figure 13). The arithmetic mean walleye catch-per-unit-effort (11.3 fish/net) was below the Fort Frances District average (12.5 walleye/net), the Northwest Region large lake average (17.9 walleye/net), and the Northwest Region average for all lakes (14.1 walleye/net). Furthermore, this represented a 49 % increase in the number of fish relative to the 2000

FWIN. However, a large proportion (49 %) of the 2005 catch was from the strong 2001 and 2003 year classes (Figure 4).

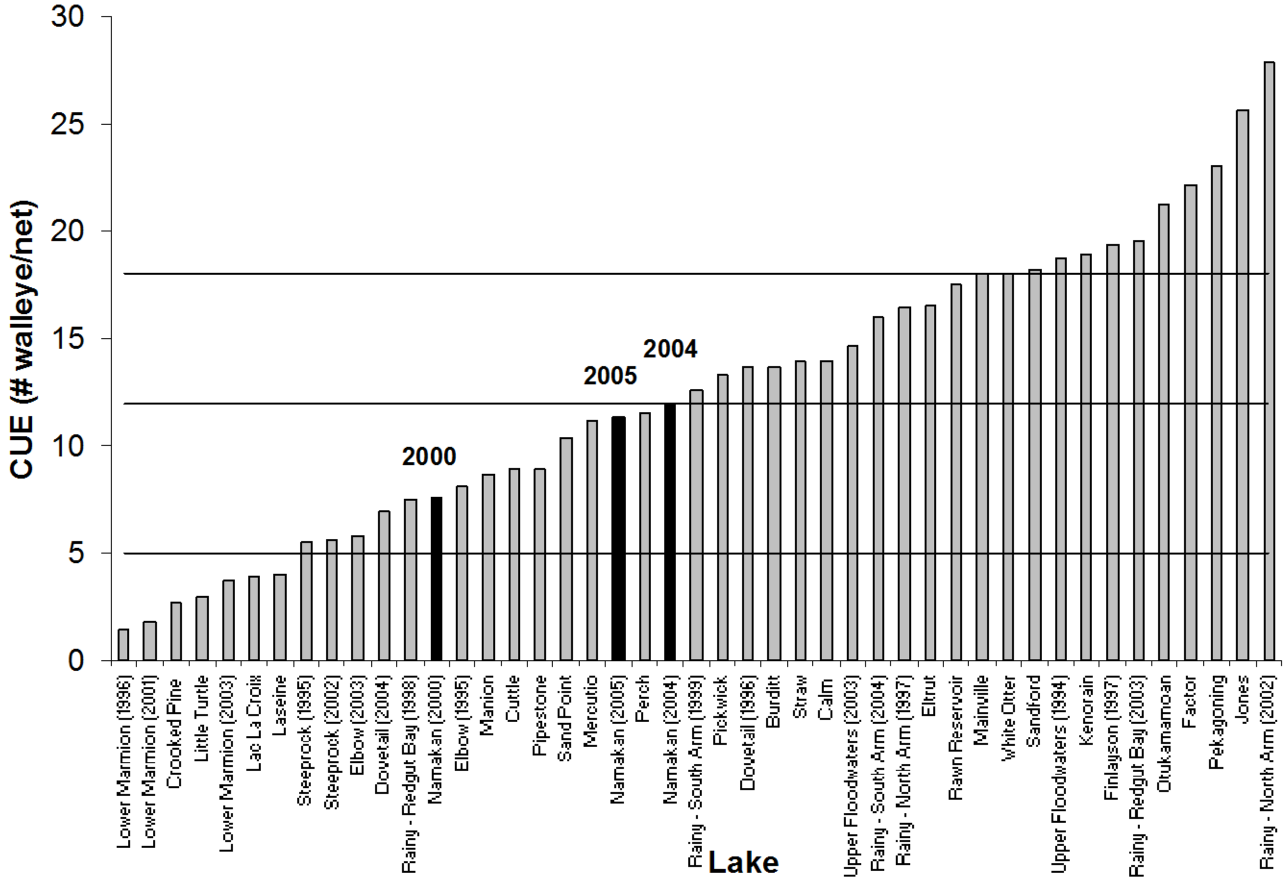

Figure 13: Comparison of walleye abundance in Namakan Lake with other Fort Frances District lakes using FWIN standards, 1994-2005. Walleye catch-per-unit-effort (CUE) between 0-5 are low, 5-12 low-average, 12-18 high average, and >18 high walleye abundance.

The geometric mean CUE for Namakan walleye (7.8 fish/net) was 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 catch of walleye ≥450 mm TL was also low at 1.1 fish/net, and well below the large lake average of 2.5 fish/net for the Northwest Region. Relative to other

Ontario waterbodies (Figure 14), this would characterize the population as “stressed”. The Shannon Diversity Index value of 0.86 indicated sufficient diversity in adult female age classes to be considered a healthy population (>0.66). However, the mean age (3.73 years) is below the average for healthy populations of 4.20 years and greater, same as the Northwest Regional average. A summary of the 2000, 2004 and 2005 FWIN assessments on Namakan Lake is presented in Table 5, with a detailed comparison of walleye population and life history parameters for the Northwest Region.

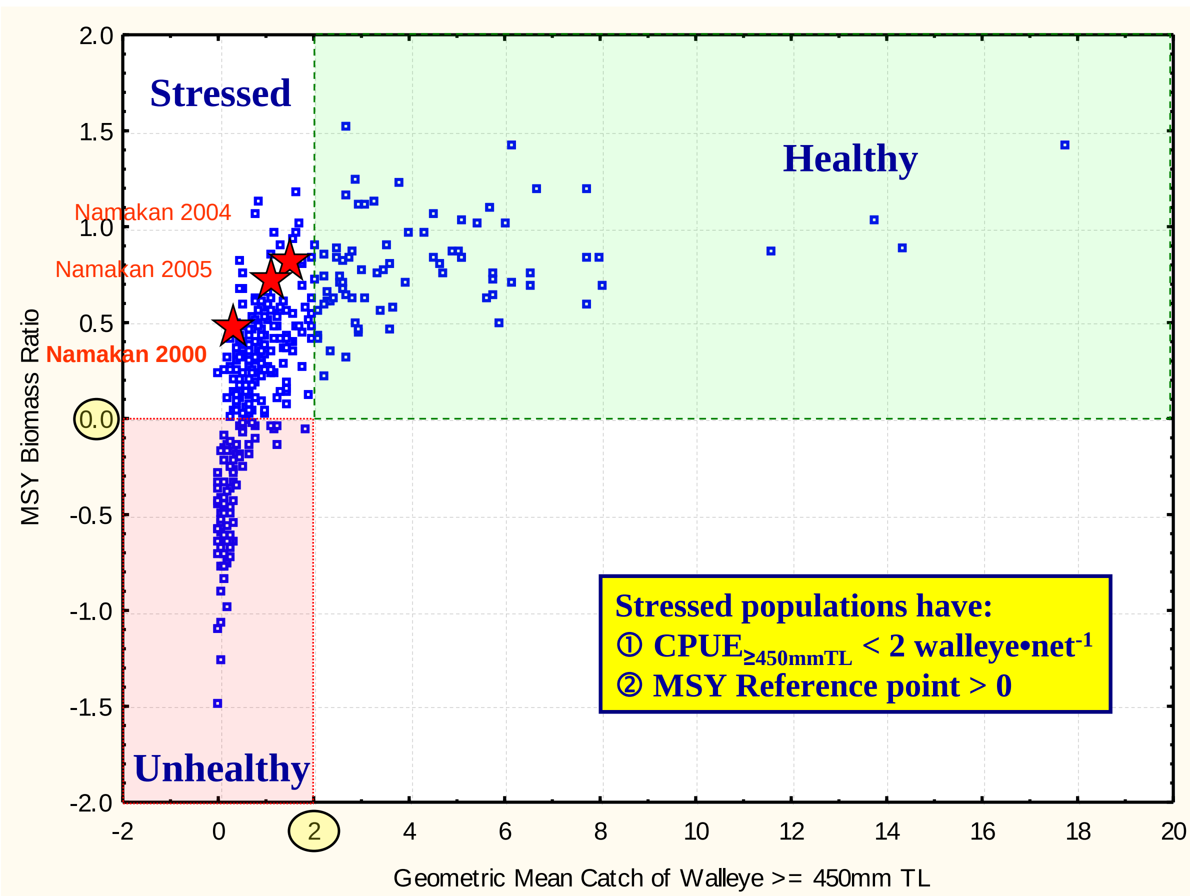

Figure 14: Comparison of walleye abundance (geometric mean catch of walleye >=450mm TL) in Namakan Lake to other Ontario lakes using FWIN standards, 1994-2005.

Table 5: Summary of Namakan walleye population parameters based on FWIN standards, relative to NW Regional benchmarks.

VARIABLE	NW MEAN (all lakes)	NW MEAN (large lakes)	NAMAKAN (2005)	NAMAKAN (2004)	NAMAKAN (2000)
SECCHI (m)	3.0	2.7	2.6	2.6	2.6
MEI	8.7	6.4	2.8	2.8	2.8
MSY (kg/ha/yr)	-	-	0.81	0.81	0.81
MSY Ref. (log_{10} FWIN/MSY)	-	-	0.72	0.88	0.52
DEGREE DAYS (GDD> 5C)	1415	1432	1646	1646	1646
MEAN CUE (kg/net)	-	-	4.25	6.07	2.69
MEAN CUE (#/net)	**14.1**	**17.9**	**11.3**	**12.0**	**7.6**
CUE ≤300 mm	4.1	5.9	6.0	3.0	3.5
CUE ≥350 mm	7.5	8.0	4.25	6.9	3.7
CUE ≥450 mm	3.1	3.5	1.6	2.2	0.7
MEAN CUE (walleye & sauger)	-	20.3	13.5	14.1	9.4
MEAN CUE (GEO) (#/net)	**10.7**	**13.1**	**7.8**	**7.9**	**5.4**
CUE ≥450 mm (GEO) (#/net)	**3.2**	**2.5**	**1.1**	**1.4**	**0.3**
TL @ 50% MATURITY ♀ (mm)	441	458	409	433	451
AGE @ 50% MATURITY ♀ (yrs)	4.80	5.24	5.29	5.48	5.81
TL @ 50% MATURITY ♂ (mm)	**356**	**369**	**370**	**358**	**365**
AGE @ 50% MATURITY ♂ (yrs)	3.49	3.81	4.78	4.42	4.42
MALE MORTALITY (5+ yrs)	0.30	0.29	0.29	0.42	0.41
FEMALE MORTALITY (5+ yrs)	0.28	0.30	0.28	0.43	0.45
MORTALITY >300 mm	-	0.34	0.29	0.35	0.42
TOTAL MORTALITY (A)	-	-	0.29	0.48	0.42
NUMBER OF AGE CLASSES (all)	-	14	12	11	10
NUMBER OF AGE CLASSES (n>1)	**10**	**13**	**12**	**11**	**7**
MEAN AGE (yrs)	**4.20**	**3.89**	**3.73**	**4.48**	**3.44**
MAXIMUM AGE (yrs)	**16**	**18**	**16**	**11**	**11**
AGE CLASSES >8	5	8	4	3	3
AGE CLASSES >10	4	6	2	1	1
SHANNON INDEX (mature females)	**0.65**	**0.79**	**0.86**	**0.78**	**0.55**
PRE_MATURATION GROWTH (h)	89	90	68	68	69
FEMALE BRODY COEFFICIENT (K)	**0.155**	**0.158**	**0.141**	**0.173**	**0.190**
FEMALE TL inf (mm)	**733**	**741**	**678**	**624**	**656**
MALE TL inf (mm)	**613**	**635**	**603**	**596**	**566**
FISHING QUALITY INDEX (FQI)	-	-	45	57	35
MEAN TOTAL LENGTH (mm)	**376**	**351**	**312**	**356**	**318**
MEAN ROUND WEIGHT (grams)	705	-	375	508	354
TL @ AGE 2 (mm)	302	293	253	222	261

HEALTHY

STRESSED

UNHEALTHY

Walleye life history characteristics in Namakan Lake for 2005 continue to be below Regional averages. The population appears to be slower growing and late maturing as indicated by growth parameters and the length and age of maturity for both sexes (Table 5). Pre-maturation growth rate (h) was 68 mm/yr, which is unchanged from 2000 and 2004, but is below the Regional benchmark values of 89-90 mm/yr.

OTHER FISH SPECIES

Northern pike were captured at an average of 1.3 fish/net on Namakan Lake (n = 31), with almost no change from a catch of 1.2 pike/net in 2000 and 1.6 pike/net in 2004. The geometric mean catch in 2005 was 1.0 fish/net.

Pike captured in the 2005 FWIN ranged in age from 1-8 years, with the older year classes (>9 years) absent from the catch sample (Figure 15). Catch was dominated by age 3 fish (2002 year class), which accounted for 36 % of the total catch. The mean age of catch in the 2005 FWIN was 4.00 years (SE=0.35). The poor representation of older age classes is consistent with the total length distribution and the small sample size, with only a few fish greater than 700 mm in total length (Figure 16). Only two fish were captured from the 'trophy' class (>900 mm TL), with the largest fish having a total length of 1035 mm. The mean total length was 648 mm (SE=25 mm) based on a small sample of 31 fish.

The mean weight of northern pike sampled was relatively small at 1891 g , but the largest fish caught weighed 6280 g (13.8 lbs). The growth rate of northern pike in Namakan Lake was rapid during the first year; with age 1 fish reaching 450 mm in total length and age 2 fish reaching a mean of 539 mm. Growth increments in subsequent years were relatively consistent, with an overall decrease in growth rate as age increases (Figure 17).

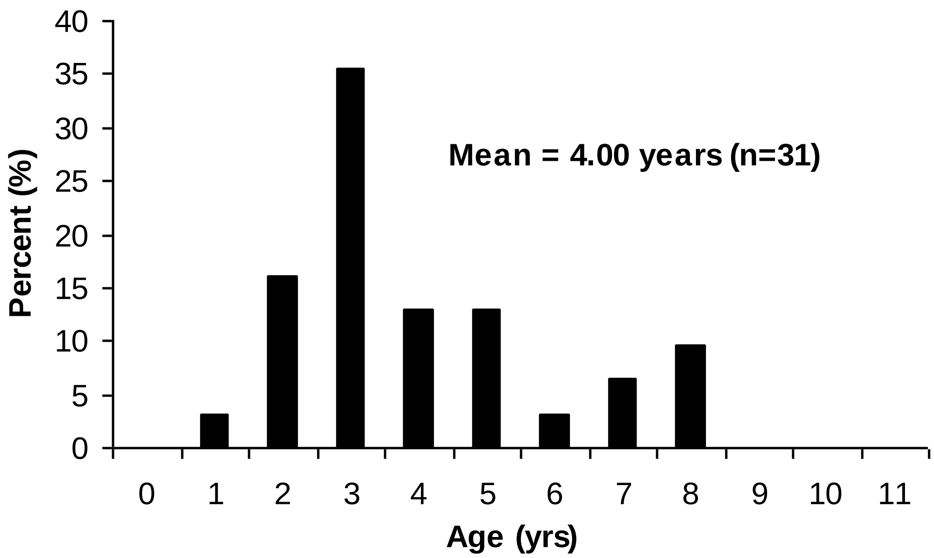

Figure 15: Age composition of northern pike in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

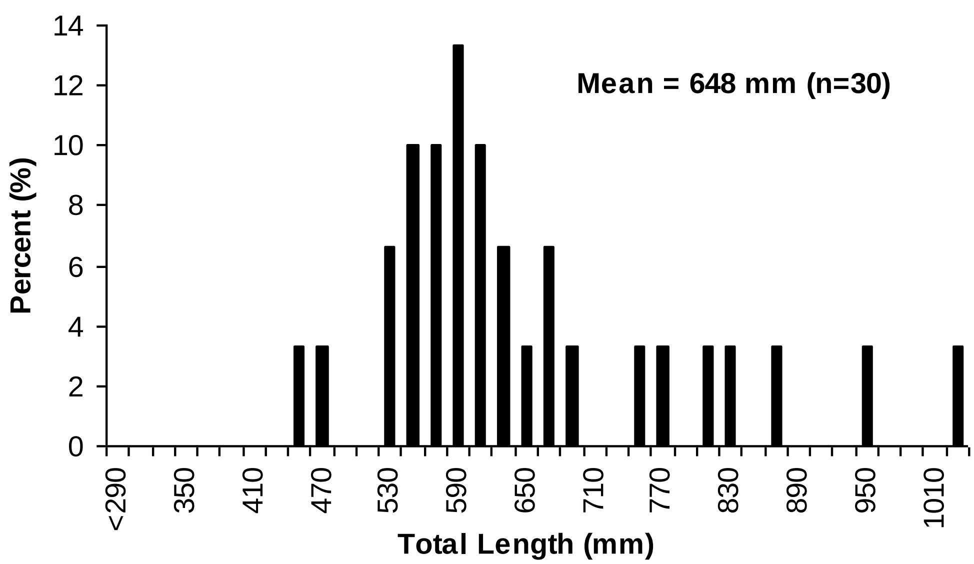

Figure 16: Length composition of northern pike in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

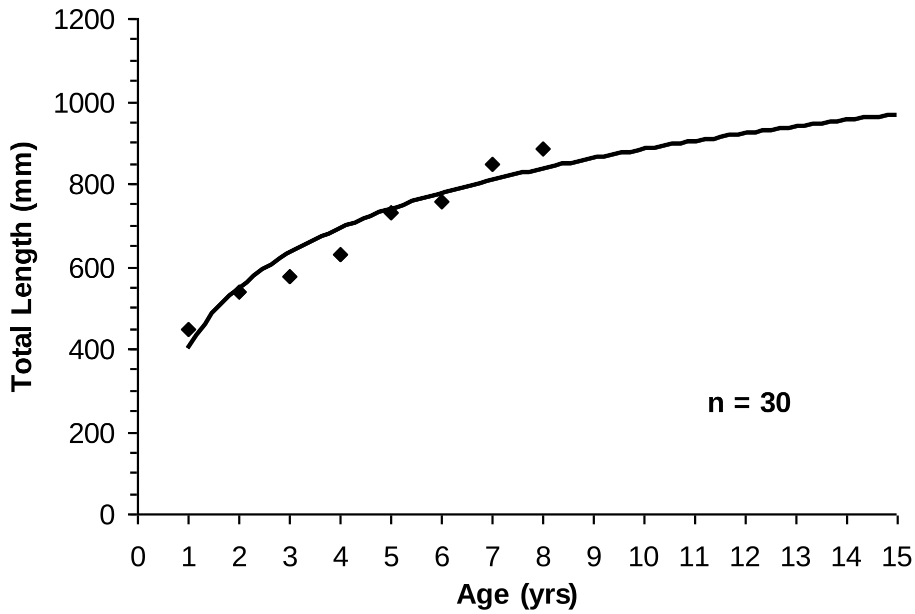

Figure 17: Growth (mean total length at age) of northern pike in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

A smallmouth bass CUE of 0.9 fish/net (SE = 0.2) in the 2005 FWIN was only slightly lower than the 1.2 fish/net (SE = 0.3) observed in the 2004 FWIN. Smallmouth bass ranged in age from 0-10 years; although sample size was limited to only 18 fish (Figure 18). The mean age of smallmouth bass in the sample was 4.78 years.

The length composition of smallmouth bass is reflective of the age distribution and the very small sample size (n=21). Size distribution was distributed among several length classes, with the largest bass having a total length of 467 mm (Figure 19). The largest proportion (33%) of fish sampled was in the 110 and 150 mm size classes, with no other size class representing more than 10 % of the sample. Most of the catch was comprised of

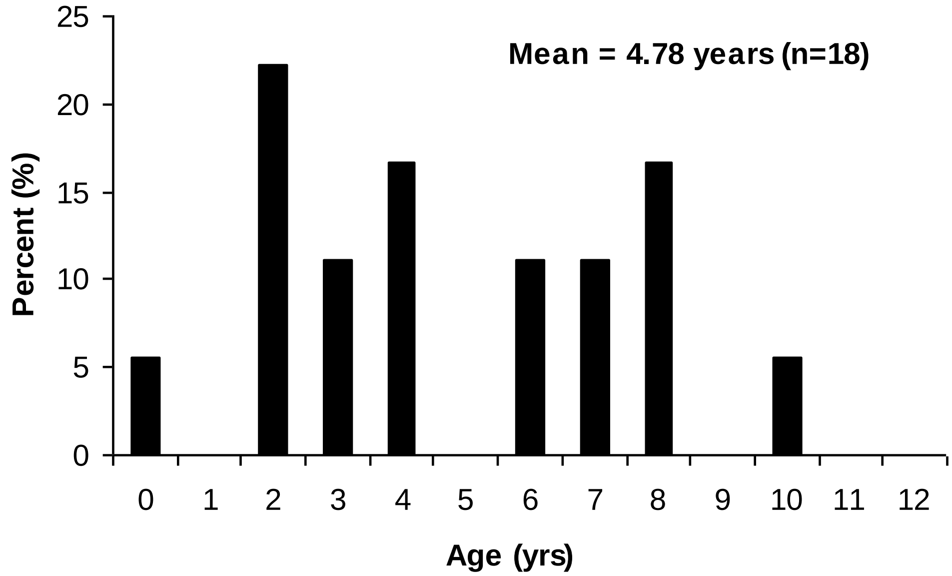

Figure 18: Age composition of smallmouth bass in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

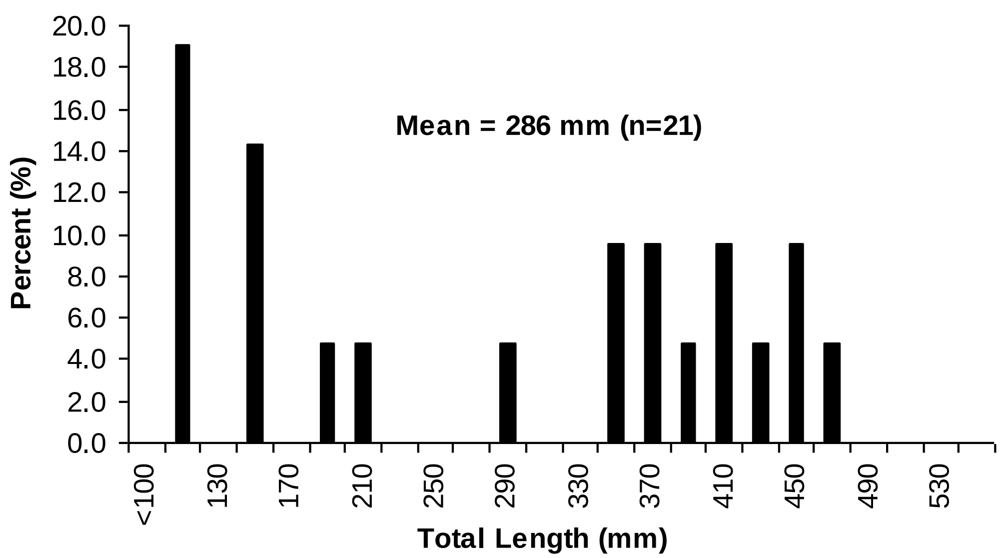

Figure 19: Length composition of smallmouth bass in Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

fish from 350-470 mm total length. A length frequency distribution for all fish species sampled has also been provided in Appendix 2.

The growth rate of smallmouth bass in the Namakan Lake shows a trend similar to other fish species. Growth is rapid during the first few years, with a gradual levelling off beyond age five (Figure 20), as adult bass presumably begin to invest more heavily in reproduction rather than growth.

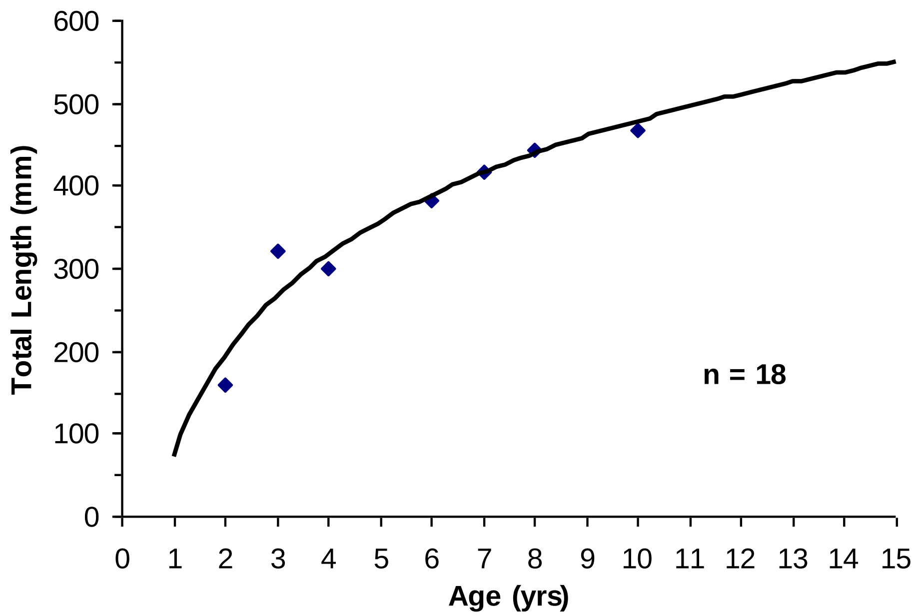

Figure 20: Growth (mean total length at age) of smallmouth bass from Namakan Lake based on Fall Walleye Index Netting (FWIN), 2005.

Namakan Lake also provides a fishery for other fish species including sauger, black crappie and lake sturgeon. Sauger were well represented in the FWIN catch with a total of 51 fish, or an arithmetic mean CUE of 2.1 fish/net. In combination with walleye, this provides a total CUE of 13.5 fish/net, which is below the Northwest Region large lake average of 20.3 walleye & sauger/net. Sauger were above average in size with a mean total length of 276 mm (140-411 mm) and a mean round weight of only 181 g (range 10-560 g), and were slightly larger than that observed in Rainy Lake.

Although reported present in Crane Lake within the Namakan Reservoir, no muskellunge were captured in 2004 or 2005 FWIN nets or any in prior index netting effort. Only 3 black crappie and 3 lake sturgeon were captured in gill nets for a mean CUE of 0.1 fish/net. From this small sample of sturgeon, mean total length was estimated at 703 mm (292-915 mm) with a mean round weight of 3263 g (80-5550 g). Whitefish were commercially fished until 2001, but showed very low representation in the FWIN catch with a mean CUE of 0.2 fish/net. 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 Namakan 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 (3.2 fish/net) likely provides an important prey resource for adult walleye (Scott and Crossman, 1998). A total of 14 different species were captured.

The initiation of the fisheries assessment program on four-year rotation (M^c^Leod, 2002) provides an excellent opportunity to monitor changes in fish population structure and life history parameters over time. Data from the 2005 FWIN project on Namakan Lake can be compared to previous studies and to other lakes using standardized methodology.

In 2004 and 2005, 24 nets were set at the random sample sites, which represents a very small change from the 25 net sites used during the 2000 FWIN. Precision targets of <20 %RSE for the walleye catch were still met with this modest reduction sample size and increasing abundance. Precision estimates based on %RSE were 20.4 % in 2005, compared to 18.6 % in 2004 and 18.1% in 2000. Over this same period, total fish mortality increased with the observed increases in walleye abundance. The catch of 272 walleye in 2005 and 287 in 2004 was only slightly higher than the provincial recommendation of 200-250 walleye (Morgan, 2002). The total walleye catch in 2000 was only 190 fish. Although currently not an issue, the increase in sampling mortality may become more important in future FWIN assessments on Namakan Lake as walleye abundance and size structure continues to improve.

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 Namakan Lake did not deviate from the Northwest Regional means, and generally show improvements compared to the 2000 FWIN (Table 4). Sampling of walleye in Namakan Lake indicate a smaller ultimate body size ($L\infty$) for males and females, along with slower growth and later maturation for both sexes relative to Northwest Region means. In addition, the number of age classes and maximum age both increased relative to the 2000 and 2004 FWIN studies. Shannon Diversity Indices have also increased, indicating greater diversity of adult females and presumably a more stable spawning population. This data suggests that regulation changes made to improve walleye populations in both Ontario and Minnesota, and/or environmental variables are providing Namakan Lake walleye populations with the opportunity to recover. 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 from 2000 to 2005.

The most positive signs regarding the status of the walleye population are the higher catch rates (number of fish per net) relative to 2000, even though they are still close to the median catch for all other lakes surveyed in Fort Frances District. Compared to 2000, the geometric mean catch increased by 44 % to 7.8 walleye/net, which appears to be driven by strong 2001 and 2003 year classes. This suggests the recovery of spawning stocks to some degree, and these strong year classes will continue to provide a foundation for future walleye production as they reach maturity. Along with the increase in the numbers of fish, the catch by weight also increased by 58 %.

Poor year classes in 2000 and 2002 are cause for some concern, although both are likely naturally occurring. The 2000 year class appeared to be weak on other District lakes including the North Arm, Redgut Bay and the South Arm of Rainy Lake (McLeod and Taillon, 2003; McLeod and Taillon, 2004; McLeod, 2005), 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). A number of fish species known to compete with, or prey upon, larval walleye are present in Namakan 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 Namakan Lake 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 (particularly females) may be contributing to inconsistent recruitment. 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.

Further comparison of walleye population structure does raise some 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). The Namakan Lake walleye population is still showing some signs of stress, but a number of indicators have improved since 2000. A proposed Walleye Benchmark Classification Key would also suggest the population is improving but currently "stressed/stable" with an overall score of 2.50 in 2005, compared to 2.25 in 2004 and only 1.25 in 2000 (G. Morgan, pers. comm.). By comparison, the individual basins of Rainy Lake had overall scores of 2.5 in 2002 and 2003, and 2.75 in 2004. A score of 2.75 or maximum of 3.0 is deemed to be "healthy/stable".

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 increased since 2000. 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. Fishing Quality Index (FQI) values of 45 and 57 for 2004 and 2005 respectively are still considered low, but do represent an improvement from a value of 35 in 2000. These FQI values are reflective of a quantity fishery (OMNR, 1990). Changes to walleye angling regulations in Northwest Ontario in 1999 and in the border waters area in 2000 appear to be having the desired effect by reducing harvest and protecting larger fish. The combined angler, commercial and subsistence harvest estimate of 2,900 kg/year (1997-2002) has been reduced through a commercial fishery buy-out in 2001, and remains below the management objective of 3,500 kg/year for Ontario waters (OMNR and MDNR, 2004).

Growth curves, particularly those based on weight; did not show definite asymptotic curves typical of many fish populations, including walleye. This may be attributable to the general absence of older fish (greater than 10 years) from the sample. Typically, walleye populations exhibit unbalanced sex ratios. Prior to maturity, males outnumber females (Colby et al., 1979) and Seyler (1998) reported a ratio of immature males to females of approximately 1.30:1 in Lake Nipissing, ON. The male:female ratio in this study was only slightly higher at 1.54:1 between the ages 2-7 years. Typically, differences in vulnerability to exploitation and greater female longevity result in a shift to a female dominated sex ratio among mature individuals, a trend that was observed in this study as well.

Sauger continue to show good representation in the fish community of Namakan Lake, with a catch rate of 2.1 fish/net in 2005. However, this is much lower than the 4.0 fish/net observed in Redgut Bay of Rainy Lake in 2003, but higher than the 1.3 sauger/net observed in the South Arm in 2004. With a mean summer secchi transparency of 2.6 m, Namakan Lake is probably better suited to walleye production. Sauger likely only contribute a small portion of the estimated annual potential yield of 4,100 kg/year (0.80 kg/ha/yr) for percids. The small average size of sauger (276 mm and 0.18 kg) also provides limited angler harvest opportunities, with no estimated harvest in 1998 (Elder, 2001).

Northern pike and bass populations in Namakan Lake appear to be healthy and sustainable at existing harvest levels, although catch rates of both species were low at 1.3 and 0.9 fish/net respectively. For northern pike, there was reasonable representation of age classes from 1-8 years, but poor representation of small fish less the 520 mm total length. Age composition of pike also suggests total mortality after age 8 could be high, however the effect of gear selectivity has not been fully evaluated. The sample size of pike (n=31) 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 1.0 fish/net in 2005 (1.1 in 2004), was well below the provincial average of 2.2 fish/net (and just above the lowest quartile of 0.9). The 2005 catch represents an improvement from the geometric mean of 0.77 fish/net observed in 2000. The mean size (648 mm) and weight (1.89 kg) of Namakan Lake pike were larger than 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 species is producing as a quantity rather than a quality fishery. However, the quality of the fishery is anticipated to improve based on the water level changes implemented in 2000 and reduced harvest levels. The combined angler, commercial and subsistence harvest of 900 kg/year (1997-2002) has been declining and remains well below the management objective of 2,700 kg/year for Ontario waters (OMNR and

MDNR, 2004). Changes to pike angling regulations in Northwest Ontario in 1999 may be having the desired effect by reducing harvest and protecting larger fish.

Recent FWIN assessments might suggest that smallmouth bass abundance is declining. Arithmetic mean CUE was only 0.9 fish/net in 2005 compared to 1.2 in 2004 and 1.5 fish/net in 2000. Based on a very small sample size of 18 fish in 2005, there was representation of 8 age classes ranging from 0 to 10 years, with a low mean age of 4.78 years. No fish were captured over 10 years of age or 470 mm in total length. Angling for smallmouth bass remains an important component of the sport fishery in Namakan Lake, while providing a quality angling experience (OMNR and MDNR, 2004). Harvest of bass averaged only 500 kg from 1997-2002, and is well below the management objective of 1,000 kg/yr. A complete review of life history parameters for smallmouth bass would likely require combining data with Sand Point Lake to improve sample size and statistical precision.

CONCLUSIONS

- Overall abundance of walleye is still below average with an arithmetic mean CUE of 11.3 fish/net (geometric mean of 7.8 fish/net), but both values represents an increase since 2000. The 2005 catch was still dominated by small and younger fish, with age two and age four fish showing good representation from the strong 2003 and 2001 year classes respectively.

- Catch rates of large adult walleye (≥450 mm TL) increased relative to the 2000 FWIN, but are still below the Northwest Region averages and indicative of a ‘stressed’ fishery.
- Most walleye life history parameters, including number of age classes (12), maximum age (16), Shannon Diversity Index (0.86), Fishing Quality Index (45), female Brody growth coefficient (0.141) and attainable total length for males (603 mm) continue to show improvement relative to the 2000 FWIN. A proposed Walleye Benchmark Classification Key for Ontario suggests the walleye population is “stressed/unstable” but improving, with a score of 2.5 out of 3. Previous classification scores were 2.25 in 2004 (stressed/unstable) and only 1.25 in 2000 (unhealthy).
- The walleye population in Namakan Lake exhibits below average pre-maturation growth, and fish appear to mature at ages that are slightly higher than the means for the Northwest Region.
- Although total mortality rates remain relatively low at 29 %, existing levels of exploitation appear to be impacting the age and length composition of the population, especially of fish greater than 11 years or 540 mm in size. Annual mortality is below the level of 50 % which would entail high risk of instability or collapse (OMNR, 1983).
- The 2000 and 2002 year classes (5 and 3 years olds) appear to be quite weak, while the 2001 and 2003 year classes (4 and 2 years olds) appear to be strong. This is consistent with previous assessments on the North Arm in 2002, Redgut Bay in 2003 and South Arm in 2004. Recruitment is highly variable but this 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. A continuation of the size limits, 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 Namakan Lake..
- Northern pike populations may be improving, while the health of the smallmouth bass population is questionable based on the limited diagnostics available. Further monitoring and interpretation is recommended, along with more detailed investigation of muskellunge and lake sturgeon populations.

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Appendix I: Fish Species Present in the Namakan Reservoir

Common Name	*Scientific Name*	MNR Species Code
Silver Lamprey	*Ichthymyzon unicuspis*	013
Lake Sturgeon	*Acipenser fulvescens*	031
Lake Whitefish	*Coregonus clupeaformis*	091
Cisco (Lake Herring)	*Coregonus artedii*	093
Rainbow Smelt	*Osmerus mordax*	121
Northern pike	*Esox lucius*	131
Mooneye	*Hiodon tergisus*	152
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
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
Black Bullhead	*Ictalurus melas*	231
Brown Bullhead	*Ictalurus nebulosus*	233
Tadpole Madtom	*Noturus gyrinus*	236
Burbot	*Lota lota*	271
Brook Stickleback	*Culaea inconstans*	281
Trout-Perch	*Percopsis omiscomaycus*	291
Rock Bass	*Amboloplites rupestris*	311
Pumpkinseed	*Lepomis macrochirus*	313
Bluegill	*Lepomis macrochirus*	314
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
Iowa Darter	*Etheostoma exile*	338
Johnny Darter	*Etheostoma nirgrum*	341
Logperch	*Percina caprodes*	442
Mottled Sculpin	*Cottus bairdi*	381

***Total Species:* 43**

Appendix II: Total length frequency distribution of fish species captured in 24 FWIN gill net sets on Namakan Lake, 2005.

Total Length (mm)	Walleye	N. Pike	SM Bass	Lake Sturgeon	Yellow Perch	Lake Herring	Whitefish
0 – 99					2		
100-119			4		40		
120-139					11	2	
140-159	2		3		12		
160-179	6				8		
180-199	38		1		3		
200-219	11		1				
220-239	16						
240-259	27						
260-279	24						
280-299	21		1	1			
300-319	14						
320-339	10						
340-359	12		2				
360-379	17		2				
380-399	18		1				
400-419	9		2				
420-439	7		1				
440-459	7	1	2				1
460-479	14	1	1				
480-499	6						1
500-519	4						2
520-539	5	2					1
540-559	1	3					
560-579	1	3					
580-599		4					
600-619	1	3					
620-639		2					
640-659		1					
660-679		2					
680-699		1					
700-719							
720-739							
740-759		1					
760-779		1					
780-799		1					
800+		5		2			
Total	**271**	**30**	**21**	**3**	**76**	**2**	**5**
Mean	**312**	**648**	**286**	**703**	**126**	**130**	**497**
Min	**151**	**450**	**100**	**292**	**98**	**125**	**452**
Max	**606**	**1035**	**467**	**915**	**188**	**134**	**537**

Appendix II: (cont'd)

Total Length (mm)	White Sucker	Shorthead Red-horse Sucker	Silver Red-horse Sucker	Rock Bass	Mooneye	Black Crappie	Sauger
0 – 99				4			
100-119				4			
120-139				16			
140-159				20			1
160-179	1			22			1
180-199		1		19			2
200-219				7		2	7
220-239	1			3			3
240-259	1						6
260-279	2						9
280-299							4
300-319					1	1	6
320-339							3
340-359							3
360-379	2						3
380-399	1						2
400-419	2						1
420-439	4				1		
440-459	3						
460-479	4	1					
480-499	2	1					
500-519	1						
520-539	3		1				
540-559	3						
560-579			1				
580-599			4				
600-619							
620-639							
640-659							
660-679							
680-699							
700-719							
720-739							
740-759							
760-779							
780-799							
800+							
Total	**30**	**3**	**6**	**95**	**2**	**3**	**51**
Mean	**427**	**386**	**576**	**162**	**368**	**239**	**276**
Min	**175**	**186**	**552**	**78**	**311**	**203**	**140**
Max	**559**	**495**	**597**	**237**	**424**	**309**	**411**