Ontario

The Status of Lake Trout Populations in Northeastern Ontario (2000-2005)

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Executive Summary

Ontario boasts nearly 2300 lake trout lakes, 25% of the global distribution (Olver et al. 1991). Lake trout are unique among Ontario sportfish and are highly valued by anglers. The species has stringent habitat requirements (deep, cold, well-oxygenated lakes with clean, windswept rock rubble shorelines for spawning) and is sensitive to habitat change. Biological attributes, such as slow growth and late maturity, limit reproductive potential and sustainable harvest levels.

A concentration of approximately 1000 lake trout lakes is distributed along the height of land between Wawa and the Quebec border within the Northeast Administrative Region (NER) of the Ontario Ministry of Natural Resources. In 2000, the Northeast Lake Trout Project, was launched to evaluate the present health of NER lake trout populations. The overall objectives of this 5 year collaborative project were to consolidate relevant historic data, to update available information regarding the status of acid damaged lake trout lakes, and to evaluate the overall health and sustainability of the regional resource. To accomplish this, estimates of fishing pressure were obtained for 679 lakes using aerial survey methods and 140 index netting surveys were conducted. These data were used to provide a snapshot of current resource health and to explore potential drivers of the observed trends in angler effort and resource status. Individual fish sampling records were pooled to develop regional life history benchmarks.

Widespread regional acidification linked to industrial pollution severely impacted approximately 100 lake trout lakes in NER. Fortunately, metal smelter emissions and surface drainage of mine tailings have been reduced over time and lake trout populations are responding positively to water quality improvements. Native populations survived acidification in 25 lakes and self-sustaining populations have been reestablished in 10 additional lakes through hatchery stocking. Restoration efforts on another 34 lakes are underway. Unfortunately, 31 lakes remain void, the majority of which require additional chemical recovery. Furthermore, fish community alterations may present a barrier to recovery in many lakes.

Applied restoration strategies are presented including a variety of lake trout stocking strategies and a range of harvest control measures. Nearly 250,000 lake trout were stocked between 2001 and 2005. Additional stocking and a long-term monitoring program are required. We propose a monitoring program which would require an estimated $30,000 annually to implement.

While acid damaged lake trout lakes in NER have shown dramatic chemical recovery in recent decades and efforts to restore lost lake trout populations are well underway, the broader state-of-resource data collected suggests that NER lake trout populations are in poor health overall. Of 915 lakes presently managed for lake trout in NER only 680 (74%) are considered to be self-sustaining.

Current levels of lake trout fishing pressure are of concern - 32% of the self-sustaining lakes surveyed are experiencing angling effort beyond sustainable levels. Fishing pressure was found to be highest in watersheds adjacent to Sault Ste. Marie, Blind River, and Elliot Lake. Surprisingly, watersheds adjacent to Sudbury were fished less intensely than watersheds closer to Sault Ste. Marie, a trend presumed to be related to poor resource status in the Sudbury area owing to the combined impacts of acidification and past exploitation.

Spatial analyses of angling effort revealed significant contributors to effort were the presence of roads and cottages. Watersheds with high road density were found to have high mean fishing pressure. Furthermore, there was a significant increase in open water effort, and in turn annual effort, on lakes with good road access. Effort on the majority of lakes with easy access (highway and primary roads) was found to exceed effort at maximum sustainable yield (E_{msy}). Effort on almost half of the cottage lakes surveyed was also found to exceed E_{msy}. Thus, accessible, developed lakes are attracting unsustainable levels of fishing pressure. While smaller, more remote lakes can have high effort during the winter from snowmobile use, observed levels of annual effort are considered 'safe' for the majority of these lakes (i.e. observed effort below E_{msy}).

One other key driver of observed angling pressure was detected. Lake trout biomass, a surrogate of angling quality, was found to have a significant positive effect on angler effort especially for remote lakes. Anglers are willing to work harder for a high quality angling experience. Together, biomass and accessibility play a significant role in the distribution of effort across the landscape.

To build on the analysis of angler effort data discussed above, standard index netting data was used to estimate current lake trout abundance on a representative subset of 130 self-sustaining NER lake trout lakes. As a means to characterize four stages of fishery status or health, estimates of lake trout density and angler effort were compared to reference points or benchmarks for expected abundance and sustainable fishing pressure at maximum sustained yield (MSY). Only 16.9% of the lakes sampled received a healthy diagnosis (i.e. observed abundance above benchmark and sustainable fishing pressure). An additional 15.4% of the lakes sampled were characterized by good lake trout abundance but are presently being over-fished; in these lakes, abundance can be expected to decline. A further 26.9% of the lakes sampled are presently being over-fished and abundance has already declined. Finally, 40.8% of the lakes sampled were classified as degraded; both abundance and fishing pressure are low. Assuming the 130 lakes selected in this study reflect the status of 696 lakes presently considered to be either self-sustaining or partly self-sustaining (i.e. 16 lakes stocked on a supplemental basis), extrapolating to the entire region reveals that there may be only 225 self-sustaining lake trout lakes in NER which presently provide for healthy levels of lake trout abundance and that nearly half of these lakes are subject to unsustainable levels of fishing pressure.

Spatial trends in resource status were detected. Only 20.0% of Sudbury District lakes were found to meet the abundance benchmark, as compared to 32.3% regionally, and a full 53.3% of Sudbury lakes were classified as degraded. Again, the poor condition of Sudbury lakes can likely be attributed to the combined impacts of acidification and past exploitation. North Bay District lakes were found to be slightly better off (22.2% meet the abundance benchmark, 40.7% classified as degraded). SSM District lakes were found to be the healthiest (44.0% meet the abundance benchmark, 30% classified as degraded).

The model of resource status used implies that given a reduction in exploitation following a decline in angling quality (ie. a reduction in lake trout abundance), populations should recover over time. However analyses showed a number of potential barriers to this recovery process. Lake trout abundance was found to decrease with increasing species richness, particularly for populations which fall below the abundance benchmark. A combination of high species richness and lake trout exploitation could lead to long term degradation. Alternately, a lake trout abundance response may be more related to the presence of certain key species than to overall species richness. For example, the data showed smallmouth bass negatively impact lake trout abundance and population status. Lake trout abundance was found to be significantly lower where smallmouth bass were present and there were disproportionately more healthy lakes where smallmouth bass were absent. Other studies have demonstrated similar negative effects where rock bass are present. Based on these findings, introduction rates for several potential competitors were explored. It was estimated that either smallmouth bass, rockbass, or both have been introduced into approximately 25% of NER lake trout lakes and that walleye have been introduced into approximately 10% of NER lake trout lakes. These introduction rates would seem alarming considering the documented impact that such competitive species can have on lake trout population health.

As supported by current literature, lake trout abundance was also found to decrease in the presence of coregonids (lake herring or whitefish). A negative shift in resource health as determined through comparison to established abundance reference points was also observed. This shift was unexpected given that the abundance benchmarks were calculated based on empirical estimates of asymptotic length (L_∞). Higher estimates of L_∞ and lower abundance reference points result where coregonids are present and should in theory balance off the reduction in observed abundance all other factors being equal. A plausible explanation for a decline in resource health would be that larger bodied lake trout populations (usually found in the presence of coregonids) are more sensitive to exploitation than smaller bodied populations. Coregonids not only serve as a forage species but also compete with young lake trout. As a large bodied lake trout population is exploited, coregonids become more abundant and can present a barrier to the survival of young lake trout. Depleted populations of large bodied lake trout may be very slow to recover given this potential barrier.

Finally, residual angler interest was identified as a potential barrier to population recovery. For lakes which fall below the abundance benchmark, angler effort was found to be positively correlated with lake trout density. Angler interest in marginal fisheries would indeed appear to be density dependant and depleted lakes may be very slow to recover without additional harvest control.

Regional benchmarks were developed for key life history parameters. These benchmarks will ultimately be used to calibrate population models and to explore potential management options. Length, weight, age, and maturity data were reviewed by sex. With biological data pooled for the region, female lake trout were found to be 50% mature at age 7 (total length = 402mm) and 90% mature at age 11 (538mm). Males were found to be 50% mature at age 6 (383mm) and 90% mature at age 11 (514mm). Comparison of male and female age distributions revealed that there are fewer old female lake trout (i.e. beyond age 10) than male lake trout in NER. Recent analyses presented by Casselman (2004) suggests that mature females are more vulnerable to angling from mid to late summer given energy requirements associated with gonad development. Specifically, commencing July 1, the proportional harvest of mature females can increase to 70% when only 13% of the population falls into this category. Such a harvest trend would be of great concern for easy access / cottage type lakes which tend to receive high summer effort.

In summary, while efforts are being made to restore damaged lake trout populations in Northeastern Ontario, decisive action is required to address emerging issues. Key factors currently impacting resource health include the proliferation of road access, over-exploitation, and the impact of introduced species. These stressors often act in tandem, where lakes with good road access have higher rates of exploitation and higher incidence of introduced species. Management options to reduce harvest include modified seasons / limits and size based restrictions. Public education initiatives and regulatory changes are suggested as a means to address the growing threat associated with introduced species. Finally, it is imperative that the location of new resource access roads be planned in a manner that does not further erode the remoteness of self-sustaining lake trout lakes.

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1.0 - Introduction

Lake trout are unique among Ontario sportfish. The species has stringent habitat requirements (deep, cold, well-oxygenated lakes with clean, windswept rock rubble shorelines for spawning) and is commonly considered to be a barometer or indicator of cold water ecosystem health. Biological attributes, such as slow growth and late maturity, limit reproductive potential and sustainable yields. The province of Ontario boasts nearly 2300 lake trout lakes, 25% of the global distribution (Olver et al. 1991). Based on this and the socioeconomic value of the associated sport fishery, Ontario has significant responsibility in ensuring that our lake trout populations are managed wisely.

A concentration of approximately 1000 lake trout lakes is distributed along the height of land between Wawa and the Quebec border in OMNR's Northeast Region (NER). Unfortunately, lake trout populations in the northeast are subject to a range of stressors including, but not limited to: acidification, over-exploitation, the impact of introduced species, water level manipulation, and nutrient loading. Ontario's Environmental Commissioner and a number of leading fisheries scientists have expressed concern regarding the status of Ontario's lake trout populations (Environmental Commissioner of Ontario 2002; Post et al. 2002). Management efforts to date have been issue driven on a lake by lake basis. Clearly, this valuable resource would benefit from a more holistic approach to resource evaluation and management, a need recognized in recent development of Ontario's new Ecological Framework for Recreational Fisheries Management (OMNR 2005).

Through implementation of the Northeast Lake Trout Project, an effort was made to consolidate information regarding lake trout lakes in NER and to evaluate the overall status and sustainability of the resource. Available / relevant historic information was captured and is stored in a new regional lake trout database available as an extension to this report. Current state-of-resource (SoR) data was also collected following the monitoring framework proposed by McGuiness et al. in 2000. Angling intensity and angler distribution data was explored as were the results of extensive index netting on a representative sub-sample of NER lakes. The angler effort and lake trout abundance data collected was combined to provide a snapshot of current resource health and to explore potential drivers of trends in resource status. Biological data was assembled for the region to support an analysis of life history parameters. Ultimately, this data will be used to calibrate a Fisheries Management Support System (FMSS) to represent the range of life history parameters and fishing effort documented in NER. The model will then be used to evaluate potential management options.

Approximately 100 lake trout lakes in NER were severely impacted by acidification linked to atmospheric deposition of metal smelter emissions and surface drainage of mine tailings (Polkinghorne and Gunn 1980; Matuzek et al. 1992). Updated information was collected to evaluate the status of these acid damaged lakes. Water quality is recovering; however, residual impacts to fish communities remain an issue. The Nordic netting standard was applied to update fish community data for 50 lakes where pH was found to meet established lake trout thresholds ($pH > 5.5$). Water quality and fish community data are presented as are selected restoration strategies and monitoring priorities.

2.0 - A Review of Historical Information and Lake Trout Stock Status Codes

A major goal of this project was to accumulate background information regarding 1000+ lake trout lakes in NER. All existing information on file at the District Offices was reviewed and key elements were entered into a customized Access application. The data captured includes general information regarding location, physical characteristics, surrounding land use designations (e.g. parks and protected areas), and stock status as well as more detailed information regarding stocking, recruitment, bathymetry, water chemistry, index netting results, fish community records, and angler survey data. The new regional lake trout browser created is available as an extension to this report.

A separate exercise was undertaken to pull together all available standard index netting data collected in NER. The condition and utility of past survey data ranged widely across the region. Some survey data was only available as original hard copy field records - these surveys were entered into Fishnet (FN2). In other cases, survey data had already been entered and archived but required substantive quality checking / data cleaning to bring it to a useable standard. The end result is a collection of 249 clean Fishnet (FN2) files (136 Nordic Surveys, 90 SLIN surveys, and 23 SPIN surveys). It should be noted that this number includes 140 netting surveys completed between 2000 and 2004 under the umbrella of this project. A final set of FN2 files has been submitted for central archiving and will be available to serve ongoing research needs.

Based on the historic information gathered and on input from District staff, all lakes in NER have been reclassified as to lake trout stock status using the classification system presented in Lake Trout Lakes in Ontario (OMNR, 1990) – a listing compiled as a component of the Lake Trout Community Synthesis. The classification system used in 1990 was expanded and clarified for this review (see Appendix 1). The only significant change to the actual coding system being the addition of 3 re-introduction codes (R, R1, and R2) used to differentiate lakes which once supported native populations from true first time introductions (I, I1, and I2). In addition to a region wide review of current stock status codes, a number of other potential sorting tools were incorporated into development of the new regional database including fields to flag acid damaged waters, put-grow-take fisheries, and lakes that are no longer being managed for lake trout. Assembling a complete list of NER lake trout lakes and classifying lakes as to current stock status is considered to be one of the key outcomes of this project.

A first attempt at describing the overall health of lake trout populations in NER was made as a direct product of the above mentioned review of lakes and stock status. There are a total of 1027 lakes in NER which either support existing lake trout populations or have historic references on file regarding lake trout presence. The first step at describing resource status was to weed out lakes not presently managed for lake trout. In order for a lake to fit this category, Districts would have indicated that lake trout are not currently present and that they do not plan to reestablish a population. In some cases, historic evidence regarding lake trout presence is weak or simply related to past stocking attempts, while in other cases; native lake trout populations have been lost. Lakes with extirpated populations were still considered to be managed for lake trout providing long-term objectives for the lake include lake trout restoration (e.g. acid damaged lakes where additional water quality improvement is anticipated). Of the 1027 lake trout lakes on record in NER, 915 are presently managed for lake trout suggesting that we have abandoned management efforts on 112 lakes. Table 1 provides a detailed breakdown of the lakes presently managed for lake trout by status code and Figure 1 presents a breakdown by current management intent.

Table 1: Breakdown of lakes presently managed for lake trout in NER by stock status code.

Stock Status	Abbreviated Description (see Appendix 1 for full description)	Number of Lakes
N1	native population - self-sustaining, not presently stocked	621
N2	native population - supplemental stocking, native strain	1
N3	native population - supplemental stocking, non-native strain	15
N5	native population - little or no reproduction, PGT stocking	30
R	reintroduced population, further information unknown	3
R1	reintroduced population, no native stock, self-sustaining	9
R2	reintroduced population, no native stock, ongoing stocking	36
I	introduced population, further information unknown	19
I1	introduced population, self-sustaining	50
I2	introduced population, ongoing stocking	82
U	history and status unknown	19
E	lake trout population extirpated	30
		Total = 915

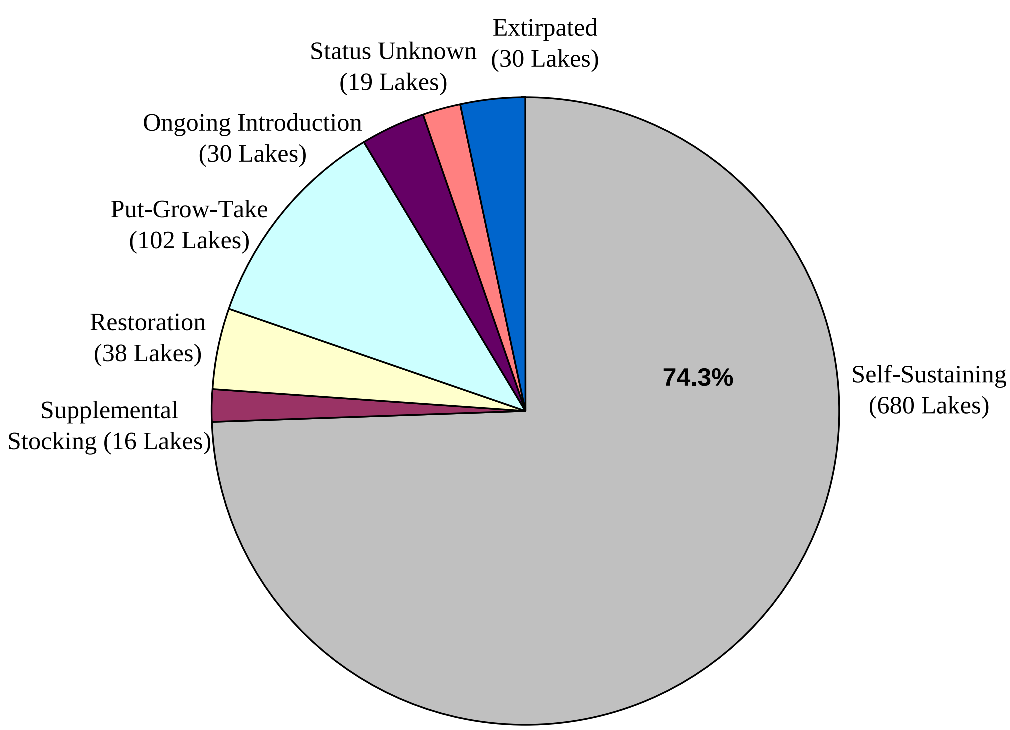

Figure 1: Classification of 915 lakes managed for lake trout in NER by management intent.

With possible exception of introduced populations being managed on a put-grow-take basis (i.e. 71 of the 82 lakes classified as I2), one can safely assume the desired management objective for the majority of the lakes included in the above breakdown to be abundant naturally reproducing lake trout. As such, Figure 1 would appear to provide initial evidence of long-term degradation of NER lake trout populations. Of the 915 lakes presently managed for lake trout, only 680 (74%) are considered to be self-sustaining.

3.0 - Collection of State-of-Resource Data: Description of Methods

A more tangible measure of resource health was gained through collection of current data regarding the status of NER lake trout lakes following methods outlined in a report entitled Monitoring the State of the Lake Trout Resource: Program Design and Costs (McGuiness et al. 2000). The authors of this report recommend comparing measures of lake trout abundance and fishing effort to appropriate reference values in order to evaluate the status of a population of lakes. Therefore, in addition to collecting current water quality data, estimates of angler effort and lake trout abundance were obtained through extensive sampling of NER lake trout lakes between 2001 and 2004. The methods used are discussed in detail below.

3.1 - Angler Effort

Initial data collection efforts were focused on estimation of annual angler effort using the aerial method proposed by Lester et al. (1991). Ten of 14 core northeast tertiary watersheds were surveyed, providing winter and open water effort data for a total of 679 lake trout lakes. The 10 watersheds surveyed were selected to maximize the number of lake trout lakes included and to provide broad geographic representation across the region (Figure 2).

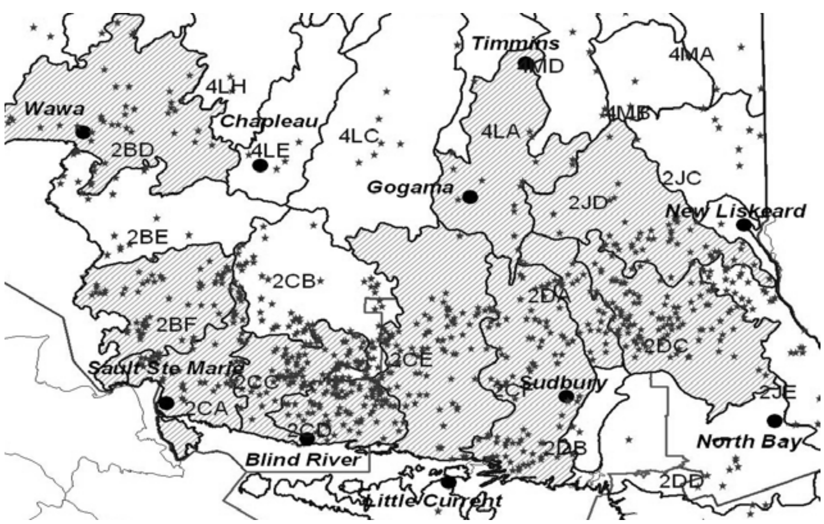

Figure 2: Geographic extent of aerial angler surveys in northeastern Ontario.

Flight lines were designed to maximize coverage within each surveyed watershed; however, in some cases outlying lakes were dropped to keep flight times reasonable. Data collection was stratified by tertiary watershed, angling season (winter vs. open water), and day type (weekdays vs. weekend days + holidays). One midday flight (i.e. between 1000 and 1400 hrs) was conducted each week, alternating between weekdays and weekends. Pressure estimates (E) were calculated by stratum from mean midday activity counts (MAC's) using the following formula from Lester et al. (1991):

$$E_j = \frac{MAC_j * T_j * \overline{p}_j * N_j}{K_{m,j}}$$

where j identifies a season, T is the length of the fishing day (14 hours for open water season, 10 hours for winter), p is mean party size (where parties were counted instead of individual anglers; e.g. in the case of occupied ice huts we applied an estimated party size of 2 anglers per hut), N is the number of fishing days in the season, and K_m is the midday bias factor.

Bias factors or expansion coefficients were used to adjust daily fishing pressure estimates obtained from midday activity counts. The bias factors applied were based on interim daily activity profiles established through preliminary analysis of available roving creel data (Scott Parker, personal communication) and are presented in Table 2. It should be noted that the factors applied do not exactly match the bias factors ultimately presented by Parker et al. (2006) and that the authors have recommended that additional work be undertaken to further refine species specific expansion coefficients. For some strata, the updated bias factors presented by Parker et al. (2006) are lower than the values applied and would result in higher pressure estimates, for other strata pressure estimates would be slightly lower. It is assumed that annual pressure estimates would vary little from those used to support the effort analysis presented in Section 4 of this report.

Table 2: Seasonal values for midday bias factors (K_m) used in expansion formulae.

Season	K_m (Weekdays)	K_m (Weekends & Holidays)
Winter (lake trout)	1.5	1.2
Open Water (general)	1.3	1.1

It should also be noted that although aerial survey methods do supply reasonable estimates of total fishing effort, one cannot partition fishing effort to a particular species without adding angler interviews to the survey design. This was not deemed practical given the coverage of 679 lake trout lakes in this survey. As a result, where multiple sportfish species are present, aerial estimates of total fishing pressure may over-state effort directed at any one particular species. An attempt was made to utilize existing roving creel data to develop guidelines to partition effort by target species where multiple sportfish exist (Scott Parker, personal communication). Unfortunately, there was not sufficient archived creel data by community type for NER to develop worthwhile guidelines in this regard. We fully support additional research in this area. We do however believe that the estimates of total angler effort obtained provide for meaningful comparison to established benchmarks for the majority of lake trout lakes in the northeast.

3.2 - Lake Trout Abundance

A second stage of data collection involved standardized index netting as a means to characterize lake trout abundance on an unbiased subset of lakes covered by the aerial effort surveys. Lakes were randomly selected by tertiary watershed and size class (small = 50 to 150 ha, medium = 150 to 400 ha, large = 400 to 20000 ha) to ensure adequate representation of lake sizes across NER. To ensure a robust dataset, a 20% sampling intensity was selected. The 20% random sample was further expanded through addition of 40 NER lakes selected from index netting data already available. Given a sample size considerably higher than would be realistic to expect from a provincial SoR monitoring program, the data collected will provide a solid baseline for future monitoring. The data will also provide information regarding among lake variation in measures of abundance and effort, which should help refine future SoR monitoring efforts.

Two different index netting standards were applied: Spring Littoral Index Netting or SLIN (Hicks, 1999) and Nordic Netting (Appelberg, 2000; Morgan and Snucins, 2005). SLIN data was for the most part collected by MNR District staff while the majority of the Nordic data was collected in partnership with Laurentian University's Cooperative Freshwater Ecology Unit. More regarding use of the index data collected to serve SoR evaluation needs is presented in Section 6.

3.3 - Water Quality

Finally, water quality sampling was conducted on the same random subset of lakes. Sampling was completed following ice-out and prior to thermal stratification of lakes (between May 3rd and May 19th, 2004), to ensure that lake waters were well mixed and that surface water samples were representative of whole-lake conditions (Clark 1995). Samples were obtained using a sub-surface grab technique, where water was taken from a depth of approximately 0.5 meters to avoid surface contamination. Measured parameters included pH, alkalinity, conductivity corrected to 25˚C, dissolved organic carbon (DOC), total phosphorous (TP), total kjeldahl nitrogen (TKN), turbidity, and colour. Standard conductivity was converted to total dissolved solids (TDS = 0.666 x Conductivity), a measure of nutrient availability and a key parameter used in the benchmarking process (see Section 6.0). The other parameters, such as pH, are considered to be general indicators of habitat suitability that will serve to support further investigation of key population drivers and as a baseline to monitor changes over time. The water quality data collected is presented in Appendix 2.

4.0 - Characterizing Angler Effort across NER

Characterizing lake trout angling effort across NER was a key deliverable of the Northeast Lake Trout Project. Aerial pressure counts were conducted between 2001 and 2003, covering both open water and winter seasons. Refer to Section 3.1 for detail regarding the data collection methods employed.

Individual lake estimates of open water, winter, and annual fishing pressure based on the aerial pressure counts conducted between 2001 and 2003 are stored in NER's new lake trout browser, available as an extension to this report. Reference points for fishing pressure at maximum sustained yield (E_{msy}) were also calculated for each lake, where TDS data was available (Equation A3.4, Appendix 3).

Approximately 32% of lakes surveyed support valued warm water sportfish species in addition to lake trout, specifically walleye, smallmouth bass and/or northern pike. In order to test the assumption that effort was not different on these more diverse fisheries, separate t-tests were used to compare mean estimated annual effort on lakes with and without each of the species of interest. No significant differences in mean effort were detected. Furthermore, with lakes classified as to presence / absence of any one of the three species, a t-test used to compared mean estimated annual effort again returned a non-significant result ($t_{524} = 0.42$, $P = 0.67$). Based on these comparisons, it was decided to adopt a conservative approach to analyses. All effort documented was assumed to be effective towards lake trout and the fishing pressure estimates obtained were compared to lake trout specific values of E_{msy}.

Historical effort data points were also available for a number of lakes stratified by season (open water, winter) or as annual estimates. These data were compiled from aerial pressure counts and roving creels conducted between 1975 and 1994. In total, there were 117 lakes with historical winter estimates, 121 lakes with summer estimates, and 106 lakes with annual estimates. The majority of these lakes were in FMZ 10 and no historical data were available for FMZ 8.

The 679 lakes surveyed were sorted by stock status code; 529 or 78% of the lakes surveyed are considered to be self-sustaining or are being stocked on a supplemental basis (N1, I1, R1, and N3). A mean regional benchmark (E_{msy}) for these self-sustaining lake trout lakes was found to be 6.4 angler-hours per hectare (ang-hrs / ha). The mean annual angling intensity documented for the same self-sustaining lakes was 5.4 ang-hrs / ha. While this would seem encouraging, documented angling intensity ranged from 0 to 30+ ang-hrs / ha and 32% of the lakes surveyed were found to have documented angler effort exceeding E_{msy} (Figure 3). The diagonal line on the scatter plot is the 1:1 line; all data points above this line had estimated effort that exceeded E_{msy}.

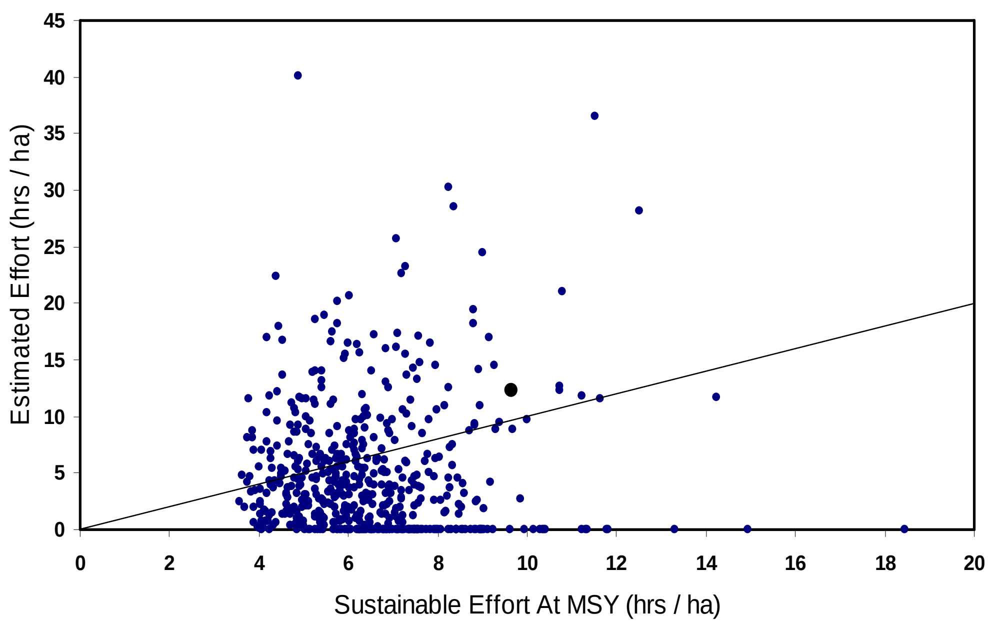

Figure 3: Documented angler effort versus sustainable angler effort (E_{msy}).

To explore potential factors that may affect effort, NER's new lake trout database was used to classify each surveyed lake for the following:

- Presence / absence of cottages
- Presence / absence of tourist outfitters
- Existence of modified angling seasons (i.e. modified winter or summer lake trout seasons)

In addition, spatial analysis was undertaken to evaluate lake accessibility. Road density in km per km^2 was calculated for each surveyed tertiary watershed and quality of access to each individual lake was classified one of seven ways:

1. Highway
2. Primary road
3. Secondary road
4. Tertiary road
5. Trail (lake > 500m but < 1000m from a road)
6. Remote (lake > 1000m from a road)
7. Restricted (gated or posted roads only)

Spatial analysis was also undertaken to determine the straight line radius from each lake to population breaks of 5000, 10000, 25000 and 50000 people. For road accessible lakes, time-to-lake was also calculated from each population centre in NER with a population base exceeding 3000. These times were based on the combination of roads needed to access the lake and an assigned travel speed for each road type (Table 3).

Table 3: Travel speeds assigned by road class for time-to-lake analysis.

Road Standard	Assigned Travel Speed (km / hr)
Highway	100
Primary	80
Secondary	40
Tertiary	20

4.1 - Temporal and Spatial Trends

Three separate paired t-tests were used to compare historical (1975 through 1994) and current estimates of winter, open water and annual angling intensity (hours•ha^{-1}). Data were transformed to logarithmic base 10 to meet parametric assumptions. For 106 lakes where both historic and current estimates of annual angling intensity were available, historical estimates were found to be significantly higher than current ones by about 2.3 hours•ha^{-1} (paired t-test: $t_{105} = 4.31$, $P < 0.001$; Figure 4).

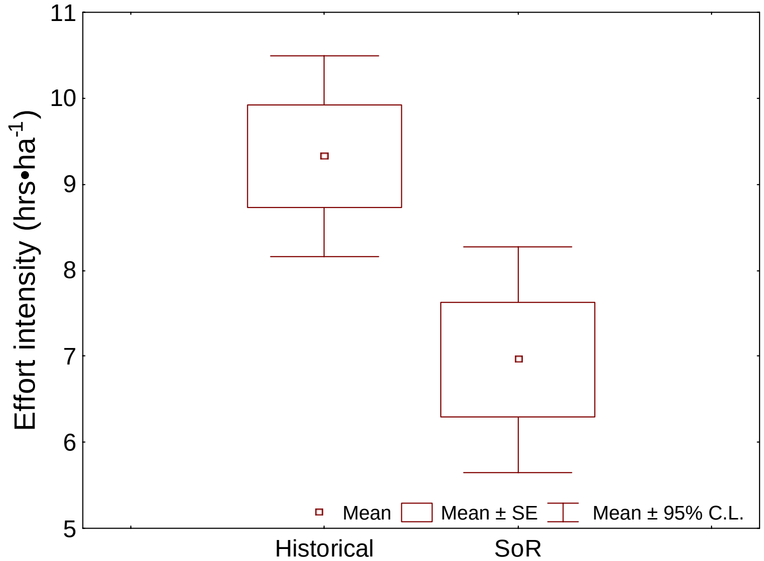

Figure 4: Historical estimates of annual effort intensity (hours•ha^{-1}) versus current estimates (SoR).

Most of the documented reduction occurred during the open water season (-2 hours; paired t-test: $t_{120} = 5.68$, $P < 0.001$), although old estimates of winter angling intensity were still significantly higher than current ones (paired t-test: $t_{116} = 2.71$, $P < 0.001$).

With the effort data summarized by tertiary watershed, spatial trends were also apparent. Figure 5 presents mean values of estimated effort intensity, for self-sustaining lake trout lakes, by surveyed watershed as compared to watershed specific E_{msy} reference points. The watersheds are colour coded: mean estimated effort well below mean E_{msy} in green, mean estimated effort approaching E_{msy} in yellow (within 1.0 ang-hr / ha of E_{msy}), and mean estimated effort exceeding E_{msy} in red.

Mean estimated effort intensity was found to be highest in areas adjacent to Sault Ste. Marie, Blind River, and Elliot Lake (i.e. watersheds 2BF, 2CA, and 2CD). By comparison, mean effort intensity was considerably lower in watersheds 2JD, 2CE, and 2BD all of which are removed from significant population centers. Effort intensity was found to be intermediate in watersheds 2CF, 2DA, and 2DC within reach of Sudbury and/or North Bay. Given that Greater Sudbury has a population base at least double that of Sault Ste. Marie, it is somewhat surprising that the watersheds nearer to Sudbury were fished less intensely than watersheds closer to Sault Ste. Marie. It is believed that this trend is related to poor resource status around Sudbury likely owing to the impacts of acidification and past exploitation. This assumption is explored in Section 7.2.

Figure 6 provides a slightly different view of effort distribution across the landscape. Watershed boundaries are dropped and the surveyed lakes are grouped by individual comparison to the regional E_{msy} benchmark of 6.4 ang-hrs / ha: landscape with estimated effort intensity below E_{msy} in green; landscape with estimated effort intensity exceeding E_{msy} in red. The figure further demonstrates an association between population centres and unsustainable levels of fishing pressure, the notable exception being the landscape adjacent to Sudbury, to be discussed later.

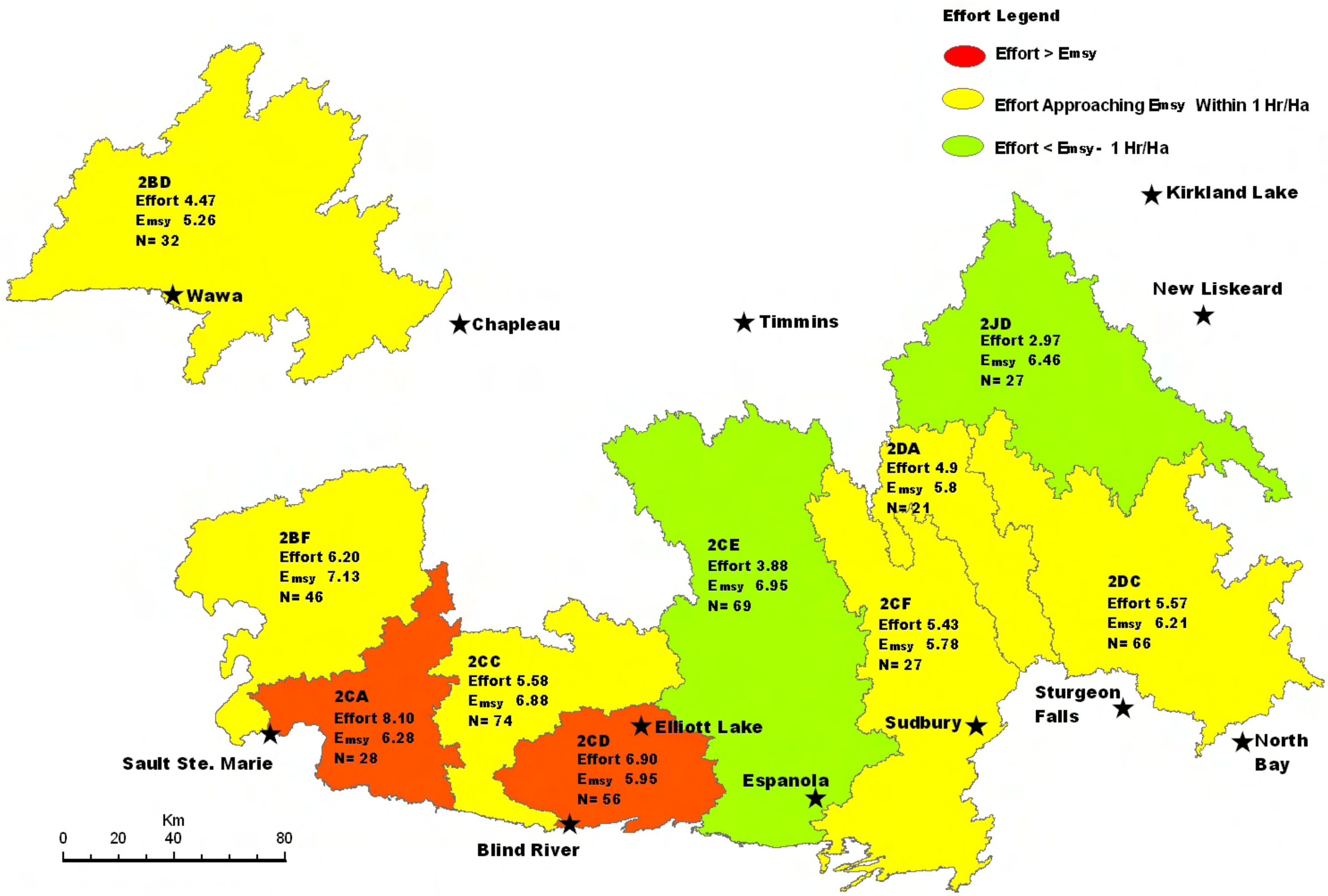

Figure 5: Mean estimated annual effort intensity (ang-hrs / ha) by watershed as compared to mean sustainable benchmarks (i.e. mean values of E_{msy} by watershed).

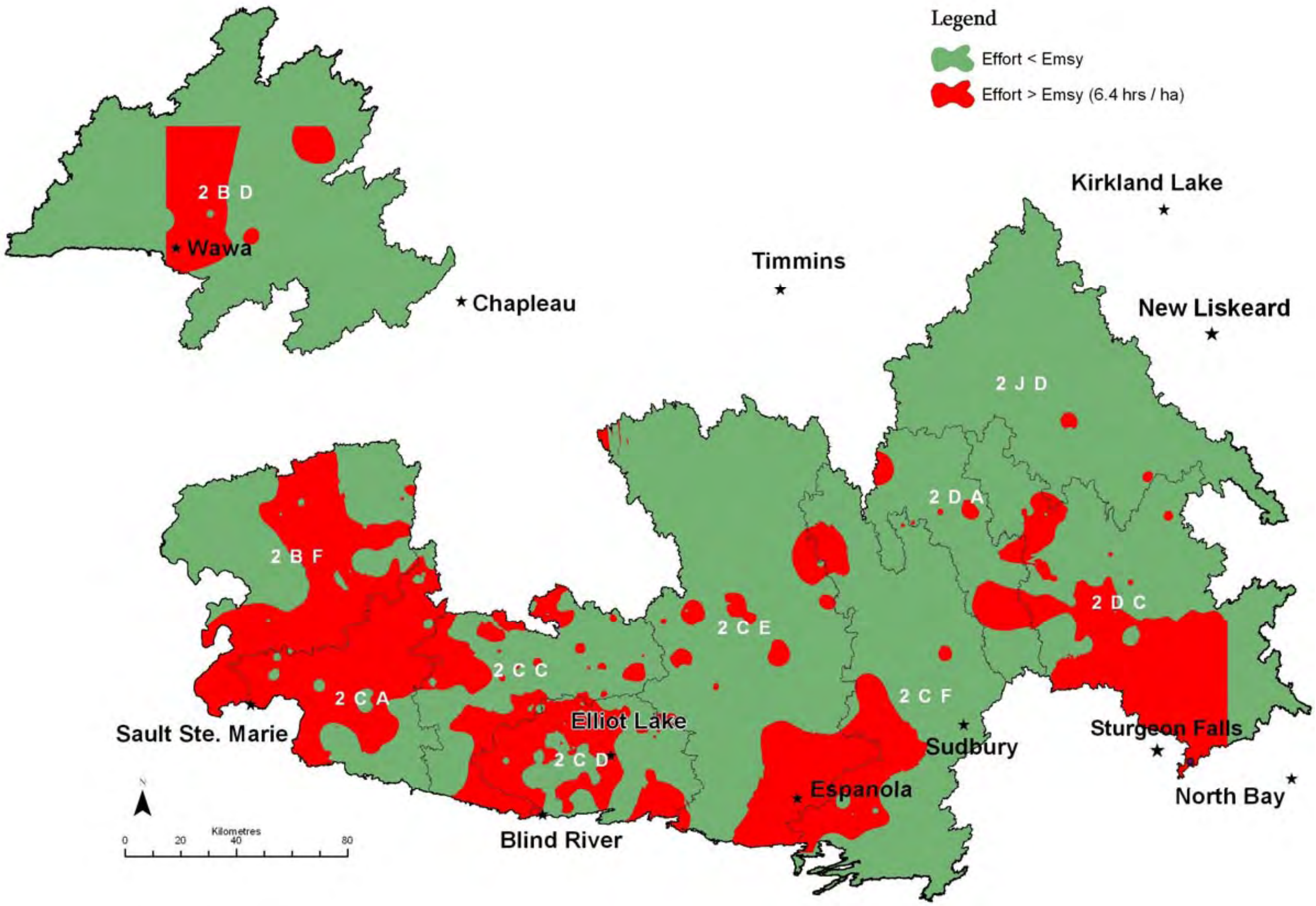

Figure 6: Distribution of unsustainable angling effort in NER as determined through comparison of individual lake pressure estimates to the regional E_{msy} benchmark of 6.4 ang-hrs / ha.

As background towards implementation of Ontario's new Ecological Framework for Recreational Fisheries Management (OMNR 2005), annual and seasonal effort estimates were compared across the proposed new fisheries management zones (FMZ's). One-way analysis of covariance (ANCOVA) was used to determine if total effort differed by FMZ while controlling for lake surface area and one-way multivariate analysis of covariance (MANCOVA) was used to explore differential seasonal responses in effort by FMZ, controlling for surface area. Lake surface area-corrected angling effort did not differ between FMZ's (ANCOVA $F_{3,674} = 0.42$, $P = 0.74$), nor was there a differential seasonal response to angling between FMZ's (MANCOVA Wilks Lambda = 0.99, $F_{6,1324} = 1.25$, $P = 0.28$).

4.2 - Seasonal Effort and Lake Surface Area

Angling effort (total hours) was related to lake surface area via linear correlation. Both axes were base ten logarithmic transformed to meet parametric assumptions. Slopes were compared using a t-test. Angling effort was found to be highly positively correlated with lake surface area, that is, larger lakes received more effort. This was evident in both winter and open water seasons, however large lakes received proportionally more effort during the open water season, and small lakes received proportionally more effort during the winter, as the slope of winter effort was significantly less than the slope of open water effort (t-test: $t_{1332} = 6.99$, $P < 0.05$; Figure 7).

Half of the observed variation in open water effort was explained by lake surface area. This dropped to less than a quarter of the variation seen in winter effort. Overall, lake surface area explained 47% of the variation seen in annual angling effort ($r^2 = 0.47$, $P < 0.001$).

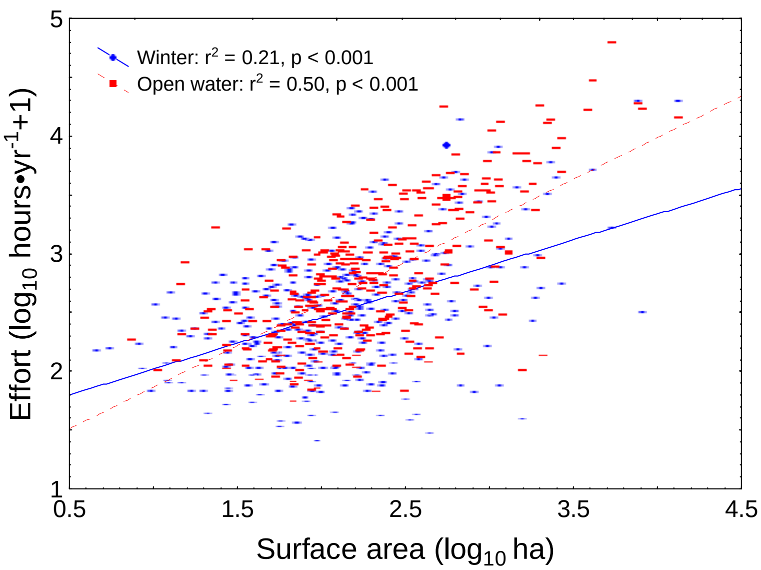

Figure 7: Lake trout winter and open water angling effort ($\log_{10}$ hours+1) versus lake surface area ($\log_{10}$).

Linear regression revealed a positive relationship between open water and winter angling intensity ($r^2 = 0.11$, $P < 0.001$), therefore lakes that tend to get fished more intensely in the summer are also fished more intensely in the winter (Figure 8).

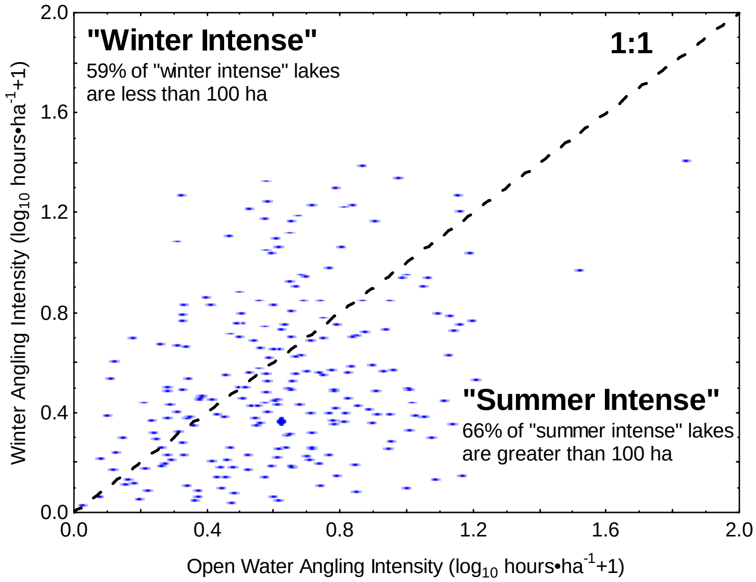

Figure 8: Winter angling intensity ($\log_{10}$hours•ha^{-1}+1) versus open water angling intensity. The line shown is y = x (1:1) to demonstrate lakes which receive proportionally more winter pressure (above line) and proportionally more summer effort (below line).

One tailed t-tests were used to test if the slope of the regression was less than 1, and if the intercept was greater than zero. The slope of the regression was significantly less than one (0.39; $t_{229} = 8.86$, $P < 0.001$), which shows the intensity of winter effort proportionally decreases as open water intensity increases. Furthermore, the intercept was significantly greater than zero (0.29; $t_{229} = 5.76$, $P < 0.001$), thus a lake with no open water effort can still expect approximately 1 hour•ha^{-1}during the winter.

An examination of the lakes which are "winter intense" (lakes above the 1:1 line; Figure 8) shows that the majority of these lakes were under 100 ha (59%), whereas the "summer intense" lakes were mostly over 100 ha in size (66%). Chi^2 analysis showed the disproportionate frequency of small lakes above the 1:1 line and lakes >100 ha below the line was significant ($\chi^2_1 = 31.08$, $P < 0.001$).

Winter and open water angling intensity (hours•ha^{-1}) was compared between lakes with surface areas <100 ha, 100-500 ha, and >500 ha using a multivariate analysis of variance (MANOVA). Lakes greater than 100 ha in size were fished significantly more intensely than lakes less than 100 ha by an average of 0.38 hours•ha^{-1} ($F_{2, 676} = 6.53$, $P = 0.002$). However, angling intensity differed significantly by season as well (MANOVA: Wilks Lambda = 0.91, $F_{4,1435} = 15.23$, $P < 0.001$). Lakes less than 100 ha in size were fished more intensely during the winter season, while lakes larger than 100 ha were fished more intensely during the open water season (Figure 9).

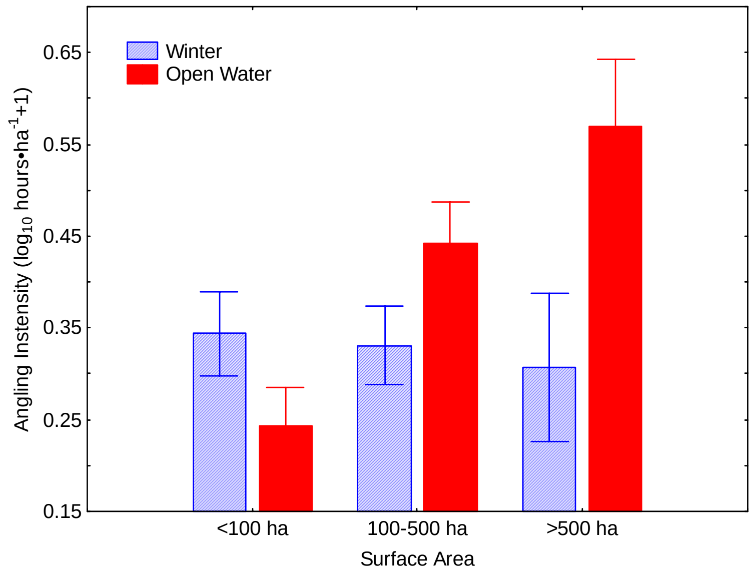

Figure 9: Winter and open water angling intensity ($\log_{10}$ hours•ha^{-1}+1)(±95% confidence interval) on different sized lakes.

4.3 - Anthropogenic Effects

Road density was explored as a potential driver of the spatial effort patterns documented in Section 4.1. Linear regression revealed a significant positive relationship between angling intensity and road density as expressed in kilometers of road per square kilometer of watershed (r^2 = 0.57, P = 0.01; Figure 10).

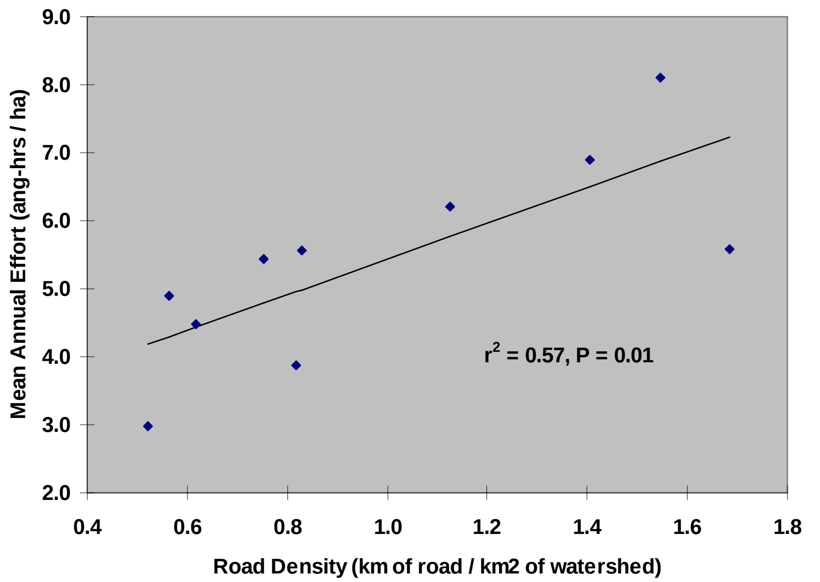

Figure 10: Mean estimated annual angling intensity versus road density by watershed.

One-way ANCOVA was used to explore differences in total effort based on road accessibility and one way MANCOVA was used to examine if seasonal effort differed by road accessibility. Both tests controlled for lake surface area. Total annual effort (corrected for surface area) was found to be significantly higher on highway access lakes as compared to trail, remote and restricted access lakes ($F_{6, 672} = 2.93$, $P = 0.008$). There was a differential seasonal response in angling effort to lake accessibility (MANCOVA Wilks Lambda = 0.94, $F_{12,1318} = 3.59$, $P < 0.001$), where there was a consistent decline in open water effort with decreased accessibility, but winter effort was unchanged regardless of access type (Figure 11).

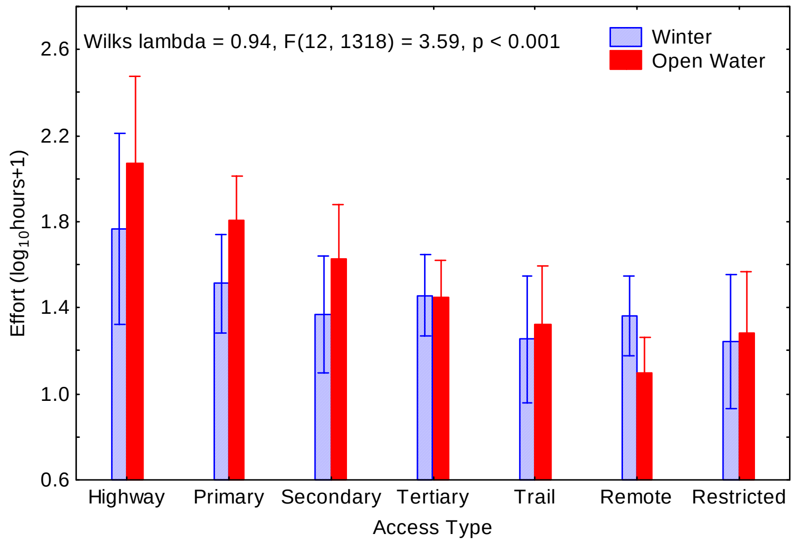

Figure 11: Lake trout angling effort (±95% confidence interval) by access type. Means are adjusted to a 100 ha lake.

Within each access type, the only significant seasonal difference found was that remote lakes received significantly more effort in the winter than in the open water season ($t_{168} = 2.28$, $P = 0.02$). These results indicate that many remote lakes are readily accessed by snowmobile.

One-way MANCOVA was used to determine differences in winter and open water effort on lakes with / without cottages and with / without modified angling seasons, controlling for lake surface area in each case. Angler effort (corrected for lake surface area) significantly increased during both the open water and winter seasons with the presence of cottages (Wilks lambda = 0.94, $F_{2,664} = 21.24$, $p < 0.001$; Figure 12). This suggests that cottagers may account for a large portion of effort on the lake of their residency, and they may be less likely to travel for angling opportunities.

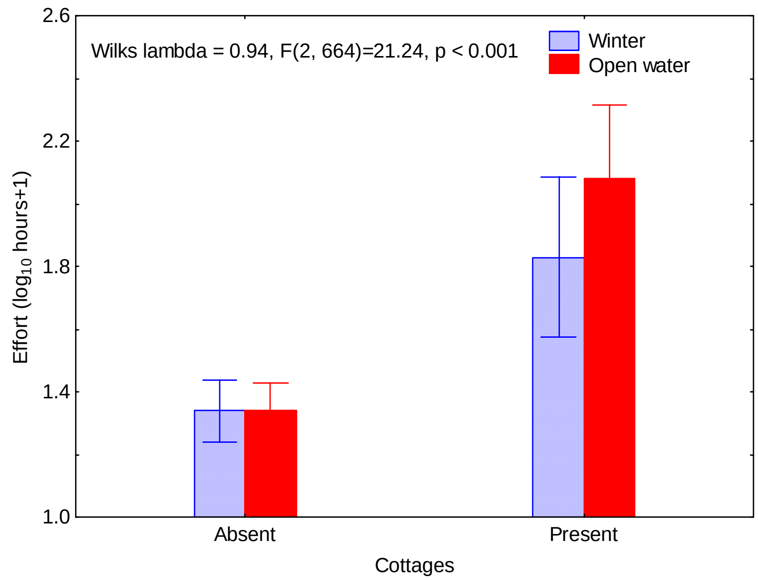

Figure 12: Lake trout angling effort ($\log_{10}$hours+1) (±95% C.L.) on lakes with and without cottages

Winter angling effort did not differ on lakes with or without modified winter seasons (ANCOVA $F_{1,668} = 0.03$, $P = 0.87$) and open water effort was actually significantly higher on lakes with modified open water seasons (ANCOVA $F_{1,673} = 4.12$, $P = 0.04$), possibly owing to the increased likelihood of accessible cottage lakes having modified regulations. A two-way ANCOVA was run to test differences in open water effort on lakes with / without cottages and with / without modified open water regulations. Only the presence of cottages resulted in a significant increase in effort (ANCOVA $F_{1,671} = 11.61$, $P < 0.001$) which indicates that accessible, developed lakes are fished more, regardless of the regulation in place. Further reasons for this are discussed in Section 4.4 below. One-way ANCOVA was used to determine the effect of the presence of tourist outfitters (main tourist lodge, remote tourist outpost, and no outfitter presence) on open water effort, controlling for surface area. Open water angling effort was significantly higher on lakes with tourist lodges compared with remote tourist outposts and no tourism presence (ANCOVA $F_{2,671} = 3.33$, $P = 0.04$).

4.4 - Observed Effort and Effort at Maximum Sustainable Yield

A paired t-test was used to investigate observed angling intensity (hours•ha^{-1}) versus effort at maximum sustainable yield (E_{msy}) on lakes with cottages. Chi^2 analysis was used to test frequencies of lakes where observed angling intensity was greater than or less than E_{msy} by presence / absence of cottages, by access type and by surface area category (three separate tests).

The presence of cottages is normally associated with easy access, which would work in tandem to account for the elevated effort observed on these lakes. Mean annual fishing intensity on cottage lakes was nearly 2.5 hours•ha^{-1} greater than the mean value for effort at maximum sustainable yield (E_{msy}) for these lakes, yet differences were not statistically significant (paired t-test: $t_{85} = 0.72$, $P = 0.48$). There was a significantly higher proportion of lakes with cottages that exceeded E_{msy} (72%; chi^2: $\chi^2_1 = 24.49$, $P < 0.001$). In addition, the proportion of lakes that exceeded E_{msy} significantly increased as ease of accessibility increased (chi^2: $\chi^2_6 = 33.12$, $P < 0.001$). For example, 57% of highway accessed lakes had observed effort greater than E_{msy}, whereas only 20% of remote access lakes surpassed this benchmark.

Of equal concern was the proportion of large (> 500 ha) lakes where the observed annual angling intensity surpassed E_{msy} (Table 4).

Table 4: Percent of lakes by surface area category where observed angling intensity (E_{obs}, hours•ha^{-1}) is less than or greater than effort at maximum sustainable yield (E_{msy}, hours•ha^{-1}). Numbers in parentheses are the number of lakes.

Lake Surface Area	0-100 ha (274 lakes)	100-500 ha (230 lakes)	>500 ha (69 lakes)	Total (573 lakes)
E_{obs} greater than E_{msy}	25 %	37 %	45 %	32 %
E_{obs} less than E_{msy}	75 %	63 %	55 %	68 %

Seventy-five percent (206 of 274) of lakes <100 ha had observed effort less than sustainable levels, whereas 63% (135 of 230) of lakes between 100 and 500 ha had observed effort less than E_{msy}. Of lakes larger than 500 ha, only 55% were found to have sustainable levels of effort (chi^2: $\chi^2_2 = 14.38$, $P < 0.001$). Overall, observed angling intensity was below E_{msy} benchmarks for 68% of lakes surveyed where data required to estimate E_{msy} was available.

4.5 - Predicting and Characterizing Effort

Stepwise multiple linear regression was used to a) determine the predictability of effort (total hours), and b) determine the major influences on effort. Since the majority of the variation in effort could be attributed to lake surface area, the residuals of the effort – surface area regression were extracted and entered into three separate multiple regression models (annual effort, winter effort, open water effort) to see if additional variation could be explained by relative proximity to population centres. The potential predictor variables explored included: straight line radius to set population breaks of 5000, 10000, 25000, and 50000; time-to-lake by road from NER population centres with populations exceeding 3000; and 'population-weighted' straight line distances and times-to-lake. In the end, a hybrid of the two approaches to evaluating proximity to population centres was selected. Specific predictor variables used in the final regression models were population weighted times-to-lake by road from the specific population centres which broke the population thresholds of 5000, 10000, 25000 and 50000 using the straight line model. For example, to calculate the 'population weighted' time-to-lake for a lake 50 minutes from Wawa (pop'n 6800): $6800 \cdot 50^{-1} = 136$, vs. a lake 120 minutes from Sudbury (pop'n 160000): $160000 \cdot 120^{-1} = 1333$.

The multiple regression model developed for annual effort was:

$$\text{Annual Effort} = -1.29 + 0.33 \mathit{TTL*POP5} + 0.22 \mathit{TTL*POP25} \quad (r^2 = 0.04, P < 0.001)$$

where, *TTL*POP5* is the population weighted time-to-lake from the population break of 5000 people, and *TTL**POP25 is the population weighted time-to-lake from the population break of 25000 people. Since this model explained only 4% of the variation above the 47% already explained by lake surface area, annual angling effort was largely unrelated to distances and times from population centres. Furthermore, 3.5% of the 4% explained variation was accounted for by the population weighted time-to-lake from the closest 5000 people, which indicates that the larger the closest population centre, the more effort the lake is likely to have received over the year. However, with only 4% of the variation explained, the predictive power of this equation is very low.

The multiple regression model developed to characterize open water effort was:

Open water effort = 0.09 + 0.43*TTL*POP5* - 0.52*TTL*POP50* + 0.22*TTL*POP10*
($r^2 = 0.06$, $P < 0.001$)

where, *TTL*POP5* is the population weighted time-to-lake from the population break of 5000 people, *TTL*POP50* is the population weighted time-to-lake from the population break of 50000 people, and *TTL*POP10* is the population weighted time-to-lake from the population break of 10000 people. However as in the model for total effort, the majority of the explained variation (4% of 6%) was accounted for by the population weighted time-to-lake from the closest 5000 people. Since the model explained only 6% of the observed variation in open water effort above the 50% explained by lake surface area, patterns in effort were again largely unrelated to geographical location.

Lastly, the multiple regression model developed for winter effort was:

Winter effort = 0.79*TTL*POP50* + 0.54*TTL*POP5* - 0.35*TTL*POP10* -2.68
($r^2 = 0.06$, $P < 0.001$)

where, *TTL*POP50* is the population weighted time-to-lake from the population break of 50000 people, *TTL*POP5* is the population weighted time-to-lake from the population break of 5000 people and *TTL*POP10* is the population weighted time-to-lake from the population break of 10000 people. With only 6% of the variation explained, very little variation in winter effort above the 21% explained by lake surface area was accounted for by geographic location. Furthermore, the time-to-lake from the closest 50000 people accounted for 5% of the 6% explained variation.

The commonality of the population weighted time to lake from 5000 people during the open water season and for annual effort indicates that overall, local populations account for more effort. However in the winter, the time to lake from the closest 50000 people was the largest driver of observed effort, which suggests that people from large population centres are traveling greater distances to angle a lake. Nonetheless, with such little variation explained by these models, it is difficult to justify conclusions and the models developed are not recommended for use as a predictive tool. The results are however highly indicative that effort is driven by factors largely unrelated to proximity to urban centres.

Two potential drivers beyond proximity to urban centres were explored in a final attempt to explain the variation in angler effort observed across NER: angling quality and quality of access. Biomass in grams per net (Nordic standard) was selected as a surrogate of angling quality inferring that few large fish or many small fish provide for similar levels of angler satisfaction. Quality of access is defined in Section 4.0. The subset of lakes used included 62 lakes evaluated using the Nordic standard. Lakes with zero effort or questionable biomass calculations were excluded. Linear regression analysis was used to relate documented angler effort to lake trout biomass, with the dataset split into lakes with and without road access (Figure 13).

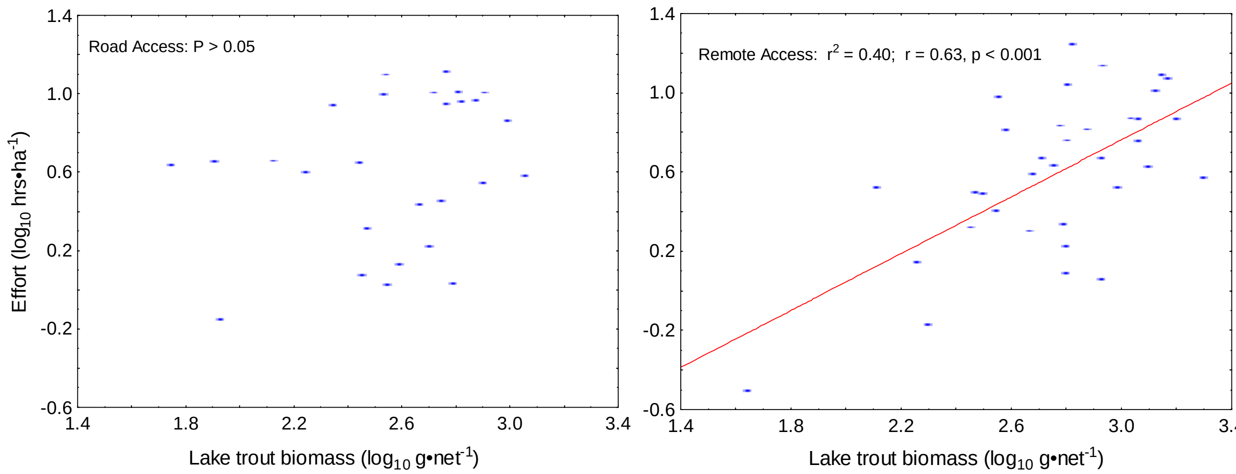

Figure 13: The effect of lake trout biomass as a surrogate of angling quality on documented effort intensity.

For remote lakes, angler effort was found to be positively correlated with lake trout biomass indicating that anglers are willing to work harder to access a lake for a high quality angling experience. This relationship did not hold true for road accessible lakes indicating that readily accessible lakes tend to be fished independent of quality.

Stepwise multiple linear regression was used to further tease out the interaction of accessibility and angling quality as key drivers of fishing pressure. The regression model developed for annual effort was:

$$\log_{10}\text{Effort (total hrs)} = 0.79 \log_{10}\text{Surface Area} + 0.48 \log_{10}\text{Biomass} - 0.57 \log_{10}\text{Access} + 0.50$$
$$(r^2 = 0.52, P < 0.001)$$

The model explained 52% of the observed variation in fishing pressure. Biomass and accessibility explained 16% of the variation beyond that explained by surface area alone: 10% by biomass, and 6% by accessibility. Both factors play a significant role in the distribution of effort across the landscape.

5.0 - Index Netting Results

Appendices 4 and 5 present a summary of the Nordic and SLIN netting surveys completed towards state-of-resource (SoR) reporting in NER (i.e. a representative subset of self-sustaining lake trout lakes); Nordic and SLIN data are provided separately. Neither the biological parameters nor the CUE values presented are directly comparable between standards given different survey methodologies and gear selectivity. Regional reference statistics are provided for each netting standard to facilitate consideration of individual lake results. Note that only lakes with a sample size of 10 or greater (i.e. number of fish sampled) were included in calculation of the regional reference values for fork length, weight, condition, and age. Furthermore, the number of lakes included in calculation of the regional reference values for age was lower than for the other biological parameters. Age interpretations were not available for all surveyed lakes at the time of reporting. Aging priorities were set based on sample size as well as the type and reliability of the aging structures collected. Use of the regional reference values presented for age should take sample size (number of lakes) into consideration. The reference values for length, weight, and condition are more robust. A more detailed analysis of the index data collected towards SoR reporting is presented in Section 7. CUE data was converted to estimates of adult density making comparison between netting standards possible.

Appendices 6 and 7 present similar netting data for lakes beyond the SoR dataset, including data collected towards evaluation of acid damaged lakes and data assembled as a product of the data capture and cleaning exercise referenced in Section 2.0. Note that the regional reference values provided are the same as those presented in Appendices 4 and 5. It was decided that regional benchmarks should be based on the representative lake set as potential recovery targets for acid damaged and other degraded populations.

All lake trout captured via the index netting surveys were biologically sampled. Nordic netting is a lethal method and otiliths were extracted to determine lake trout ages. The SLIN standard on the other hand is non-lethal and lake trout ages were interpreted from either scales or fin rays where age interpretations are considered suspect (Casselman 1990). Given that lake trout sample sizes tend to be relatively low using either netting standard, only a small proportion of the lakes sampled were found to have sample sizes which would support worthwhile individual lake analysis. Undertaking so few lake specific analyses was not deemed critical to assessment of resource status at a regional scale. As an alternate approach, biological data were mined from available NER Nordic Fishnet files and pooled to support the life history analysis presented below. Approximately 4000 individual lake trout samples are represented from 105 lakes. Table 5 presents a summary of mean values for lake trout age, length, and weight for the pooled database.

Table 5: Mean values for age, length, and weight of lake trout sampled via the Nordic method from 105 lakes between 2000 and 2005.

	N	Mean Age (yrs)	Fork Length (mm)	Total Length (mm)	Mean RWT (g)
All Fish Sampled	3954	7.1	355	400	752
Females Only	1646	7.3	366	410	763
Males Only	1579	8.4	389	436	896

Figures 14 and 15 present length at age data for male and female lake trout. Note that there is substantial variation in growth and that the observed variation becomes most evident beyond age 10. It should also be noted that male and female growth patterns would appear to be very similar. Student’s t-tests were used to verify that there was no difference between males and females sampled for length at age 5 (t_{227} = 0.74, P = 0.46) and length at age 10 (t_{55} = 0.88, P = 0.38).

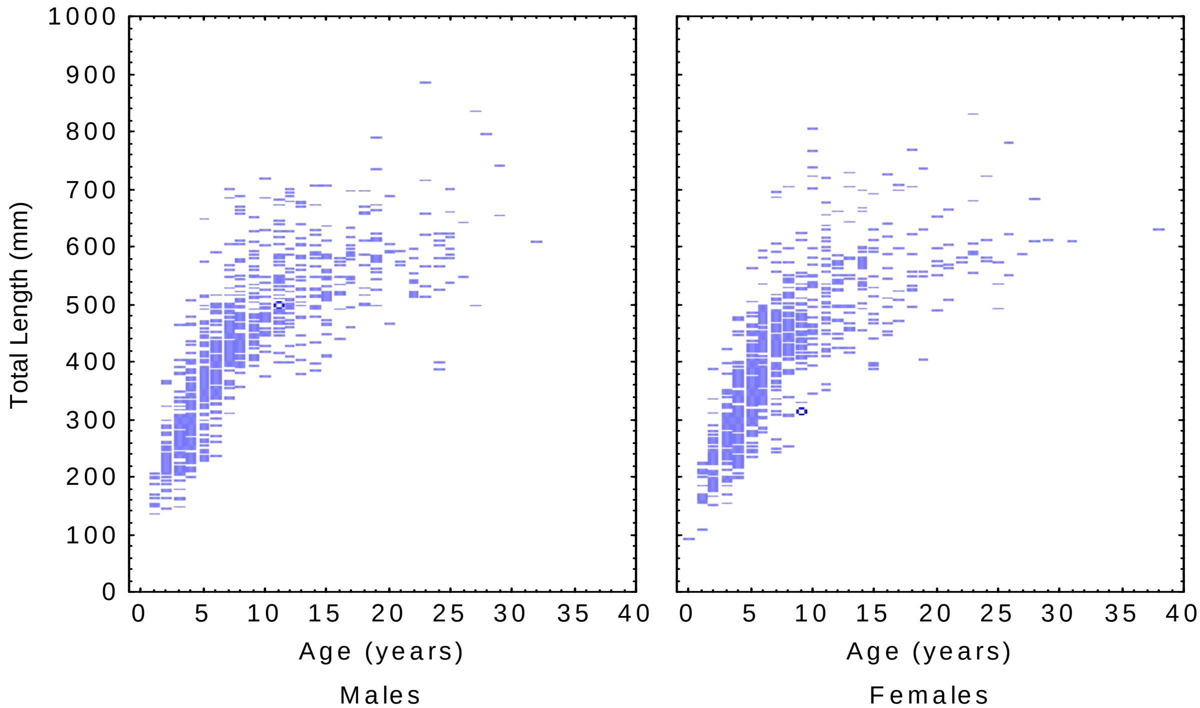

Figure 14: Scatter plot of total length at age for male and female lake trout sampled.

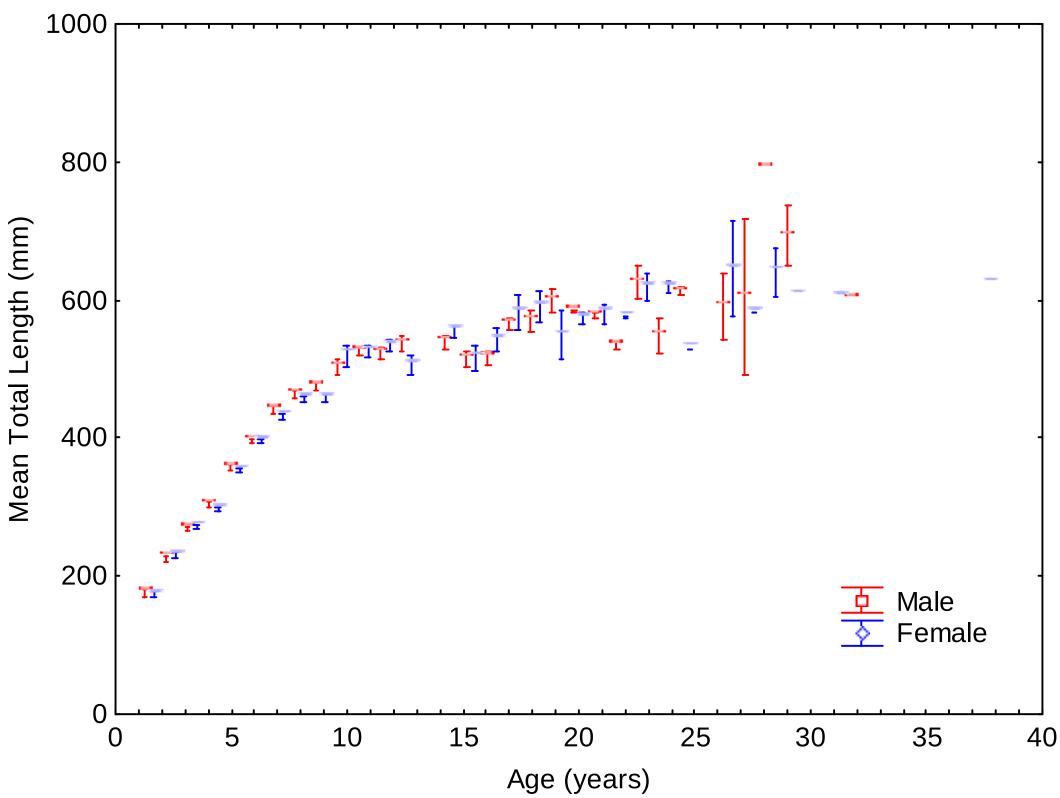

Figure 15: Mean length at age (showing 95% CL's) for male and female lake trout sampled.

Age and length distributions were also investigated (male, female, and combined). Initially, visual comparison of male and female age distributions indicated that there were fewer female lake trout beyond age 10. Chi^2 analysis confirmed that, with lake trout samples pooled across the region, there were disproportionately fewer females caught beyond age 10 (19.1% versus 28.0% for males; $\chi^2_1 = 20.78$, $P < 0.001$). A t-test used to compare mean age for male and female lake trout (8.4 yrs versus 7.3 yrs respectively) supported this finding ($t_{1902} = 4.50$; $P < 0.001$). Such a result could be related to sex-specific reproductive costs. Higher active metabolic cost for females can result in higher catchability given increased energy requirements for gonad development. Recent analyses (Casselman 2004) suggest that mature female lake trout are more vulnerable to angling from mid to late summer. Specifically, gonad development in lake trout commences after July 1 and the proportional harvest of mature females can increase to 70% when only 13% of the population falls into this category.

Although sex based differences associated with older age classes were found, length and age distributions for male and female lake trout were combined and data is presented in Figures 16 and 17.

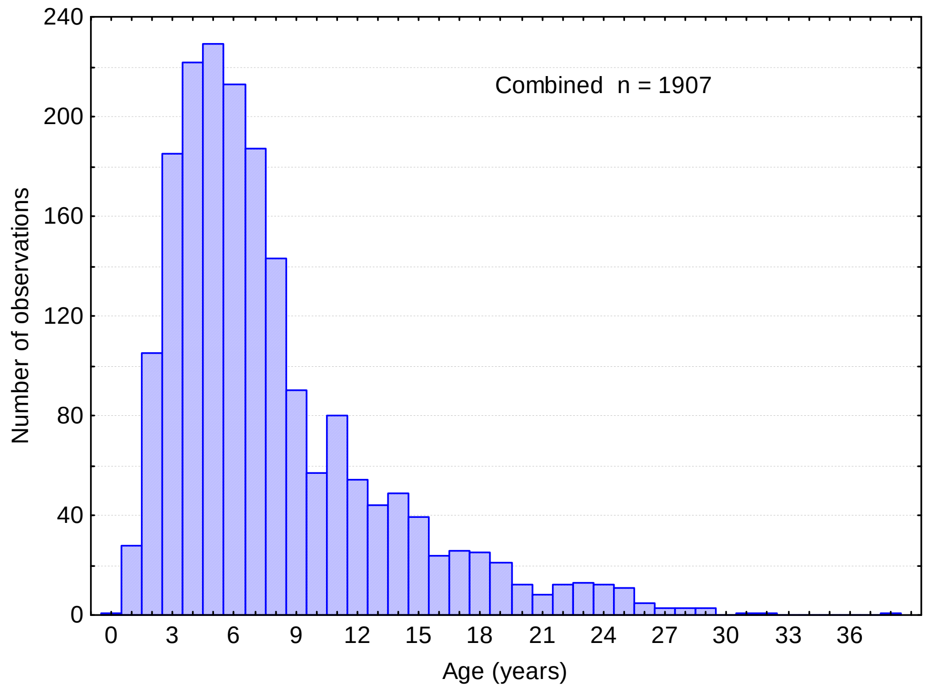

Figure 16: Age frequency distribution for all lake trout sampled.

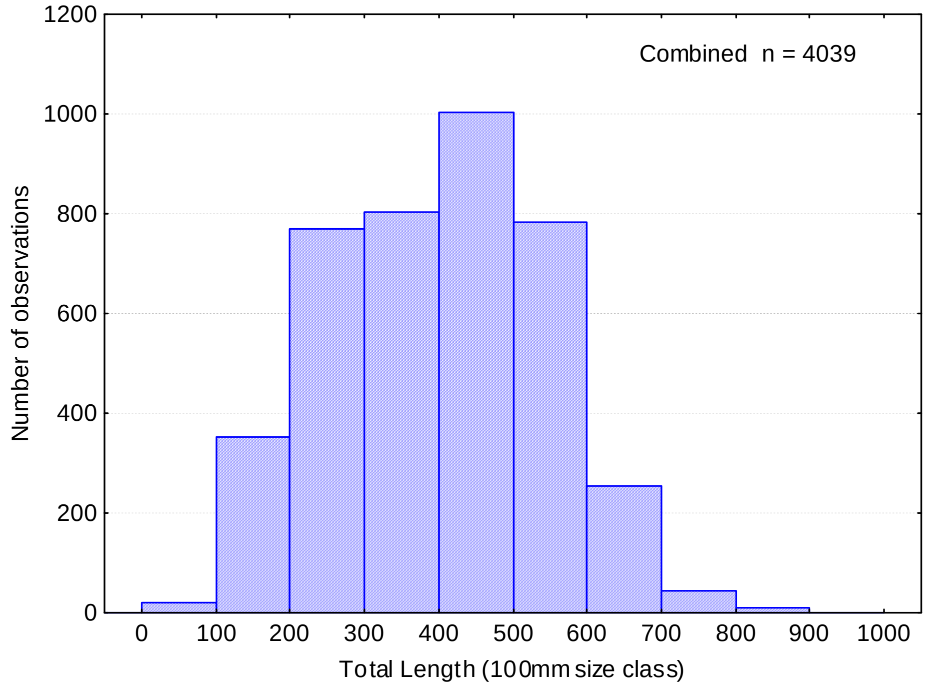

Figure 17: Length frequency distribution for all lake trout sampled.

Note that the most abundant cohort sampled for both sexes was age 5, representing the age of full recruitment to the Nordic gear. Lake trout maturity data was also reviewed. Results for female lake trout are presented in Figure 18 and Table 6 while Figure 19 and Table 7 present the results for males.

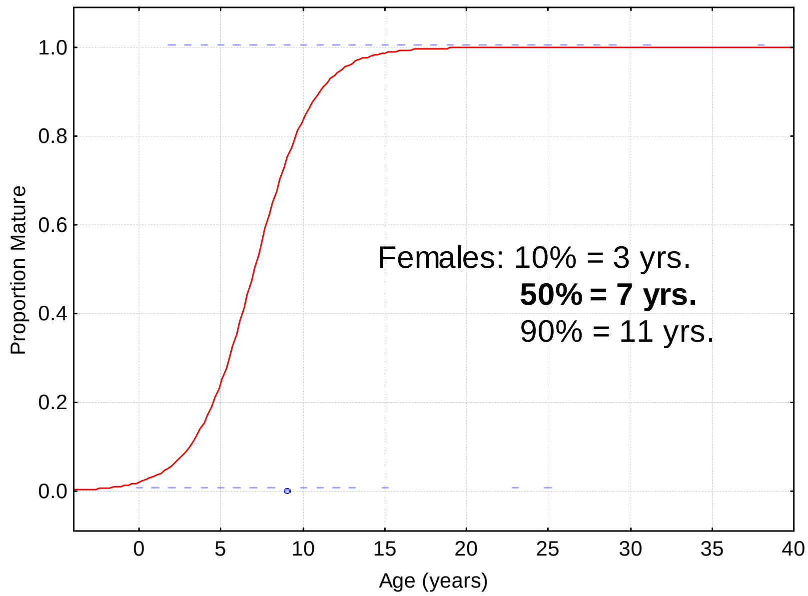

Figure 18: Proportion of female lake trout mature by age for NER.

Table 6: Maturity schedule for female lake trout in NER by age, length, and weight.

Proportion Mature	Age (years)	Total Length (mm)	Weight (g)
10% Mature	3	301	218
50% Mature	7	402	552
90% Mature	11	538	1276

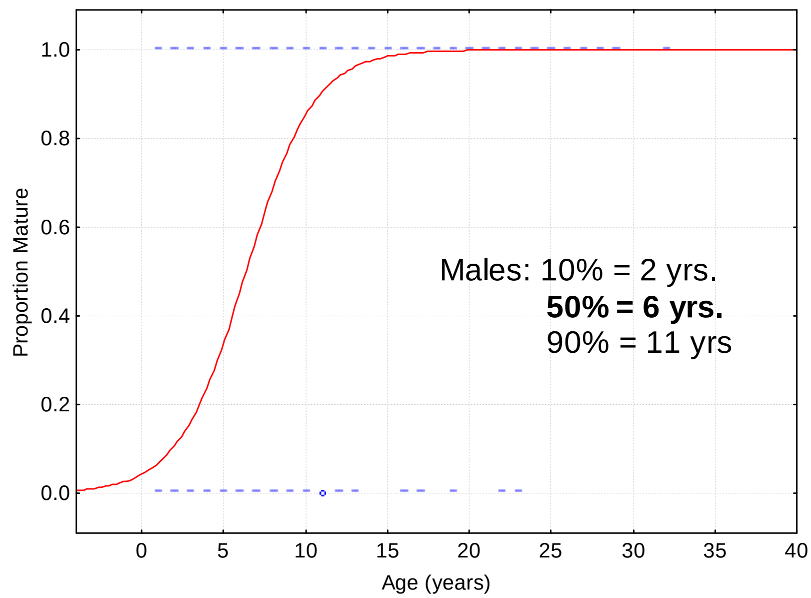

Figure 19: Proportion of male lake trout mature versus age for NER.

Table 7: Maturity schedule for male lake trout in NER by age, length, and weight.

Proportion Mature	Age (years)	Total Length (mm)	Weight (g)
10% Mature	2	286	168
50% Mature	6	383	531
90% Mature	11	514	1346

The length distribution and maturity schedules presented will provide the basis for the protection of spawning stock, should size based harvest control be warranted.

6.0 - The Quadrant Approach

Criteria to evaluate the status of a population of lake trout lakes at a landscape scale are presented in Lester and Dunlop (2004). Maximum sustained yield (MSY) is viewed as a threshold not to be exceeded, and reference points or benchmarks for expected abundance and sustainable fishing pressure at MSY are calculated for a given lake based on the Shuter et al. (1998) exploitation model (Appendix 3). Current estimates of fishing effort and lake trout abundance are required for comparison to the reference points established. Section 3.1 presents a summary of the methods used in estimation of annual angler effort. Additional detail regarding formulas etc. can be obtained through a review of Lester et al. (1991), McGuiness et al. (2000), and Lester and

Dunlop (2004). A combination of SLIN and Nordic data was used to characterize lake trout abundance on a representative set of lakes. Janoscik and Lester (2003) provide a method for conversion of SLIN CUE to estimated lake trout density, whereas a separate formula was developed for conversion of Nordic CUE data to density (Appendix 8). The balance of the benchmarking process was identical between the two netting methods.

Lester and Dunlop (2004) recommend a plot of Log (observed abundance / expected abundance at MSY) against Log (observed effort / sustainable effort at MSY) as a means to characterize four stages of fishery status or health (Figure 20).

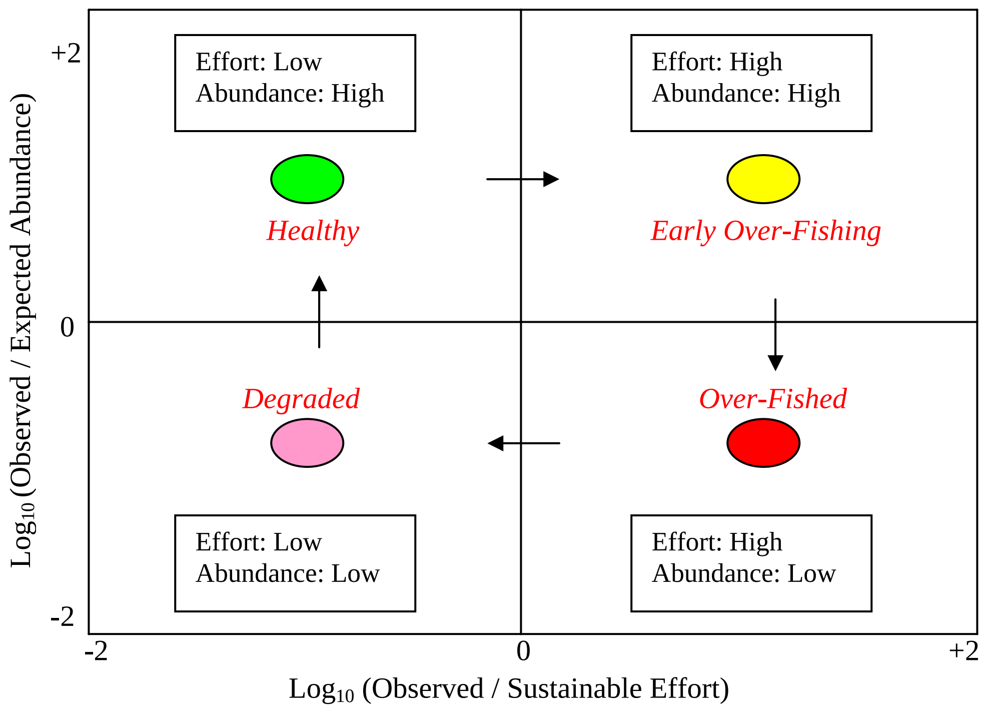

Figure 20: Categorization of lake trout lakes – the quadrant approach.

- **Quadrant 1 (healthy)**: Good lake trout abundance and sustainable fishing pressure. Abundance can be expected to remain high providing fishing pressure remains low.

- **Quadrant 2 (early over-fishing)**: Good lake trout abundance but fishing pressure above sustainable benchmark. A transient state - abundance can be expected to decline if fishing pressure remains high.

- **Quadrant 3 (over-fished)**: Lake trout abundance has declined and fishing pressure remains above sustainable benchmark. A high risk scenario – population heavily stressed, stock extinction could result if angler effort is not reduced.

- **Quadrant 4 (degraded)**: Lake trout abundance and current fishing pressure both low - status likely related to past over-fishing. If fishing pressure remains low one might expect gradual stock recovery. However, habitat limitations and introduced species may slow or even prevent lake trout recovery.

It should be noted that application of the Shuter et al. (1998) exploitation model to NER lakes warrants further consideration. Appendix 9 presents some extended discussion regarding use of the model and the relevance of certain intrinsic assumptions to the analysis presented below.

7.0 - NER Quadrant Analysis

7.1 - The SoR Dataset

The dataset used for the NER quadrant analysis included a combination of 90 randomly selected lakes and 40 reasonable additions. It should be noted that 16 randomly selected lakes were either omitted from the survey schedule or the quadrant analysis or both. These included: 9 acid damaged lakes either known to be presently void of lake trout or where preliminary restoration efforts were underway; 5 put-grow-take lakes; and 2 lakes not presently managed for lake trout. The dataset was expanded to include 40 reasonable lake additions where required index netting and effort data was found to be available and where no known limitations to lake trout abundance beyond fishing pressure were identified. The final dataset only included lakes classified as self-sustaining (N1, I1, R1) and lakes presently being stocked on a supplemental basis (N3). As such, the results of the quadrant analysis should be considered representative of the corresponding lake classifications in the full regional dataset (specifically, 680 self-sustaining lakes + 16 lakes being stocked on a supplemental basis).

Prior to proceeding with full analysis of the quadrant output, the expanded dataset was compared to the random dataset to ensure that the additions were valid and that the expanded set of lakes was representative of the range of conditions in NER. No significant difference was detected between the expanded dataset and the random dataset in the distribution of lakes across the four quadrants (Chi-square test: $\chi^2_3 = 0.35$, $P > 0.05$; Figure 21) validating use of the full 130 lake set.

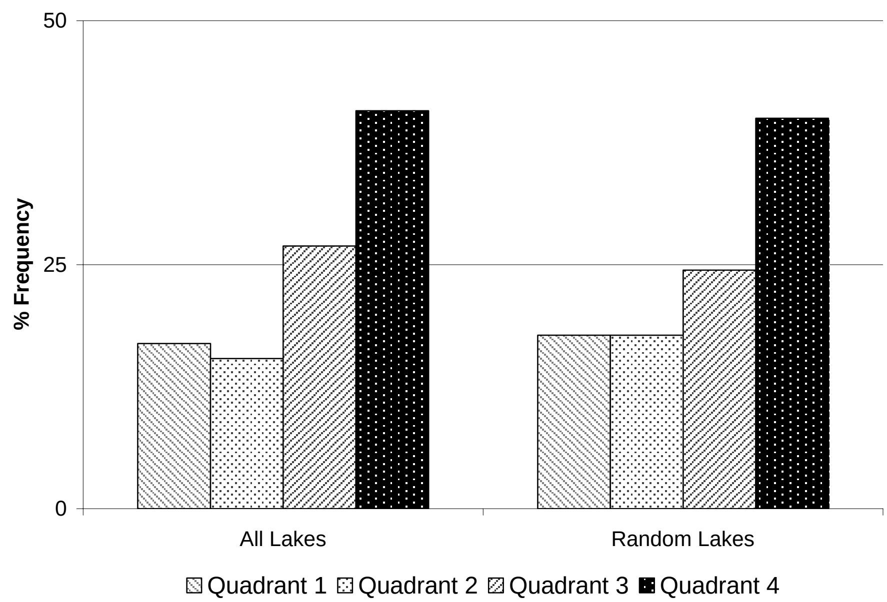

Figure 21: Distribution of lakes across the four quadrants – comparing an expanded 130 lake set (All Lakes) with 90 randomly selected lakes.

Potential differences between the two netting standards employed were also explored – i.e. Nordic versus SLIN results. Mean values for estimated density of mature fish were virtually identical between the two netting methods (2.6 adults per hectare, n = 57 for SLIN; 2.5 adults per hectare, n = 73 for Nordic). A student's t-test confirmed no significant difference between mean values of density calculated using the two methods ($t_{128} = 0.53$, $P = 0.60$). This would seem encouraging; however, a chi-square test did reveal a significant difference in the distribution of lakes across the quadrants by survey type ($\chi^2_3 = 11.335$, $P = 0.01$; Figure 22). There were disproportionately more Nordic lakes in Quadrant 4, fewer Nordic lakes in Quadrant 2. This result may be more an artifact of geography rather than bias associated with index netting standard. Lakes around Sudbury were more often assessed using the Nordic method whereas lakes around Sault Ste. Marie were more often assessed using the SLIN method. As explored in Section 7.3, lakes in SSM District appear more often in Quadrant 2, whereas lakes in Sudbury District appear more often in Quadrant 4.

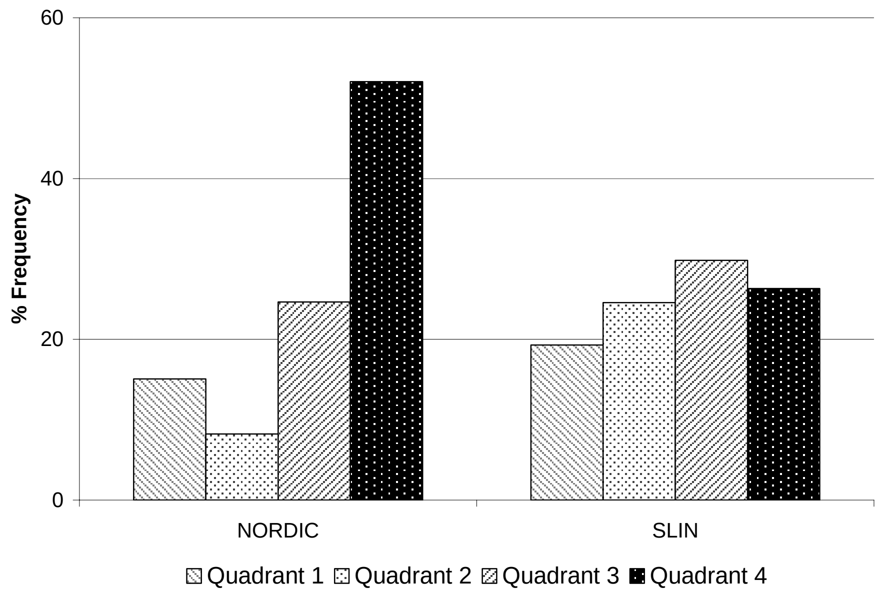

Figure 22: Distribution of lakes across the four quadrants comparing lakes assessed using the Nordic method with lakes assessed using the SLIN method.

7.2 - The Current Status of Lake Trout Resources in NER

A representative sample of 130 lakes including 90 random SoR selections and 40 valid additions provides a solid basis to explore the status of NER lake trout populations. Appendix 10 presents a summary of key parameters generated in completion of the quadrant analysis. Figure 23 provides a snapshot of the overall status of lake trout populations in NER using the quadrant plot. As an alternate way to view the quadrant results, the scatter of points was converted into an ellipse using a standard deviational tool in a GIS environment. Standard deviational ellipses are based on the x, y distribution of a point theme having major and minor axes which match the standard deviations of the x and y coordinates of the points. The ellipse generated is rotated to fit the slope of the distribution. Figure 24 presents the results of the NE quadrant analysis using a standard deviational ellipse making it easier to visualize the actual distribution of points on the quadrant plot.

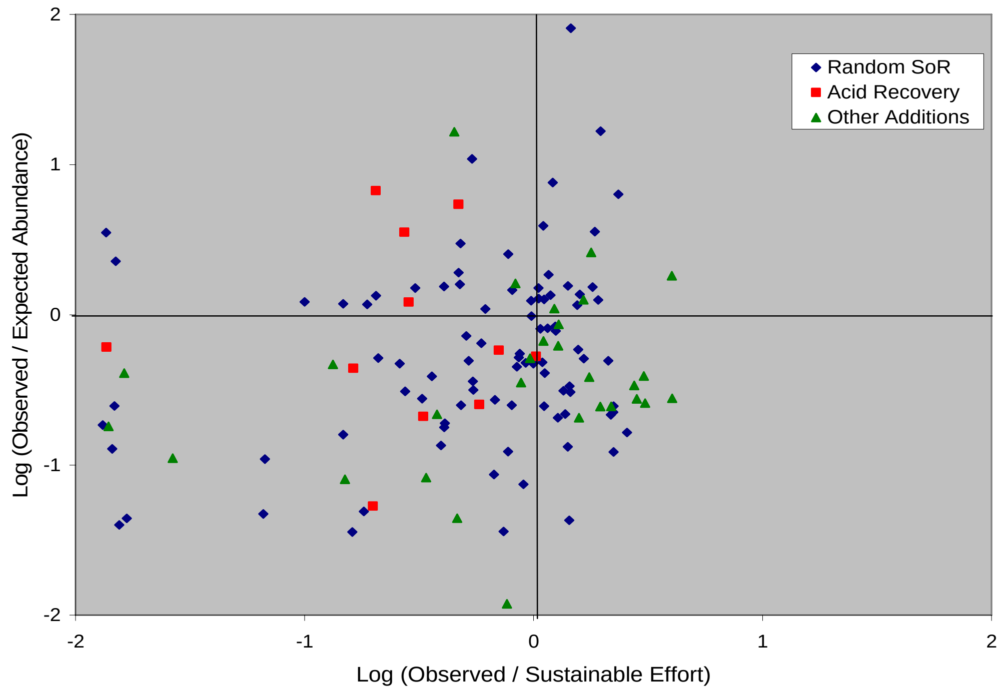

Figure 23: Current status of NER lake trout populations - expanded lake set (130 lakes).

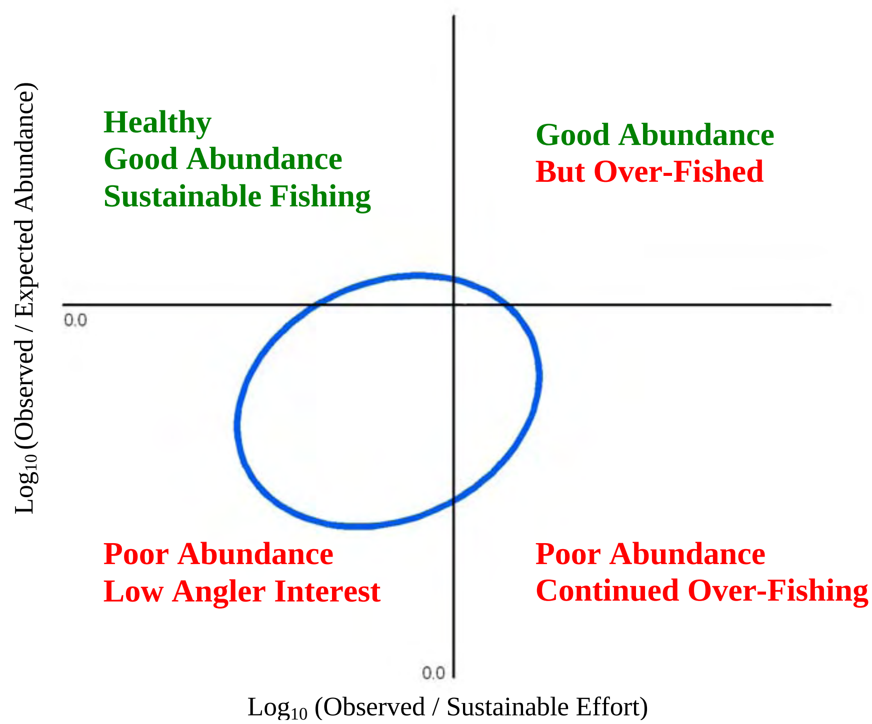

Figure 24: Status of NER lake trout populations demonstrated using a deviational ellipse.

Table 8 summarizes the breakdown of lakes by Quadrant. Only 16.9% of the lakes sampled can be characterized by abundant lake trout and sustainable fishing pressure. An additional 15.4% of the lakes sampled are characterized by good lake trout abundance but are presently being over-fished, and lake trout abundance can be expected to decline. A further 26.9% of the lakes sampled are best described as over-fished: abundance has declined and fishing pressure remains high. Finally, a full 40.8% of the lakes sampled are classified as degraded: both abundance and fishing pressure are presently low.

Table 8: Breakdown of NER lake trout lakes by SoR Quadrant.

Quadrant	Number of Lakes	% by Lake Count
1 = Healthy	22	16.9
2 = Early Over-Fishing	20	15.4
3 = Over-Fished	35	26.9
4 = Degraded	53	40.8

In theory, given low fishing pressure, the lake trout populations in Quadrant 4 should recover. However, a number of factors can interfere with recovery. Where past over-harvest is responsible for reduced abundance levels, residual angler interest can prevent recovery. Other factors which can potentially interfere with recovery include habitat degradation and fish community complication. Such factors are difficult to address and some of the lakes in Quadrant 4 may never recover.

7.3 - Spatial Trends in Resource Status

Differences in resource status become apparent when the SoR data is grouped by District (Table 9).

Table 9: Quadrant breakdown by District.

District	Total # of lakes assessed (n)	Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4
North Bay	27	1 (3.7%)	5 (18.5%)	10 (37.0%)	11 (40.7%)
Sudbury	30	6 (20.0%)	0 (0.0%)	8 (26.7%)	16 (53.3%)
SSM	50	7 (14.0%)	15 (30.0%)	13 (26.0%)	15 (30.0%)
Wawa	8	2 (25.0%)	0 (0.0%)	3 (37.5%)	3 (37.5%)
Chapleau	3	1 (33.3%)	0 (0.0%)	1 (33.3%)	1 (33.3%)
Timmins	6	1 (16.7%)	0 (0.0%)	0 (0.0%)	5 (83.3%)
Kirkland Lake	6	4 (66.7%)	0 (0.0%)	0 (0.0%)	2 (33.3%)
NER	130	22 (16.9%)	20 (15.4%)	35 (26.9%)	53 (40.8%)

For statistical analysis, data from Kirkland Lake, Timmins, Chapleau, and Wawa Districts were pooled into a Northern Districts group (to increase sample size). A chi-square test revealed a significant difference in the distribution of lakes across the quadrants by District ($\chi^2_9 = 28.252$, P = 0.001). Specifically, there are disproportionately more degraded or Quadrant 4 lakes in

Sudbury (53.3%) than in either SSM (30%) or North Bay (40.7%). Similarly, there are disproportionately more lakes which meet the abundance benchmark (Quadrants 1 and 2 combined), in SSM (44.0%) and in the Northern Districts (34.8%) than in either Sudbury (20.0%) or North Bay (22.2%). Figure 25 demonstrates the shift in resource status between Districts.

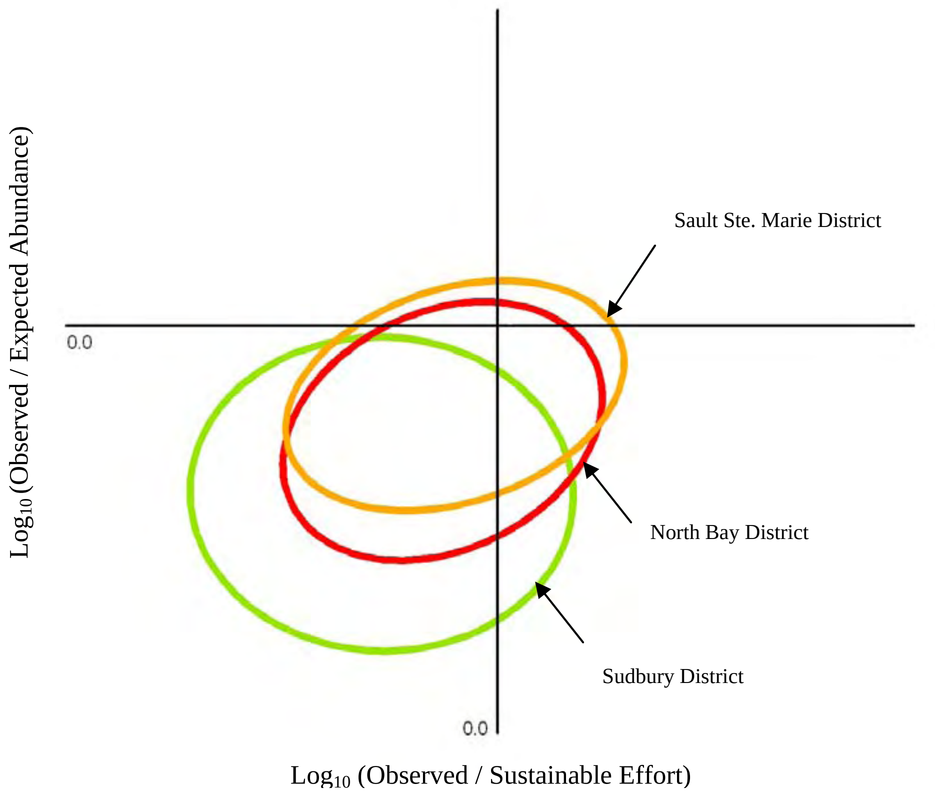

Figure 25: Apparent shift in resource status by District.

In summary, Sudbury lakes were found to be mostly degraded, with some improvement observed in North Bay District. SSM lakes were found to be the healthiest (44.0% of SSM lakes were found to meet the abundance benchmark as compared to 32.3% regionally). Results for northern Districts pooled were similar to the regional breakdown (34.8% of northern lakes were found meet the abundance benchmark) with fewer lakes in Quadrants 2 and 3 compared to Quadrants 1 and 4 given lower angling pressure. The high proportion of Quadrant 4 lakes in Sudbury District was likely related to the combined impacts of acidification and past exploitation. Somewhat surprising was the high proportion of Quadrant 4 lakes found in the northern Districts (47.8%). The 11 northern lakes in Quadrant 4 were reviewed individually. Estimated lake trout abundance was found to be reasonable (2.0 to 4.0 adults per hectare) and approach the benchmark for 4 of the lakes considered. Lake trout abundance was found to be very low on the remaining 7 lakes (0.0 to 0.9 adults per hectare). Potential limiting factors were noted for 5 of these 7 lakes, a common theme being the presence of piscivorous competitors including pike, walleye, and smallmouth bass. While it is recognized that the incidence of walleye and pike in lake trout lakes likely does increase as one moves north within the region, introductions are believed to be at least in part responsible for increased community complication for 3 of the lakes. Although these species naturally coexist with lake trout in many lakes, one can expect lower lake trout productivity as a result. Water level manipulation was also noted as a potential limiting factor for two of the lakes reviewed.

Potential differences between the proposed new Fisheries Management Zones (FMZ's) in NER were also explored. Estimated adult lake trout density was found to meet or exceed the abundance benchmark on a greater proportion of lakes evaluated in FMZ 10 (33.7%) than in FMZ 11 (28.1%); however, a chi-square test did not reveal a significant difference in the distribution of lakes across the quadrants by FMZ (χ^2_9 = 5.31, P > 0.05). Conversely, mean adult density was found to be somewhat higher in FMZ 11 (3.3 adults per hectare) than in FMZ 10 (2.4 adults per hectare). Again, a student's t-test indicated that the difference in density between the two FMZ's was not significant (t_{119} = 0.91, P = 0.37). Sample sizes for FMZ 7 (6 lakes) and FMZ 8 (3 lakes) prevented valid comparisons of resource status for these FMZ's. In conclusion, based on the SoR data collected, no significant difference in resource status between FMZ's was detected. It is however interesting to note that although mean density would appear to be somewhat lower in FMZ 10, more lakes appear to meet the abundance benchmark reflecting lower theoretical carrying capacity (i.e. lower abundance benchmarks or reference values) on average in FMZ 10. Upon further investigation, a higher mean abundance benchmark in FMZ 11 related to a greater proportion of small bodied lake trout populations. Specifically, 37.5% of the lakes surveyed in FMZ 11 had L_∞ < 50cm whereas only 18.0 % of the FMZ 10 lakes had L_∞ < 50 cm. As explored in Section 6.0, smaller bodied lake trout populations demonstrate higher expected abundance at MSY.

7.4 - Potential Habitat Limitations and Fish Community Interactions

Further to the brief reference in Section 7.2 regarding potential habitat and fish community factors that can limit lake trout abundance, a variety of statistical approaches were applied to explore potential drivers of resource status in NER. Chi-square tests were used to investigate potential differences in the distribution of lakes across the quadrants, t-tests and one way ANOVA were used to compare observed adult densities, and linear regression analysis was used to relate observed adult density to certain quantifiable variables. For all t-tests, ANOVAs, and regressions reported, densities were log transformed to meet parametric assumptions. The specific factors investigated are divided into 3 categories: habitat factors, fish community factors, and residual angler interest. Significant findings are presented below.

7.4.1 - Habitat Factors

Lake Size: One way ANOVA revealed a significant difference in observed adult density with lakes blocked by surface area (Figure 26). Specifically, mean adult density was found to be significantly higher on lakes with surface area less than 150 hectares (3.5 adults per hectare, n = 59) than on lakes with surface area exceeding 400 hectares (1.6 adults per hectare, n = 35). This trend has been well documented (Payne et al. 1990; Shuter et al. 1998). The differences are in part driven by the SLIN calibration procedure (Appendix 8) which utilizes surface area in conversion of SLIN CUE to estimated density. It should be noted however that a similar trend was revealed using only Nordic density data, where density was calculated independent of surface area. Specifically, although differences were not statistically significant (ANOVA, F(2,70) = 1.46, P = 0.24), mean adult density as estimated from Nordic CUE was found to be considerably higher on lakes with surface area less than 150 hectares (3.0 adults per hectare, n = 44) than on lakes with surface area exceeding 150 hectares (1.8 adults per hectare, n = 29).

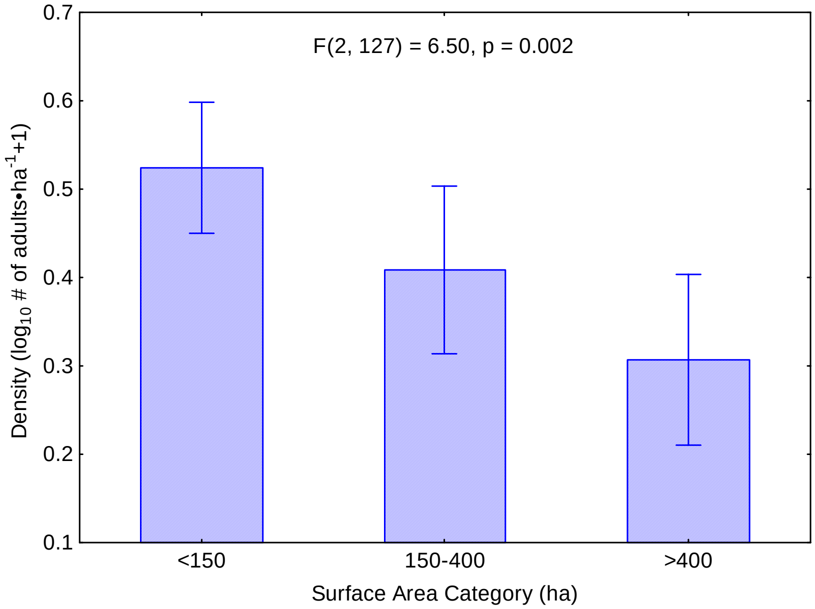

Figure 26: Estimated adult lake trout density with lakes blocked by surface area.

Regardless of any effect surface area may have on lake trout density, the observed distribution of lakes across the 4 quadrants was not found to vary significantly with the lakes blocked by surface area. Abundance reference points calculated via application of the equations presented in Appendix 3 depend on L_{∞}, which is correlated with surface area. Resource status as determined through comparison of estimated abundance to lake specific abundance benchmarks or reference points would not be expected to vary with surface area.

Thermal Habitat Availability: There are two accepted measures of late summer habitat availability: thermal habitat volume or THV (Payne et al. 1990) and mean volume weighted hypolimnetic dissolved oxygen or MVWHDO (Evans 2005). Unfortunately, both approaches require data not readily available for all of the SoR lakes, so two alternative indices were selected to investigate the potential effect of late summer habitat limitations on the quadrant results: maximum depth and predicted thermal habitat volume as a proportion of total lake volume (pV). Predicted pV values were calculated by Nigel Lester (personal communication) for all 130 SoR lakes using a modified version of the predictive model of optimal habitat boundaries presented by Dillon et al. (2003). Both regression analysis and t-tests were used in an attempt to relate observed densities to either maximum depth or pV. Surprisingly, neither approach revealed a significant relationship between observed adult density and predicted thermal habitat availability. In fact, density would appear to be somewhat higher in shallow lakes (2.9 adults per hectare where max depth is less than 25m versus 2.4 adults per hectare where maximum depth exceeds 25m) and lakes with low pV (3.0 adults per hectare where pV is less than 0.1 versus 2.4 adults per hectare where pV exceeds 0.1), an observation likely linked to surface area. Large lakes are typically deep and as discussed above support lower estimated densities.

Acidification: The potential relationship between current pH and observed adult density was not investigated; however, the spatial trends in resource status noted in Section 7.3 (Figure 25) would suggest that the impact of past and residual acid damage is playing a role in NER, where the majority of lakes in proximity to Sudbury are in Quadrant 4. The impacts of acidification are discussed in detail in Section 8.0. One hundred northeastern lake trout lakes were severely impacted by acidification linked to atmospheric deposition of metal smelter emissions and surface drainage of mine tailings. The majority of these lakes are located SE and NW of Sudbury. While extirpation / degradation was only documented on this specific lake set, additional lakes may very well have been stressed to the point that current lake trout carrying capacity may be compromised as a result of past recruitment failure, subsequent shifts in native fish community structure, and the introduction of non-native species such as smallmouth bass and walleye.

Water Levels: Table 10 provides a breakdown of lakes by quadrant with and without water level manipulation.

Table 10: Breakdown of lakes by quadrant with and without water level manipulation.

Quadrant	Lakes without Drawdowns		Lakes with Drawdowns	
	Lake Count	% by Quadrant	Lake Count	% by Quadrant
1 = Healthy	22	18.8	0	0.0
2 = Early Over-Fishing	19	16.2	1	7.7
3 = Over-Fished	26	22.2	9	69.2
4 = Degraded	50	42.7	3	23.1
TOTAL	117		13	

Chi-square analysis was not used to test for significant variation in the distribution of lakes by quadrant given the low sample size for lakes with draw downs. It is interesting to note however that lake trout abundance was found to be below the abundance benchmark for 12 of the 13 lakes with draw downs and that a student's t-test revealed a significant difference in mean observed density between lakes with and without draw downs ($t_{128} = 2.61$, $P = 0.01$). Lake trout densities would appear to be significantly lower on lakes with draw downs (0.9 adults per hectare, n = 13) than on lakes without draw downs (2.7 adults per hectare, n = 117). It must be recognized however that there is nearly an order of magnitude difference in sample sizes and the results of the t-test are questionable. One also needs to consider the fact that lakes with draw downs are typically larger, supporting more complex fish communities and tend to be more accessible. It is not possible to tease out the contribution of these various factors to the low densities documented. Although we cannot flag any statistically valid findings around water levels, it should be recognized that there is some indication that water level manipulation may be playing a role.

7.4.2 - Fish Community Factors

Species Richness: Regression analysis was used to explore the potential relationship between species richness (i.e. the total number of species present) and observed lake trout density. The analysis revealed a significant decrease in adult lake trout abundance with increasing species richness ($r^2 = 0.035$, $P = 0.03$). Lake trout are adapted to the deep, cold, well-oxygenated lakes typically characterized by low nutrient availability and relatively simple fish communities. In a pristine community, lake trout often represent the sole top predator. The presence of other competitive piscivorous species will result in reduced resources available for any single species. Moreover, when the dataset was split into lakes below the abundance benchmark versus lakes above the abundance benchmark, a significant decline in abundance was only observed for populations falling below the abundance benchmark (Figure 27).

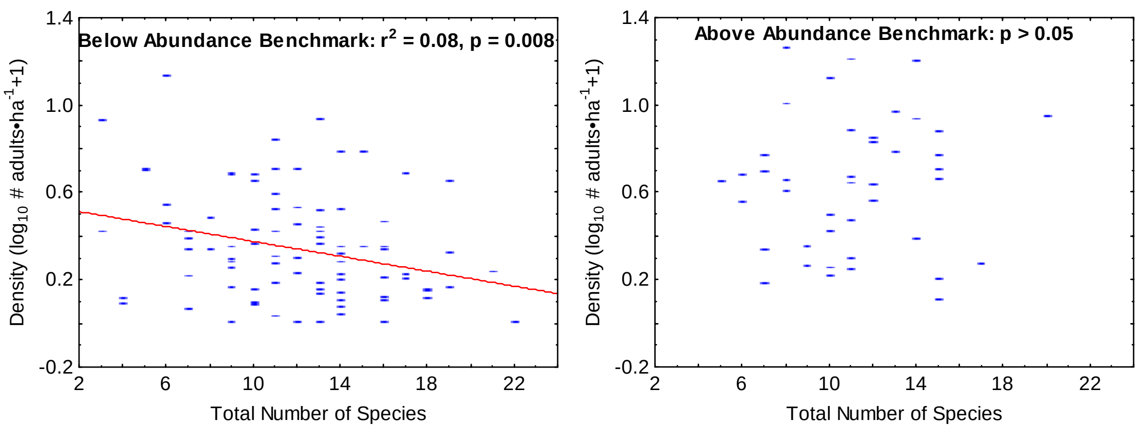

Figure 27: The effect of increasing species richness on estimated adult lake trout density for populations falling below the expected abundance reference point.

Perhaps a combination of high species richness and lake trout exploitation is a recipe for long term degradation. Alternately, lake trout density may be more related to the presence / absence of certain key species than to overall species richness. Higher species richness among populations which meet the lake trout abundance benchmark might be accounted for by an increased number of benign cyprinid species which would not be expected to negatively affect lake trout population health.

Presence / Absence of Key Species: Further to the discussion regarding general community complication presented above, clearly some species (e.g. centrarchids) would have a greater expected impact on lake trout abundance than others (e.g. cyprinids). T-tests and chi-square analysis were used to explore the potential affect that the presence of rock bass, smallmouth bass, coregonids, and rainbow smelt may have on lake trout density and in turn resource health in NER.

Surprisingly, no significant density effects were observed for lakes with and without rockbass. Current research suggests that rockbass can have a significant negative impact on lake trout production (Brown 2003). Smallmouth bass were found to have a very clear impact on lake trout abundance and resource status in NER. A student's t-test revealed a significant decrease in lake trout abundance in the presence of smallmouth bass ($t_{128} = 3.93$, $P < 0.001$), a result that holds true for both netting standards employed (Figure 28).

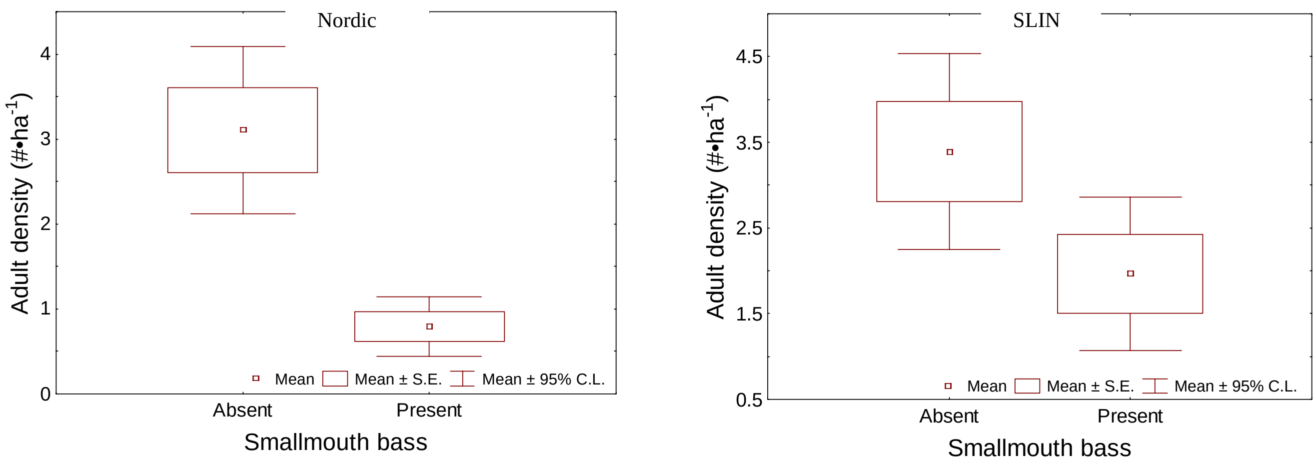

Figure 28: Estimated adult lake trout density with and without the presence of smallmouth bass.

Chi-square analysis in turn revealed disproportionately more healthy (Quadrant 1) lakes without smallmouth bass (χ^2_3 = 10.997, P = 0.012; Figure 29) and Figure 30 demonstrates a clear shift downwards on the quadrant plot in the presence of smallmouth bass.

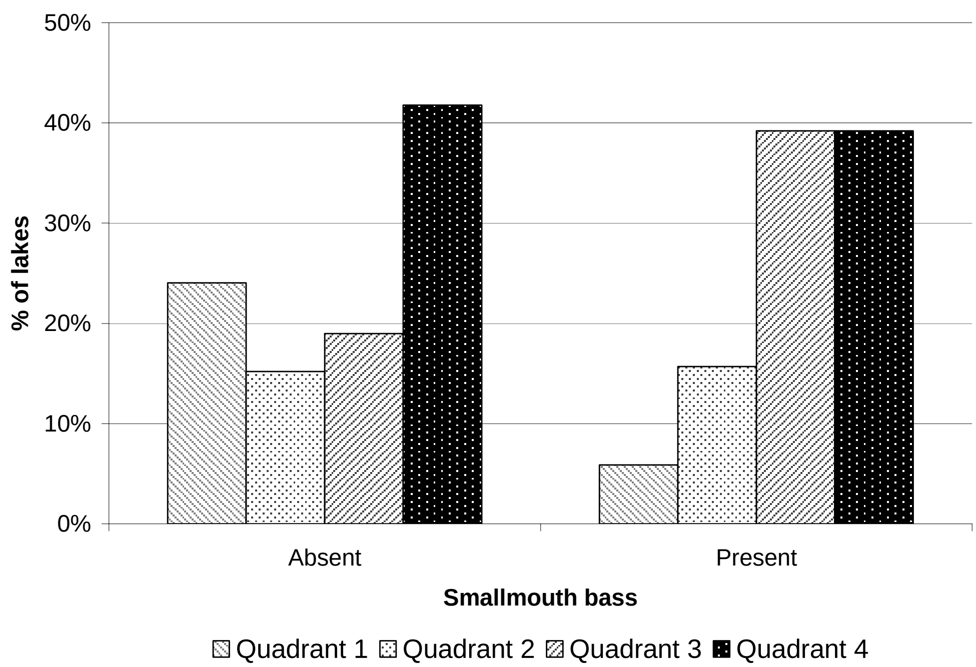

Figure 29: Distribution of lakes across the SoR quadrants with and without smallmouth bass.

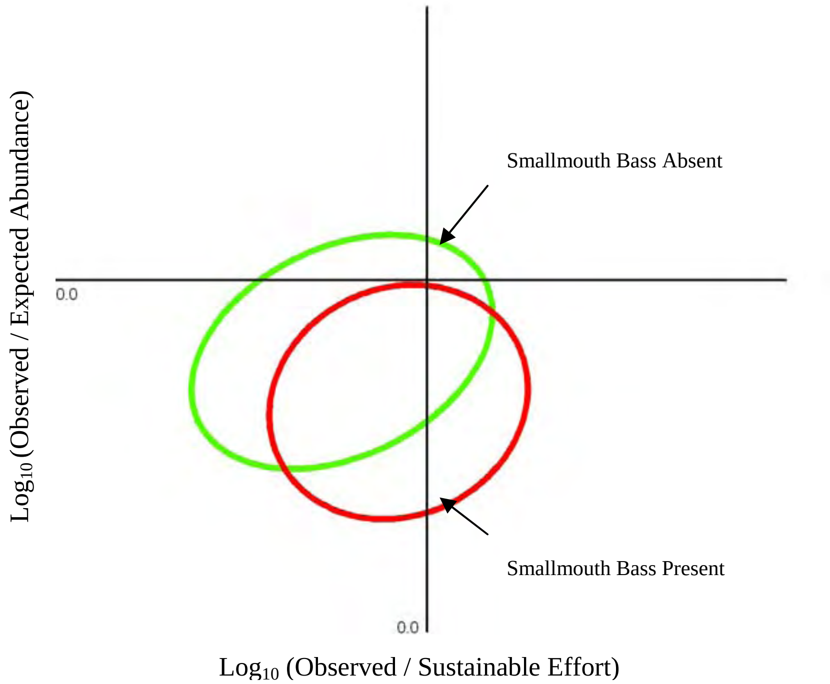

Figure 30: A negative shift in resource status in the presence of smallmouth bass.

A reduction in the availability of forage fish following bass introductions has been shown to have adverse impacts on native top predators, including the lake trout, which rely on littoral prey fish (Vander Zanden et al. 1999). It has been further suggested that lakes lacking pelagic forage fish are most vulnerable to the impacts of bass introductions (Vander Zanden et al. 2004). Where pelagic fish species are present (smelt, whitefish, herring) lake trout are buffered somewhat from the impacts of bass on littoral prey fish populations. In lakes lacking pelagic prey fish, lake trout are more linked to the littoral food web through consumption of near shore forage fishes. Given the apparent impact of smallmouth bass on lake trout production, an effort was made to assess the rate at which the species is spreading on the landscape. A total of 108 lake trout lakes in NER have both original lake survey (AHI) netting records and updated Nordic netting records. Current presence / absence of bass was compared to the presence / absence of bass at the time of the original lake survey. Smallmouth bass have been introduced in 16 of 108 lakes (14.8%). If the query is expanded to include rock bass, the introduction rate reaches 24.1%. The introduction rate for another species with a range known to be expanding in NER was also evaluated. Walleye have been introduced in 10 of the 108 lakes included in the query (9.3%). These introduction rates would seem alarming considering the documented impact that such competitive species have on lake trout population health.

The presence of coregonids was also found to have a significant negative effect on lake trout abundance (t-test: $t_{128} = 6.28$, $P < 0.001$), again a result that holds true for both netting standards employed (Figure 31). Although chi-square analysis did not reveal significant variation in the distribution of lakes across the quadrants, Figure 32 demonstrates an apparent shift downwards on the quadrant plot where coregonids are present.

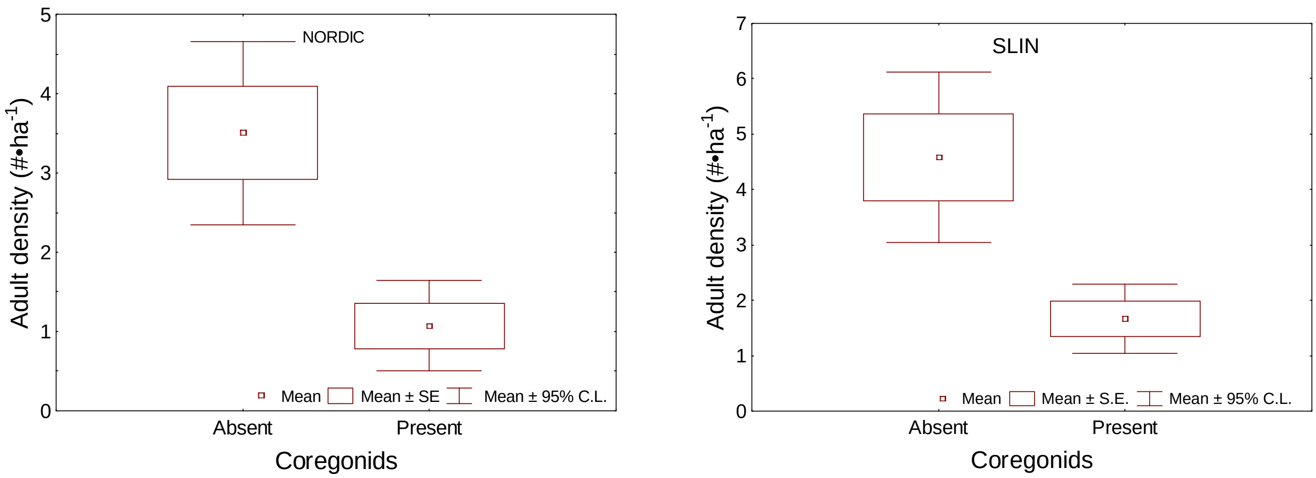

Figure 31: Estimated adult lake trout density with and without the presence of coregonids (i.e. lake herring and / or whitefish).

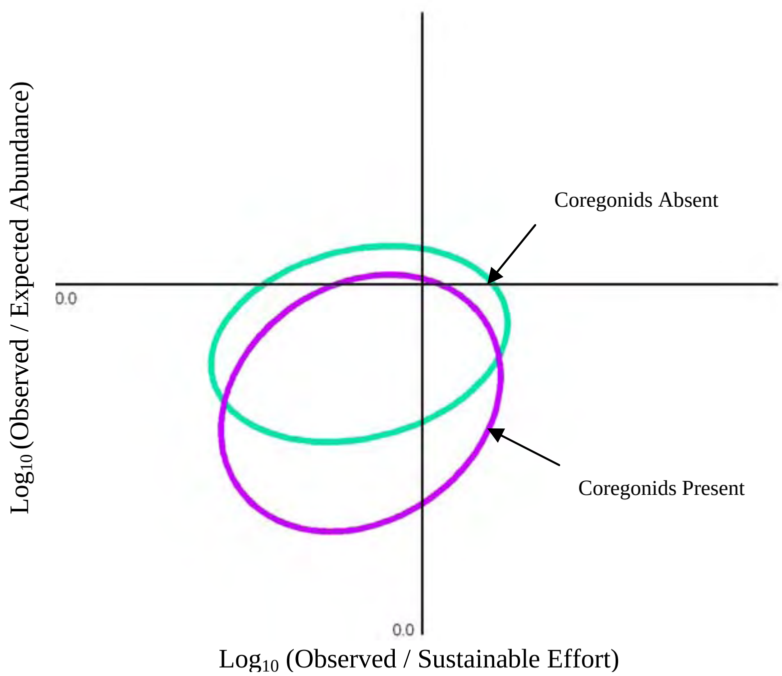

Figure 32: A negative shift in resource status in the presence of coregonids.

The apparent decline in resource status associated with the presence of coregonids is not as easily explained as the shift associated with the presence of smallmouth bass. While decreased overall abundance in the presence of coregonids is to be expected (Carl et al. 1990), the equations applied in calculation of the abundance reference points or benchmarks used should theoretically account for this given that L_∞ was estimated from actual lake trout length distributions. Specifically, a higher L_∞ can be expected where coregonid species are present as forage. A higher L_∞ in turn lowers the reference point for expected abundance (see Section 6.0) and should in theory balance off the reduction in observed abundance (i.e.

resource status would not necessarily change) unless other factors are at play. Two possible explanations for the apparent shift in resource status come to mind. Perhaps the yield equations applied do not fully account for the expected reduction in abundance associated with the larger bodied lake trout growth form. A more likely explanation would be that larger bodied lake trout populations are more sensitive to exploitation than then are smaller bodied populations which would explain a decline in current resource status where coregonids are present. This scenario is not unreasonable given that larger bodied lake trout are found in lower numbers and that coregonids not only serve as a forage species but also compete with young lake trout. As explored in greater detail in Section 8.1.2, abundant lake herring populations have clearly been shown to restrict the survival and growth of stocked lake trout (Powell et al. 1986; Gunn et al. 1987; Evans and Olver 1995; Gunn and Mills 1998). As a large bodied population is fished down, coregonids become more abundant increasing competition with young native lake trout and causing a downward spiral of the lake trout population (Powell and Carl 2004). It would be more difficult for a depleted population of large bodied lake trout to recover given increased coregonid abundance.

Finally, although the presence / absence of rainbow smelt was not found to have a significant effect on estimated lake trout abundance, chi-square analysis revealed disproportionately fewer degraded (Quadrant 4) lakes and disproportionately more lakes which meet the abundance benchmark (Quadrants 1 and 2 combined) where smelt are present (Figure 33).

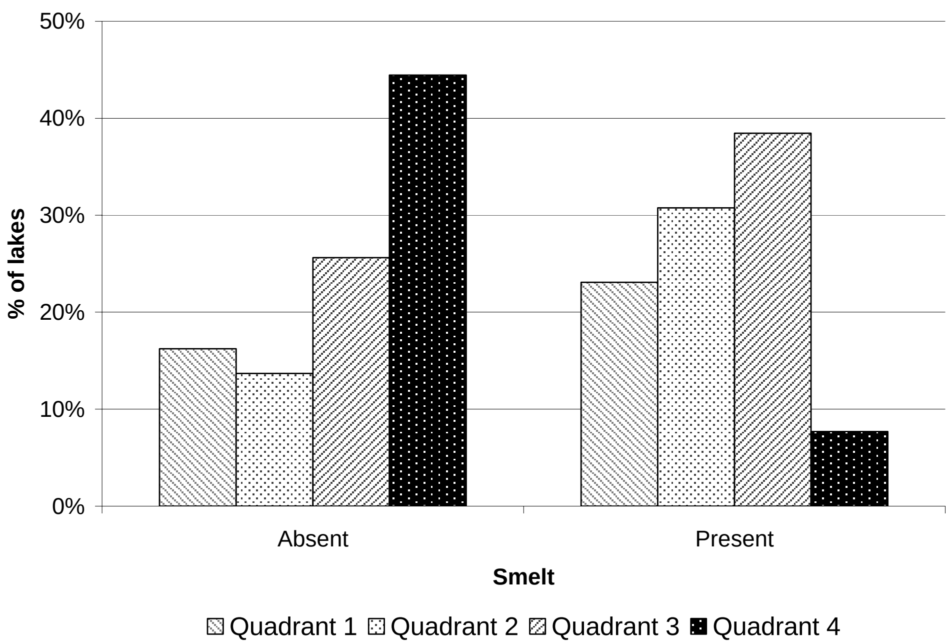

Figure 33: Distribution of lakes across the four quadrants with and without rainbow smelt.

It should be noted that the sample size for lakes with smelt was low (n = 13) compared to lakes without smelt (n = 117) and that the validity of the chi-square result is questionable. The finding however is supported by a suggestion made by Vander Zanden et al. (2004) that the presence of pelagic forage fish can buffer lake trout populations from the impact of bass and other piscivorous competitors on littoral prey fish abundance. A smelt influence is also supported by the fact that the smelt lakes sampled were more accessible, experienced more effort, and had higher incidence of centrarchids than the lakes without smelt, all factors which should in theory result in poorer resource status. Given that smelt represent abundant pelagic forage heavily utilized by lake trout where present, it is not unreasonable to expect that smelt would mitigate the normal loss of resources available to lake trout accompanying increasing community complication and/or the presence of littoral zone competitors like smallmouth bass - a common denominator in many degraded lakes. In essence, the presence of smelt may make it less likely that a lake trout population would be unable to recover from low abundance.

7.4.3 - Residual Angler Interest

Where past exploitation is responsible for reduced lake trout abundance, residual angler interest can present a barrier to population recovery. Anglers eventually lose interest in a fishery given poor returns, however, as abundance on historically exploited lakes increases and catches improve, a resurgence of angler interest can be expected. Linear regression analysis was used to relate documented angler effort to observed lake trout density, with the dataset split into lakes with observed lake trout density below the abundance benchmark versus lakes above the abundance benchmark (Figure 34).

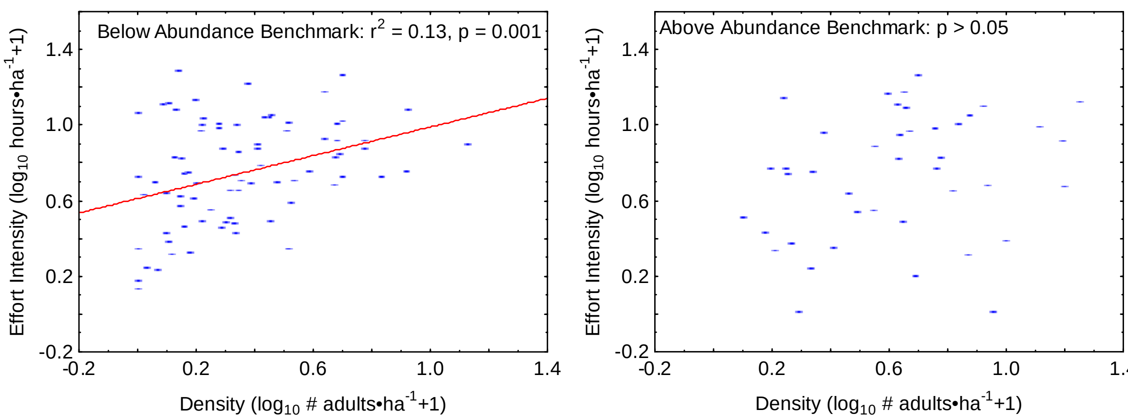

Figure 34: The effect of increasing adult lake trout density on angler effort for populations falling below the expected abundance reference point.

For lakes below the abundance benchmark, angler effort was found to be positively correlated with observed lake trout density, that is, angler interest would indeed appear to be density dependant. Regardless of whether the fish community factors explored in Section 7.4.2 are at play or not, over-fished (Quadrant 3) and degraded (Quadrant 4) lakes may never recover without additional harvest control.

8.0 - Status and Recovery of Acid Damaged Lake Trout Populations in NER

Based on the SoR analysis presented in Section 7.3, acidification continues to be a primary driver of resource status in NER as evidenced by the high number of degraded lakes in proximity to Sudbury. One hundred lake trout lakes in NER are on record as severely impacted by acidification linked to atmospheric deposition of metal smelter emissions and surface drainage of mine tailings. The majority of these damaged lakes lie northeast and southwest of Sudbury. Two other smaller groupings of damaged lakes have been identified: lakes impacted by historic uranium mining in the Elliot Lake area and lakes impacted by historic smelting activities near Wawa. A few scattered lakes were also severely affected (e.g. Grey Owl and Kirk Lakes) with impacts related to landscape sensitivity (i.e. bedrock characteristics) rather than to any particular point source of industrial pollution, highlighting the fact that deposition of pollutants was widespread across the northeast landscape.

Substantial effort has been made to reverse damage related to acid-forming SO2 emissions in Ontario. Emissions from the Sudbury smelters have been reduced by 90% resulting in increasing pH values and decreasing metal concentrations in the area (Keller et al. 2001). Sulphate deposition now appears to be dominated by the effects of continent-wide distribution of air pollutants rather than by local point sources (Snucins et al. 2001). Chemical recovery rates have slowed considerably, suggesting that further attention be paid to broad scale pollution reduction in both the United States and Canada (Gunn and Mills 1998). Reductions beyond currently legislated levels will likely be needed if full recovery of all acid-damaged lakes in sensitive areas like Killarney is to occur (Snucins et al. 2001).

Water quality of NER lake trout lakes is clearly recovering (Figure 35). Further recovery is required and impacts to fish communities remain an issue.

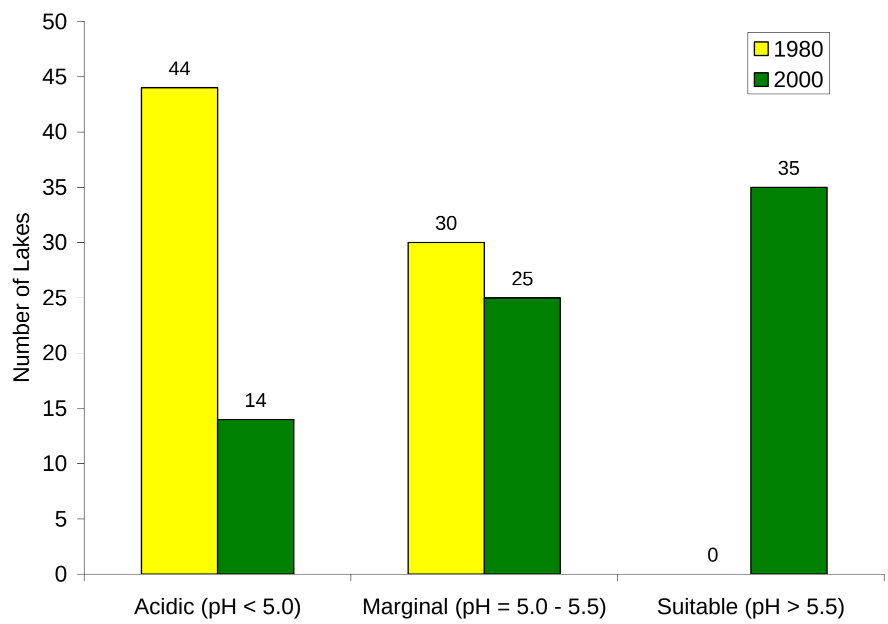

Figure 35: Chemical recovery of 74 acid damaged lake trout lakes in the Sudbury basin.

Note the pH category classed as marginal (pH 5.0 to 5.5). Lake trout reproductive failure resulting from mortality of early life changes normally occurs as pH declines below a pH of 5.5; however, direct adult mortality does not normally occur until pH approaches or declines below 5.0. Where pH declines to a point below 5.5 but remains above 5.0, continual reproductive failure can eventually result in extirpation (Gunn and Mills 1998).

Chemical recovery rates depend on physical lake characteristics, location within a catchment basin, and the nature of eroding bedrock in the area. Lakes with high ratios of watershed area to lake area or volume have fast flushing rates and generally recover quicker (Keller et al. 2001). Lake trout lakes, especially large deep headwater lakes (e.g. Nellie Lake), recover very slowly given long flushing times (Gunn and Mills 1998).

Through implementation of the northeast lake trout project, an effort has been made to update current knowledge regarding the status of acid damaged lakes in NER. Updated water quality data was collected in 2000 / 2001 and is presented in Appendix 11. Updated fish community data was collected using the Nordic netting standard to evaluate 50+ lakes where pH was found to exceed or approach the accepted threshold for lake trout (pH 5.5) and is presented in Appendix 12. Refer to Snucins (2000, 2001, and 2002) for a more detailed lake by lake summary of the Nordic data collected. These companion reports also present relevant historical information and recommended restoration strategies for the lakes evaluated. For further information regarding the history and status of acid damaged lakes in Sudbury and North Bay Districts refer to Polkinghorne and Gunn (1981) and McCrudden (1993). Appendix 13 provides supplemental information assembled regarding damaged lakes in Wawa, Sault Ste. Marie, and Sudbury (Espanola Area) Districts.

Table 11 presents a listing of 100 acid damaged lakes including relevant information regarding location and physical characteristics as well as current pH and stock status. The lakes listed are grouped by District and ordered by ascending pH with values colour coded as to suitability for lake trout: red = too acidic for lake trout (pH < 5.2); yellow = marginal - lake trout if present should survive and grow but will not reproduce (pH 5.2 to 5.49); green = suitable for lake trout survival and reproduction (pH 5.5 or greater). The following lakes have been removed from previous lists of acid damaged lake trout lakes in NER.

- Low Lake (Sudbury District): A well buffered lake not affected by pH depression. Lake trout have been reduced to a remnant population with exploitation and introduced species being the likely factors involved. Emigration from Helen Lake at high water levels may very well have been largely responsible for historic lake trout records.
- De Lamorandiere Lake (Sudbury District): With a maximum depth of 7.6m and a mean depth of 2.0m it is highly unlikely that this lake ever supported a self-sustaining lake trout population.
- Barbara Lake (SSM District): District has questioned historic evidence of lake trout presence; considered to be a brook trout lake.
- Kwagama, Andre, and West Andre Lakes (Wawa District): District has questioned historic evidence of lake trout presence; all three are managed as brook trout lakes. It is also believed that Little Agawa Lake was originally a brook trout lake; however, lake trout were stocked in 1991 and are presently self-sustaining.
- Marjory Lake (Wawa District) - District has questioned historic evidence of lake trout presence.

Table 11: Acid damaged lake trout lakes in NER including relevant locational information, physical parameters, current pH, and stock status listed by District in ascending order of measured pH (pH values colour coded: red = acid; yellow = marginal; green = suitable for lake trout).

District	Lake Name	Township	WBYLID	Latitude	Longitude	Surface Area (ha)	Maximum Depth (m)	Mean Depth (m)	pH (year)	Stock Status	Nordic
Kirkland Lake	Lady Sydney	Leo	17-5599-52502	472413	801220	232.3	25.6	7.4	6.15 (2000)	N1	2001
North Bay	Landers	Selby	17-5390-52352	471623	802841	107.4	24.0	4.9	5.00 (2004)	E	
North Bay	Justin	Coleman	17-5838-52437	472046	795330	38.6	32.0	6.4	5.21 (2000)	R2	
North Bay	Jerry	Gamble	17-5263-52458	472201	803911	53.3	35.0	10.7	5.33 (2004)	R2	2002
North Bay	Florence	Parker	17-5335-52315	471428	803358	1021.8	38.1	7.5	5.35 (2000)	R2	2000
North Bay	Grays	Whitson	17-5467-52535	472607	802248	179.0	15.7	5.9	5.37 (2004)	R2	2001
North Bay	Jim Edwards	Selby	17-5431-52386	471806	802551	88.6	22.6	8.7	5.45 (2000)	R1	2002
North Bay	Banks	Trethewey	17-5452-52595	472903	802401	304.3	29.3	10.0	5.52 (1977)	N1	
North Bay	Marina	Corley	17-5258-52493	472352	803931	38.2	16.8	4.6	5.59 (2000)	R2	2001
North Bay	Bluesucker	Dundee	17-5298-52239	471010	803624	147.7	21.4	7.3	5.70 (2000)	N1	2000
North Bay	Rodd	Dundee	17-5274-52242	471022	803816	31.8	17.0	5.1	5.81 (2000)	N1	2001
North Bay	Turner	Cole	17-5695-52367	471657	800452	136.1	25.6	9.2	5.82 (1993)	N1	2001
North Bay	Linger	Seagram	17-5367-52152	470531	803055	72.1	18.0	3.1	5.85 (2000)	N1	2002
North Bay	Benner	Dundee	17-5288-52236	471002	803714	58.1	26.0	8.8	5.95 (2004)	N1	2001
North Bay	Bull	Turner	17-5317-52165	470613	803457	105.1	21.0	7.8	6.12 (2000)	N1	
North Bay	Smoothwater	Corley	17-5243-52488	472344	804048	909.6	88.4	31.4	6.15 (1996)	N1	
North Bay	Gullrock	Brigstocke	17-5804-52398	471833	795609	225.8	12.7	4.1	6.20 (2000)	R2	
North Bay	Dees	Mcgiffin	17-5371-52429	472025	803031	81.0	14.0	4.6	6.22 (2000)	R2	2002
North Bay	Makobe	Trethewey	17-5430-52549	472644	802513	2015.8	22.6	5.8	6.25 (2000)	N1	
North Bay	Barter	Cole	17-5674-52374	471720	800625	116.7	32.3	14.4	6.48 (2004)	N1	2002
North Bay	Sugar	Dane	17-5670-52431	472015	800634	230.1	26.5	8.0	6.60 (1983)	N1	2001
North Bay	Anima Nipissing	Banting	17-5827-52344	471537	795414	1929.2	76.2	13.7	6.98 (2004)	N1	
SSM	Grey Owl	Runnalls	16-7118-52382	471550	841210	199.8	31.1	6.7	5.52 (2001)	R2	2000
SSM	Kirk	Lecaron	17-3414-51701	464004	830425	59.1	21.9	9.5	5.86 (2001)	R2	2001
SSM	Quirke	Buckles	17-3810-51468	462923	823307	2072.7	104.0	38.7	5.94 (2001)	R1	
SSM	May	Joubin	17-3852-51434	462556	822902	329.9	47.0	14.3	6.14 (1983)	R1	2002
SSM	Pecors	Joubin	17-3872-51356	462315	822743	353.0	28.0	7.9	6.75 (2001)	N1	
SSM	Nordic	Esten	17-3782-51358	462144	823608	122.6	27.0	9.9	7.00 (1987)	R	
SSM	McCabe	Joubin	17-3797-51421	462524	823357	174.9	25.2	9.3	7.01 (2004)	R1	2002
SSM	Hough	Joubin	17-3851-51403	462432	822939	163.2	29.9	8.9	7.14 (2001)	R	

District	Lake Name	Township	WBYLID	Latitude	Longitude	Surface Area (ha)	Maximum Depth (m)	Mean Depth (m)	pH (year)	Stock Status	Nordic
Sudbury	Nellie	Roosevelt	17-4594-51088	460800	813132	248.0	54.9	19.2	4.61 (2001)	E	
Sudbury	Lake # 37	Aylmer	17-5216-51920	465231	804237	34.1	19.0	7.9	4.72 (2000)	E	
Sudbury	Ruth-Roy	Carlyle	17-4806-51039	460525	811502	54.5	18.0	4.1	4.72 (2001)	E	
Sudbury	Franks	Mackelcan	17-5267-51920	465253	803840	19.8			4.76 (2000)	E	
Sudbury	Dougherty	Demorest	17-5253-52060	470041	804001	427.8	53.4	13.3	4.81 (2000)	E	
Sudbury	Bonhomme	Aylmer	17-5216-51846	464903	804244	34.6			4.87 (2000)	E	
Sudbury	O.S.A.	Killarney	17-4691-51000	460312	812353	279.4	39.7	12.0	4.88 (2001)	E	
Sudbury	Foy	Foy	17-4809-51809	464634	811504	55.1			4.89 (2000)	E	
Sudbury	Silvester	Mackelcan	17-5267-51883	465029	803843	56.1			4.93 (2000)	E	
Sudbury	Chief	Tilton	17-4987-51346	462143	810102	105.2	34.0	9.9	4.95 (2000)	E	
Sudbury	Dewdney	Mcconnell	17-5254-51902	465219	803851	172.2	34.0	9.6	4.97 (2000)	E	
Sudbury	Burke	Killarney	17-4630-50974	460152	812845	8.4	15.6	5.2	5.00 (2000)	E	
Sudbury	Potvin	Kelly	17-5396-51819	464730	802849	48.7	62.0	27.5	5.01 (2000)	E	
Sudbury	Wolf	Mackelcan	17-5279-51902	465110	803755	87.5			5.02 (2000)	E	2000
Sudbury	Acid	Killarney	17-4657-50979	460209	812637	19.7	29.0	10.9	5.05 (2001)	E	
Sudbury	Frederick	Stobie	17-5228-52091	470217	804155	311.7	21.0	7.5	5.08 (2000)	E	
Sudbury	Rand	Bowell	17-4885-51790	464608	810858	21.9			5.09 (2000)	E	
Sudbury	Telfer	Telfer	17-5165-51976	465645	804718	337.0	32.9	10.4	5.10 (2000)	E	2000
Sudbury	Killarney	Killarney	17-4723-51015	460408	812120	327.0	61.0	10.8	5.10 (2001)	E	
Sudbury	Lumsden	Killarney	17-4665-50976	460131	812559	23.8	21.8	9.0	5.15 (2001)	E	
Sudbury	David	Goschen	17-4776-51097	460823	811733	405.0	24.4	7.0	5.16 (2001)	E	
Sudbury	Wavy	Eden	17-4923-51272	461809	810533	306.8	34.0	15.0	5.16 (2004)	E	2004
Sudbury	Colin Scott	Mccarthy	17-5379-51863	464949	803013	43.5	43.0	16.6	5.20 (2000)	R2	2000
Sudbury	Grace	Curtin	17-4535-51088	460800	813604	47.3	17.2	6.2	5.21 (2000)	E	
Sudbury	Norway	Killarney	17-4759-51035	460514	811832	63.4	33.6	15.1	5.25 (2001)	E	
Sudbury	Donald	Mccarthy	17-5370-51830	464801	803053	503.2	60.0	15.4	5.28 (2000)	R2	2000
Sudbury	Great Mountain	Hansen	17-4723-51114	460926	812134	198.5	37.5	9.9	5.29 (2000)	R2	2002
Sudbury	Broker	Attlee	17-5002-51098	460842	805941	97.7	24.1	9.5	5.34 (2000)	R2	2000
Sudbury	Chiniguchi	Telfer	17-5240-51985	465612	804148	1198.3	44.2	13.6	5.34 (2000)	R2	2000
Sudbury	Laundrie	Howey	17-5110-52189	470732	805116	370.5	20.4	4.9	5.42 (2004)	R2	2003
Sudbury	Marjorie	Mcconnell	17-5292-51958	465436	803714	97.5	35.0	9.3	5.44 (2001)	E	
Sudbury	Davis	Mcconnell	17-5241-52013	465741	804035	35.8	14.0	5.2	5.46 (2000)	R2	2000
Sudbury	Three Narrows	Hansen	17-4670-51065	460647	812519	811.5	51.9	14.5	5.46 (2000)	N1	2003
Sudbury	Caswell	Aylmer	17-5229-51902	465151	804230	39.8	24.0	7.9	5.48 (2000)	R2	2002
Sudbury	Stouffer	Turner	17-5228-52105	470357	804058	145.7	17.0	4.5	5.49 (2000)	R2	2000
Sudbury	White Oak	Tilton	17-5000-51272	461756	805952	273.6	43.0	14.5	5.49 (2000)	R1	2003
Sudbury	Matagamasi	Rathbun	17-5305-51809	464626	803620	1300.8	61.0	8.7	5.51 (2000)	R2	2000

District	Lake Name	Township	WBYLID	Latitude	Longitude	Surface Area (ha)	Maximum Depth (m)	Mean Depth (m)	pH (year)	Stock Status	Nordic
Sudbury	Parsons	Demorest	17-5308-52065	470049	803538	39.0	10.4	2.8	5.57 (2000)	E	2001
Sudbury	MacDonald	Emo	17-4573-51969	465536	813336	83.1	22.0	6.0	5.68 (2000)	L	
Sudbury	Johnnie (Bushcamp)	Carlyle	17-4826-51036	460513	811330	342.8	33.6	10.0	5.68 (2004)	R2	2001
Sudbury	Barron	Stobie	17-5152-52045	465945	804759	55.8			5.69 (2000)	E	2001
Sudbury	Michaud	Tyrone	17-4821-51845	464837	811403	148.5	24.0	7.0	5.77 (2000)	R1	2004
Sudbury	Twin Lakes	Demorest	17-5304-52013	465812	803635	69.2			5.82 (1987)	N1	
Sudbury	Bowland	Howey	17-5120-52145	470513	805031	107.3	28.0	6.9	5.83 (2000)	R1	2003
Sudbury	Mickey	Sheppard	17-5395-51925	465306	802857	70.1	19.0	6.8	5.83 (2000)	N1	
Sudbury	Lake # 27	Kelly	17-5462-51807	464644	803155	17.3	17.0	7.6	5.86 (2000)	R2	2001
Sudbury	Tyson	Sale	17-4910-51070	460701	810659	1089.1	39.6	11.9	5.91 (2001)	R2	2001
Sudbury	Bell	Goschen	17-4836-51079	460742	811219	217.7	26.8	8.1	5.93 (2001)	R2	2001
Sudbury	Edna	Mccarthy	17-5381-51884	465007	802941	27.2	16.0		5.96 (2000)	E	
Sudbury	Elboga	Muldrew	17-4518-52073	470113	813809	27.2	16.2	5.9	6.01 (2000)	R2	2002
Sudbury	Lower Matagamasi	Mccarthy	17-5393-51873	465010	802904	132.1	18.0	6.9	6.05 (2000)	R2	2000
Sudbury	George	Killarney	17-4690-50971	460150	812401	188.9	36.6	16.4	6.05 (2001)	R2	2001
Sudbury	Rawson	Mcconnell	17-5330-51961	465503	803400	164.1	26.0	5.6	6.05 (2004)	N1	2003
Sudbury	Whiskey	Gaiashk	17-3974-51436	462623	822007	992.8	55.2	22.5	6.06 (2001)	R2	2002
Sudbury	Fraleck	Fraleck	17-5089-51954	465454	805257	166.3	23.2	6.9	6.09 (1996)	R2	2003
Sudbury	Nook	Lehman	17-3887-51486	462845	822632	28.0	18.0		6.09 (2001)	R2	2000
Sudbury	Chuggin	Kelly	17-5377-51779	464520	803024	31.4			6.10 (2000)	N1	2001
Sudbury	Pedro	Sheppard	17-5352-51958	465459	803215	63.1	11.0	6.4	6.19 (2000)	R1	2004
Sudbury	White Pine	Mcleod	17-5128-52363	471655	804950	64.3	19.0	5.6	6.21 (2000)	N1	2004
Sudbury	Maskinonge	Kelly	17-5427-51794	464625	802625	1455.7	27.4	9.6	6.28 (2000)	N1	
Sudbury	Kakakise	Killarney	17-4750-51010	460354	811911	112.8	30.5	13.5	6.35 (2001)	E	2001
Sudbury	Kukagami	Kelly	17-5344-51754	464357	803303	1864.8	54.9	14.4	6.45 (2000)	N1	2003
Sudbury	Peter	Goschen	17-4836-51150	461124	811250	132.7	30.5	12.9	6.62 (2004)	R2	2003
Sudbury	Kindle	Lehman	17-3921-51464	462752	822418	311.3	44.2	19.7	7.03 (2004)	R2	2000
Sudbury	Kettyle	Mccarthy	17-5356-51847	464843	803218	59.8	23.5	8.9	7.64 (2000)	R1	2000
Wawa	Molybdenite	Andre	16-6520-53237	480303	845738	91.1	49.0	8.1	5.32 (2001)	I2	2000
Wawa	Black Beaver	Greenwood	16-6882-52534	472432	843022	165.3	40.0	12.1	5.79 (2001)	N1	
Wawa	North Hubert	Larson	16-6930-52450	471949	842641	32.6	37.5	12.2	5.87 (2001)	N1	
Wawa	Hubert	Larson	16-6933-52436	471930	842630	85.0	38.0	11.3	5.91 (2001)	N1	2000
Wawa	Little Agawa	Larson	16-6981-52469	472051	842235	137.9	41.5	10.9	5.93 (2001)	I1	2000

Note: The most recent pH measurements available are reported in this table. Lakes are sorted by District in ascending order of measured pH. The pH measurements have been colour coded as to suitability for lake trout: red = too acidic for lake trout (pH < 5.2); yellow = marginal - lake trout if present should survive and grow but will not reproduce (pH 5.2 to 5.49); green = suitable for lake trout survival and reproduction (pH 5.5 or greater).

In summary, Table 12 presents the overall breakdown of lakes by current pH category and Table 13 provides a breakdown by current stock status.

Table 12: Breakdown of Acid Damaged Lake Trout Lakes in NER by pH Category.

Current pH Category	# of Lakes
Suitable (pH 5.5 or greater)	57 lakes
Marginal (pH 5.2 to 5.49)	20 lakes
Acidic (pH < 5.2)	23 lakes

Table 13: Breakdown of Acid Damaged Lake Trout Lakes in NER by Current Stock Status.

Status Code	Description	# of Lakes
N1	self-sustaining native populations	25
I1	introduced population, presently self-sustaining	1
R1	re- introduced population, presently self-sustaining	9
I2	introduced population, presently sustained by stocking	1
R2	re- introduced population, presently sustained by stocking	31
R	re-introduced population, present status unknown	2
E	extinct native population	30
L	lost population of unknown origin	1

Of the 100 lake trout lakes listed as acid damaged in NER, 25 are presently classed N1 indicating that native populations survived acidification and are presently self-sustaining. A number of these lakes have been stocked at least once and the potential contribution of stocked fish to the genetic makeup of the current population is uncertain. Native genetic stocks are considered to be fully intact for the following 15 lakes given no recorded lake trout stocking.

Banks	Bull	Rawson
Barter	Hubert	Rodd
Benner	Linger	Smoothwater
Black Beaver	Mickey	Turner
Bluesucker	North Hubert	Twin Lakes

Reproducing populations have been established through hatchery stocking in 10 lakes and re-stocking of 32 additional lakes is underway. Hough and Nordic lakes in SSM District are classified as re-introduced populations, present status unknown – assessment of these lakes should be given a high priority. Thirty one lakes remain void of lake trout, the majority of which require additional chemical recovery.

8.1 - Consideration of Potential Restoration Strategies

8.1.1 - Lake Liming

Research has shown that while whole lake liming can produce rapid improvements in water quality, it is a costly option the benefits of which can be short lived (Snucins and Gunn 1992).

The practice was deemed to have limited value for broad application based on experience gained on Bowland Lake (Gunn et al. 1990). This position was restated by Gunn and Mills (1998). Liming has been shown to be effective on a small scale, application across a large landscape would be cost prohibitive.

8.1.2 - Stocking to Reestablish Lost Lake Trout Populations

While chemical recovery is well underway in the Sudbury Basin, re-colonization by native plant and animal species depends on the availability of colonists and on mechanisms for overcoming barriers to dispersal (wind, water currents, animal vectors). Repopulation of isolated lakes by less mobile species such as fish and deepwater zooplankton is expected to occur slowly or not at all (Snucins et al. 2001). Natural recovery of a native fish population depends on either the presence of remnant individuals or immigration from adjacent populations. The process of biological recovery can be accelerated by the introduction of hatchery fish or the transfer of wild fish from one waterbody to another.

The composition of fish communities in recovering lakes has been shown to have a significant effect on the success of lake trout restocking efforts. Introduced lake trout often do poorly in species-rich lakes (Snucins and Gunn 2003). Growth and survival of stocked lake trout can be expected to decrease in proportion to the number and density of other species present (Evans and Olver 1995). More specifically, abundant cisco populations appear to greatly restrict the survival and growth of stocked lake trout (Powell et al. 1986; Gunn et al. 1987; Evans and Olver 1995; Gunn and Mills 1998). Reduced lake trout growth and abundance has also been linked to the present of centrarchid species including rockbass and smallmouth bass (Vander Zanden et al. 1999). Such species interactions can be particularly relevant when dealing with restoration of acid damaged waters. One of the most obvious results related to loss of lake trout, a top predator, from an acidifying lake is the existence of large populations of acid tolerant species like the cisco (Kelso & Gunn 1984). Furthermore, unauthorized introductions of other sportfish species such as smallmouth bass or walleye often occur in advance of lake trout restoration efforts and can limit success. On a more encouraging note, Gunn et al. (1987) did find that survival of stocked fish increases with size at stocking. Planting of larger hatchery products may therefore be an effective strategy in overcoming competitive barriers and restoring community balance.

Lakes were selected for restocking where the following criteria were met: reasonable historic evidence of a native lake trout population; current pH > 5.2 (preferably > 5.5); and remnant lake trout not present. The target size of fish to be stocked was determined based on the presence / absence of coregonid and centrarchid populations. Stocking of adult lake trout and advanced culture of a 2 year old hatchery product are being used as alternatives to regular yearling stocking in the face of complex fish communities. Adult transfers (from one lake to another) are both labour intensive and unpalatable to stakeholders interested in the health of the donor rather than the recipient lake. The use of surplus adult broodstock released from the provincial fish culture system was found to be a more practical alternative; however, such products are only sporadically available. The use of broodstock has for the most part been reserved for situations where immediate removal is not anticipated (i.e. where harvest restrictions are in place). A regular, long-term supply of large 2 year old lake trout (mean 150g compared to 20g yearlings) is viewed as key to successful restoration of lake trout populations in many damaged lakes.

8.1.3 - Multi-Species Stocking to Reconstruct Native Fish Communities

In light of the community related factors explored above, the concept of multi-species introductions would seem risky. Potential consequences outweigh potential benefits at least from the perspective of successful lake trout restoration. Lake trout are known to prey successfully on a variety of organisms, and excellent yields are possible from lakes that have simple food webs and few fish species (Martin and Olver 1980). Furthermore, to a great extent species losses beyond lake trout are poorly documented. Although pre-impact species richness can be estimated, the composition of the original communities would be largely guess work. It is recommended that such strategies not be considered with the possible exception of specific research oriented initiatives where good evidence of historic species composition exists. Should such an undertaking be entertained, Powell and Carl (2004) suggest that a healthy lake trout population should be reestablished prior to reintroduction of other species.

8.1.4 - Monitor Natural Recovery Processes

Hatchery stocking was not considered where a reasonable number of native lake trout were found to be present in a lake. Instead, an effort should be made to facilitate natural recovery of the remnant population and the population should be monitored closely. In a few cases, remnant lake trout are present but at extremely low abundance. Under these circumstances, two valid approaches exist: proceed with restocking assuming that it is highly unlikely that the native lake trout population will recover or monitor the remnant population. A non-interference strategy may be appropriate for a limited number of research lakes regardless of whether remnant lake trout are present or not. Snucins and Gunn (1992) have suggested that a limited number of lakes be left to recover on their own and provide the opportunity to study natural recovery processes.

8.1.5 - Harvest Control

Angler harvest can be viewed either as a stocking objective or as a barrier to establishment of a self-sustaining population. Stocked lakes can offer excellent recreational opportunities; however, self-sustaining populations are more readily established with angler harvest curtailed (Evans and Olver 1995). Powell and Carl (2004) recommended that where the stocking objective is to develop a self-sustaining population, a lake should be closed to lake trout angling for a sufficient period of time to allow introduced lake trout an opportunity to produce three years of progeny (i.e. to reach age 10). On the other hand, interim closures can present significant management challenges in the long-term as stakeholders eventually expect restored fisheries to be opened. Gunn and Sein (2004) documented a disturbing 72% removal rate of lake trout in a period of less than 5 months following opening of the Michaud Lake fishery.

Recognizing that there are clearly pros and cons to interim harvest regulation, an attempt has been made to strike a balance between the two stocking objectives (i.e. angling opportunities vs. establishment of self-sustaining populations) with the underlying assumption being that the two objectives are not necessarily mutually exclusive. For many lakes, stocking is ongoing with regular 9 month open seasons recognizing that angling pressure will build concurrent with biomass. It is presumed that sufficient individuals will escape the recreational fishery to establish an age class structure typical of exploited native populations thereby providing an opportunity for natural recruitment should conditions be favorable. The lakes with open seasons tend to fall into

2 categories: large accessible lakes and smaller more remote lakes where stocking events have been intentionally omitted from District stocking lists in the hope that angler interest will be more manageable. In either scenario, reasonable opportunity does exist for stocked lake trout to mature and spawn. For the remaining lakes, harvest control strategies have been applied, ranging from reduced winter lake trout seasons to year round sanctuaries. Given a range of regulatory strategies, and the fact that all background information was collected using a standard protocol (Nordic Netting), a sound framework for future research initiatives has been established.

8.2 - Selected Restoration Strategies

The final set of restoration strategies selected was limited to lake trout stocking (Table 14) combined with a range of harvest control options (Table 15). Appendix 14 provides a lake by lake summary of both historic stocking and stocking undertaken through implementation of this project. The following hatchery products are being used: spring yearlings (16 lakes), fall yearlings (1 lake), 2 year olds (13 lakes), and adult broodstock (5 lakes). In total, nearly 250,000 lake trout were stocked between 2001 and 2005. Note that White Oak Lake is included in Table 14 without an identified restoration strategy. A reproducing lake trout population has already been reestablished (origin - 1996 adult plant). White Oak was intentionally included whereas 8 other lakes with self-sustaining re-introduced populations (R1 lakes, Table 11) were not in order to highlight the fact that White Oak is one of three genetic refugia established to support conservation of rare provincial strains. Should additional stocking be required at some point in the future, only the assigned strains should be used (White Oak Lake – Big Sound strain; Great Mountain Lake – Iroquois Bay strain; Caswell Lake – Kinscote strain). It should also be noted that specific decisions were made not to proceed with lake trout restoration on the following 6 lakes based on the reasons listed.

- Barron Lake (Sudbury District): Presently suitable for lake trout with an extremely low abundance of remnant lake trout present (a single lake trout caught 2001 Nordic). Concern re: potential emigration of hatchery fish to Paradise Lake. May want to consider an adult transfer from Paradise at some point in the future, or, simply allow natural processes to unfold.
- Edna Lake (Sudbury District): Good evidence of historic lake trout presence given it’s location in Chiniguichi River system with excellent lake trout populations known to have existed both upstream and downstream prior to acidification. Concern re: emigration of hatchery fish to Maskinonge Lake. Decision made not to proceed with lake trout restoration. Edna Lake provides limited cold water habitat (surface area 28.7ha, 16m maximum depth). The presence of rock bass and absence of deep water forage fishes would further limit potential lake trout productivity. The lake may very well be repopulated via movement of stocked fish from upstream (Matagamasi Lake). Movement of stocked lake trout between lakes was one of the discoveries of early lake trout restoration efforts in Killarney Provincial Park (Snucins and Gunn 2003).
- Kakakise Lake (Sudbury District): Given location in Killarney Provincial Park and the potential presence of remnant lake trout (i.e. a single lake trout caught 2001 Nordic), it was agreed to allow natural recovery processes to unfold and monitor.
- Parsons Lake (Sudbury District): Evidence of historic lake trout presence; however, given marginal habitat conditions (i.e. a maximum depth of 10.4m) and the presence of introduced walleye and smallmouth bass, it was decided that a lake trout restoration attempt would prove futile.

Table 14: Lakes Selected for Restoration and Stocking Strategies Established via Northeast Lake Trout Enhancement Project.

District	Lake	Size (ha)	Access	Recommended Product	Stocking Strategy		
					Allocated Product	Number	Frequency*
North Bay	Dees	82	Road (4X4)	Adults or 2 Year Olds	2 Year Olds - Killala	350	Alternate (2005)
North Bay	Florence	1006.9	Fixed Wing	Yearlings OK	Yearlings - Killala (completed 2003)	10,000	Assess
North Bay	Grays	179.8	Fixed Wing	Yearlings OK	Yearlings - Killala	2000	Alternate (2006)
North Bay	Gullrock	229.4	Fixed Wing	Yearlings OK	Yearlings – Killala	2000	Alternate (2006)
North Bay	Jerry	56.3	Rotary	Yearlings OK	Yearlings – Killala	500	Alternate (2005)
North Bay	Marina	36.9	Rotary	Yearlings OK	Yearlings – Killala	500	Alternate (2005)
SSM	Grey Owl	247.9	Fixed Wing	Yearlings OK	Yearlings - Mishibishu	2400	2002, 03, 05, 06
SSM	Kirk	59	Fixed Wing or Portage	Yearlings OK	Yearlings - Mishibishu	600	Alternate (2005)
Sudbury	Bell	347.4	Road	Adults or 2 Year Olds	Adults - Mishibishu	255 @ 4.2 kg 164 @ 2.4kg	2001 2003
Sudbury	Bellows	274.3	Fixed Wing	Adults or 2 Year Olds	2 Year Olds - Killala	1400	Alternate (2005)
Sudbury	Broker	81	Fixed Wing	Adults or 2 Year Olds	Adults (Nordic Calibration) 2 Year Olds - Killala (Regular Product)	324 Simcoe @ 1.0 kg 460 Simcoe @ 1.5 kg 300	2001 2002 Alternate (2002)
Sudbury	Caswell	39	Rotary	Yearlings OK **Genetic Refugia** **Kingscote Only**	Adult – Kingscote	550 @ 204g	2002
Sudbury	Chiniguchi	1295.7	Fixed Wing	Yearlings OK	Yearlings – Killala	13,000	Alternate (2006)
Sudbury	Colin Scott	43.9	Rotary	Yearlings OK	Yearlings – Killala	500	Alternate (2005)
Sudbury	Davis	34.1	Rotary	Yearlings OK	Adults (Nordic Calibration) Yearlings - Killala (Regular Product)	136 Simcoe @ 1.1 kg 500	2001 Alternate (2005)
Sudbury	Donald	498.2	Fixed Wing	Yearlings OK	Yearlings – Killala	5,000	Alternate (2006)
Sudbury	Elboga	27.9	Road	Yearlings OK	Adults (Nordic Calibration) Yearlings - Killala (Regular Product)	228 MP @ 4.0kg 230 IB @ 3.4kg 500	2003 Alternate (2004)
Sudbury	Fraleck	173.9	Fixed Wing	2 Year Olds	2 Year Olds - Killala	700	Alternate (2006)
Sudbury	George	188.5	Road	Adults or 2 Year Olds	Adults	330 Slate @ 3.7kg 252 MP @ 2.2kg	2002 2004
Sudbury	Geneva	356.1	Road	Adults or 2 Year Olds	2 Year Olds - Killala	1500	Alternate (2006)

District	Lake	Size (ha)	Access	Recommended Product	Stocking Strategy		
					Allocated Product	Number	Frequency*
Sudbury	Great Mountain	191.5	Fixed Wing	Adults or 2 Year Olds **Genetic Refugia Iroquois Bay Only**	Adults	190 IB @ 2.95kg 174 IB @ 3.9kg 336 IB @ 740g	2001 2004 2006
Sudbury	Johnnie	342.3	Road	Adults or 2 Year Olds	Adults - Michipicoten / Mishibishu	400 MP @ 4.5 kg 164 ML @ 2.4kg	2001 2003
Sudbury	Kelly #27	17.1	Rotary	Yearlings OK	Yearlings – Killala	500	Alternate (2006)
Sudbury	Kindle	311.3	Fixed Wing	Adults or 2 Year Olds	paired plant (2 Year Olds & Yearlings) long term - 2 Year Olds - Killala	1000 2yr /1500 ylgs or 1400 2 yr olds	Alternate (2005)
Sudbury	Laundrie	370.5	Fixed Wing	Yearlings OK	Yearlings – Killala	3500	Alternate (2005)
Sudbury	Lower Metagamasi	131.8	Fixed Wing	Adults or 2 Year Olds	2 Year Olds - Killala	700	Alternate (2006)
Sudbury	Metagamasi	1392.7	Fixed Wing	Yearlings OK	Yearlings – Killala	14,000	Alternate (2005)
Sudbury	Nook	27	Fixed Wing	Adults or 2 Year Olds	2 Year Olds - Killala	350	Alternate (2005)
Sudbury	Peter	131	Fixed Wing	2 Year Olds	2 Year Olds - Killala	700	Alternate (2006)
Sudbury	Snapshot	82.5	Fixed Wing	Adults or 2 Year Olds	2 Year Olds - Killala	350	Alternate (2005)
Sudbury	Stouffer	141	Fixed Wing	Yearlings OK	2 Year Olds - Killala	700	Alternate (2006)
Sudbury	Trout	929.6	Road	Adults or 2 Year Olds	2 Year Olds - Killala	4000	Alternate (2006)
Sudbury	Tyson	1142.2	Road	Adults or 2 Year Olds	Adults 2 Year Olds - Killala (Regular Product)	590 Slate @ 1.7kg 187 MP @ 4.6kg 4500	2003 2004 Alternate (2005)
Sudbury	Whiskey	916.6	Road	Adults or 2 Year Olds	Adults Fall Yearlings - Manitou (Regular Product)	2178 Slate @ 900g 6000	2001 Alternate (2005)
Sudbury	White Oak	265.7	Fixed Wing	Adults **Genetic Refugia Big Sound Only**	Adults (completed 1996)		
Wawa	Molybdenite	93.6	Road	Yearlings OK	Yearlings	1000	Alternate (2005)

Notes: *Under frequency, last date stocked included in brackets as a guide to future year alternate stocking.

Two other damaged lakes presently being stocked on a put-grow-take basis by North Bay District: Justin and Bear (Kaotisinimigo) Lakes.

Stocking Rates: 10 ylgs (@ 20g) per hectare at commencement of restoration effort (range 6 to 10 alternate years for sustained stocking)
4 two year olds (@125g) per hectare alternate years
Up to 10 adults per hectare for one shot stocking, fewer for repeat stockings

- McDonald Lake (Sudbury District): Questionable anecdotal evidence of historic lake trout presence. Currently managed as a put-grow-take brook trout lake.
- Telfer Lake (Sudbury District): Not presently suitable for lake trout. F1 Splake were stocked 2001 to 2003 in an effort to provide interim angling opportunities; however, emigration of stocked fish to Paradise Lake was reported and splake stocking was discontinued. Given additional water quality recovery, lake trout stocking should be considered; however, the concern re: emigration of stocked fish to Paradise Lake will remain.

Table 15: Summary of harvest control measures applied to acid damaged lake trout lakes in NER.

District	Lake	Stock Status	Current Stocking	Regulation
Kirkland Lake	Lady Sydney	N1	No	split season - lake trout open Feb 15 - Mar 15 & 3rd Sat in May - Sep 30
North Bay	Florence	R2	Yes	lake trout closed all year
Sault Ste. Marie	Kirk	R2	Yes	sanctuary - closed Jan 1 to May 30
Sault Ste. Marie	Quirke	R1	No	catch and release only
Sudbury	Acid	E	No	sanctuary - closed all year
Sudbury	Bell	R2	Yes	lake trout closed all year
Sudbury	Boland	R1	No	sanctuary - closed all year
Sudbury	Broker	R2	Yes	lake trout closed all year
Sudbury	Burke	E	No	sanctuary - closed all year
Sudbury	Caswell	R2	Yes	lake trout closed Oct 1 to Fri before last Sat in Apr
Sudbury	David	E	No	sanctuary - closed all year
Sudbury	George	R2	Yes	sanctuary - closed all year
Sudbury	Grace	E	No	sanctuary - closed all year
Sudbury	Great Mountain	R2	Yes	sanctuary - closed all year
Sudbury	Johnnie	R2	Yes	lake trout closed all year
Sudbury	Kakakise	E	No	lake trout closed all year
Sudbury	Killarney	E	No	sanctuary - closed all year
Sudbury	Kukagami	N1	No	sanctuary - Oct 1 to Fri before last Sat in Apr
Sudbury	Lumsden	E	No	sanctuary - closed all year
Sudbury	Nellie	E	No	sanctuary - closed all year
Sudbury	Norway	E	No	sanctuary - closed all year
Sudbury	O.S.A.	E	No	sanctuary - closed all year
Sudbury	Peter	R2	Yes	lake trout closed all year
Sudbury	Ruth-Roy	E	No	sanctuary - closed all year
Sudbury	White Oak	R1	No	sanctuary - closed all year
Sudbury	White Pine	N1	No	sanctuary - closed all year
Wawa	Molybdenite	I2	Yes	lake trout closed all year
Wawa	Little Agawa	I1	No	lake trout closed all year

8.3 - Monitoring Priorities

A multi-year monitoring schedule is not provided. It is anticipated that priorities for any given year will need to be established based on the nature of available funding, linked research initiatives, and any logistical challenges that may arise. Monitoring priorities are suggested in Table 16 with selection for any given year dependant on the objectives set.

Table 16: Monitoring priorities related to restoration of acid damaged lake trout lakes in NER.

Assessment Objective	Priorities	Suggested Lakes
Monitor for continued chemical recovery	High priority where pH is approaching lake trout threshold of 5.5 (i.e. lakes presently in marginal condition). Suggest 2010 water chemistry updates - first verify what has been covered through routine monitoring by OMOEE.	Priority 1: 20 lakes pH 5.2 to 5.5 Priority 2: 22 lakes pH < 5.2 Priority 3: 27 lakes pH 5.5 to 6.0 Refer to Table 11
Collect baseline inventory data for new lakes	High priority where pH approaches or exceeds threshold of 5.5 (as a minimum pH should exceed 5.2).	Marjorie
Monitor natural recovery	High priority where current abundance is low but a decision has been made to hold off on restocking to give residual fish additional time to generate noticeable recruitment.	Pecors Three Narrows – allow time for additional chemical recovery
Evaluate survival of stocked fish	High priority where complex fish communities exist.	Tyson Kindle (paired plant) Lower Metagamasi Stouffer Nook
	High priority where stocking is limited either due to availability of suitable product or where District and/or Park staff have decided to limit initial stocking rates / frequency.	Hough Nordic Florence Grey Owl Caswell – best to assume survival and wait until 2010 to evaluate recruitment in order to reduce mortality (additional Kinscotes are not readily available)
Monitor for natural recruitment	High priority with timing dependant on stocking strategy (i.e. age of stocked fish & date of initial stocking); allow sufficient time for three years of potential natural recruitment (i.e. allow stocked fish to reach age 10).	Bell Johnnie George Great Mountain - allow time for additional chemical recovery

Short term monitoring priorities are highlighted providing a list of 14 lakes to select from over the next 3 to 4 years. It should be noted that monitoring priorities to serve research needs may vary from those presented above depending on the research objectives involved. The Nordic standard should clearly be adopted as the tool of choice for monitoring the recovery of damaged lakes given the role that fish community structure plays in setting restoration strategies and in determining success. Standardized data will also serve to feed research programs as the data collected can be stratified by treatment type (e.g. closed vs. open lakes, simple vs. complex communities, yearling vs. 2 year old vs. adult stockings, etc.).

8.4 - Monitoring Costs

Given completion of the regional lake trout project, future stocking and monitoring requirements will need to be taken on by the District Offices. While the Districts involved are prepared to assume responsibility for monitoring, the work will not get done without dedicated funding. An estimate of minimum long-term funding requirements is provided below.

Over 30 lakes are presently being restocked and additional lakes with marginal chemistry continue to recover. A monitoring plan with a target to revisit all lakes presently being stocked over a 10 year period, while allowing for baseline inventory of new lakes, will require a minimum of 4 Nordic surveys per year. Annual costs are estimated below; however, it should be recognized that future costs will rise with the cost of labor, aircraft, and equipment.

Survey Crew Costs (4 lakes X 5.0K per lake)	20.0K
Aircraft Costs (approximate)	5.0K
Equipment Costs (net replacement etc.)	5.0K
	Total = 30.0K

9.0 - Summary of Key Findings

9.1 - Stock Status Review

- Of 1027 lake trout lakes on record in NER, only 915 are presently managed for lake trout and only 680 (66.2%) are considered to be self-sustaining. It should be noted that an effort is being made to enhance the resource base. An additional 30 lakes are classified as introductions in progress, 38 lakes as restorations, and 30 lakes as void - to be considered for restoration pending additional water quality improvement.

9.2 - Angler Effort Patterns

- Levels of lake trout fishing pressure estimated in NER between 2001 and 2003 are of concern. Although mean annual angling intensity documented for the 529 self-sustaining lakes surveyed (5.4 hours•ha^{-1}) was found to be below the mean sustainable benchmark (E_{msy}) for the same self-sustaining lakes (6.4 hours•ha^{-1}), estimated angling intensity ranged from 0 to 30+ hours•ha^{-1} and 32% of the lakes surveyed were found to have documented angler effort exceeding E_{msy}.

- Current levels of angling intensity were found to be 2.5 angler-hours•ha^{-1} lower than historical estimates. The majority of the reduction occurred in the open water season (2 hours•ha^{-1}), although there was still a significant reduction of 0.5 hours•ha^{-1} during the winter season.

- Fishing pressure was found to be highest in areas adjacent to Sault Ste. Marie, Blind River, and Elliot Lake (i.e. watersheds 2BF, 2CA, and 2CD). Watersheds adjacent to Sudbury are fished less intensely than watersheds closer to Sault Ste. Marie, a trend presumed to be related to poor resource status in the Sudbury Area owing to the combined impacts of acidification and past exploitation.

- The four watersheds adjacent to Sault Ste. Marie, Blind River, and Elliot Lake were also found to have the highest road density. Linear regression revealed a significant relationship between road density and annual angler effort.

- There was no detectable difference in angling pressure across the proposed new Fisheries Management Zones while correcting for lake surface area.

- Lake surface area was consistently driving the observed patterns in lake trout angling effort. Although large lakes received more effort overall, distinct seasonal differences were observed, where smaller lakes were fished more intensely in the winter and larger lakes were fished more intensely in the summer. The majority of lakes which experienced more $hours \bullet ha^{-1}$ in the winter were less than 100 ha in size.

- Significant contributors to observed patterns in angling effort were the presence of cottages, tourist outfitters, and roads. There was consistently higher effort on lakes with cottages and tourist lodges. There was also an increase in open water effort, and in turn annual effort, on lakes with good road access. There was no significant difference in winter effort related to road accessibility indicating that many remote lakes are readily accessed by snowmobile. Winter effort was found to be higher than summer effort on remote lakes.

- While a visual review of effort distribution across the landscape suggested some association between effort and population centres, regression analysis revealed that the proximity of lakes to population centres had very little influence on observed effort, explaining at most 6% of the observed variation beyond that explained by surface area. Two key drivers of fishing pressure beyond proximity to urban centres were identified: angling quality and quality of access. Lake trout biomass, a surrogate of angling quality, was found to have a significant positive effect on angler effort especially for remote lakes. Anglers are willing to work harder for a high quality angling experience. Furthermore, angling quality was found to interact with accessibility. Together, biomass and accessibility explained 16% of the variation in effort beyond that explained by surface area alone. Both factors play a significant role in the distribution of effort across the landscape.

- As discussed above, high effort was observed on lakes with cottages. Effort on almost half of these lakes exceeded effort at maximum sustainable yield (E_{msy}). The majority of lakes with easy access (highway and primary roads) also had observed effort greater than E_{msy}. Developed lakes with roads and cottages are attracting unsustainable levels of angling. On the contrary, three quarters of small lakes (<100 ha), and lakes with more difficult access (trail and remote access) had observed effort less than E_{msy}, reflecting the relatively low level of effort these lakes are attracting.

- In conclusion, large, accessible lakes seem to be most vulnerable to over-fishing at present (i.e. observed effort above E_{msy}), primarily due to increased open water effort. Small lakes with poor road access have higher effort during the winter from snowmobile use; however, for the majority of these lakes, observed levels of annual effort are considered 'safe' (i.e. observed effort below E_{msy}). Although there has been a reduction in angling intensity of nearly 2.5 hours•ha^{-1} over the last 30 years, 32% of the lakes sampled are still experiencing effort beyond sustainable levels.

9.3 - Life History Analysis

- With biological data pooled for the region, female lake trout were found to be 50% mature at age 7 (total length = 402mm) and 90% mature at age 11 (538mm). Males were found to be 50% mature at age 6 (383mm) and 90% mature at age 11 (514mm).

- Comparison of male and female age distributions revealed that there were fewer old female lake trout (i.e. beyond age 10). Unrelated analyses completed by Casselman (2004) suggest that mature female lake trout are more vulnerable to angling from mid to late summer given energy requirements associated with gonadal development. Specifically, commencing July 1, the proportional harvest of mature females can increase to 70% when only 13% of the population falls into this category. Such a harvest trend would be of great concern for easy access / cottage type lakes which tend to receive more summer effort.

9.4 - Quadrant Analysis

- A representative set of 130 lakes was used to evaluate the current health of NER lake trout lakes. Only 16.9% of the lakes sampled received a healthy diagnosis (i.e. abundant lake trout and sustainable fishing pressure). An additional 15.4% of the lakes sampled were characterized by good lake trout abundance but are presently being over-fished; abundance can be expected to decline. A further 26.9% of the lakes sampled are presently being over-fished and abundance has already declined. Finally, 40.8% of the lakes sampled were classified as degraded; both abundance and fishing pressure are low. The 130 lakes selected theoretically reflect the status of 696 lakes presently considered to be self-sustaining (N1, R1, I1) or partly self-sustaining (N3) and the following extrapolation can be made. There are only estimated to be 225 self-sustaining lake trout lakes in NER which presently provide for healthy levels of lake trout abundance and nearly half of these lakes are presently subject to unsustainable levels of fishing pressure.

- Spatial trends in resource status were detected. Only 20.0% of Sudbury lakes were found to meet the abundance benchmark (Quadrants 1 & 2 combined), as compared to 32.3% regionally, and a full 53.3% of Sudbury lakes were classified as degraded (Quadrant 4). The extremely poor condition of Sudbury lakes is likely attributable to the combined impacts of acidification and past exploitation. North Bay District lakes were found to be slightly better; 22.2% meet the abundance benchmark and 40.7% are classified as degraded. SSM District lakes were found to be the healthiest; 44.0% meet the abundance benchmark and 30% are classified as degraded.

- Despite the spatial trend in resource status observed by District, no differences were detected across the proposed new Fisheries Management Zones. Specifically, FMZ 10 and FMZ 11 lakes are in similar condition.

- Lake trout abundance was found to decrease with increasing species richness. With the dataset partitioned, a significant effect is only observed for populations falling below the abundance benchmark. A combination of high species richness and lake trout exploitation could be a recipe for long term degradation. Alternately, a lake trout abundance response may be more related to the presence of certain key species than to overall species richness. Clearly some species (e.g. centrarchids) would have greater implications than others (e.g. cyprinids).

- Smallmouth bass were found to have a very clear impact on lake trout abundance and population status in NER. Lake trout abundance is lower where bass are present and there are disproportionately more healthy lakes where smallmouth bass are absent. This finding is supported by existing literature, where researchers have documented severe competitive effects (Vander Zanden et al., 1999 and Vander Zanden et al., 2004)

- Smallmouth bass were found to have been introduced in 14.8% of lakes where original lake survey data was available. If rock bass are included in the query, the introduction rate increases to 24.1%. Walleye were found to have an introduction rate of 9.3%. These introduction rates would seem alarming considering the documented impact that such competitive species have on lake trout population health.

- As supported by current literature, lake trout abundance was found to decrease in the presence of coregonids (lake herring and / or whitefish). However, given that the abundance benchmarks were calculated based on empirical estimates of L_∞, the observed shift downwards on the quadrant plot is not expected. Higher estimates of L_∞ and lower abundance reference points result where coregonids are present and should in theory balance off the reduction in observed abundance all other factors being equal. A plausible explanation for a decline in resource health would be that larger bodied lake trout populations are more sensitive to exploitation than smaller bodied populations. Coregonids not only serve as a forage species but also compete with young lake trout. As a large bodied population is fished down, coregonids become more abundant and can present a barrier to the survival of young lake trout. Depleted populations of large bodied lake trout may be very slow to recover given this potential barrier.

- An interesting find - there were disproportionately more lakes found to meet the abundance benchmark (Quadrants 1 and 2 combined) and fewer degraded (Quadrant 4) lakes where smelt were present. This finding is supported by Vander Zanden et al. (2004). The presence of pelagic forage fish can buffer lake trout populations from the impact of bass and other competitors on littoral prey fish abundance.

- Finally, residual angler interest can present a barrier to population recovery. For lakes below the abundance benchmark, angler effort was found to be positively correlated with lake trout density. Angler interest in marginal fisheries would indeed appear to be density dependant and depleted lakes may be very slow to recover without additional harvest control.

9.5 – Recovery of Acid Damaged Lakes

- Acidification continues to be a primary driver of resource status in NER as evidenced by the high number of degraded lakes in proximity to Sudbury. Approximately 100 lake trout lakes in NER have been severely impacted by industrial pollution.

- Sudbury smelter emissions have been reduced by 90% and NER lake trout lakes are recovering. Approximately 60% of the industrially damaged lakes on record are presently suitable for lake trout. Research has shown that currently, sulphate deposition is dominated by continent-wide distribution of air pollutants rather than by local point sources. Broad emission reductions beyond currently legislated levels may be required if all acid-damaged lakes in sensitive areas like Killarney are to recover.

- Despite ongoing chemical recovery, fish community problems persist. On a positive note, native populations survived acidification and are presently self-sustaining in 25 lakes and self-sustaining populations have been reestablished in 10 additional lakes through hatchery stocking. Furthermore, 34 lakes where native populations were extirpated are presently suitable for lake trout and restoration is underway. However, 31 lakes remain void, the majority of which require additional chemical recovery.

- Re-establishment of reproducing lake trout populations has proven to be very difficult in lakes with abundant competitors or predators (bass, walleye, herring, whitefish, etc.), but almost routine in lakes with relatively simple fish communities (Gunn et al., 1987; Evans and Olver, 1995).

- Applied restoration strategies include lake trout stocking and a range of harvest control measures. Surplus adult broodstock and 2 year old hatchery products are being used as alternatives to regular yearling stocking in the face of complex fish communities. Nearly 250,000 lake trout were stocked between 2001 and 2005 and additional restocking is required. Although reproducing populations are more readily established where angler harvest is curtailed, substantive harvest resulting from a pulse of angler interest can be expected when a closed fishery is opened. For the majority of the lakes being restored, stocking is ongoing with regular 9 month open seasons recognizing that angling pressure will build concurrent with lake trout biomass. For the remaining lakes, harvest control strategies have been applied, ranging from reduced winter lake trout seasons to full year round sanctuaries.

10.0 - Recommendations

10.1 – Harvest Control

Given that a substantial number of NER lake trout lakes are presently being over-fished, that the resource is in poor health overall, and that residual angler effort would appear to be density dependant limiting population recovery, additional harvest control measures should be implemented.

- Reducing the lake trout catch limit to 2 as recommended in the draft Lake Trout Tool Kit (OMNR 2006) would seem like a logical first step although it is generally accepted that such a change will not be sufficient to address sustainability concerns.
- Reducing winter seasons as suggested by Olver et al. (1991) would be another option. It should be noted however, that results of the extensive aerial creel data collected do not support previous observations that a disproportionate amount of annual effort on lake trout lakes occurs during the winter months (Evans et al. 1991). Winter effort was only found to exceed open water effort on small remote lakes and for the majority of these lakes, observed annual effort was below the E_{msy} benchmark. Furthermore, winter effort can be expected to decline over time without modification of the open season given a trend towards warmer winters and reduced periods of safe ice cover. Finally, it must be recognized that shortened winter lake trout seasons will direct angler effort and associated impacts to other species (e.g. brook trout and walleye) and that the reduction in winter lake trout effort and harvest realized may not be as substantial as one might expect (Amtstaetter 2006). Lake trout effort may simply become more concentrated with anglers targeting other species outside of a reduced open season, switching interest to lake trout when the season opens.
- An earlier mid to late summer closure date should also be considered. Such a regulation would reduce selective harvest of mature females and improve reproductive potential. A shortened late summer season would have a lesser affect on angling opportunities and may be better received than a reduced winter season.
- Based on the life history analysis presented, the effectiveness of selective protection of mature fish above 40 to 50 cm should be evaluated as a potential alternative to shortened seasons. A one over 40, 45, or 50 cm regulation may address variation in lake trout growth patterns across the landscape and the relative sensitivity of large versus small bodied populations. Specifically, such a regulation should disproportionately reduce the number of mature lake trout harvested on large bodied lakes as compared to small bodied lakes, a strategy which would seem to make sense given that smaller bodied populations tend to be more resilient.

In addition to potential harvest control measures, the value of stocked put-grow-take trout fisheries (F1 splake, brook trout, and lake trout) in absorbing / deflecting angling pressure cannot be overstated. An effort should be made to maintain or expand such stocking programs especially where suitable recipient water bodies exist in proximity to self-sustaining lake trout lakes.

It is important to recognize, as potential regulatory options are evaluated and effectiveness monitoring strategies are developed, that a number of questions remain regarding the benchmarks used in SoR reporting and the effect of habitat and community variables on potential lake trout production. Not all lakes below the abundance benchmark are there as a result of past exploitation and some may not have the potential to move upwards regardless of harvest control efforts.

10.2 – Introduced Species

To address the threat of introduced species, MNR and OFAH should work together to educate anglers as to the consequences of fish transfers - both intentional transfers and unintentional transfers through careless use of bait. Some excellent communications products were recently developed by OFAH in partnership with NER. Additional effort should be made to ensure that the messaging developed reaches the intended audience. Furthermore, the illegal transfer of live fish should be given a high enforcement priority and should carry stiff penalties. While a lake trout population may recover from illegal harvest the effect of an unauthorized bass or walleye introduction is irreversible.

Furthermore, given mounting evidence regarding the impact of introduced species on lake trout and other valued sportfish, consideration should be given to restricting the use of baitfish in the province of Ontario. While one option would be an outright ban on the sale and use of baitfish, such a move would generate considerable opposition among both the baitfish industry and anglers in general. Other, more palatable options might include a province wide ban on the sale and use of 'live' baitfish or perhaps a restriction on the capture of baitfish for personal use. If all baitfish originated from licensed retailers, which were audited on a regular basis, the incidence of undesirable species in personal bait buckets might be reduced. Furthermore, licensed baitfish retailers should be restricted to retail of local bait only. As a minimum, baitfish from southern Ontario should not be transported north given the constant barrage of Great Lakes invaders.

10.3 - Road Access and Development

Unsustainable fishing pressure and the spread of invasive species can both be linked to road access. It is imperative that the location of new resource access roads be planned in a manner that does not further erode the remoteness of our self-sustaining lake trout lakes. Already the network of resource access roads created in Ontario has resulted in but a small portion of the Boreal landscape that can still be considered remote (Gunn and Sein, 2000).

Similarly, unsustainable fishing pressure and the spread of invasive species can be linked to lake development (i.e. cottage development). NER should fully support current policy initiatives relating to development on lake trout lakes and the restrictive approach proposed for self-sustaining lakes.

While it is recognized that the network of protected areas in NER affords a degree of protection from both access and development, only 30% of the self-sustaining lake trout lakes in NER lie completely within protected area classes which can be expected to effectively limit the creation of new access. Clearly access and development considerations need to extend beyond the current protected areas network.

10.4 – Acid Recovery

Work to restore acid damaged lakes in NER must continue. Additional stocking and a long-term monitoring program are required. While the Districts involved may be prepared to assume responsibility for monitoring, the work will not get done without dedicated funding beyond base allocations. The cost of a minimum monitoring program has been estimated at $30,000 annually.

The Nordic standard should clearly be adopted as the tool of choice for monitoring the recovery of damaged lakes given the role that fish community structure plays in setting restoration strategies and in determining success. Standardized data will also serve to feed research programs. Given the range of stocking and restoration strategies applied, a framework for future research initiatives has been established.

10.5 – Water Levels

There is some indication that water level manipulation is affecting the health of lake trout populations in NER. The potential affects of winter draw downs on lake trout should be given continued consideration through effectiveness monitoring as part of water management planning exercises and elevated as a science priority to the Waterpower Science Strategy Steering Committee.

10.6 - Future State-of-Resource Monitoring

Consideration should be given to adopting the Nordic standard as the tool of choice for assessment of lake trout lakes within the framework of the proposed provincial SoR program. Nordic CUE's have been calibrated to lake trout abundance and further refinement of the relationship will be possible as additional data is collected. The Nordic standard also provides valuable data regarding the status of other sportfish (e.g. walleye) and the structure of the fish community in general. Given the obvious role that fish community factors play in the health of lake trout populations, this aspect of resource status needs to be considered. Information around fish community structure will prove instrumental in further refinement of abundance reference points.

Assuming funding for future monitoring cycles does materialize, consideration should be given to reducing aircraft costs through selection of representative watersheds for aerial effort surveys and increasing sample size within selected watersheds for the index netting component (i.e. above the 10% sample recommended by McGuiness et al. (2000)).

Furthermore, as recommended by McGuiness et al. (2000), consideration should be given to establishment of fixed sampling sites (lakes) to supplement random index netting for future monitoring cycles in NER. It has been suggested that the 20 lake trout lakes currently monitored by Ontario's FAU network could serve the need for fixed sampling sites to support trend through time analysis. A key concern with this approach is that there are presently no FAU lakes in NER.

11.0 – Final Comments

While acid damaged lake trout lakes in NER have shown dramatic chemical recovery in recent decades and efforts to restore lost lake trout populations are well underway, the broader state-of-resource data collected suggests that NER lake trout populations are in poor health overall. There are only estimated to be 225 self-sustaining lake trout lakes in NER which presently provide for healthy levels of lake trout abundance. Furthermore, the data collected clearly suggests that proliferation of road access (resulting in over-exploitation) and the impact of introduced species are two significant issues currently impacting resource health. Often, these emerging stressors occur in tandem, where lakes with good road access have higher rates of exploitation and higher incidence of introduced species.

Given limited reproductive potential and sustainable yields, lake trout populations are highly sensitive to exploitation. Even a short term harvest pulse associated with the construction of a new access road can have long-term effects on population abundance and sustainability as fish community imbalances can result and are difficult to reverse. Fishing pressure data collected on self-sustaining lake trout lakes in the northeast shows that angling intensity is highest on large lakes with good road access. Smaller, more remote lakes are fished less intensely with winter effort exceeding open water effort. For the majority of these lakes, annual effort is considered to be ‘safe’ (i.e. below E_{msy}). Overall, 32% of the self-sustaining lakes surveyed are experiencing angling effort beyond sustainable levels and nearly 50% of the lakes found to still support healthy lake trout abundance levels are being over-fished. Furthermore, the introduction of competitive species, such as smallmouth bass (*Micropterus dolomieu*) and walleye (*Sander vitreus*) is occurring at an alarming rate. Standardized population assessments from 130 lakes showed a 40% decrease in adult lake trout density in lakes with smallmouth bass present.

Finally, to speak of lake trout and not mention the potential impact of climate change would seem remiss. Shuter and Lester (2004) offer the following predictions: As surface waters warm and longer stratification periods produce anoxia in deeper waters, usable habitat for lake trout will contract. This in turn will result in reductions in sustainable harvest levels and sustainable angling pressure. At the same time, anglers may become more proficient given that fish will be confined by narrower bands of summer habitat for extended periods of time. The overall effect of climate change on many populations will be to render current levels of use grossly unsustainable and to mandate levels of protection far more stringent than those currently in place. Furthermore, warming will drive changes in fish community structure, changes that can be exacerbated by species introductions caused by humans (Vander Zanden et al. 2004).

In summary, while efforts are being made to recover damaged lake trout populations in Northeastern Ontario, managerial responses to emerging issues are needed. Decisive action must be taken to reduce harvest, maintain remoteness, and address the potential impact of introduced species.

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Appendix 1: Clarification / modification of lake trout stock status codes from Lake Trout Lakes in Ontario (OMNR 1990) - *2003 NER additions / clarification in italics*.

Native Populations

- N1 – native population, natural reproduction, self-sustaining, unstocked *Clarification: if stocking has been terminated in favor of natural recruitment then N1 regardless of historic stocking records*
- N2 – native population, natural reproduction, partly self-sustaining, supplemented by plantings of native stock *Clarification: some natural recruitment, ongoing supplemental stocking with native stock – very rare*
- N3 – native population, natural reproduction, partly self-sustaining, supplemented by plantings of non-native stock *Clarification: as per N2 but currently being supplemented with non-native stock, more common but being phased out*
- N4 – native population, little or no reproduction, population maintained by plantings of native stock *Clarification: ongoing put-grow-take stocking with native stock – very rare*
- N5 – native population, little or no reproduction, population maintained by plantings of non-native stock *Clarification: ongoing put-grow-take stocking, non-native stock - common*
- N6 – native remnant population, self-sustaining, supplemented by plantings of F1 splake *Clarification: native lake trout lake converted to F1 splake put-grow-take, normally only where native population has been lost*

Introduced Populations *Clarification: no evidence of native population historically*

- I1 – introduced population, no native stock, self-sustaining
- I2 – Introduced population, no native stock, population maintained by plantings
- I – introduced population, further information unknown *Clarification: stocked without follow-up assessment or reasonable anecdotal evidence of establishment or failure*

Re-Introduced Populations *Clarification: same coding breakdown as per Introduced Populations, the difference being restoration of an extinct population in a known lake trout lake (eg. these are the codes that should be applied to the acidified lakes where restocking has or is occurring)*

- *R1 – reintroduced population, no native stock, self-sustaining*
- *R2 – reintroduced population, no native stock, population maintained by plantings*
- *R – reintroduced population, further information unknown*

Other Codes

- U – history unknown *Clarification: Use of this code should be reserved for a limited number of lakes where history and status are truly unknown. Some Districts regularly applied this code to native lake trout lakes based on an absence of recent assessment data ie. we don't know how the population is doing. If we know lake trout are still present (eg. observed angler caught fish) and know that the lake has not been stocked then it should be classified as N1 recognizing that present level of abundance is unknown*
- E – extinct population; native or introduced population that disappeared from a lake after a known period of natural reproduction
- L – lost population; population of unknown history and reproductive status which disappeared from a lake
- O – other (specify)

Appendix 2: Spring chemistry data for 104 randomly selected lakes in NER.

DISTRICT	WBY LID	LAKE NAME	LAT	LONG	DATE	Alkalinity (mg/L)	pH	Conductivity (*u* mhos/cm)	TDS (mg/L)	Turbidity (NTU)	Colour (TCU)	DOC (mg/L)	Phosphorous (*u* g/L)	TKN (*u* g/L)
Chapleau	16-7142-53440	Blackfish	481256	840655	11/05/2004	10.09	6.94	36.0	23.98	0.12	84.22	14.07	9.15	424.8
Chapleau	17-3426-53189	Nemegosenda	480018	830638	11/05/2004	53.54	7.77	127.1	84.65	0.01	45.52	7.65	7.30	304.0
Chapleau	17-2934-53143	Windermere	475707	834607	11/05/2004	21.87	7.37	58.8	39.16	0.01	37.58	7.64	7.05	265.3
Kirkland Lake	17-5561-52598	Greenwater	472928	801523	18/05/2004	5.23	6.73	26.9	17.92	0.17	13.49	2.95	7.25	158.1
Kirkland Lake	17-5606-52675	Munroe	473336	801140	18/05/2004	5.76	6.62	34.5	22.98	0.01	34.74	6.61	4.85	206.6
Kirkland Lake	17-5182-52469	Smith	472241	804528	18/05/2004	0.83	5.91	20.5	13.65	0.01	11.70	3.61	3.95	183.6
North Bay	17-5827-52344	Anima Nipissing	471537	795414	19/05/2004	8.58	6.98	39.4	26.24	0.01	6.95	3.28	4.60	166.7
North Bay	17-5674-52374	Barter	471720	800625	19/05/2004	3.34	6.48	28.8	19.18	0.05	18.91	5.22	5.95	181.5
North Bay	17-6069-51648	Bear	463749	793610	11/05/2004	1.97	6.06	20.0	13.32	0.04	36.68	7.49	7.30	280.4
North Bay	17-5288-52236	Benner	471002	803714	18/05/2004	0.88	5.95	23.8	15.85	0.01	9.79	2.70	3.95	147.6
North Bay	17-5533-52097	Clearwater	470226	801746	19/05/2004	5.39	6.89	35.2	23.44	0.01	2.61	1.80	4.90	155.0
North Bay	17-5788-51912	Cross	465213	795747	19/05/2004	9.43	7.17	58.5	38.96	0.01	14.74	3.37	6.05	172.2
North Bay	17-5521-51877	Cucumber	465040	801858	19/05/2004	10.47	7.10	47.0	31.30	0.01	5.35	1.73	3.80	113.9
North Bay	17-5605-51996	Cummings	465653	801222	19/05/2004	6.71	6.83	31.3	20.85	0.05	14.85	4.21	5.70	212.2
North Bay	17-5566-51724	Dana	464216	801533	19/05/2004	3.59	6.34	27.3	18.18	0.09	26.47	5.34	5.25	228.1
North Bay	17-5603-51797	Deschamps	464612	801235	19/05/2004	4.98	6.66	30.9	20.58	0.01	22.76	5.49	5.20	220.7
North Bay	17-5580-52276	Diamond	471210	801432	19/05/2004	3.67	6.64	27.1	18.05	0.01	12.93	4.04	5.20	178.4
North Bay	17-5467-52535	Grays	472607	802248	18/05/2004	0.30	5.37	19.9	13.25	0.01	19.79	4.29	3.60	130.2
North Bay	17-5491-52005	Iron	465728	802117	19/05/2004	1.27	6.07	26.4	17.58	0.01	6.78	2.90	4.00	169.8
North Bay	17-5263-52458	Jerry	472201	803911	18/05/2004	0.05	5.33	21.2	14.12	0.01	7.74	2.02	2.10	138.2
North Bay	17-5390-52352	Landers	471623	802841	18/05/2004	-0.06	5.00	19.7	13.12	0.04	21.40	4.42	4.40	175.7
North Bay	17-5401-52454	McGiffin	472139	802804	18/05/2004	7.21	6.86	35.2	23.44	0.01	20.54	4.33	5.30	175.0
North Bay	17-5259-52267	Pilgrim	471143	803930	18/05/2004	0.27	5.50	22.5	14.99	0.01	11.06	3.02	3.90	194.7
North Bay	17-5351-52163	Seagram	470603	803213	18/05/2004	0.32	5.60	23.1	15.38	0.01	20.18	3.87	3.75	157.1
North Bay	17-5573-51927	Turtleshell	465321	801451	19/05/2004	5.90	6.90	32.1	21.38	0.01	11.24	3.74	4.80	178.0
North Bay	17-5476-52058	Wawiagama (Round)	470001	802255	19/05/2004	14.65	7.30	53.0	35.30	0.53	21.10	4.46	9.10	249.5
North Bay	17-5756-52313	Whitewater	471354	800005	19/05/2004	19.46	8.41	61.3	40.83	0.55	4.56	2.64	5.50	215.3
SSM	17-3486-51441	Admiral (Duck)	462613	825800	05/05/2004	3.69	6.47	23.0	15.32	0.34	27.97	4.04	7.60	207.7
SSM	17-3382-51620	Burns	463540	830651	05/05/2004	0.59	5.93	19.0	12.65	0.00	2.70	0.86	3.15	98.7
SSM	17-3792-51405	Canyon	462436	823414	04/05/2004	8.43	6.82	35.7	23.78	0.09	7.63	2.22	7.90	245.7
SSM	17-3423-51340	Chiblow	462050	830218	05/05/2004	4.32	6.07	28.0	18.65	0.00	4.15	2.20	4.95	144.9
SSM	17-3290-51439	Constance	462548	831328	05/05/2004	10.47	6.98	43.9	29.24	0.72	14.17	3.91	11.50	274.9
SSM	17-3039-51641	Darragh	463615	833331	11/05/2004	5.93	6.77	28.5	18.98	0.01	13.22	3.96	5.90	358.7
SSM	17-3465-51920	Daystar	465150	830054	05/05/2004	8.18	6.66	32.0	21.31	0.06	19.41	3.92	6.70	204.2
SSM	17-2752-51845	Deil (Devil's)	464641	835640	11/05/2004	5.39	6.84	26.1	17.38	0.01	11.84	3.91	4.90	242.4
SSM	17-3746-51867	Dubbelewe	464930	823844	05/05/2004	3.28	6.42	19.3	12.85	0.00	5.99	2.41	6.90	203.3

DISTRICT	WBY LID	LAKE NAME	LAT	LONG	DATE	Alkalinity (mg/L)	pH	Conductivity (u mhos/cm)	TDS (mg/L)	Turbidity (NTU)	Colour (TCU)	DOC (mg/L)	Phosphorous (u g/L)	TKN (u g/L)
SSM	17-3320-51621	East Caribou	463537	831130	05/05/2004	4.07	6.45	24.0	15.98	0.00	15.79	3.27	5.20	173.1
SSM	17-2815-51794	Fern	464405	835136	11/05/2004	6.46	6.77	28.7	19.11	0.01	13.25	3.89	4.95	376.2
SSM	17-3634-51607	Flack	463516	824649	05/05/2004	5.64	6.73	33.9	22.58	0.00	4.72	2.86	5.05	169.1
SSM	17-2933-51822	Garden	464554	834224	11/05/2004	7.01	6.69	31.7	21.11	0.12	47.03	7.82	7.10	371.4
SSM	17-3762-51303	Grandeur	461904	823631	04/05/2004	8.40	6.96	77.6	51.68	0.00	18.86	3.79	8.80	240.1
SSM	17-3500-51516	Keelor	463012	825726	05/05/2004	3.71	6.50	21.9	14.59	0.00	18.08	3.43	8.10	211.2
SSM	17-3509-51882	Kindiogami	464957	825717	05/05/2004	10.33	6.84	37.6	25.04	0.00	19.21	3.01	6.65	167.5
SSM	17-3006-52333	Lawer	471323	833800	11/05/2004	6.82	6.59	29.2	19.45	0.05	90.31	12.89	9.50	404.1
SSM	17-3813-51665	Little Sister	463835	823300	04/05/2004	4.68	6.64	27.6	18.38	0.00	3.75	1.16	7.30	143.6
SSM	17-3078-52210	Lodestone	470651	833206	11/05/2004	6.83	6.80	27.3	18.18	0.01	26.53	6.26	5.80	263.7
SSM	17-3585-51264	Magog (Granary)	461632	825027	04/05/2004	17.78	9.42	58.3	38.83	0.48	18.14	3.86	7.10	266.7
SSM	16-6811-52113	Mamainse	470158	843657	11/05/2004	2.82	6.46	19.7	13.12	0.01	5.90	2.17	3.85	184.7
SSM	17-3797-51421	McCabe	462524	823357	04/05/2004	9.02	7.01	374.0	249.08	0.00	4.83	2.03	4.35	195.3
SSM	17-3678-51289	McGiverin	461809	824259	04/05/2004	13.43	7.95	46.2	30.77	0.11	23.25	4.76	7.75	255.5
SSM	17-3090-52347	Megisan	471456	833125	11/05/2004	11.76	7.04	39.8	26.51	0.01	42.11	7.76	6.25	273.1
SSM	17-2857-52090	Morrison	470007	834907	11/05/2004	3.87	6.48	22.9	15.25	0.01	15.41	4.51	4.60	209.4
SSM	16-7200-51762	Northland (Loon)	464221	840719	11/05/2004	2.75	6.29	19.6	13.05	0.01	28.10	5.21	5.40	244.1
SSM	17-3053-51969	Ranger	465343	833317	11/05/2004	7.48	6.91	32.5	21.65	0.01	8.22	3.23	3.65	162.6
SSM	17-3843-51532	Rochester	463132	823049	04/05/2004	3.13	6.35	22.0	14.65	0.56	27.91	4.79	22.50	436.0
SSM	17-3822-51676	Rosemarie	463920	823224	04/05/2004	5.07	6.69	28.5	18.98	0.00	5.99	2.04	9.55	188.8
SSM	17-3298-51798	Seymour	464507	831349	05/05/2004	7.71	6.85	30.5	20.31	0.00	23.34	4.32	7.90	212.7
SSM	17-3008-51554	Skookum	463127	833539	11/05/2004	5.69	6.83	29.9	19.91	0.01	7.85	2.81	5.60	194.6
SSM	17-3629-51531	Ten Mile	463121	824718	05/05/2004	4.85	6.72	26.9	17.92	0.00	2.10	1.28	4.75	109.3
SSM	17-3635-51676	Tenfish	463852	824609	05/05/2004	3.44	6.45	22.4	14.92	0.00	5.68	2.46	5.70	131.8
SSM	17-3398-51886	Three Lakes	464928	830603	11/05/2004	33.84	7.68	89.2	59.41	0.01	2.79	0.86	5.70	408.9
SSM	17-3342-51796	Toodee	464505	831013	05/05/2004	19.23	9.15	57.5	38.30	0.00	19.24	4.25	6.35	209.2
SSM	16-7076-51899	Tupper	464957	841639	11/05/2004	4.92	6.65	20.7	13.79	0.16	21.13	4.79	6.80	306.3
SSM	16-7101-51724	Upper Island (Island)	464022	841500	11/05/2004	6.43	6.82	47.2	31.44	0.01	16.05	3.72	6.25	246.0
SSM	17-3393-51732	White Bear	464157	830625	05/05/2004	7.87	6.87	30.3	20.18	0.00	4.68	2.36	4.45	127.2
Sudbury	17-4304-51587	Acheson	463448	815417	04/05/2004	3.07	6.32	26.8	17.85	0.00	32.09	4.11	6.90	206.8
Sudbury	17-4129-51783	Alces	464519	820823	04/05/2004	4.76	6.59	26.2	17.45	0.43	25.19	3.52	8.30	199.5
Sudbury	17-4523-51979	Antrim	465601	813733	17/05/2004	4.95	6.66	40.5	26.97	0.09	36.15	6.09	7.85	236.1
Sudbury	17-4281-52070	Big Squaw (Big Squirrel)	470050	815649	17/05/2004	3.53	6.43	26.1	17.38	0.06	32.80	6.28	6.70	211.2
Sudbury	17-4026-51425	Folson	462552	821601	04/05/2004	3.13	6.38	20.6	13.72	0.02	10.49	3.13	8.00	248.1
Sudbury	17-4734-51994	Friday	465747	812034	17/05/2004	3.36	6.38	28.1	18.71	0.01	16.30	4.09	6.00	168.2
Sudbury	17-4514-51934	Halfway	465340	813817	11/05/2004	6.78	6.91	60.6	40.36	0.01	21.96	5.33	4.60	262.5
Sudbury	17-4564-51144	Hannah	461102	813355	03/05/2004	10.13	7.11	66.1	44.02	0.00	13.23	2.98	8.35	228.1
Sudbury	17-4099-51964	Jeanne	465525	821116	05/05/2004	1.95	6.14	20.5	13.65	0.00	7.81	3.25	7.95	196.8
Sudbury	17-4826-51036	Johnnie (Bushcamp)	460513	811330	03/05/2004	0.66	5.68	23.5	15.65	0.00	12.86	3.42	5.45	230.1
Sudbury	17-4001-51234	Kecil	461548	821741	03/05/2004	2.85	6.23	23.7	15.78	0.57	27.57	4.65	8.65	339.3

DISTRICT	WBY LID	LAKE NAME	LAT	LONG	DATE	Alkalinity (mg/L)	pH	Conductivity (u mhos/cm)	TDS (mg/L)	Turbidity (NTU)	Colour (TCU)	DOC (mg/L)	Phosphorous (u g/L)	TKN (u g/L)
Sudbury	17-3921-51464	Kindle	462752	822418	03/05/2004	9.06	7.03	51.0	33.97	0.00	8.27	2.48	8.00	216.3
Sudbury	17-4154-51623	Klondyke North	463638	820615	04/05/2004	1.97	6.09	20.1	13.39	0.18	22.79	3.62	6.70	194.1
Sudbury	17-4975-51827	Kumska	464747	810252	18/05/2004	3.20	6.49	27.3	18.18	0.16	29.30	4.35	5.35	451.2
Sudbury	17-4009-51893	Lake # 42 (Foucault Twp)	465106	821759	05/05/2004	2.56	6.17	21.4	14.25	0.21	34.39	5.94	6.70	236.9
Sudbury	17-5110-52189	Laundrie	470732	805116	18/05/2004	0.39	5.42	24.0	15.98	0.04	34.78	5.55	6.70	423.0
Sudbury	17-4236-51138	Long (Harrow # 23)	461030	815921	03/05/2004	8.24	6.78	41.2	27.44	0.23	40.01	5.99	12.05	327.8
Sudbury	17-4113-51461	Millen	462752	820920	04/05/2004	3.62	6.35	22.3	14.85	0.00	10.17	3.03	6.35	194.9
Sudbury	17-4836-51150	Peter	461124	811250	03/05/2004	4.31	6.62	35.9	23.91	0.00	7.48	2.98	6.40	227.1
Sudbury	17-3909-51461	Rangers (Caribou)	462752	822551	04/05/2004	8.14	6.82	34.2	22.78	0.00	3.68	1.86	6.00	156.6
Sudbury	17-5330-51961	Rawson	465503	803400	18/05/2004	1.22	6.05	28.1	18.71	0.01	13.75	3.50	4.70	104.9
Sudbury	17-4302-51759	Rushbrook	464408	815444	04/05/2004	6.80	6.71	32.6	21.71	0.32	11.64	2.66	11.95	290.1
Sudbury	17-5156-51907	Sam Martin	465211	804742	18/05/2004	2.71	6.45	29.0	19.31	0.01	15.12	3.63	4.65	210.9
Sudbury	17-4248-51802	Shakwa	464615	815912	04/05/2004	2.74	6.22	23.9	15.92	0.00	10.62	3.12	6.70	239.9
Sudbury	17-4277-51933	Sinaminda	465309	815621	17/05/2004	5.10	6.85	27.3	18.18	0.14	12.89	3.93	6.90	208.1
Sudbury	17-4569-52032	Sugarbush	465918	813410	11/05/2004	2.91	6.25	21.1	14.05	0.01	20.77	4.35	4.95	191.2
Sudbury	17-4810-51976	Venetian	465646	811452	17/05/2004	3.39	6.60	26.3	17.52	0.01	17.29	4.50	6.05	280.3
Sudbury	17-4608-51161	Walker	461149	813038	03/05/2004	9.43	7.00	69.7	46.42	0.00	11.32	2.88	5.55	200.9
Sudbury	17-4923-51272	Wavy	461809	810533	03/05/2004	-0.09	5.16	25.9	17.25	0.07	13.98	2.85	6.20	253.2
Timmins	17-4933-52284	Leask	471238	810510	18/05/2004	5.26	6.62	28.4	18.91	0.01	19.43	4.52	4.85	201.1
Timmins	17-4728-52266	Oshawong	471143	812145	17/05/2004	23.42	7.36	69.3	46.15	0.01	42.93	6.37	7.25	279.2
Timmins	17-4860-52213	Pilon	470850	811105	17/05/2004	2.23	6.36	22.6	15.05	0.03	25.39	5.37	5.30	245.7
Timmins	17-4902-52259	Prune	471111	810759	18/05/2004	4.99	6.76	30.3	20.18	0.13	12.55	3.69	4.90	184.4
Timmins	17-4971-52299	Welcome	471309	810231	11/05/2004	5.83	6.87	32.5	21.65	0.01	15.41	4.89	7.85	215.9
Wawa	16-6751-53308	Goetz	480640	843859	11/05/2004	33.30	7.66	93.6	62.34	0.01	8.72	2.21	4.30	166.9
Wawa	16-6718-52845	Mijinemungshing	474136	844237	11/05/2004	3.89	6.51	19.9	13.25	0.04	26.42	5.57	5.50	228.0
Wawa	16-6710-52766	Old Woman	473721	844327	11/05/2004	2.98	6.31	17.5	11.66	0.01	17.08	4.27	4.25	199.9
Wawa	16-6879-53337	Pivot	480728	842829	11/05/2004	5.38	6.70	25.8	17.18	0.01	20.58	6.34	4.25	247.1
Wawa	16-6606-53045	Treeby	475236	845105	11/05/2004	13.90	7.28	56.9	37.90	0.01	27.57	6.00	6.60	260.8

Appendix 3: Reference points for expected lake trout density and sustainable effort at maximum sustained yield (MSY) – from: Monitoring the state of Ontario's inland lakes fisheries resources: a pilot study (OMNR 2004).

Lake trout density at MSY

Simulations based on the exploitation model developed by Shuter et al. (1998) were run to estimate the abundance of adult lake trout when populations are exploited at *MSY* levels (Janoscik and Lester 2003). Because lake trout typically grow to larger sizes on larger lakes, abundance at *MSY* is inversely related to lake area. The results imply the following relationship between density of mature fish (D_m, # fish/ha) and asymptotic length:

$$D_m = 1112 \; e^{-0.105 L_\infty} \qquad \text{(A3.1)}$$

This formula assumes an initial growth rate (ω) of 10 cm/yr. Variation in growth rate affects this relationship, but the effect is small for the range of ω observed in lake trout.

To apply equation A1.1 in calculating an abundance reference point for each lake, we used catch data to estimate L_∞. Pauly (1984) recommends using maximum observed length (L_{max}) to estimate asymptotic length:

$$L_\infty = \frac{L_{\max}}{0.95} \qquad \text{(A3.2)}$$

This approach does not work well for lake trout because small bodied populations often contain a few very large lake trout which do not represent the population at large, but rather a small sub-population that sustains higher growth by feeding on lake trout. Following the guidance of Janoscik and Lester (2003), L_{max} was calculated as the mean of the 5 largest fish within the 95th percentile of observed lengths (i.e. largest 5% of the sample is ignored) and an initial estimate of L_∞ was obtained from equation A1.2. When this estimate was based on a sample size < 50 fish, a correction for small sample size was applied: the initial estimate was divided by $1 - e^{0-.039(n+32)}$ where *n* is the sample size. When the samples size was very small (i.e. n < 10), a formula based on lake area (Shuter et al. 1998) was used:

$$L_\infty = 37.15 \, Area^{0.071} \qquad \text{(A3.3)}$$

Sustainable angling effort at MSY

Based on the Shuter et al. (1998) exploitation model, Lester and Dunlop (2004) developed the following formula for calculating effort at *MSY*:

$$E_{msy} = 10^{0.0054 + \frac{1.892}{Area^{0.16}} - 0.222 \log_{10} TDS + 0.073 \log_{10} Area * \log_{10} TDS} \qquad \text{(A3.4)}$$

This formula implies E_{msy} ranges from xx to xx angler-hrs.ha depending on lake area and *TDS*.

Appendix 4: Summary of index netting results for 73 Nordic netting surveys used in the NER state-of-resource analysis (i.e. representative lakes assessed using the Nordic standard) including regional reference statistics.

District	Lake Name	WBY LID	FN2 Code	Date	CUE (all strata)		CUE (> 6m)		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (years)			
					# Sets	CUE	# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
Chapleau	Blackfish	16-7142-53440	21D_IA03_BLA	21/08/2003	40	0.48	26	0.73	15	503	395	348	947	968	690	44	3320	1.28	1.29	0.94	1.48	7.6	6	2	17
Chapleau	Windermere	17-2934-53143	21D_IA03_WIN	26/08/2003	56	0.02	35	0.00	1	627	627	627	627	3100	3100	3100	3100	1.26	1.26	1.26	1.26	17.0	17	17	17
Kirkland	Greenwater	17-5561-52598	25D_IA02_GRE	09/08/2002	24	2.54	14	3.21	61	395	423	114	591	787	860	12	2360	1.13	1.09	0.81	3.01	9.5	8	3	26
Kirkland	Lady Sydney	17-5599-52502	25D_IA01_LAD	24/08/2001	60	0.28	26	0.65	16	476	441	212	810	1988	1500	89	6500	1.09	1.10	0.89	1.43	10.7	8	3	28
Kirkland	Munroe	17-5606-52675	25D_IA02_MUN	22/08/2002	24	1.50	12	3.00	36	325	263	100	671	647	168	9	3300	0.99	0.97	0.78	1.31	7.5	7	1	19
Kirkland	Smith	17-5182-52469	25D_IA02_SMI	30/08/2002	40	1.43	21	2.67	57	285	287	94	531	444	240	7	1900	1.10	1.08	0.78	1.47	4.8	5	0	12
North Bay	Barter	17-5674-52374	36D_IA02_BAR	12/07/2002	80	0.99	26	2.77	79	362	384	129	540	672	600	16	2080	1.06	1.06	0.59	1.50	6.8	6	2	18
North Bay	Benner	17-5288-52236	35D_IA01_BEN	02/08/2001	46	1.26	15	3.53	57	265	245	95	453	297	158	8	1275	1.11	1.11	0.66	1.42	4.2	4	1	18
North Bay	Bluesucker	17-5298-52239	36D_IA00_BLU	30/08/2000	40	1.03	24	1.67	41	346	362	125	475	553	530	20	1450	1.12	1.14	0.79	1.44	3.7	3	1	7
North Bay	Deschamps	17-5603-51797	33D_IA03_DES	10/08/2003	32	0.09	18	0.17	3	414	417	381	445	860	840	620	1120	1.18	1.16	1.12	1.27	8.7	8	6	12
North Bay	Iron	17-5491-52005	33D_IA04_IRO	20/08/2004	32	1.56	18	2.78	50	243	204	128	610	279	79	10	2650	0.98	0.93	0.47	1.91				
North Bay	Jim Edwards	17-5431-52386	36D_IA02_JIM	19/07/2002	72	0.13	18	0.50	9	286	217	116	600	567	105	15	2420	0.96	0.93	0.76	1.15				
North Bay	Linger	17-5367-52152	35D_IA02_LIN	25/07/2002	52	0.29	6	2.33	15	299	285	163	480	376	250	46	1180	1.08	1.08	0.94	1.27				
North Bay	McGiffin	17-5401-52454	36D_IA02_MCG	16/08/2002	32	0.75	18	0.94	24	337	358	103	525	665	595	8	1780	1.10	1.17	0.73	1.32	7.7	7	1	16
North Bay	Pilgrim	17-5259-52267	35D_IA04_PIL	22/07/2004	40	4.60	26	6.69	184	297	300	89	455	306	260	4	1100	0.98	0.98	0.57	1.26	5.2	5	0	15
North Bay	Rodd	17-5274-52242	36D_IA01_ROD	09/08/2001	36	0.19	6	1.00	7	314	390	119	435	525	710	15	970	1.08	1.09	0.89	1.20	4.7	6	1	8
North Bay	Sugar	17-5670-52431	36D_IA01_SUG	17/08/2001	60	0.18	26	0.42	11	352	339	130	550	1074	630	27	3250	1.53	1.44	1.23	2.05	5.1	5.5	1	11
North Bay	Turner	17-5695-52367	36D_IA01_TUR	17/08/2001	60	0.17	26	0.31	10	507	582	109	734	2519	2525	10	6100	1.27	1.37	0.77	1.54	5.6	7	1	10
SSM	Admiral (Duck)	17-3486-51441	34D_IA03_DUC	09/08/2003	24	0.00	10	0.00																	
SSM	Bobowash	17-3635-51568	34D_IA03_BOB	01/08/2003	32	0.63	18	0.89	20	431	508	90	560	1373	1545	6	2480	1.21	1.21	0.80	1.63	11.6	11	1	22
SSM	Burns	17-3382-51620	34D_IA01_BUR	24/08/2001	40	1.05	26	1.54	42	306	276	135	573	442	187	20	2380	1.00	0.95	0.70	1.57				
SSM	Canyon	17-3792-51405	34D_IA03_CAN	11/09/2003	24	0.17	10	0.20	4	560	583	415	660	2470	2630	1020	3600	1.33	1.33	1.25	1.43	7.0	6	4	11
SSM	Christman	17-3675-51601	34D_IA03_JIM	05/09/2003	24	0.79	10	1.70	19	352	366	241	516	528	550	150	1440	1.08	1.05	0.93	1.26				
SSM	Darragh	17-3039-51641	34D_IA03_DAR	16/08/2003	40	1.95	26	3.00	78	310	311	58	600	502	285	1	3100	1.03	0.99	0.72	1.44	5.1	4	0	18
SSM	Daystar	17-3465-51920	34D_IA03_DAY	13/08/2003	32	0.75	18	0.94	24	351	324	219	595	632	358	105	3300	1.08	1.05	0.84	1.57	7.6	7	3	14
SSM	Dollyberry	17-3633-51558	34D_IA03_DOL	06/09/2003	40	0.45	26	0.58	18	360	366	127	550	768	545	21	1930	1.08	1.11	0.80	1.31				
SSM	Dubbelewe	17-3746-51867	34D_IA03_DUB	25/07/2003	32	0.25	18	0.44	8	631	634	581	683	3213	3175	2150	4300	1.26	1.27	1.03	1.35	10.5	11.5	5	13
SSM	East Caribou	17-3320-51621	34D_IA03_ECA	06/08/2003	40	0.35	24	0.33	14	382	381	210	558	896	685	112	2090	1.12	1.16	0.85	1.34	6.1	4	2	15
SSM	Keelor	17-3500-51516	34D_IA03_KEE	30/07/2003	40	2.45	26	3.77	98	329	328	79	570	464	338	5	2500	0.99	0.97	0.69	1.60	7.7	6	1	38
SSM	Little Sister	17-3813-51665	34D_IA04_LIT	09/07/2004	24	2.21	10	2.80	53	369	374	169	528	666	620	57	1600	1.13	1.16	0.95	1.26				
SSM	May	17-3852-51434	34D_IA02_MAY	30/08/2002	88	0.17	27	0.44	15	433	460	222	580	1240	1320	112	2500	1.20	1.18	1.02	1.36				
SSM	McCabe	17-3797-51421	34D_IA02_MCC	16/08/2002	80	0.24	26	0.73	19	444	462	153	590	1219	1180	25	2220	1.18	1.20	0.68	1.37				
SSM	McGiverin	17-3678-51289	34D_IA02_MCG	09/09/2002	42	1.31	30	1.37	55	311	289	134	630	468	240	20	4000	1.03	1.01	0.79	1.60	5.2	5	0	12

District	Lake Name	WBY LID	FN2 Code	Date	CUE (all strata)		CUE (> 6m)		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (years)			
					# Sets	CUE	# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
SSM	Rochester	17-3843-51532	34D_IA04_ROC	15/07/2004	24	0.21	10	0.50	5	487	460	379	630	1828	1300	690	3900	1.35	1.34	1.13	1.56				
SSM	Rosemarie	17-3822-51676	34D_IA03_ROS	10/08/2003	32	1.13	18	2.00	36	306	302	109	518	462	310	20	2100	1.18	1.16	0.96	1.54	4.7	3.5	1	24
SSM	Samried	17-3658-51570	34D_IA03_SAM	01/08/2003	32	0.81	18	1.17	26	353	350	160	604	648	400	38	2350	1.00	0.99	0.80	1.25				
SSM	Semiwite	17-3712-51594	34D_IA03_SEM	07/07/2003	48	2.00	28	3.32	96	271	260	98	550	309	190	8	2040	1.01	1.01	0.78	1.23				
SSM	Skookum	17-3008-51554	34D_IA03_SKO	17/07/2003	24	0.00	10	0.00																	
SSM	Ten Mile	17-3629-51531	34D_IA03_TEN	09/07/2003	56	2.13	36	2.81	119	333	358	82	627	579	550	5	3500	1.14	1.15	0.69	1.65	6.8	6	1	20
SSM	Tenfish	17-3635-51676	34D_IA04_TEN	29/07/2004	32	3.63	19	5.68	116	292	299	91	692	423	308	7	4350	1.12	1.13	0.83	1.42	4.5	4	0	18
SSM	Three Lakes	17-3398-51886	34D_IA03_THR	13/07/2003	32	0.31	18	0.44	10	508	510	392	611	1854	1840	700	3200	1.32	1.31	1.05	1.55	7.3	7	4	14
SSM	Toodee	17-3342-51796	34D_IA03_TOO	17/08/2003	40	1.13	24	1.71	45	359	361	95	550	662	515	10	1975	1.08	1.10	0.80	1.36	6.4	5	1	19
SSM	White Bear	17-3393-51732	34D_IA03_WHI	01/08/2003	46	1.76	28	2.50	81	320	306	101	526	473	275	9	2080	0.98	0.96	0.77	1.44	5.8	5	1	25
Sudbury	Acheson	17-4304-51587	33D_IA04_ACH	06/08/2004	40	1.75	26	2.69	70	378	371	171	593	658	565	46	2160	1.06	1.07	0.84	1.26				
Sudbury	Antrim	17-4523-51979	35D_IA04_ANT	05/08/2004	24	0.04	10	0.10	1	104	104	104	104	11	11	11	11	0.93	0.93	0.93	0.93				
Sudbury	Bear	17-4652-51149	35D_IA03_BEA	15/08/2003	48	0.46	28	0.79	22	388	375	241	601	742	545	120	2820	1.06	1.03	0.86	1.45	6.2	6	3	14
Sudbury	Big Squaw	17-4281-52070	35D_IA03_BIG	29/08/2003	32	0.50	18	0.67	16	395	329	196	630	1003	349	70	3200	1.00	0.96	0.84	1.28	7.4	5	2	18
Sudbury	Fairbank	17-4672-51457	35D_IA03_FAI	29/08/2003	48	0.50	28	0.86	24	357	311	234	599	688	292	114	2900	1.03	1.01	0.80	1.35				
Sudbury	Folson	17-4026-51425	35D_IA03_FOL	05/09/2003	40	0.38	25	0.60	15	376	410	143	547	758	650	27	1940	1.07	1.06	0.92	1.29	5.5	6.5	2	8
Sudbury	Foucault # 42	17-4009-51893	35D_IA03_L42	13/08/2003	24	0.50	10	0.80	12	396	381	166	615	1026	665	40	3000	1.17	1.11	0.87	1.56	7.8	7	3	13
Sudbury	Halfway	17-4514-51934	35D_IA03_HAL	25/07/2003	32	0.59	16	1.19	19	290	287	147	462	371	235	31	1190	1.01	0.98	0.91	1.21	3.9	4	2	6
Sudbury	Ishmael	17-4542-51063	35D_IA03_ISH	28/08/2003	24	0.08	10	0.20	2	448	448	274	621	1545	1545	190	2900	1.07	1.07	0.92	1.21	6.5	6.5	3	10
Sudbury	Jeanne	17-4099-51964	35D_IA04_JEA	30/07/2004	41	0.05	27	0.07	2	613	613	590	635	2500	2500	2000	3000	1.07	1.07	0.97	1.17				
Sudbury	Kettyle	17-5356-51847	35D_IA00_KET	31/08/2000	32	0.53	18	0.94	17	282	232	76	487	421	141	4	1400	1.06	1.07	0.52	1.40	2.6	2	0	7
Sudbury	Klondyke North	17-4154-51623	35D_IA02_NOR	02/08/2002	24	0.38	12	0.58	9	422	404	225	558	1062	760	130	2100	1.22	1.21	1.09	1.34	8.8	7	4	16
Sudbury	Kumska	17-4975-51827	33D_IA04_KUM	12/08/2004	40	0.20	25	0.28	8	525	528	391	683	1749	1620	740	3550	1.16	1.25	0.76	1.39				
Sudbury	Michaud	17-4821-51845	35D_IA04_MIC	20/08/2004	40	0.50	26	0.77	20	360	375	187	465	593	610	74	1120	1.14	1.13	0.97	1.34				
Sudbury	Millen	17-4113-51461	35D_IA03_MIL	18/07/2003	32	0.59	17	0.76	19	320	282	172	765	591	340	50	4200	1.05	1.04	0.85	1.52	6.0	4.5	2	27
Sudbury	Nelson	17-4928-51746	35D_IA04_NEL	07/08/2004	48	1.33	28	2.29	64	292	294	89	730	457	312	7	5500	1.08	1.08	0.83	1.63				
Sudbury	Pedro	17-5352-51958	35D_IA04_PED	22/07/2004	24	0.63	8	1.63	15	447	474	48	542	1264	1300	1	2100	1.18	1.21	0.74	1.33				
Sudbury	Rangers (Caribou)	17-3909-51461	35D_IA02_CAR	25/07/2002	40	3.00	26	3.58	120	293	272	125	493	358	201	17	1300	1.09	1.09	0.68	2.10	5.6	5	2	11
Sudbury	Rawson	17-5330-51961	35D_IA03_RAW	22/08/2003	40	1.88	26	2.88	75	203	198	120	430	147	88	12	1060	1.14	1.15	0.66	1.63	4.3	4	2	13
Sudbury	Rushbrook	17-4302-51759	35D_IA02_RUS	29/08/2002	30	0.13	16	0.25	4	415	441	265	515	995	1063	205	1650	1.20	1.22	1.10	1.24	8.3	8	4	13
Sudbury	Sinaminda	17-4277-51933	35D_IA03_SIN	09/07/2003	56	0.14	36	0.22	8	356	338	272	568	589	385	225	2000	1.08	1.10	0.97	1.21	8.3	7.5	4	19
Sudbury	Sugarbush	17-4569-52032	35D_IA03_SUG	07/09/2003	32	1.22	18	2.00	39	329	305	216	596	493	320	90	2100	1.08	1.08	0.89	1.31	5.5	4	2	18
Sudbury	Three Narrows	17-4670-51065	35D_IA03_THR	20/07/2003	48	0.04	29	0.07	2	692	692	570	813	4750	4750	2500	7000	1.33	1.33	1.30	1.35				
Timmins	Pilon	17-4860-52213	27D_IA03_PIL	21/08/2003	24	0.29	10	0.70	7	293	243	108	477	600	144	11	1460	1.11	1.05	0.83	1.35	5.7	4	1	11
Timmins	Welcome	17-4971-52299	27D_IA04_WEL	28/08/2004	48	0.15	28	0.25	7	261	220	134	404	298	98	21	760	0.99	0.94	0.88	1.15				

District	Lake Name	WBY LID	FN2 Code	Date	CUE (all strata)		CUE (> 6m)		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (years)			
					# Sets	CUE	# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
Wawa	Goetz	16-6751-53308	23D_IA03_GOE	17/07/2003	32	1.91	16	3.25	61	285	336	114	403	334	405	11	790	1.02	1.05	0.66	1.52	9.7	10	2	24
Wawa	Mijinemungshing	16-6718-52845	34D_IA03_MIJ	18/07/2003	46	1.46	28	2.25	67	386	408	191	590	779	800	67	2080	1.14	1.13	0.82	1.46	8.6	7	2	29
Wawa	Old Woman	16-6710-52766	34D_IA04_OLD	07/08/2004	48	0.88	28	1.50	42	375	369	123	619	633	508	16	2775	0.93	0.94	0.67	1.17				
Wawa	Pivot	16-6879-53337	23D_IA03_PIV	12/07/2003	32	0.69	16	0.88	22	376	424	109	563	913	800	9	2260	1.08	1.09	0.61	1.39	6.8	7	2	19
Wawa	Treeby	16-6606-53045	34D_IA04_TRE	13/08/2004	40	1.38	26	1.88	55	357	370	150	470	546	540	33	1020	1.10	1.10	0.87	1.34	6.0	6	1	9

Regional Reference Values

	CUE	CUE	FLEN	RWT	COND	AGE
Mean	0.90	1.47	352	722	1.10	6.4
Maximum	4.60	6.69	508	2519	1.53	11.6
90th Percentile	2.00	3.21	444	1240	1.20	9.5
75th Percentile	1.33	2.33	382	787	1.14	7.6
Median	0.59	0.94	352	632	1.08	6.1
25th Percentile	0.21	0.44	306	457	1.03	5.1
10th Percentile	0.09	0.20	285	334	0.99	4.2
Minimum	0.00	0.00	203	147	0.93	2.6
Sample Size (# of lakes)	73	73	54	54	54	38
	all strata	> 6m				

Appendix 5: Summary of index netting results for 57 SLIN netting surveys used in the NER state-of-resource analysis (ie. representative lakes assessed using the SLIN standard) including regional reference statistics.

District	Lake Name	WBY LID	FN2 Code	Standard	Date	Index CUE		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (Years)			
						# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
Chapleau	Nemegosenda	17-3426-53189	21D_IA01_NEM	SLIN	10/05/2001	39	0.36	14	658	612	344	1060	4619	3475	400	15220	1.37	1.42	0.98	1.67	10.3	10.5	7	14
Kirkland	Mendelssohn	17-5595-52642	25D_IA01_MEN	SPIN	22/07/2001	60	1.25	75	346	324	200	720	569	350	75	4500	1.01	1.00	0.81	1.33				
Kirkland	Midlothian	17-5001-53061	25D_IA00_MID	SLIN	08/06/2000	30	1.13	34	381	355	195	680	875	473	71	3721	1.06	1.06	0.95	1.18				
North Bay	Anima Nipissing	17-5827-52344	36D_IA00_ANI	SLIN	18/05/2000	30	1.00	30	439	442	315	550	981	903	260	1975	1.06	1.07	0.81	1.30				
North Bay	Clearwater	17-5533-52097	36D_IA99_CLE	SLIN	14/05/1999	30	1.97	59	345	348	175	395	367	375	40	617	0.87	0.85	0.66	1.33				
North Bay	Cross	17-5788-51912	36D_IA04_CRO	SLIN	14/05/2004	30	0.27	8	475	485	307	600	1281	1225	200	2501	1.03	1.05	0.69	1.23				
North Bay	Cucumber	17-5521-51877	NPS_IA99_CUC	SLIN	14/05/1999	30	0.80	24	410	410	275	590	791	713	200	2500	1.03	1.02	0.93	1.22				
North Bay	Cummings	17-5605-51996	33D_IA01_CUM	SPIN	15/08/2001	30	0.80	24	380	396	202	734	841	545	75	5600	1.01	0.91	0.83	1.50				
North Bay	Dana	17-5566-51724	33D_IA03_DAN	SLIN	21/05/2003	30	0.53	16	312	309	205	482	368	300	70	1400	1.00	0.99	0.81	1.25	2.9	3	1	6
North Bay	Diamond	17-5580-52276	33D_IA03_DIA	SLIN	15/05/2003	30	0.30	9	503	440	342	726	2191	1075	500	5300	1.28	1.25	1.12	1.51				
North Bay	Emerald	17-5515-51958	33D_IA99_EME	SLIN	05/05/1999	30	1.77	53	377	376	272	515	582	500	175	1750	1.02	1.00	0.80	1.28				
North Bay	Lower Bass	17-5601-52035	36D_IA99_LOW	SLIN	10/05/1999	30	1.80	54	334	330	203	632	459	350	75	4100	1.03	1.00	0.71	1.62				
North Bay	Manitou (Devil's)	17-5548-51889	33D_IA99_MAN	SLIN	05/05/1999	30	0.53	16	453	449	350	588	1097	925	450	2650	1.09	1.09	0.93	1.30				
North Bay	Marten	17-5953-51723	33D_IA98_MAR	SLIN	07/05/1998	30	0.37	11	418	361	294	584	965	500	260	2280	1.07	1.05	0.96	1.20				
North Bay	Obabika	17-5566-52101	33D_IA98_OBA	SLIN	08/05/1998	30	0.03	1	380	380	380	380	392	392	392	392	0.71	0.71	0.71	0.71				
North Bay	Turtleshell	17-5573-51927	33D_IA01_TR2	SLIN	11/05/2001	30	1.40	42	309	286	215	432	380	230	104	1100	1.09	1.09	0.83	1.36				
North Bay	Wawiagama (Round)	17-5476-52058	33D_IA01_WAW	SLIN	15/05/2001	30	0.50	15	457	490	230	635	1327	1200	100	3000	1.07	1.06	0.82	1.27				
North Bay	Whitewater	17-5756-52313	33D_IA01_WHI	SPIN	17/08/2001	30	1.90	57	314	322	172	488	469	360	52	1350	1.14	1.07	0.91	1.64				
SSM	Basswood	17-3164-51328	34D_IA01_BAS	SLIN	22/05/2001	57	0.77	44	453	444	384	704	991	850	600	4000	1.02	1.02	0.74	1.22	6.5	6	5	12
SSM	Chiblow	17-3423-51340	34D_IA02_CHI	SLIN	29/05/2002	60	0.65	39	412	425	227	589	785	750	106	2220	1.01	0.99	0.83	1.19				
SSM	Constance	17-3290-51439	34D_IA03_CON	SLIN	22/05/2003	30	0.93	28	637	630	350	830	3881	3336	452	8200	1.34	1.19	1.05	1.88	8.6	6	4	20
SSM	Cumming	17-3191-51490	34D_IA03_CUM	SLIN	13/05/2003	30	0.97	29	411	437	201	620	973	900	40	3290	1.06	1.05	0.49	1.45				
SSM	Deil (Devil's)	17-2752-51845	34D_IA00_DEV	SLIN	03/05/2000	30	0.63	19	585	567	520	752	2617	2450	1730	4400	1.28	1.28	1.03	1.47				
SSM	Denman (L. Chiblow)	17-3360-51357	34D_IA02_LIT	SLIN	25/05/2002	75	2.43	182	359	329	240	667	605	373	140	3150	1.04	1.04	0.69	1.33				
SSM	Dunlop	17-3673-51503	34D_IA98_DUN	SLIN	29/04/1998	30	1.97	59	482	502	315	575	1585	1725	425	2750	1.34	1.34	1.13	1.58	6.7	7	4	10
SSM	Elliot	17-3690-51389	34D_IA99_ELL	SLIN	30/04/1999	30	0.57	17	390	370	225	603	782	500	150	2600	1.08	1.02	0.88	1.34				
SSM	Flack	17-3634-51607	34D_IA03_FLA	SLIN	16/05/2003	30	0.80	24	442	429	387	740	1034	750	600	5300	1.07	1.08	0.78	1.31	9.3	8	7	17
SSM	Garden	17-2933-51822	34D_IA02_GAR	SLIN	14/05/2002	30	1.03	31	421	360	232	643	1149	500	110	4000	1.11	1.06	0.79	1.52	4.2	3	2	8
SSM	Gullbeak	17-3645-51403	34D_IA99_GUL	SLIN	29/04/1999	30	0.43	13	446	380	340	640	1313	650	420	3600	1.18	1.14	1.01	1.37				
SSM	Kindiogami	17-3509-51882	34D_IA04_KIN	SLIN	28/05/2004	30	2.50	75	417	390	255	670	994	700	150	3800	1.12	1.10	0.78	1.58				
SSM	Lawer	17-3006-52333	34D_IA03_LAW	SLIN	23/05/2003	30	4.80	144	330	333	170	690	492	400	30	4600	1.08	1.09	0.44	1.41	3.7	3	1	18
SSM	Lodestone	17-3078-52210	34D_IA04_LOD	SLIN	29/05/2004	30	1.60	48	354	398	180	615	858	730	40	3050	1.08	1.09	0.67	1.63				
SSM	Magog (Granary)	17-3585-51264	34D_IA04_GRA	SLIN	12/05/2004	30	0.90	27	527	565	175	640	2395	2700	50	4150	1.39	1.38	0.79	1.75				

District	Lake Name	WBY LID	FN2 Code	Standard	Date	Index CUE		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (Years)			
						# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
SSM	Mamainse	16-6811-52113	34D_IA02_MAM	SLIN	30/05/2002	30	1.10	33	444	430	344	620	1018	840	400	3400	1.07	1.06	0.91	1.43	4.5	4	3	7
SSM	Matinenda	17-3525-51387	34D_IA02_MAT	SLIN	14/06/2002	60	2.45	147	360	336	192	603	611	380	60	2600	1.04	1.04	0.82	1.48				
SSM	Megisan	17-3090-52347	34D_IA04_MEG	SLIN	21/05/2004	30	5.47	164	372	370	223	718	675	530	100	5450	1.09	1.07	0.67	1.47				
SSM	Morrison	17-2857-52090	34D_IA04_MOR	SLIN	17/05/2004	30	1.53	46	399	420	190	565	854	780	60	2800	1.08	1.07	0.76	1.68				
SSM	Northland (Loon)	16-7200-51762	34D_IA01_NOR	SLIN	04/05/2001	30	1.43	43	445	424	177	792	1581	1129	55	7100	1.27	1.24	0.88	1.71				
SSM	Pecors	17-3872-51356	34D_IA00_PEC	SLIN	05/05/2000	30	0.13	4	450	465	220	650	1649	1275	46	4000	1.06	1.17	0.43	1.46				
SSM	Quimby	17-3659-51361	34D_IA99_QUI	SLIN	03/05/1999	30	0.47	14	598	598	360	865	2836	2600	500	7984	1.20	1.21	1.01	1.40				
SSM	Ranger	17-3053-51969	34D_IA02_RGR	SLIN	07/06/2002	30	2.03	61	403	400	290	650	841	720	230	4200	1.12	1.10	0.90	1.53	5.9	6	3	11
SSM	Seymour	17-3298-51798	34D_IA02_SEY	SLIN	30/05/2002	30	0.97	29	400	400	190	680	914	600	60	2800	1.06	1.05	0.74	1.35	3.8	4	1	10
SSM	Wakomata (Clear)	17-3191-51595	34D_IA04_WAK	SLIN	07/05/2004	67	0.60	40	549	555	390	720	2065	2035	750	4000	1.22	1.21	0.88	1.64				
Sudbury	Alces	17-4129-51783	35D_IA04_ALC	SLIN	13/05/2004	30	0.20	6	579	539	530	698	2363	2038	1750	3400	1.20	1.22	1.00	1.32				
Sudbury	Friday	17-4734-51994	35D_IA02_FRI	SLIN	06/06/2002	30	1.80	54	402	359	181	632	931	445	85	3050	1.06	1.03	0.89	1.43	5.9	5	2	14
Sudbury	Hannah	17-4564-51144	35D_IA03_HAN	SLIN	23/05/2003	30	0.13	4	530	594	212	720	2448	2450	92	4800	1.15	1.17	0.97	1.29	7.0	8	3	9
Sudbury	Sam Martin	17-5156-51907	35D_IA03_SAM	SLIN	30/05/2003	30	0.67	20	281	263	177	465	299	175	48	1100	0.94	0.96	0.81	1.09	5.5	5	3	9
Sudbury	Shakwa	17-4248-51802	35D_IA02_SHA	SLIN	30/05/2002	30	3.63	109	387	370	243	918	809	485	140	9643	1.02	1.01	0.73	1.45	5.5	5	2	19
Sudbury	Venetian	17-4810-51976	35D_IA03_VEN	SLIN	22/05/2003	30	0.07	2	516	516	471	561	1713	1713	1275	2150	1.22	1.22	1.22	1.22	8.5	8.5	6	11
Sudbury	Walker	17-4608-51161	35D_IA02_WKR	SLIN	31/05/2002	30	1.20	36	384	354	256	693	794	433	160	4700	1.05	1.05	0.71	1.41	7.7	8	5	17
Timmins	Little Burwash	17-4930-52197	27D_IA04_LBU	SLIN	20/05/2004	30	1.63	49	310	265	185	750	496	240	75	5700	1.19	1.15	0.62	1.90				
Timmins	Muskasenda	17-4773-53267	27D_IA01_MUS	SPIN	06/08/2001	30	0.73	22	335	302	203	687	704	310	76	4250	1.15	1.13	0.89	1.57	5.8	5	2	12
Timmins	Oshawong	17-4728-52266	27D_IA03_OSH	SLIN	22/05/2003	30	0.03	1	560	560	560	560	2700	2700	2700	2700	1.54	1.54	1.54	1.54	8.0	8	8	8
Timmins	Prune	17-4902-52259	27D_IA04_PRU	SLIN	14/05/2004	30	1.40	42	378	395	193	565	754	700	80	2000	1.20	1.18	0.76	2.12				
Wawa	Anjigami	16-6809-53004	23D_IA02_ANJ	SPIN	12/08/2002	75	0.15	11	312	251	174	622	620	155	47	2940	1.02	0.99	0.89	1.22	6.1	5	2	15
Wawa	Dog	16-7139-53538	23D_IA02_DOG	SPIN	03/08/2002	90	0.80	72	398	348	175	827	1100	435	55	6400	1.06	1.04	0.77	1.43	7.7	7	2	22
Wawa	Manitowik	16-6953-53376	23D_IA01_MAN	SPIN	11/07/2001	90	0.93	84	412	370	186	731	1164	578	60	4700	1.10	1.11	0.74	1.54	5.2	4.5	2	20

Regional Reference Values

	CUE	FLEN	RWT	COND	AGE
Mean	1.18	412	1106	1.10	6.1
Maximum	5.47	658	4619	1.39	10.3
90th Percentile	2.43	549	2395	1.28	9.3
75th Percentile	1.60	444	1100	1.14	7.7
Median	0.93	400	858	1.07	5.9
25th Percentile	0.53	359	620	1.04	4.5
10th Percentile	0.15	312	459	1.01	3.7
Minimum	0.03	281	299	0.87	2.9
Sample Size (# of lakes)	57	49	49	49	19

Appendix 6: Summary of index netting results for 62 additional Nordic netting surveys completed in NER (i.e. beyond the representative lake set used in the SoR analysis).

District	Lake Name	WBY LID	FN2 Code	Date	CUE (all strata)		CUE (> 6m)		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (years)			
					# Sets	CUE	# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
Cochrane	Hawley	16-6538-60420	26D_IA01_HAW	08/08/2001	69	2.57	37	4.11	177	485	499	92	660	1188	1190	7	2700	0.96	0.96	0.55	1.27	14.9	14	3	29
Kirkland	Stock	17-5358-53588	25D_IA01_STO	27/07/2001	24	0.50	14	0.86	12	492	519	301	650	1742	1525	320	3500	1.23	1.23	1.01	1.38				
North Bay	Dees	17-5371-52429	36D_IA02_DEE	09/08/2002	54	0.00	10	0.00																	
North Bay	Florence	17-5335-52315	36D_IA00_FLO	28/08/2000	56	0.00	36	0.00																	
North Bay	Grays	17-5467-52535	36D_IA01_GRA	24/08/2001	52	0.00	16	0.00																	
North Bay	Jerry	17-5263-52458	36D_IA02_JER	22/08/2002	62	0.00	18	0.00																	
North Bay	Marina	17-5258-52493	36D_IA01_MAR	10/08/2001	36	0.00	6	0.00																	
SSM	Kirk	17-3414-51701	34D_IA01_KIR	18/08/2001	24	0.00	10	0.00																	
Sudbury	Barron	17-5152-52045	35D_IA01_BAR	12/07/2001	42	0.02	5	0.20	1	524	524	524	524	2150	2150	2150	2150	1.49	1.49	1.49	1.49	14.0	14	14	14
Sudbury	Barron	17-5152-52045	35D_IA03_BAR	16/07/2003	20	0.00	8	0.00																	
Sudbury	Barron	17-5152-52045	35D_IA04_BAR	14/07/2004	20	0.00	8	0.00																	
Sudbury	Bell	17-4836-51079	35D_IA01_BEL	17/07/2001	98	0.09	28	0.32	9	542	535	505	622	1989	1850	1600	3000	1.24	1.21	1.16	1.37	12.2	11.5	10	17
Sudbury	Bowland	17-4835-52068	35D_IA03_BOW	22/08/2003	40	0.63	26	0.96	25	334	327	134	499	523	375	18	1520	1.05	1.06	0.75	1.30				
Sudbury	Broker	17-5002-51098	35D_IA00_BRO	14/08/2000	32	0.00	18	0.00																	
Sudbury	Broker	17-5002-51098	35D_IA02_BR1	19/07/2002	29	0.38	17	0.53	11	376	442	200	490	767	780	59	1490	1.03	1.02	0.74	1.31				
Sudbury	Broker	17-5002-51098	35D_IA02_BR2	17/08/2002	30	0.30	17	0.53	9	331	230	190	508	595	96	56	1500	0.95	0.85	0.79	1.21				
Sudbury	Broker	17-5002-51098	35D_IA03_BRO	20/06/2003	38	1.16	23	1.52	44	427	466	180	565	832	860	46	2000	0.88	0.88	0.62	1.28				
Sudbury	Caswell	17-5229-51902	35D_IA02_CAS	01/08/2002	44	0.00	14	0.00																	
Sudbury	Chiniguchi	17-5240-51985	35D_IA00_CHI	17/08/2000	56	0.05	37	0.08	3	364	326	305	460	683	400	350	1300	1.24	1.23	1.15	1.34	2.7	2	2	4
Sudbury	Chuggin	17-5377-51779	35D_IA01_CHU	26/07/2001	36	0.33	6	1.50	12	475	545	144	668	2030	2175	40	4100	1.34	1.35	1.08	1.51	6.5	7	1	13
Sudbury	Davis	17-5241-52013	35D_IA00_DAV	12/08/2000	16	0.00	6	0.00																	
Sudbury	East Bull	17-4085-51426	35D_IA02_EAS	09/08/2002	30	0.00	18	0.00																	
Sudbury	Elboga	17-4518-52073	35D_IA02_ELB	05/07/2002	56	0.02	6	0.17	1	715	715	715	715	5200	5200	5200	5200	1.42	1.42	1.42	1.42				
Sudbury	Elboga	17-4518-52073	35D_IA03_ELB	30/05/2003	16	0.56	5	0.20	9	668	676	563	755	4392	4175	2825	6600	1.44	1.51	1.26	1.58				
Sudbury	Fraleck	17-5089-51954	35D_IA03_FRA	01/08/2003	32	0.03	16	0.06	1	115	115	115	115	14	14	14	14	0.90	0.90	0.90	0.90				
Sudbury	George	17-4690-50971	35D_IA01_GEO	28/08/2001	90	0.07	26	0.19	6	508	523	281	709	1925	1700	238	4400	1.17	1.16	1.05	1.31	7.3	9	2	11
Sudbury	Great Mountain	17-4723-51114	35D_IA02_GRE	29/07/2002	80	0.09	26	0.27	7	586	568	531	643	2295	1910	1725	2980	1.12	1.12	1.04	1.19				
Sudbury	Helen (Helens)	17-4563-51062	35D_IA03_HEL	29/08/2003	32	0.41	18	0.72	13	440	394	251	650	1210	717	130	3400	0.99	0.97	0.82	1.24	9.1	9	3	19
Sudbury	Johnnie (Bushcamp)	17-4826-51036	35D_IA00_JOH	03/08/2000	48	0.42	28	0.71	20	551	554	505	582	1841	1800	1200	2450	1.10	1.11	0.83	1.33	9.1	9	5	13
Sudbury	Johnnie (Bushcamp)	17-4826-51036	35D_IA01_JOH	01/08/2001	98	0.17	28	0.36	17	574	570	338	720	2558	2250	400	5500	1.24	1.20	1.02	1.58	9.2	10	3	11
Sudbury	Kakakise	17-4750-51010	35D_IA01_KAK	10/08/2001	88	0.01	26	0.04	1	750	750	750	750	5900	5900	5900	5900	1.40	1.40	1.40	1.40				
Sudbury	Kakakise	17-4750-51010	35D_IA03_KAK	13/08/2003	40	0.00	26	0.00																	
Sudbury	Kelly # 27	17-5462-51807	35D_IA01_KEL	06/07/2001	44	0.00	8	0.00																	
Sudbury	Kindle	17-3921-51464	34D_IA00_KIN	25/08/2000	47	0.09	27	0.15	4	489	540	277	598	1743	2100	172	2600	1.17	1.25	0.81	1.36	5.0	5	3	7
Sudbury	Kukagami	17-5344-51754	35D_IA03_KUK	29/08/2003	64	0.52	43	0.74	33	434	389	99	774	1620	735	8	6350	1.25	1.26	0.77	1.48				
Sudbury	Laundrie	17-5110-52189	35D_IA03_LAU	08/07/2003	33	0.12	8	0.38	4	457	452	355	570	1405	1310	520	2480	1.28	1.28	1.14	1.43	10.3	13	4	14
Sudbury	Little Panache	17-4721-51252	35D_IA03_LPA	08/08/2003	40	0.00	25	0.00																	

District	Lake Name	WBY LID	FN2 Code	Date	CUE (all strata)		CUE (> 6m)		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (years)			
					# Sets	CUE	# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
Sudbury	Long	17-4936-51346	35D_IA03_LO4	29/08/2003	60	0.03	40	0.05	2	214	214	200	228	85	85	69	102	0.86	0.86	0.86	0.86	2.0	2	2	2
Sudbury	Long	17-4936-51346	35D_IA04_LN4	08/08/2004	49	0.00	29	0.00																	
Sudbury	Lower Matagamasi	17-5393-51873	35D_IA00_LOW	21/08/2000	32	0.03	16	0.06	1	376	376	376	376	650	650	650	650	1.22	1.22	1.22	1.22	7.0	7	7	7
Sudbury	Manitou	17-4235-50696	35D_IA04_MAN	03/09/2004			36	0.50	18	421	426	125	610	1027	875	20	2320	1.09	1.09	0.90	1.28				
Sudbury	Matagamasi	17-5305-51809	35D_IA00_MAT	25/07/2000	56	0.71	36	1.11	40	212	200	123	379	155	85	17	800	1.06	1.02	0.86	1.49	1.9	2	1	4
Sudbury	Michaud	17-4821-51845	35D_IA02_MIC	19/07/2002	80	0.70	26	2.00	56	275	255	135	550	298	169	22	1960	1.03	1.02	0.71	1.28				
Sudbury	Nepawhin	17-5026-51439	35D_IA04_NEP	23/07/2004	33	0.00	16	0.00																	
Sudbury	Parsons	17-5308-52065	35D_IA01_PAS	12/07/2001	44	0.00	9	0.00																	
Sudbury	Pedro	17-5352-51958	35D_IA02_PED	25/07/2002	38	0.71	8	3.25	27	393	472	48	562	1026	1225	0	2240	1.15	1.16	0.36	1.36				
Sudbury	Pedro	17-5352-51958	35D_IA03_PED	25/07/2003	24	1.17	8	2.88	28	413	416	155	595	1017	900	40	2440	1.17	1.19	0.94	1.49				
Sudbury	Peter	17-4836-51150	35D_IA03_PET	01/08/2003	30	0.07	20	0.10	2	569	569	530	608	2500	2500	2100	2900	1.35	1.35	1.29	1.41				
Sudbury	Trout	17-5317-51186	37D_IA03_TRO	11/08/2003	47	1.30	27	2.26	61	453	452	233	590	1054	1000	130	2140	1.04	1.03	0.75	1.28				
Sudbury	Tyson	17-4910-51070	35D_IA01_TYS	20/07/2001	80	0.06	37	0.14	5	605	605	532	660	3494	2900	2120	5250	1.52	1.47	1.31	1.83	10.0	8.5	7	16
Sudbury	Wavy	17-4923-51272	35D_IA04_WAV	18/08/2004	48	0.00	28	0.00																	
Sudbury	Whiskey	17-3974-51436	35D_IA02_WHS	12/07/2002	56	1.18	35	1.83	66	393	414	197	617	762	674	80	2700	1.05	1.04	0.87	1.49	5.4	5	2	12
Sudbury	White Oak	17-5000-51272	35D_IA03_WHI	08/07/2003	48	0.25	28	0.32	12	436	447	185	620	1117	1075	60	2200	1.08	1.07	0.92	1.28				
Sudbury	White Pine	17-5128-52363	35D_IA01_WHI	10/07/2001	72	0.49	10	2.90	35	363	394	92	540	705	700	8	1540	1.13	1.14	0.76	1.62	8.4	7.5	1	22
Sudbury	White Pine	17-5128-52363	35D_IA02_WHT	10/07/2002	74	0.95	20	3.25	70	302	267	96	543	489	195	8	2140	1.02	0.99	0.64	1.75	8.1	5	1	25
Sudbury	White Pine	17-5128-52363	35D_IA04_WHI	08/07/2004	24	1.58	10	3.70	38	281	269	98	495	345	206	9	1620	1.07	1.07	0.90	1.34				
Wawa	Boulder	16-6743-53628	23D_IA03_BOU	12/07/2003	39	0.31	26	0.42	12	357	337	227	675	646	375	105	3800	0.96	0.95	0.85	1.24	5.8	5.5	3	14
Wawa	Eaglet	16-6252-53354	23D_IA03_EAG	04/09/2003	20	0.05	12	0.08	1	460	460	460	460	1300	1300	1300	1300	1.34	1.34	1.34	1.34				
Wawa	Katzenbach	16-6239-53245	23D_IA03_KAT	08/07/2003	50	2.56	26	3.65	127	453	499	86	624	1142	1288	4	2500	0.98	0.99	0.57	1.30				
Wawa	Michi (Island)	16-5821-52883	23D_IA03_MIC	10/08/2003	40	2.33	26	3.50	93	515	507	205	699	1543	1450	75	3100	1.10	1.11	0.69	1.37				
Wawa	Mishi	16-6222-53262	23D_IA03_MIS	23/07/2003	54	1.83	26	2.23	99	422	465	80	749	952	990	5	5000	0.99	0.98	0.63	1.49	12.0	11	0	32
Wawa	Mishibishu	16-6184-53256	23D_IA03_MSB	23/07/2003	70	2.06	36	2.67	144	422	437	80	778	842	815	4	4200	0.95	0.96	0.71	1.24				

Regional Reference Values

	CUE	CUE	FLEN	RWT	COND	AGE
Mean	0.90	1.47	352	722	1.10	6.4
Maximum	4.60	6.69	508	2519	1.53	11.6
90th Percentile	2.00	3.21	444	1240	1.20	9.5
75th Percentile	1.33	2.33	382	787	1.14	7.6
Median	0.59	0.94	352	632	1.08	6.1
25th Percentile	0.21	0.44	306	457	1.03	5.1
10th Percentile	0.09	0.20	285	334	0.99	4.2
Minimum	0.00	0.00	203	147	0.93	2.6
Sample Size (# of lakes)	73	73	54	54	54	38
	all strata	> 6m				

Appendix 7: Summary of index netting results for 56 additional SLIN / SPIN netting surveys completed in NER (i.e. beyond the representative lake set used in the SoR analysis).

District	Lake Name	WBY LID	FN2 Code	Standard	Date	Index CUE		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (years)			
						# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
Chapleau	Borden	17-3280-52990	21D_IA98_BL1	SLIN	14/05/1998	27	0.00																	
Chapleau	Emerald	17-3340-53046	21D_IA01_EME	SPIN	06/09/2001	27	0.48	13	517	500	450	677	1835	1700	1200	3600	1.29	1.27	1.12	1.52	5.8	6	4	8
Cochrane	Aquatuk	16-6588-60271	26D_IA91_AL1	SLIN	20/06/1991	36	0.03	1	714	714	714	714	4400	4400	4400	4400	1.21	1.21	1.21	1.21	23.0	23	23	23
Kirkland	Clarice	17-6090-53547	25D_IA98_CLA	SLIN	17/05/1998	30	0.43	13	457	497	214	701	1365	1360	96	4650	1.12	1.11	0.98	1.35				
Kirkland	Elmer	17-5125-53027	25D_IA98_ELM	SLIN	09/05/1998	30	0.50	15	482	486	378	663	1467	1370	510	3433	1.23	1.25	0.94	1.52				
Kirkland	Larder	17-6010-53265	25D_IA98_LAR	SLIN	14/05/1998	60	3.20	192	327	292	123	786	537	229	49	5650	0.99	0.96	0.69	1.61				
Kirkland	Long (Kushog)	17-5555-53075	25D_IA98_LNG	SLIN	09/05/1998	33	0.09	3	593	625	530	625	2523	2230	1990	3350	1.21	1.34	0.91	1.37				
Kirkland	Perry	17-5661-53749	25D_IA01_PER	SLIN	25/05/2001	30	1.30	39	316	300	181	823	567	325	56	6818	1.15	1.14	0.76	1.45				
Kirkland	St. Anthony	17-5962-53128	25D_IA98_STA	SLIN	16/05/1998	30	0.97	29	429	430	262	793	1239	700	155	8000	1.08	1.01	0.71	1.65				
Kirkland	Stock	17-5358-53588	25D_IA01_STO	SPIN	25/07/2001	45	0.24	11	462	525	170	679	1693	1898	52	3600	1.18	1.18	1.00	1.31	5.0	4	1	11
Kirkland	Trollope	17-5969-53816	25D_IA01_TRO	SPIN	20/07/2001	45	1.00	45	356	333	226	565	630	400	110	2400	1.08	1.05	0.81	1.41				
Kirkland	Watabeag	17-5314-53425	25D_IA98_WAT	SLIN	20/05/1998	60	0.90	54	447	380	253	855	1449	563	141	7695	1.06	1.02	0.65	1.56				
North Bay	Bear	17-6069-51648	33D_IA01_BEA	SPIN	19/08/2001	30	0.37	11	347	253	176	750	971	200	68	5600	1.19	1.21	1.01	1.36				
North Bay	Benner	17-5288-52236	33D_IA01_BEN	SPIN	02/08/2001	30	1.70	51	294	267	169	459	367	230	52	1250	1.17	1.16	0.88	1.53				
North Bay	Caribou	17-5718-50868	33D_IA00_CAR	SLIN	02/05/2000	30	0.40	12	541	569	368	690	2037	2200	540	3450	1.17	1.17	1.04	1.44				
North Bay	Clear (Transparent)	17-6580-51459	33D_IA01_TRA	SLIN	10/05/2001	30	0.30	9	417	410	268	536	808	690	160	1550	0.99	1.00	0.83	1.10				
North Bay	Cross	17-5788-51912	33D_IA98_CRO	SLIN	11/05/1998	30	0.40	12	562	554	425	770	2057	1870	730	4864	1.07	1.05	0.92	1.31				
North Bay	Cut	17-6323-51802	NPS_IA00_CUT	SLIN	19/05/2000	24	0.42	10	494	453	357	680	1859	1338	500	4500	1.32	1.35	1.10	1.48	6.4	4	3	18
North Bay	Talon	17-6497-51295	33D_IA97_TAL	SLIN	14/05/1997	30	0.40	12	465	430	373	691	1417	950	600	4400	1.18	1.15	0.97	1.41				
North Bay	McConnell	17-6268-51774	33D_IA00_MCL	SLIN	15/05/2000	30	0.67	20	334	314	176	550	621	360	50	2100	1.12	1.16	0.90	1.31	3.5	3	2	9
North Bay	Memesagamesing	17-5779-50969	33D_IA97_SAG	SLIN	23/05/1997	30	0.93	28	383	346	252	692	789	440	140	4050	1.05	1.05	0.87	1.22				
North Bay	Net	17-5909-52183	36D_IA00_NET	SLIN	15/05/2000	30	0.40	12	487	492	209	815	1848	1238	150	7200	1.12	1.07	0.88	1.64				
North Bay	Rabbit	17-6031-52053	33D_IA99_RAB	SLIN	10/05/1999	30	0.33	10	530	515	435	725	2100	1750	1000	5500	1.29	1.27	1.12	1.59				
North Bay	Restoule	17-5950-51006	33D_IA99_RES	SLIN	04/05/1999	30	0.20	6	440	430	299	575	1214	905	275	2600	1.19	1.19	1.03	1.37				
North Bay	Turtleshell	17-5573-51927	33D_IA01_TR1	SPIN	12/07/2001	30	0.63	19	305	276	180	685	469	225	75	3500	1.07	1.06	0.77	1.48				
SSM	Duborne	17-3523-51234	34D_IA02_DUB	SLIN	05/06/2002	60	0.15	9	653	690	492	787	4422	4500	1600	8000	1.47	1.46	1.31	1.69				
SSM	Fern	17-2815-51794	34D_IA02_FER	SLIN	22/05/2002	30	1.40	42	439	479	175	655	1085	1060	40	3650	1.01	1.01	0.71	1.47	4.4	5	1	7
SSM	Rocky Island	17-3460-51979	FRU_IA03_RIL	SLIN	10/05/2003	30	0.13	4	635	639	531	732	3400	3300	2000	5000	1.26	1.28	1.13	1.34	11.5	12	6	16
SSM	Scarfe	17-3429-51270	34D_IA02_CAN	SLIN	16/05/2002	45	0.00																	
Sudbury	Geneva	17-4583-51789	35D_IA02_GEN	SLIN	27/05/2002	30	0.07	2	755	755	651	859	4850	4850	2800	6900	1.05	1.05	1.01	1.09	6.0	6	5	7
Sudbury	George	17-4690-50971	SBG_IA94_GEO	SLIN	07/05/1994	123	0.27	33	404	373	200	720	1016	575	80	4800	1.11	1.12	0.95	1.29				
Sudbury	Kindle	17-3921-51464	35D_IA99_KIN	SLIN	29/05/1999	27	0.22	6	488	478	362	638	1479	1120	340	3100	1.03	1.03	0.72	1.39				
Sudbury	Kukagami	17-5344-51754	35D_IA00_KUK	SLIN	13/05/2000	42	0.55	23	464	474	270	705	1407	1184	198	4172	1.10	1.11	1.01	1.19				

District	Lake Name	WBY LID	FN2 Code	Standard	Date	Index CUE		# Fish	Fork Length (mm)				Weight (g)				Condition - Fulton's				Age (years)			
						# Sets	CUE		Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max	Mean	Med	Min	Max
Sudbury	Laundrie	17-5110-52189	SBG_IA94_LAU	SLIN	22/05/1994	71	0.59	42	466	480	319	607	1252	1225	375	2400	1.14	1.13	0.98	1.37				
Sudbury	Michaud	17-4821-51845	SBG_IA94_MIC	SLIN	17/05/1994	69	1.46	101	346	325	191	521	516	380	70	1510	1.09	1.10	0.87	1.39				
Sudbury	Peter	17-4836-51150	SBG_IA94_PET	SLIN	12/05/1994	76	0.04	3	266	240	219	340	220	110	100	450	0.96	0.95	0.80	1.14				
Sudbury	Trout	17-5317-51186	33D_IA03_TRO	SLIN	16/05/2003	36	0.56	20	674	685	442	839	4274	3725	950	8400	1.28	1.29	1.00	1.56				
Sudbury	White Pine	17-5128-52363	36D_IA92_WHP	SLIN	28/05/1992	131	0.96	125	441	437	575	177	970	900	50	1850	1.10	1.10	0.79	1.33				
Sudbury	White Pine	17-5128-52363	36D_IA93_WHP	SLIN	15/05/1993	204	1.35	275	427	430	266	634	848	850	150	2500	1.04	1.06	0.59	1.36	6.9	6	4	11
Sudbury	White Pine	17-5128-52363	36D_IA94_WHP	SLIN	31/05/1994	285	1.32	375	392	397	222	632	687	700	100	2400	1.07	1.07	0.66	1.51	5.6	5	3	10
Timmins	Clearwater	17-5002-53926	27D_IA01_CLE	SPIN	11/08/2001	30	0.13	4	583	651	313	716	3129	3650	317	4900	1.24	1.24	1.03	1.43				
Timmins	Currie	17-5172-53366	27D_IA01_CUR	SPIN	09/08/2001	30	2.80	84	324	313	190	514	411	300	65	1500	0.96	0.94	0.79	1.34	6.2	5.5	2	12
Timmins	Ferrier	17-4769-53206	27D_IA01_FE2	SPIN	01/08/2001	30	0.23	7	430	420	230	630	989	700	120	2100	1.00	0.99	0.84	1.14				
Timmins	Kasasway	17-4304-53073	27D_IA01_KAS	SPIN	15/08/2001	30	0.03	1	255	255	255	255	165	165	165	165	1.00	1.00	1.00	1.00	2.0	2	2	2
Timmins	Radisson	17-5180-53389	27D_IA01_RAD	SPIN	09/08/2001	30	2.87	86	345	315	188	604	573	305	57	2600	1.05	1.02	0.86	1.44	6.0	5	2	21
Timmins	Semple	17-4776-53163	27D_IA01_SEM	SPIN	05/08/2001	30	0.30	9	442	353	258	659	1862	600	215	4400	1.34	1.28	1.17	1.58	4.7	4	1	10
Timmins	Waonga	17-4663-52723	27D_IA01_WAO	SPIN	20/09/2001	30	1.13	34	357	336	220	514	643	433	115	1800	1.15	1.15	0.95	1.46	3.3	3	2	7
Timmins	Welcome	17-4971-52299	27D_IA03_WEL	SLIN	15/05/2003	30	0.17	5	633	613	600	670	2980	2600	2500	3600	1.17	1.20	1.09	1.20	8.3	8	5	12
Wawa	Charon	16-5724-54965	23D_IA98_CHA	SLIN	09/05/1998	30	1.23	37	414	362	293	735	932	400	200	5500	0.95	0.94	0.66	1.39	10.4	10	7	24
Wawa	Fearless	16-5940-53862	23D_IA00_FRL	SLIN	22/05/2000	30	1.17	35	444	527	179	660	1448	1657	54	3384	1.08	1.13	0.94	1.18				
Wawa	Iron	16-6285-53427	23D_IA01_IRO	SPIN	08/07/2001	60	0.17	10	590	579	531	710	2900	2625	2000	5400	1.38	1.35	1.27	1.51	9.8	9.5	6	14
Wawa	Jimmy Kash	16-6437-53384	23D_IA01_JIM	SPIN	02/07/2001	60	0.03	2	637	637	608	665	3250	3250	3000	3500	1.26	1.26	1.19	1.33	16.5	16.5	12	21
Wawa	Klinestiver	16-5388-54811	23D_IA01_KLI	SPIN	04/07/2001	75	0.35	26	489	536	213	779	1653	1675	97	5600	1.09	1.09	0.74	1.34	7.3	7.5	2	16
Wawa	Pagwachuan	16-5657-55074	23D_IA00_PAG	SLIN	16/05/2000	45	0.49	22	520	545	295	640	1659	1800	300	2700	1.09	1.10	0.93	1.28				
Wawa	Ravine	16-5972-54118	23D_IA00_RAV	SLIN	19/05/2000	31	0.00																	
Wawa	Stranded	16-7021-53225	23D_IA00_STR	SLIN	25/05/2000	30	0.27	8	502	502	465	544	1437	1418	1114	1833	1.12	1.12	1.11	1.14				

Regional Reference Values

	CUE	FLEN	RWT	COND	AGE
Mean	1.18	412	1106	1.10	6.1
Maximum	5.47	658	4619	1.39	10.3
90th Percentile	2.43	549	2395	1.28	9.3
75th Percentile	1.60	444	1100	1.14	7.7
Median	0.93	400	858	1.07	5.9
25th Percentile	0.53	359	620	1.04	4.5
10th Percentile	0.15	312	459	1.01	3.7
Minimum	0.03	281	299	0.87	2.9
Sample Size (# of lakes)	57	49	49	49	19

Appendix 8: Estimation of adult lake trout abundance from Spring Littoral Index Netting (SLIN) and Nordic CUE's – expanded from: Monitoring the state of Ontario's inland lakes fisheries resources: a pilot study (OMNR 2004).

Adult lake trout abundance was estimated from SLIN netting results using the relationship between lake trout density, SLIN CUE and lake area developed by Janoscik and Lester (2003):

$$\hat{D} = \frac{81 * CUE_m^{\ 1.07}}{Area^{0.5}} \qquad \text{(A8.1)}$$

where CUE_m is the mean number of lake trout caught per net that were greater than or equal to the fork length at maturity and *Area* is the size of the waterbody in hectares (ha).

Similarly, adult lake trout abundance was estimated from Nordic netting results using the following relationship between lake trout density and Nordic CUE (for depth strata below 6meters) developed by Ed Snucins (personal communication):

$$log_{10}Density = (log_{10}((CUE_m > 6m)+1))/0.43$$

$$Density = 10^{(log_{10}Density)} - 1 \qquad \text{(A8.2)}$$

where CUE_m is the mean number of lake trout greater than or equal to the fork length at maturity caught per net set below 6 meters.

Length at maturity was estimated using the relationship from Shuter et al. (1998):

$$L_m = 1.56 * \omega^{0.257} * L_\infty^{0.625} \qquad \text{(A8.3)}$$

where L_m is length at maturation in cm, ω is early life growth rate (cm. yr^{-1}) and L_∞ is asymptotic length in cm.

Early growth was estimated from TDS (measured in mg.L^{-1}) using the empirical relationship outlined in Shuter et al. (1998):

$$\omega = 5.60 * TDS^{0.162} \qquad \text{(A8.4)}$$

Asymptotic length (L_∞) was estimated using one of three methods, depending on the sample size of lake trout caught.

For samples of greater than 50 lake trout, asymptotic length was estimated using the approach suggested by Janoscik and Lester (2003):

$$L_\infty = \frac{L_{95}}{0.95} \qquad \text{(A8.5)}$$

where L_{95} is the mean length of the 5 largest fish within the 95th percentile of observed lengths (i.e. the largest 5% of the sample is ignored). This approach excludes the largest fish caught, which may represent a sub-population of fish which sustain higher growth than the general population by feeding on lake trout (Janoscik and Lester 2003).

For sample sizes between 10 and 50 lake trout, this estimate was modified based on the relationship between sample size and the ratio of estimated to true asymptotic length (Janoscik and Lester 2003):

$$L_\infty = \frac{L_{95}}{0.95 * (1 - e^{-0.039*(n+32)})} \qquad \text{(A8.6)}$$

where n is the number of mature lake trout captured. For samples of less than 10 lake trout, asymptotic length was predicted based on the relationship with lake area reported by Shuter et al. (1998):

$$L_\infty = 37.15 * Area^{0.071} \qquad \text{(A8.7)}$$

Appendix 9: Application of the Shuter et al. (1998) exploitation model to NER lake trout lakes.

Application of the Shuter et al. (1998) exploitation model to NER lakes warrants further investigation. One weakness of the Shuter et al. model is that it is driven mainly by lake area and ignores details regarding lake depth and the fish community (Nigel Lester, personal communication). The model was calibrated using a set of lakes > 100ha in size, the majority of which can be characterized as providing good lake trout habitat (ie. good depth for size, good thermal habitat volume / surface area ratio). The lake set used does not fully capture potential variation in habitat and fish community factors. Formulas developed by Shuter et al. (1998) may provide overly optimistic yield estimates and reference points where such factors are significant (ie. unrealistic benchmarks where habitat or fish community limitations are at play). For example, in the case of low summer habitat availability, a scenario that could simply relate to intrinsic lake characteristics (e.g. marginal lake depth) or could result from either nutrient loading or climate change, one would expect reduced lake trout carrying capacity and hence reduced sustainable yield. Similarly, added community complication resulting from invasive or introduced species can be expected to result in greater demand for available resources and reduced lake trout production. Lester and Dunlop 2004 suggest that while benchmarks based on the Shuter et al. model can safely be used as a means to indicate how much resource loss has occurred due to a combination of lake trout exploitation and changes in habitat and fish community structure, alternate reference points may ultimately be required to make more defensible assumptions re: the specific impact of exploitation. We fully support additional research in this regard.

Furthermore, in proceeding through the benchmarking process, the relative sensitivity of both the abundance benchmark and the calculation of abundance from netting data to estimates of asymptotic length (L_∞) became apparent. Based on the Shuter et al. model, L_∞ for lake trout ranges from 40-90 cm and is positively related to lake area, whereas expected abundance at MSY is inversely related to L_∞. Lake trout populations characterized by a large ultimate size (i.e. large bodied or piscivorous lake trout) demonstrate greater length at maturity and lower expected abundance. Smaller bodied lake trout populations (planktivorous populations) on the other hand, demonstrate lower length at maturity and higher expected abundance. Estimation of L_∞ from surface area as per the Shuter equation assumes that larger lakes support more diverse fish communities, hence greater prey availability, and higher L_∞. Such assumptions can prove problematic where small lakes support populations of pelagic forage fish or where large lakes support simple fish communities. Janoscik and Lester (2003) recommend an alternate approach to estimation of L_∞ using actual length distribution data where available, in order to minimize intrinsic assumptions of the Shuter et al. model.

The benchmarking procedure applied via the NE lake trout project essentially followed that proposed by Janoscik and Lester (2003). L_∞ was estimated from lake trout length distributions associated with the SLIN and Nordic surveys where sample size permitted. Janoscik and Lester (2003) explored the sensitivity of L_∞ estimates to sample size. Estimates of L_∞ can be expected to be within 95% of true asymptotic length where lake trout sample sizes exceed 50. For sample sizes below 50 a correction factor is recommended. The Shuter equation based on lake area was applied where sample sizes were below 10. The range of L_∞ estimated using this approach matched the expected range of L_∞ reported by Shuter et al. (1998); estimated L_∞ only fell outside the range of 40-90 cm for 3 of the 130 lakes sampled.

Given the differences in estimation of L_∞ from either lake area or length distribution data and the relative importance of the criterion, the benchmarking process (i.e. classification of lakes into quadrants) was completed using both potential methods and compared. While only 14.6% of lakes were found to meet the abundance benchmark using the Shuter et al. (1998) equation to estimate L_∞ from lake surface area, 32.3% of lakes meet the abundance benchmark using length distribution data to estimate L_∞. The specific quadrants shifts between the two methods were investigated: all 23 of the observed quadrant shifts resulting from use of actual length distribution data were positive, from either Quadrant 3 to Quadrant 2 or Quadrant 4 to Quadrant 1. A few lake specific examples are presented below which demonstrate the violation of assumptions by both methods.

- Pilgrim Lake – A relatively small lake (130 hectares) with a very high index CUE that fails the abundance test with L_∞ estimated from lake area. Clearly, Pilgrim Lake supports a high density population of very small bodied lake trout. L_∞ estimated from length distribution data is below that predicted from lake area and, as a result, the lake passes the abundance test.
- Seymour & Munroe Lakes – Two small lakes (60 and 76 hectares respectively) with good index CUE's and observed L_∞'s beyond that predicted by lake area. The fact that these lakes pass the abundance test with L_∞ estimated from length distribution data would seem appropriate.
- Friday & Midlothian Lakes – Two medium size lakes (305 and 382 ha respectively) with reasonable index CUE's and good lake trout size ranges. Again, observed growth exceeds that predicted by lake area and it would appear to make sense that these lakes pass the abundance test.
- Quimby, Nemegosenda, and Three Lakes – Three lakes with low index CUE's and potential recruitment problems (i.e. a few large lake trout present). Values for L_∞ estimated from length distributions were high (86.5, 102.5, and 73.8 cm respectively) resulting in low abundance benchmarks and spurious passing grades.

Based on the above examples (and others not shown), a true picture of resource status likely lies somewhere between the classifications using lake area to estimate L_∞ and the classifications using length distribution data to estimate L_∞. Given that both approaches would seem to have pros and cons, the use of empirical data (based on actual length distributions) was selected as the most unbiased view of the resource.

Appendix 10: Summary of key parameters generated in completion of the NER quadrant analysis.

District	Lake Name	WBY LID	FN2 Code	Standard	Random	Area (ha)	TDS	Omega (cm)	L_{-inf} (cm)	L_{mat} (cm)	D_{obs} (# / ha)	D_{msy} (# / ha)	E_{obs} (hrs / ha)	E_{msy} (hrs / ha)	Quadrant
Chapleau	Blackfish	16-7142-53440	21D_IA03_BLA	Nordic	Yes	212.7	24.0	9.37	62.44	43.33	0.39	1.58	2.62	5.45	4
Chapleau	Nemegosenda	17-3426-53189	21D_IA01_NEM	SLIN	Yes	1830.8	84.6	11.49	102.52	63.51	0.26	0.02	2.17	4.03	1
Chapleau	Windermere	17-2934-53143	21D_IA03_WIN	Nordic	Yes	3821.9	39.2	10.14	66.73	46.23	0.00	1.01	4.17	3.75	3
Kirkland	Greenwater	17-5561-52598	25D_IA02_GRE	Nordic	Yes	56.7	17.9	8.94	51.45	37.64	14.90	5.01	3.63	7.57	1
Kirkland	Lady Sydney	17-5599-52502	25D_IA01_LAD	Nordic	No	232.3	18.4	8.98	89.47	54.45	0.62	0.09	1.11	5.42	1
Kirkland	Mendelssohn	17-5595-52642	25D_IA01_MEN	SPIN	No	459.1	31.2	9.78	53.05	39.31	0.92	4.24	1.79	4.72	4
Kirkland	Midlothian	17-5001-53061	25D_IA00_MID	SLIN	Yes	382.1	60.0	10.87	67.09	47.23	1.15	0.97	0.70	4.75	1
Kirkland	Munroe	17-5606-52675	25D_IA02_MUN	Nordic	Yes	76.1	23.0	9.31	66.77	45.23	1.91	1.00	3.23	6.86	1
Kirkland	Smith	17-5182-52469	25D_IA02_SMI	Nordic	Yes	218.7	13.7	8.55	47.09	35.09	3.74	7.92	5.56	5.58	4
North Bay	Anima Nipissing	17-5827-52344	36D_IA00_ANI	SLIN	Yes	1929.2	26.2	9.51	58.82	41.80	1.20	2.31	3.39	3.93	4
North Bay	Barter	17-5674-52374	36D_IA02_BAR	Nordic	Yes	116.7	19.2	9.04	51.87	37.95	6.55	4.79	10.00	6.28	2
North Bay	Benner	17-5288-52236	35D_IA01_BEN	Nordic	Yes	58.1	15.9	8.76	40.23	31.80	4.01	16.27	17.02	7.61	3
North Bay	Bluesucker	17-5298-52239	36D_IA00_BLU	Nordic	No	147.7	20.0	9.10	48.39	36.30	4.01	6.91	4.18	5.93	4
North Bay	Clearwater	17-5533-52097	36D_IA99_CLE	SLIN	Yes	116.9	23.4	9.34	40.76	32.60	12.43	15.40	6.62	6.18	3
North Bay	Cross	17-5788-51912	36D_IA04_CRO	SLIN	Yes	1629.3	39.0	10.14	62.81	44.39	0.33	1.52	5.53	4.02	3
North Bay	Cucumber	17-5521-51877	NPS_IA99_CUC	SLIN	Yes	67.7	31.3	9.78	57.20	41.34	3.71	2.74	8.15	6.87	2
North Bay	Cummings	17-5605-51996	33D_IA01_CUM	SPIN	Yes	68.2	20.8	9.16	57.51	40.79	3.36	2.65	7.91	7.11	2
North Bay	Dana (Pine)	17-5566-51724	33D_IA03_DAN	SLIN	Yes	113.8	18.2	8.96	48.71	36.32	0.88	6.68	8.92	6.34	3
North Bay	Deschamps	17-5603-51797	33D_IA03_DES	Nordic	Yes	99.1	20.6	9.14	51.48	37.87	0.43	4.99	4.36	6.49	4
North Bay	Diamond	17-5580-52276	33D_IA03_DIA	SLIN	Yes	954.0	18.0	8.95	60.47	41.92	0.40	1.94	5.46	4.28	3
North Bay	Emerald	17-5515-51958	33D_IA99_EME	SLIN	No	583.4	55.0	10.72	46.29	36.77	3.37	8.61	13.65	4.50	3
North Bay	Iron	17-5491-52005	33D_IA04_IRO	Nordic	Yes	80.2	17.6	8.91	42.93	33.34	1.57	12.26	0.10	6.92	4
North Bay	Jim Edwards	17-5431-52386	36D_IA02_JIM	Nordic	No	88.6	16.1	8.78	51.08	37.29	0.28	5.21	1.35	6.80	4
North Bay	Linger	17-5367-52152	35D_IA02_LIN	Nordic	No	72.1	20.2	9.12	51.12	37.67	2.28	5.19	1.15	7.03	4
North Bay	Lower Bass	17-5601-52035	36D_IA99_LOW	SLIN	No	106.1	28.0	9.61	40.59	32.75	7.33	15.67	4.51	6.24	4
North Bay	Manitou (Devil's)	17-5548-51889	33D_IA99_MAN	SLIN	No	343.5	50.0	10.55	65.81	46.27	0.96	1.11	6.24	4.85	3
North Bay	Marten	17-5953-51723	33D_IA98_MAR	SLIN	No	1158.1	46.3	10.42	66.75	46.56	0.28	1.00	11.77	4.17	3
North Bay	McGiffin	17-5401-52454	36D_IA02_MCG	Nordic	Yes	118.1	23.4	9.34	58.36	41.39	1.15	2.43	1.61	6.17	4
North Bay	Obabika	17-5566-52101	33D_IA98_OBA	SLIN	No	3225.7	31.5	9.79	65.93	45.44	0.00	1.10	0.10	3.77	4
North Bay	Pilgrim	17-5259-52267	35D_IA04_PIL	Nordic	Yes	130.0	15.0	8.68	42.00	32.65	16.95	13.52	11.93	6.23	2
North Bay	Rodd	17-5274-52242	36D_IA01_ROD	Nordic	No	31.8	17.6	8.92	47.50	35.67	4.01	7.59	9.20	8.97	3
North Bay	Sugar	17-5670-52431	36D_IA01_SUG	Nordic	No	230.1	31.8	9.81	62.56	43.90	0.39	1.56	3.06	5.29	4
North Bay	Turner	17-5695-52367	36D_IA01_TUR	Nordic	No	136.1	28.0	9.61	85.35	53.69	0.51	0.14	1.61	5.91	1
North Bay	Turtleshell	17-5573-51927	33D_IA01_TR2	SLIN	Yes	159.3	21.4	9.20	45.98	35.19	2.42	8.90	3.94	5.81	4

District	Lake Name	WBY LID	FN2 Code	Standard	Random	Area (ha)	TDS	Omega (cm)	L_{-inf} (cm)	L_{mat} (cm)	D_{obs} (# / ha)	D_{msy} (# / ha)	E_{obs} (hrs / ha)	E_{msy} (hrs / ha)	Quadrant
North Bay	Wawiagama (Round)	17-5476-52058	33D_IA01_WAW	SLIN	Yes	643.8	35.3	9.98	76.01	50.19	0.57	0.38	4.71	4.48	2
North Bay	Whitewater	17-5756-52313	33D_IA01_WHI	SPIN	Yes	244.3	40.8	10.21	45.31	35.79	3.91	9.55	5.79	5.17	3
SSM	Admiral (Duck)	17-3486-51441	34D_IA03_DUC	Nordic	Yes	86.3	15.3	8.71	50.98	37.17	0.00	5.26	0.45	6.87	4
SSM	Basswood	17-3164-51328	34D_IA01_BAS	SLIN	No	2699.9	31.0	9.77	56.41	40.94	1.05	2.98	3.37	3.82	4
SSM	Bobowash	17-3635-51568	34D_IA03_BOB	Nordic	No	66.7	13.3	8.52	65.67	43.73	2.92	1.13	13.29	7.44	2
SSM	Burns	17-3382-51620	34D_IA01_BUR	Nordic	Yes	168.4	12.7	8.45	53.38	38.02	1.13	4.09	1.93	5.93	4
SSM	Canyon	17-3792-51405	34D_IA03_CAN	Nordic	Yes	50.5	23.8	9.36	49.08	36.91	1.19	6.43	0.10	7.61	4
SSM	Chiblow	17-3423-51340	34D_IA02_CHI	SLIN	Yes	2003.5	18.6	9.00	56.67	40.21	0.65	2.90	8.67	3.89	3
SSM	Christman (Jim Christ)	17-3675-51601	34D_IA03_JIM	Nordic	No	56.1	32.4	9.84	52.15	38.93	0.84	4.66	0.10	7.18	4
SSM	Constance	17-3290-51439	34D_IA03_CON	SLIN	Yes	119.5	29.2	9.68	91.79	56.45	5.86	0.07	8.81	6.06	2
SSM	Cumming	17-3191-51490	34D_IA03_CUM	SLIN	No	522.7	23.0	9.31	65.89	44.84	1.38	1.10	7.70	4.66	2
SSM	Darragh	17-3039-51641	34D_IA03_DAR	Nordic	Yes	190.5	19.0	9.02	52.42	38.20	3.79	4.53	7.02	5.64	3
SSM	Daystar	17-3465-51920	34D_IA03_DAY	Nordic	Yes	74.8	21.3	9.19	52.36	38.36	1.44	4.56	3.78	6.93	4
SSM	Deil (Devil's)	17-2752-51845	34D_IA00_DEV	SLIN	Yes	197.0	17.4	8.89	81.54	51.06	3.55	0.21	11.05	5.63	2
SSM	Denman (Little Chiblow)	17-3360-51357	34D_IA02_LIT	SLIN	No	644.4	26.0	9.49	58.29	41.54	1.63	2.44	4.97	4.50	3
SSM	Dollyberry	17-3633-51558	34D_IA03_DOL	Nordic	No	159.2	9.0	7.99	62.83	41.78	0.62	1.52	0.10	6.13	4
SSM	Dubbelewe	17-3746-51867	34D_IA03_DUB	Nordic	Yes	94.4	12.9	8.47	51.31	37.06	1.70	5.09	9.77	6.81	3
SSM	Dunlop	17-3673-51503	34D_IA98_DUN	SLIN	No	1030.9	21.0	9.17	59.31	41.65	4.00	2.20	16.98	4.23	2
SSM	East Caribou	17-3320-51621	34D_IA03_ECA	Nordic	Yes	187.0	16.0	8.77	65.73	44.09	0.55	1.12	2.98	5.72	4
SSM	Elliot	17-3690-51389	34D_IA99_ELL	SLIN	No	631.4	73.0	11.22	63.94	46.11	0.37	1.35	17.90	4.44	3
SSM	Flack	17-3634-51607	34D_IA03_FLA	SLIN	Yes	945.1	22.6	9.28	57.58	40.96	1.26	2.63	3.95	4.28	4
SSM	Garden	17-2933-51822	34D_IA02_GAR	SLIN	Yes	140.3	21.1	9.18	70.78	46.85	2.57	0.66	6.59	5.98	2
SSM	Gullbeak	17-3645-51403	34D_IA99_GUL	SLIN	No	242.0	28.7	9.65	73.54	48.68	0.80	0.49	4.39	5.27	1
SSM	Keelor	17-3500-51516	34D_IA03_KEE	Nordic	Yes	134.7	14.6	8.64	49.58	36.41	4.96	6.10	7.12	6.19	3
SSM	Kindiogami	17-3509-51882	34D_IA04_KIN	SLIN	Yes	482.2	25.0	9.44	61.26	42.87	3.31	1.79	5.48	4.71	2
SSM	Lawer (Gull)	17-3006-52333	34D_IA03_LAW	SLIN	Yes	137.6	19.4	9.06	47.37	35.75	11.97	7.69	8.54	6.04	2
SSM	Little Sister	17-3813-51665	34D_IA04_LIT	Nordic	Yes	62.0	18.4	8.97	49.12	36.54	7.42	6.40	11.43	7.37	2
SSM	Lodestone	17-3078-52210	34D_IA04_LOD	SLIN	Yes	62.8	18.2	8.96	58.90	41.21	8.08	2.29	0.10	7.36	1
SSM	Magog (Granary)	17-3585-51264	34D_IA04_GRA	SLIN	Yes	319.3	38.8	10.13	73.11	49.10	3.26	0.52	11.62	4.96	2
SSM	Mamainse	16-6811-52113	34D_IA02_MAM	SLIN	Yes	148.6	13.1	8.50	60.75	41.50	4.79	1.89	4.72	6.09	1
SSM	Matinenda	17-3525-51387	34D_IA02_MAT	SLIN	No	4143.4	34.1	9.92	57.60	41.68	0.64	2.63	8.08	3.71	3
SSM	May	17-3852-51434	34D_IA02_MAY	Nordic	No	329.9	266.4	13.84	70.14	51.76	0.86	0.70	1.31	4.58	1
SSM	McCabe	17-3797-51421	34D_IA02_MCC	Nordic	Yes	174.9	249.1	13.69	66.97	50.05	0.51	0.98	1.04	4.94	4
SSM	McGiverin	17-3678-51289	34D_IA02_MCG	Nordic	Yes	276.0	30.8	9.76	50.34	37.94	1.07	5.63	2.10	5.13	4
SSM	Megisan	17-3090-52347	34D_IA04_MEG	SLIN	Yes	616.1	26.5	9.52	49.79	37.43	8.98	5.97	1.38	4.53	1
SSM	Morrison	17-2857-52090	34D_IA04_MOR	SLIN	Yes	376.6	15.3	8.71	59.14	41.02	3.45	2.24	2.03	4.99	1

District	Lake Name	WBY LID	FN2 Code	Standard	Random	Area (ha)	TDS	Omega (cm)	L_{-inf} (cm)	L_{mat} (cm)	D_{obs} (# / ha)	D_{msy} (# / ha)	E_{obs} (hrs / ha)	E_{msy} (hrs / ha)	Quadrant
SSM	Northland (Loon)	16-7200-51762	34D_IA01_NOR	SLIN	Yes	86.9	13.1	8.49	71.26	46.13	4.75	0.63	8.43	6.95	2
SSM	Pecors	17-3872-51356	34D_IA00_PEC	SLIN	No	353.0	191.8	13.12	56.34	44.13	0.25	3.00	1.57	4.61	4
SSM	Quimby	17-3659-51361	34D_IA99_QUI	SLIN	No	178.5	56.6	10.77	86.54	55.80	2.08	0.13	2.42	5.37	1
SSM	Ranger	17-3053-51969	34D_IA02_RGR	SLIN	Yes	2322.0	21.6	9.22	52.44	38.42	2.23	4.52	8.15	3.84	3
SSM	Rochester	17-3843-51532	34D_IA04_ROC	Nordic	Yes	54.2	14.7	8.65	49.33	36.30	1.57	6.26	6.28	7.81	4
SSM	Rosemarie	17-3822-51676	34D_IA03_ROS	Nordic	Yes	86.1	19.0	9.02	49.94	36.99	1.79	5.87	9.79	6.76	3
SSM	Samreid	17-3658-51570	34D_IA03_SAM	Nordic	No	88.1	17.3	8.89	60.63	41.93	1.19	1.91	8.68	6.77	3
SSM	Semiwite	17-3712-51594	34D_IA03_SEM	Nordic	No	309.6	27.5	9.58	45.03	35.07	3.78	9.83	8.86	5.05	3
SSM	Seymour	17-3298-51798	34D_IA02_SEY	SLIN	Yes	60.0	20.3	9.12	67.05	45.13	3.49	0.97	13.66	7.37	2
SSM	Skookum	17-3008-51554	34D_IA03_SKO	Nordic	Yes	66.9	19.9	9.09	50.07	37.13	0.00	5.79	10.26	7.18	3
SSM	Ten Mile	17-3629-51531	34D_IA03_TEN	Nordic	Yes	1034.7	17.9	8.94	49.79	36.83	5.84	5.97	4.14	4.23	4
SSM	Tenfish	17-3635-51676	34D_IA04_TEN	Nordic	Yes	94.0	14.9	8.68	43.60	33.46	14.65	11.43	7.10	6.74	2
SSM	Three Lakes	17-3398-51886	34D_IA03_THR	Nordic	Yes	50.4	59.4	10.85	73.80	50.29	0.73	0.48	12.60	6.96	2
SSM	Toodee	17-3342-51796	34D_IA03_TOO	Nordic	Yes	138.8	38.3	10.11	53.85	40.05	2.28	3.89	9.04	5.76	3
SSM	Wakomata (Clear)	17-3191-51595	34D_IA04_WAK	SLIN	No	2489.8	21.0	9.17	70.13	46.55	0.78	0.71	4.70	3.81	2
SSM	White Bear	17-3393-51732	34D_IA03_WHI	Nordic	Yes	286.0	20.2	9.11	51.16	37.68	2.85	5.17	4.52	5.19	4
Sudbury	Acheson	17-4304-51587	33D_IA04_ACH	Nordic	Yes	187.4	17.8	8.93	53.60	38.67	4.96	4.00	5.54	5.68	1
Sudbury	Alces	17-4129-51783	35D_IA04_ALC	SLIN	Yes	62.3	17.4	8.90	49.82	36.80	1.84	5.95	2.04	7.40	4
Sudbury	Antrim	17-4523-51979	35D_IA04_ANT	Nordic	Yes	95.9	27.0	9.55	51.36	38.25	0.00	5.06	1.16	6.40	4
Sudbury	Bear	17-4652-51149	35D_IA03_BEA	Nordic	Yes	691.9	56.6	10.77	55.85	41.70	0.68	3.16	9.60	4.41	3
Sudbury	Big Squaw (Big Squirrel)	17-4281-52070	35D_IA03_BIG	Nordic	Yes	92.3	17.4	8.89	75.06	48.33	0.95	0.42	0.10	6.69	1
Sudbury	Fairbank	17-4672-51457	35D_IA03_FAI	Nordic	No	705.1	44.8	10.37	61.82	44.18	0.57	1.69	12.15	4.41	3
Sudbury	Folson	17-4026-51425	35D_IA03_FOL	Nordic	Yes	210.1	13.7	8.56	61.92	42.11	0.65	1.67	2.02	5.62	4
Sudbury	Foucault # 42	17-4009-51893	35D_IA03_L42	Nordic	Yes	68.6	14.3	8.61	66.02	44.01	1.19	1.09	4.53	7.34	1
Sudbury	Friday	17-4734-51994	35D_IA02_FRI	SLIN	Yes	305.0	18.7	9.00	62.38	42.86	2.53	1.59	2.45	5.14	1
Sudbury	Halfway	17-4514-51934	35D_IA03_HAL	Nordic	No	205.9	40.4	10.19	52.95	39.69	0.88	4.28	8.42	5.33	3
Sudbury	Hannah	17-4564-51144	35D_IA03_HAN	SLIN	Yes	388.5	44.0	10.34	56.73	41.70	0.35	2.88	10.71	4.79	3
Sudbury	Ishmael	17-4542-51063	35D_IA03_ISH	Nordic	No	73.0	23.2	9.32	50.38	37.52	0.25	5.61	3.22	6.92	4
Sudbury	Jeanne	17-4099-51964	35D_IA04_JEA	Nordic	Yes	115.3	13.7	8.55	52.04	37.50	0.19	4.71	0.10	6.45	4
Sudbury	Kettyle	17-5356-51847	35D_IA00_KET	Nordic	No	59.8	21.5	9.21	57.79	40.98	1.57	2.57	0.10	7.34	4
Sudbury	Klondyke North	17-4154-51623	35D_IA02_NOR	Nordic	Yes	96.0	13.4	8.53	51.37	37.15	1.25	5.05	0.10	6.76	4
Sudbury	Kumska	17-4975-51827	33D_IA04_KUM	Nordic	Yes	141.2	18.2	8.96	52.80	38.32	0.78	4.35	2.46	6.03	4
Sudbury	Michaud	17-4821-51845	35D_IA04_MIC	Nordic	No	148.5	16.8	8.85	52.00	37.81	1.00	4.73	1.98	5.99	4
Sudbury	Millen	17-4113-51461	35D_IA03_MIL	Nordic	Yes	84.9	14.9	8.67	60.93	41.79	0.30	1.85	1.02	6.92	4
Sudbury	Nelson	17-4928-51746	35D_IA04_NEL	Nordic	No	308.8	22.8	9.30	47.47	36.04	1.86	7.61	9.96	5.09	3
Sudbury	Pedro	17-5352-51958	35D_IA04_PED	Nordic	No	63.1	21.8	9.22	66.54	45.02	5.59	1.03	3.40	7.23	1

District	Lake Name	WBY LID	FN2 Code	Standard	Random	Area (ha)	TDS	Omega (cm)	L_{-inf} (cm)	L_{mat} (cm)	D_{obs} (# / ha)	D_{msy} (# / ha)	E_{obs} (hrs / ha)	E_{msy} (hrs / ha)	Quadrant
Sudbury	Rangers (Caribou)	17-3909-51461	35D_IA02_CAR	Nordic	Yes	233.7	22.8	9.29	44.15	34.34	3.37	10.79	7.24	5.36	3
Sudbury	Rawson	17-5330-51961	35D_IA03_RAW	Nordic	Yes	164.1	18.7	9.00	34.00	28.63	1.13	31.31	4.31	5.82	4
Sudbury	Rushbrook	17-4302-51759	35D_IA02_RUS	Nordic	Yes	174.1	21.7	9.22	53.59	38.98	0.49	4.00	4.41	5.70	4
Sudbury	Sam Martin	17-5156-51907	35D_IA03_SAM	SLIN	Yes	151.7	19.3	9.05	46.47	35.29	1.39	8.45	15.13	5.91	3
Sudbury	Shakwa	17-4248-51802	35D_IA02_SHA	SLIN	Yes	438.4	15.9	8.77	51.87	37.66	6.42	4.79	0.99	4.84	1
Sudbury	Sinaminda	17-4277-51933	35D_IA03_SIN	Nordic	Yes	1076.2	18.2	8.96	60.98	42.17	0.07	1.84	0.68	4.20	4
Sudbury	Sugarbush	17-4569-52032	35D_IA03_SUG	Nordic	Yes	54.4	14.1	8.59	54.92	38.91	1.57	3.48	6.63	7.84	4
Sudbury	Three Narrows	17-4670-51065	35D_IA03_THR	Nordic	No	811.5	17.7	8.92	59.77	41.57	0.17	2.09	0.66	4.38	4
Sudbury	Venetian	17-4810-51976	35D_IA03_VEN	SLIN	Yes	1019.7	17.5	8.90	60.75	42.00	0.14	1.89	3.83	4.24	4
Sudbury	Walker	17-4608-51161	35D_IA02_WKR	SLIN	Yes	350.4	46.4	10.43	62.72	44.67	1.20	1.54	6.07	4.85	3
Timmins	Little Burwash	17-4930-52197	27D_IA04_LBU	SLIN	Yes	95.2	45.3	10.39	50.22	38.50	3.69	5.70	3.64	6.16	4
Timmins	Muskasenda	17-4773-53267	27D_IA01_MUS	SPIN	Yes	482.3	82.6	11.45	55.78	42.33	0.43	3.18	1.80	4.56	4
Timmins	Oshawong	17-4728-52266	27D_IA03_OSH	SLIN	Yes	108.9	46.2	10.42	51.83	39.35	0.21	4.81	0.10	5.98	4
Timmins	Pilon	17-4860-52213	27D_IA03_PIL	Nordic	Yes	76.5	15.1	8.69	50.55	36.93	1.98	5.51	3.85	7.10	4
Timmins	Prune	17-4902-52259	27D_IA04_PRU	SLIN	Yes	198.3	20.2	9.11	55.76	39.91	3.88	3.19	0.56	5.57	1
Timmins	Welcome	17-4971-52299	27D_IA04_WEL	Nordic	Yes	676.9	21.6	9.22	59.01	41.56	0.00	2.27	0.30	4.48	4
Wawa	Anjigami	16-6809-53004	23D_IA02_ANJ	SPIN	No	1141.2	15.3	8.71	53.16	38.22	0.05	4.19	3.19	4.17	4
Wawa	Dog	16-7139-53538	23D_IA02_DOG	SPIN	No	5330.4	64.0	10.98	68.21	47.88	0.22	0.86	11.53	3.76	3
Wawa	Goetz	16-6751-53308	23D_IA03_GOE	Nordic	Yes	69.0	62.3	10.94	41.31	34.26	7.42	14.54	10.67	6.44	3
Wawa	Manitowik	16-6953-53376	23D_IA01_MAN	SPIN	No	2680.3	75.2	11.28	65.56	46.94	0.59	1.14	3.79	3.92	4
Wawa	Mijinemungshing	16-6718-52845	34D_IA03_MIJ	Nordic	Yes	604.6	13.3	8.51	50.95	36.93	7.70	5.28	3.71	4.60	1
Wawa	Old Woman	16-6710-52766	34D_IA04_OLD	Nordic	Yes	267.9	11.7	8.34	55.63	38.94	2.34	3.23	2.74	5.38	4
Wawa	Pivot	16-6879-53337	23D_IA03_PIV	Nordic	Yes	118.8	17.2	8.88	64.05	43.47	1.57	1.33	1.18	6.30	1
Wawa	Treeby	16-6606-53045	34D_IA04_TRE	Nordic	Yes	138.2	37.9	10.09	44.61	35.32	4.96	10.28	6.31	5.77	3

Appendix 11: Updated water quality data for acid damaged lakes in NER.

DISTRICT	WBY LID	LAKE NAME	LAT	LONG	DATE	Alk (mg/L)	pH	Cond (*u* mhos/cm)	TDS (mg/L)	DOC (mg/L)	Phosphorous (*u* g/L)
Kirkland Lake	17-5599-52502	Lady Sydney	472413	801220	07/03/2000	1.860	6.15	27.7	18.45	4.9	3.0
North Bay	17-5827-52344	Anima Nipissing	471537	795414	19/05/2004	8.580	6.98	39.4	26.24	3.3	4.6
North Bay	17-5674-52374	Barter	471720	800625	19/05/2004	3.340	6.48	28.8	19.18	5.2	6.0
North Bay	17-5288-52236	Benner	471002	803714	07/03/2000	0.648	5.79	28.7	19.11	1.9	3.0
North Bay	17-5298-52239	Bluesucker	471010	803624	07/03/2000	0.680	5.70	30.0	19.98	2.9	2.4
North Bay	17-5317-52165	Bull	470613	803457	07/03/2000	1.323	6.12	33.1	22.05	2.9	6.6
North Bay	17-5371-52429	Dees	472025	803031	07/03/2000	1.922	6.22	26.5	17.65	2.6	3.8
North Bay	17-5335-52315	Florence	471428	803358	07/03/2000	0.135	5.35	28.1	18.72	1.9	2.8
North Bay	17-5467-52535	Grays	472607	802248	18/05/2004	0.300	5.37	19.9	13.25	4.3	3.6
North Bay	17-5804-52398	Gullrock	471833	795609	07/03/2000	3.371	6.20	26.9	17.92	4.5	4.0
North Bay	17-5263-52458	Jerry	472201	803911	07/03/2000	-0.031	5.30	25.9	17.25	0.5	2.4
North Bay	17-5431-52386	Jim Edwards	471806	802551	07/03/2000	0.187	5.45	24.1	16.05	1.2	3.2
North Bay	17-5838-52437	Justin	472046	795330	07/03/2000	0.201	5.21	27.3	18.18	6.9	7.2
North Bay	17-5390-52352	Landers	471623	802841	07/03/2000	-0.263	5.01	25.5	16.98	2.8	4.6
North Bay	17-5367-52152	Linger	470531	803055	07/03/2000	1.007	5.85	30.4	20.25	4.0	3.6
North Bay	17-5430-52549	Makobe	472644	802513	07/03/2000	1.766	6.25	26.7	17.78	3.0	6.0
North Bay	17-5258-52493	Marina	472352	803931	07/03/2000	0.648	5.59	29.3	19.51	2.7	4.0
North Bay	17-5274-52242	Rodd	471022	803816	07/03/2000	1.138	5.81	26.5	17.65	3.3	6.0
North Bay	17-5243-52488	Smoothwater	472344	804048	31/01/1996	1.408	6.15	32.5	21.65	1.9	2.0
North Bay	17-5670-52431	Sugar	472015	800634	12/07/2004	2.819	6.63	25.0	16.65	4.1	4.8
SSM	16-7118-52382	Grey Owl	471550	841210	16/01/2001	0.429	5.52	14.6	9.70	4.0	4.0
SSM	17-3851-51403	Hough	462432	822939	29/01/2001	16.712	7.14	509.0	338.99	2.3	2.0
SSM	17-3797-51421	McCabe	462524	823357	04/05/2004	9.020	7.01	374.0	249.08	2.0	4.4
SSM	17-3872-51356	Pecors	462315	822743	29/01/2001	6.370	6.75	288.0	191.81	1.7	4.0
SSM	17-3810-51468	Quirke	462923	823307	29/01/2001	0.945	5.94	268.0	178.49	1.4	2.0
SSM	17-3414-51701	Kirk	464004	830425	29/01/2001	0.417	5.86	17.3	11.52	2.2	4.0
SSM	17-3852-51434	May	462556	822902	29/01/2001	13.921	7.14	642.0	427.57	2.5	
Sudbury	17-4657-50979	Acid	460209	812637	03/03/2000	-0.584	4.89	28.7	19.11	1.9	4.4
Sudbury	17-5152-52045	Barron	465945	804759	06/03/2000	1.006	5.69	33.5	22.31	4.2	
Sudbury	17-4836-51079	Bell	460742	811219	03/03/2000	0.383	5.29	28.7	19.11	5.4	7.2
Sudbury	17-5216-51846	Bonhomme	464903	804244	07/03/2000	-0.652	4.87	34.0	22.64	4.4	11.6

DISTRICT	WBY LID	LAKE NAME	LAT	LONG	DATE	Alk (mg/L)	pH	Cond (*u* mhos/cm)	TDS (mg/L)	DOC (mg/L)	Phosphorous (*u* g/L)
Sudbury	17-4835-52068	Bowland	470513	805031	08/03/2000	1.008	5.83	26.6	17.72	2.9	5.2
Sudbury	17-5002-51098	Broker	460842	805941	03/03/2000	0.402	5.34	29.3	19.51	3.8	7.0
Sudbury	17-4630-50974	Burke	460152	812845	03/03/2000	-0.355	5.00	26.2	17.45	2.8	6.6
Sudbury	17-5229-51902	Caswell	465151	804230	06/03/2000	0.285	5.48	31.0	20.65	1.3	6.6
Sudbury	17-4987-51346	Chief	462143	810102	03/03/2000	-0.285	4.95	32.2	21.45	1.8	6.0
Sudbury	17-5240-51985	Chiniguchi	465612	804148	07/03/2000	-0.110	5.34	31.7	21.11	0.8	3.2
Sudbury	17-5377-51779	Chuggin	464520	803024	06/03/2000	1.595	6.10	29.3	19.51	2.8	6.8
Sudbury	17-5379-51863	Colin Scott	464949	803013	06/03/2000	-0.180	5.20	33.6	22.38	0.4	2.2
Sudbury	17-4776-51097	David	460823	811733	03/03/2000	-0.407	5.02	23.9	15.92	1.1	3.0
Sudbury	17-5241-52013	Davis	465741	804035	07/03/2000	0.392	5.46	27.4	18.25	2.9	4.0
Sudbury	17-5254-51902	Dewdney	465219	803851	06/03/2000	-0.406	4.97	33.3	22.18	0.9	3.2
Sudbury	17-5370-51830	Donald	464801	803053	06/03/2000	-0.192	5.17	33.4	22.24	0.6	1.8
Sudbury	17-5253-52060	Dougherty	470041	804001	06/03/2000	-0.741	4.81	33.9	22.58	0.3	2.4
Sudbury	17-5381-51884	Edna	465007	802941	06/03/2000	1.208	5.96	32.7	21.78	3.6	4.4
Sudbury	17-4518-52073	Elboga	470113	813809	08/03/2000	3.010	6.01	121.8	81.12	6.5	9.6
Sudbury	17-4809-51809	Foy	464634	811504	08/03/2000	-0.568	4.89	29.2	19.45	2.2	6.6
Sudbury	17-5089-51954	Fraleck	465454	805257	12/07/2004	0.997	6.10	21.2	14.12	4.0	5.5
Sudbury	17-5267-51920	Franks	465253	803840	06/03/2000	-0.712	4.76	34.0	22.64	1.5	2.8
Sudbury	17-5228-52091	Frederick	470217	804155	08/03/2000	-0.257	5.08	32.1	21.38	0.9	3.2
Sudbury	17-4690-50971	George	460150	812401	03/03/2000	1.087	5.83	30.4	20.25	1.9	3.6
Sudbury	17-4535-51088	Grace	460800	813604	03/03/2000	-0.095	5.21	24.3	16.18	2.4	4.0
Sudbury	17-4723-51114	Great Mountain	460926	812134	03/03/2000	0.067	5.29	24.5	16.32	1.9	5.4
Sudbury	17-4826-51036	Johnnie	460513	811330	03/03/2000	0.879	5.69	28.5	18.98	3.8	6.8
Sudbury	17-4750-51010	Kakakise	460354	811911	03/03/2000	2.739	6.36	31.3	20.85	2.8	4.8
Sudbury	17-5356-51847	Kettyle	464843	803218	06/03/2000	0.455	7.64	32.3	21.51	1.5	3.4
Sudbury	17-4723-51015	Killarney	460408	812120	03/03/2000	-0.491	4.94	28.0	18.65	1.7	3.6
Sudbury	17-3921-51464	Kindle	462752	822418	29/01/2001	1.820	6.15	232.0	154.51	2.3	4.0
Sudbury	17-5344-51754	Kukagami	464357	803303	06/03/2000	2.506	6.45	40.3	26.84	1.9	6.2
Sudbury	17-5462-51807	Kelly # 27	464644	803155	06/03/2000	0.909	5.86	32.1	21.38	2.2	2.0
Sudbury	17-5216-51920	Aylmer # 37	465231	804237	06/03/2000	-0.803	4.72	32.1	21.38	1.4	50.0
Sudbury	17-5110-52189	Laundrie	470732	805116	08/03/2000	0.604	5.52	29.0	19.31	4.3	10.2
Sudbury	17-5393-51873	Lower Matagamasi	465010	802904	06/03/2000	1.418	6.05	32.7	21.78	3.2	5.2
Sudbury	17-4665-50976	Lumsden	460131	812559	03/03/2000	-0.229	5.03	24.1	16.05	1.5	3.4
Sudbury	17-4573-51969	MacDonald	465536	813336	08/03/2000	0.640	5.68	23.0	15.32	3.0	4.8
Sudbury	17-5292-51958	Marjorie	465436	803714	06/03/2000	-1.202	4.59	33.5	22.31	1.4	5.0
Sudbury	17-5427-51794	Maskinonge	464625	802625	06/03/2000	2.356	6.28	34.7	23.11	2.6	3.4

DISTRICT	WBY LID	LAKE NAME	LAT	LONG	DATE	Alk (mg/L)	pH	Cond (u mhos/cm)	TDS (mg/L)	DOC (mg/L)	Phosphorous (u g/L)
Sudbury	17-5305-51809	Matagamasi	464626	803620	06/03/2000	0.380	5.51	31.5	20.98	1.8	4.8
Sudbury	17-4821-51845	Michaud	464837	811403	08/03/2000	0.987	5.77	25.3	16.85	3.6	6.6
Sudbury	17-5395-51925	Mickey	465306	802857	06/03/2000	2.238	5.83	36.3	24.18	8.2	6.0
Sudbury	17-4594-51088	Nellie	460800	813132	03/03/2000	-1.291	4.61	37.3	24.84	0.1	0.8
Sudbury	17-3887-51486	Nook	462845	822632	29/01/2001	1.658	6.09	250.0	166.50	1.4	2.0
Sudbury	17-4759-51035	Norway	460514	811832	03/03/2000	-0.073	5.18	27.5	18.32	0.9	2.0
Sudbury	17-4691-51000	O.S.A.	460312	812353	03/03/2000	-0.758	4.80	35.0	23.31	0.6	2.2
Sudbury	17-5308-52065	Parsons	470049	803538	06/03/2000	1.325	5.57	37.6	25.04	7.7	7.6
Sudbury	17-5352-51958	Pedro	465459	803215	06/03/2000	1.676	6.19	32.7	21.78	2.4	4.0
Sudbury	17-4836-51150	Peter	461124	811250	03/05/2004	4.310	6.62	35.9	23.91	3.0	6.4
Sudbury	17-5396-51819	Potvin	464730	802849	06/03/2000	-0.289	5.01	35.1	23.38	0.8	4.0
Sudbury	17-4885-51790	Rand	464608	810858	08/03/2000	0.193	5.09	26.3	17.52	6.2	13.6
Sudbury	17-5330-51961	Rawson	465503	803400	06/03/2000	1.096	5.92	34.7	23.11	2.7	4.8
Sudbury	17-4806-51039	Ruth-Roy	460525	811502	02/01/2001	-0.918	4.72	26.5	17.65	1.0	2.0
Sudbury	17-5267-51883	Silvester	465029	803843	06/03/2000	-0.478	4.93	33.3	22.18	1.4	13.0
Sudbury	17-5228-52105	Stouffer	470357	804058	08/03/2000	0.509	5.49	30.2	20.11	2.0	5.2
Sudbury	17-5165-51976	Telfer	465645	804718	06/03/2000	-0.251	5.10	30.2	20.11	1.0	4.0
Sudbury	17-4670-51065	Three Narrows	460647	812519	03/03/2000	0.257	5.46	26.6	17.72	3.1	11.6
Sudbury	17-4910-51070	Tyson	460701	810659	03/03/2000	1.173	5.96	31.2	20.78	3.9	7.2
Sudbury	17-4923-51272	Wavy	461809	810533	03/03/2000	-0.660	4.85	31.8	21.18	3.4	11.4
Sudbury	17-3974-51436	Whiskey	462623	822007	29/01/2001	1.199	6.06	239.0	159.17	1.4	4.0
Sudbury	17-5000-51272	White Oak	461756	805952	03/03/2000	0.373	5.49	31.4	20.91	3.1	7.6
Sudbury	17-5128-52363	White Pine	471655	804950	07/03/2000	1.681	6.21	26.4	17.58	3.1	3.4
Sudbury	17-5279-51902	Wolf	465110	803755	06/03/2000	-0.306	5.02	32.9	21.91	1.1	2.0
Wawa	16-6882-52534	Black Beaver	472432	843022	16/01/2001	0.507	5.79	14.2	9.46	2.0	2.0
Wawa	16-6933-52436	Hubert	471930	842630	16/01/2001	0.984	5.91	14.5	9.66	2.2	4.0
Wawa	16-6981-52469	Little Agawa	472051	842235	16/01/2001	1.451	5.93	15.0	9.97	4.4	8.0
Wawa	16-6520-53237	Molybdenite	480303	845738	16/01/2001	0.210	5.32	17.9	11.94	6.9	8.0
Wawa	16-6930-52450	North Hubert	471949	842641	16/01/2001	0.918	5.87	14.4	9.60	2.1	4.0

Appendix 12: Updated fish community data collected using the Nordic netting standard to evaluate 50+ acid damaged lake trout lakes in NER where pH was found to exceed or approach a threshold for lake trout survival and recruitment (pH 5.5).

DISTRICT	LAKE	YEAR	# SETS	CATCH (# of individuals collected by species)																																					
				80	81	82	91	93	121	131	141	162	163	182	183	185	194	198	200	201	206	208	209	212	214	233	271	281	284	311	313	314	316	317	331	334	338	341	342	380	382
Kirkland L.	Lady Sydney	2001	40		17		343						3			11														113					869						
NBay	Barter	2002	40		79			42					36				361	214				33		4						74	4				957					10	
NBay	Benner	2001	26		58								43	30		248							4		8			9									1				
NBay	Bluesucker	2000	40	13	41								145	62									4					13													
NBay	Dees	2002	24	7			25	45				150	31			99	6							184	17										782		1				
NBay	Florence	2000	56	4									55			15	25																		1478						
NBay	Grays	2001	32	1			30						218			31	3	1																	1383						
NBay	Jerry	2002	32	32																				3	15																
NBay	Jim Edwards	2002	32	113	9																			45																	
NBay	Linger	2002	20		15					5			27				1							7						200	71	85			707						
NBay	Marina	2001	16	2									84			2															1				1592						
NBay	Rodd	2001	16		7								76			97											4								413						
NBay	Sugar	2001	40		11		181			1			10					7				15					9			151	4		117		322				1		
NBay	Turner	2001	40		10		234						97			459	1										17												98		
SSM	Grey Owl	2000	40																																						
SSM	Kirk	2001	24											316														73													
SSM	May	2002	48		15								104	8		122		465						110			35	1			160				2		14				
SSM	McCabe	2002	39		19		2						254	30		16									397		74				65										
Sudbury	Barron	2001	16		1								51			48														807											
Sudbury	Bell	2001	48		9		9	424		19			40				18					38				30				184	41		74		709						
Sudbury	Bowland	2003	40		25								13				2																		912						
Sudbury	Broker	2000	32					33																							78				1865						
Sudbury	Caswell	2002	24																																						
Sudbury	Chiniguchi	2000	56		3						1		160							1						19							51		2157						
Sudbury	Chuggin	2001	16		12						1			1			1								1										1919						
Sudbury	Colin Scott	2000	32			1																																			
Sudbury	Davis	2000	16								5																								880						
Sudbury	Donald*	2000	42																														2		1629						
Sudbury	Elboga	2002	16		1							167	13	786	73	392		48					21					37													1
Sudbury	Fraleck	2003	32		1								24																		1		46		222	57					
Sudbury	George	2001	40		6			253					7									3				24				535	15		106		284						
Sudbury	GreatMountain	2002	40		7			349																							59		117	347							
Sudbury	Johnnie	2000	48		20		2	136		1			55				15									31				312	3		118		239			2			
Sudbury	Kakakise	2001	40		1			244		1			10									77								351	45		138		204		1		3		
Sudbury	Kelly # 27	2001	14								1																								767						

DISTRICT	LAKE	YEAR	# SETS	CATCH (# of individuals collected by species)																																					
				80	81	82	91	93	121	131	141	162	163	182	183	185	194	198	200	201	206	208	209	212	214	233	271	281	284	311	313	314	316	317	331	334	338	341	342	380	382
Sudbury	Kettyle	2000	32		17	1																																			
Sudbury	Kindle	2000	47		4		1	67					38														1			887			52								
Sudbury	Kukagami	2003	64		33		192						167												2	8	43			5			40		2374	74					
Sudbury	L. Matagamasi	2000	32		1			113					29			1		23												109	2		100		112		2				
Sudbury	Laundrie	2003	33		4								253				1																32		1726						
Sudbury	Low	2001	24					36	17													3				2				101	5	51	53	3	52		1				2
Sudbury	Matagamasi	2000	56		40					1			34				4			1						212				265			55		684	9					
Sudbury	Michaud	2004	40		20						1		19				24	267						1											412						
Sudbury	Nook	2000	16		3			19				1	32				1													380			14		6						
Sudbury	Parsons	2001	24								6		90																				13			18					
Sudbury	Pedro	2005	24		59								707	42	10			3							11			14		136											
Sudbury	Peter	2003	30		2			146					5																	208	10		108		177				9		
Sudbury	Rawson	2003	40		75								117			18															5		313		105						
Sudbury	Stouffer*	2000	30							8			62					77												414					626						
Sudbury	Telfer*	2000	20																																						
Sudbury	Three Narrows	2003	48		2			150		6			3						91			26				38				232	17	27	95		304	1					
Sudbury	Tyson	2001	53		5			155		1			42				29					2				53				243	32		105	2	773				19		
Sudbury	Wavy	2004	40																																2313						
Sudbury	Whiskey	2002	56	1	66			110	3				63					1									1	1		1143			54		32	2					1
Sudbury	White Oak	2003	48		12								3				45								36	80					89				2329						
Sudbury	White Pine	2004	24		38								32		3		21	1						22	51		5								255		7				
Sudbury	Wolf*	2000	34																																713						
Wawa	Hubert*	2000	8	13	8											3								6	1																
Wawa	Little Agawa*	2000	30		73												10			1				21				9													
Wawa	Molybdenite*	2000	24		7									2		20									13																

Note*: Surveys completed on Donald, Hubert, Little Agawa, Molybdenite, Stouffer, Telfer, and Wolf Lakes were non-standard (ie. completed after September 15th and /or below recommended netting effort)

Key to Species Captured

080 - brook trout	121 - rainbow smelt	182 - northern redbelly dace	200 - blacknose shiner	212 - creek chub	284 - fourspine stickleback	317 - largemouth bass	342 - logperch
081 - lake trout	131 - northern pike	183 - finescale dace	201 - spottail shiner	214 - pearl dace	311 - rock bass	331 - yellow perch	380 - sculpin species
082 - splake	141 - central mudminnow	185 - lake chub	206 - mimic shiner	233 - brown bullhead	313 - pumpkinseed	334 - walleye	382 - slimy sculpin
091 - lake whitefish	162 - longnose sucker	194 - golden shiner	208 - bluntnose minnow	271 - burbot	314 - bluegill	338 - Iowa darter	
093 - lake herring (cisco)	163 - white sucker	198 - common shiner	209 - fathead minnow	281 - brook stickleback	316 - smallmouth bass	341 - johnny darter	

Appendix 13: Supplemental information gathered regarding damaged lakes in Wawa, Sault Ste. Marie, and Sudbury (Espanola Area) Districts. Note: for historic information regarding other damaged lakes in Sudbury and North Bay Districts Lakes refer to Polkinghorne and Gunn (1981) and McCrudden (1993) respectively.

<u>Sault Ste. Marie District</u>

Grey Owl Lake (Status = R2)

- Little historic information available, given a maximum depth of 31m and the fact that pH is still depressed (5.52 in 2001) it is assumed that anecdotal reports re: historic presence of lake trout are accurate and that the population was extirpated as a result of acidification
- Extent of pH depression unknown: pH measurements averaged 5.20 in 1982/83 with readings in shoreline areas as low as 4.6
- Nordic Survey 2000: no fish caught
- Lake trout restoration initiated 2001

Hough Lake (Status = R)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Restocked 1984 to 1996
- Unsure of present status - needs to be assessed
- Potential need for additional stocking

Kirk Lake (Status = R2)

- An acid sensitive lake – no point source of pollution
- Lake trout present and reproducing at time of original 1971 lake survey (pH 7.0 to 7.5)
- Extent of pH depression unknown: pH = 5.79 in 2001, measurements as low as 5.57 in 1981
- Lake trout population lost to pH depression or exploitation (or both)
- Nordic Survey 2001: no lake trout present
- Lake trout restoration initiated 2003

May Lake (Status = R1)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Restocked 1984 to 2002
- Nordic Survey 2002: 12 of 15 lake trout sampled unclipped (natural recruitment)
- Lake trout stocking discontinued - allow continued recovery

McCabe Lake (Status = R1)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Restocked 1984, 1985 & 1991 to 2002
- Nordic Survey 2002: 15 of 19 lake trout sampled unclipped (natural recruitment)
- Lake trout stocking discontinued - allow continued recovery

Nordic Lake (Status = R)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Restocked 1988 to 1998, stocking discontinued – lost road access
- Unsure of present status - needs to be assessed
- Potential need for additional stocking

Pecors Lake (Status = N1)

- Impacted by Elliot Lake uranium mining - last impacted lake in Serpent River chain
- Native lake trout population degraded
- Remnant lake trout population likely comprised of native stock - only stocked once (1995)
- SLIN Survey 2000: 4 unclipped lake trout, 2 below length of maturity (natural recruitment but very low abundance)
- Monitor for continued natural recovery
- Potential need for additional stocking

Quirke (Status = R1)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Restocked 1986 to 1992 & 1996 to 2000
- Evidence of natural recruitment, stocking discontinued, allow continued recovery
- Catch & release fishery only since January 1998

<u>Sudbury District (Espanola Area)</u>

Kindle Lake (Status = R2)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Restocked 1984 to 1993 – fishery closed 1994 to 1999 following a planting of adult broodstock in 1993 in an attempt to address coregonid barrier
- Nordic Survey 2000: present lake trout abundance low, 4 lake trout captured, 3 large adults remaining from 1993 planting and 1 small unclipped fish (the small unclipped fish either related to emigration from Quirke Lake as per Nook Lake comment or a natural recruit)
- Lake trout restoration effort resumed in 2001 – stocking of 2 year olds

Nook Lake (Status = R2)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Very little historic information available - given a maximum depth of 18m and the location of this lake relative to other lake trout lakes in the Serpent River system it is assumed that anecdotal reports re: historic presence of lake trout are accurate
- Nordic Survey 2000: present lake trout abundance low, 3 lake trout captured, 2 large unclipped fish and 1 small clipped fish (the three lake trout captured most likely the result of emigration of stocked lake trout from Quirke Lake located immediately upstream)
- Lake trout restoration initiated in 2001

Whiskey Lake (Status = R2)

- Impacted by Elliot Lake uranium mining, native lake trout population lost / degraded
- Restocked 1983 to 2005
- Nordic Survey 2002: 60 of 66 lake trout sampled unclipped, although the significant number of unclipped fish would seem to indicate strong natural recruitment local managers remain unconvinced (the unclipped fish likely in part related to stocking of 2400 unclipped broodstock in 2001)
- Suggest continued monitoring with a view to discontinue stocking in favour of natural recruitment

Wawa District

Black Beaver (Status = N1)
- An acid sensitive lake – no point source of pollution, located just north of Montreal River
- Lake trout present at time of original 1980 Lake Survey
- Extent of pH depression unknown: pH = 5.79 in 2001; measurements in1983 range 4.7 - 5.3
- No record of lake trout stocking
- Lake trout presently self-sustaining - a reflection of limited impact and / or natural recovery

Hubert (Status = N1)
- An acid sensitive lake – no point source of pollution, located just north of Montreal River
- Lake trout present at time of original 1978 Lake Survey – abundance low
- Extent of pH depression unknown: pH = 5.91 in 2001, measurements as low as 5.4 in 1983
- No record of lake trout stocking
- Nordic Survey 2000 (non-standard timing & netting effort): 8 lake trout caught in 8 sets
- Lake trout presently self-sustaining - a reflection of limited impact and / or natural recovery

Little Agawa (Status = I1)
- An acid sensitive lake – no point source of pollution, located just north of Montreal River
- Lake trout reported to have been present historically; however, this has never been verified - there were no lake trout present at time of original 1979 lake survey (suspected that this lake only supported brook trout historically)
- Extent of pH depression unknown: pH = 5.93 in 2001, measurements as low as 5.5 in 1983
- Record of a single stocking of lake trout in 1991
- Nordic Survey 2000 (non-standard timing and netting effort): 35 of 73 lake trout sampled were unclipped
- Introduced (or re-introduced) lake trout population presently self-sustaining

Molybdenite (Status = R2)
- Impacted by historic smelting operations near Wawa
- Extent of pH depression unknown: pH = 5.32 in 2001, measurements as low as 5.0 in 1978
- No lake trout present at time of original 1978 lake survey, District suspects that this lake never supported a native lake trout population despite anecdotal reports re: historic lake trout presence
- Record of a single stocking of lake trout in 1991
- Nordic Survey 2000 (non-standard timing and effort): 7 clipped lake trout sampled, a result of 1991 stocking
- Lake trout stocking resumed in 2005

North Hubert (Status = N1)
- Lake trout present at time of original 1978 Lake Survey
- Extent of pH depression unknown: pH = 5.87 in 2001, measurements in 1978 range 6.0 - 6.5
- No record of lake trout stocking
- Lake trout presently self-sustaining - a reflection of limited impact and / or natural recovery

Appendix 14: Record of stocking completed towards restoration of acid damaged lake trout lakes in NER (including historic stocking events).

District	Lake	Pre 2001 Stocking	Recent Stocking – Northeast Lake Trout Project				
			2001	2002	2003	2004	2005
North Bay	Dees	None					500 2yr olds
North Bay	Florence	1953-54 & 1977	9900 ylgs	10000 ylgs	11000 ylgs		
North Bay	Grays	None		2000 ylgs		2000 ylgs	
North Bay	Gullrock	1977, 1988, 1998-2000					
North Bay	Jerry	None					500 ylgs
North Bay	Marina	None			500 ylgs		500 ylgs
SSM	Grey Owl	None		2400 ML ylgs	2400 ML ylgs		1375 MP ylgs 1100 MsL ylg
SSM	Kirk	None			600 ML ylgs		600 ML ylgs
Sudbury	Bell	1984-89 & 1992 5635 ML @ 0.8kg in 92	255 ML @ 4.2kg		164 ML @ 2.4kg		
Sudbury	Broker	1994 (500 Seneca Adults)	324 Simcoe @ 1.0 kg 162 2yr old & 324 ylgs	460 Simcoe @ 1.5 kg 800 2yr olds			
Sudbury	Caswell	1989		550 Kingscote @ 204g			
Sudbury	Chiniguchi	1977 & 1994-2000	3600 2yr olds 4230 ylgs	14000 ylgs	13700 ylgs	12500 ylgs	11500 ylgs
Sudbury	Colin Scott	1987-89	1000 ylgs		500 ylgs		500 ylgs
Sudbury	Davis	1955 & 1984-85	136 Simcoe @ 1.1 kg 68 2yr olds & 133 ylgs		500 ylgs		500 ylgs
Sudbury	Donald	1977 & 1987-88	6000 ylgs	4000 ylgs	5000 ylgs	5000 ylgs	
Sudbury	Elboga	1969 & 1974-77			228 MP @ 4.0kg 230 IB @ 3.4kg	500 ylgs	
Sudbury	Fraleck	1977 & 1984-86				700 2yr olds	
Sudbury	George	1977 & 1984-92		330 Slate I. @ 3.7 kg		252 MP @ 2.2kg	
Sudbury	Great Mountain	None	190 IB @ 2.9kg			174 IB @ 3.9kg	
Sudbury	Johnnie	1992 (emig. from Bell)	393 MP @ 4.5kg		164 ML @ 2.4kg		
Sudbury	Kelly #27	None				500 ylgs	
Sudbury	Kindle	1984-93 1372 ML @ 1.1 kg in 1993	1000 2yr olds 1500 ylgs		400 2yr olds 2000 ylgs		1000 2yr olds 1500 ylgs
Sudbury	Laundrie	1977 & 1980-86					4000 ylgs
Sudbury	Lower Metagamasi	None	720 2yr olds		800 2yr olds		

District	Lake	Pre 2001 Stocking	Recent Stocking – Northeast Lake Trout Project				
			2001	2002	2003	2004	2005
Sudbury	Matagamasi	1951 & 1998-2000	5760 2yr olds	8000 ylgs	10000 ylgs	12000 ylgs	11500 ylgs
Sudbury	Nook	None	360 2yr olds		400 2yr olds		300 2yr olds
Sudbury	Peter	1984-85, 1989-92				700 2yr olds	
Sudbury	Stouffer	None	720 2yr olds		800 2yr olds		
Sudbury	Telfer	None	4500 F1's	6500 F1's	5000 F1's		
Sudbury	Tyson	1956-58 & 1981 -94		4100 2yr olds	590 Slate @1.7kg	187 MP @ 4.6kg 3300 2yr olds	3100 2yr olds
Sudbury	Whiskey	1947-53, 1983-2000	2178 Slate @ 900g 6250 fall ylgs (LM)		5400 LM fall ylgs	6250 LM fall ylgs	7000 LM fall ylgs
Sudbury	White Oak	1955 & 1996 250 BS @ 1.5kg in 96					
Wawa	Molybdenite	1991					2000 ylgs

Notes:

All yearling and 2 year old hatchery products were Killala Lake strain (KL) unless otherwise specified

Other Strains Being Used Include: BS = Big Sound (Lake Huron); IB = Iroquois Bay (Lake Huron); Kingscote Lake; Lake Simcoe; ML = Mishibishu Lake (Lake Superior); MP = Michipicoten Island (Lake Superior); Seneca Lake; & Slate Island (Lake Superior)

The stocking rates and frequencies outlined in Table # ? should serve as a guideline for continued stocking of these damaged waters. It should be noted that the stocking rates and frequencies presented in the above table above may not correspond exactly with the strategies outlined in Table # ?. Potential reasons for this being the use of heavier initial stocking rates or annual initial stocking strategies given that these lakes have been void of lake trout for some time and potential forage species are presently at very high abundance. Excellent initial growth is expected.