Strategy for Reducing Lake Trout Stocking in Lake Huron

Drafted by the Lake Huron Technical Committee

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Executive Summary

The Lake Huron Technical Committee (LHTC) recommends that the Lake Huron Committee consider adopting an integrated set of criteria that could be used to evaluate when to reduce or discontinue stocking hatchery-reared lake trout into Lake Huron. The three criteria are relative survival of stocked year classes, recruitment of wild lake trout, and relative or absolute abundance of wild adult lake trout. Decisions to reduce or discontinue stocking should be made in each of six spatial areas in Lake Huron. Trends in the catch per unit effort at a given age per number stocked will be the first criteria to evaluate the necessity of stocking hatchery lake trout. One relative survival index will describe the relative abundance of year classes of stocked lake trout at age-7 per million stocked in the main basin of Lake Huron. A second index will describe relative abundance of year classes of stocked lake trout at ages 3-6 in the Cape Rich area of southern Georgian Bay. When the relative survival of stocked lake trout falls below a level judged to be effective for 3-5 years, managers should reduce or discontinue stocking. Declines in the relative survival of stocked fish should, however, be judged in light of the other two criteria. The recruitment criteria will consist of the catch per unit effort of age-0 lake trout in fall bottom-trawl surveys and the relative abundance of wild year classes represented in survey or commercial catches. These two indices will provide evidence of the scale of natural reproduction and recruitment. The LHTC further suggests that when stable or increasing levels of reproduction result in the contribution of multiple year classes of wild age-5 and older lake trout to survey gear and fisheries, stocking should be reduced or discontinued. The relative and/or absolute abundance of wild adult lake trout is the last criteria for evaluating future stocking levels. These indices will consist of the catch per unit effort of mature spawning wild lake trout at multiple spawning sites around Lake Huron and statistical catch-at-age estimates of spawning biomass of wild lake trout in each spatial area of the main basin. Catch-at-age estimates of spawning biomass levels observed during 2002-2004 should be viewed as sufficient for maintaining natural reproduction.

Introduction

Fishery management agencies in both the United States and Canada have been attempting to rehabilitate self-sustaining populations of indigenous lake trout (*Salvelinus namaycush*) in the Laurentian Great Lakes since the late 1950s and early 1960s, with little success (see Pycha and King 1975, Selgeby 1995, Hansen et al. 1995, Eshenroder et al. 1995, Holey et al. 1995, Cornelius et al. 1995, Elrod et al. 1995). Managers believed that once sea lamprey (*Petromyzon marinus*) populations were reduced stocking of hatchery-reared fish would quickly build adult populations and natural reproduction would follow (Pycha and King 1975, Selgeby 1995. After more than five decades of intensive management actions, lake trout are self-sustaining at nearly historic levels only in Lake Superior (Wilberg et al. 2003, Bronte et al. 2003). Measureable numbers of naturally produced lake trout have been detected in Lake Ontario since 1994 and large numbers were detected during 1995-2001, but since then restoration has stalled and there has been little natural reproduction (Lantry and Lantry 2012). Natural reproduction of lake trout in lakes Michigan and Erie has been minimal to non-existent and naturally produced adult fish remain rare (Bronte 2008, Markham 2009).

On the other hand, rehabilitation of lake trout in Lake Huron has advanced quickly since 2004 when populations of adult alewife collapsed and measurable numbers of age-0 wild lake trout were captured during fall bottom-trawl surveys throughout the lake (Riley et al. 2007, Bence et al. 2008). Age-0 wild lake trout have been captured nearly every year since 2004 and catches in 2012 were larger than in any year during 1973-2012. Fishery agencies have observed substantial recruitment of these wild fish into both the juvenile and adult portions of the lake trout population at both nearshore and offshore sites (He et al. 2012). Year class abundance of wild lake trout has been increasing through time and at least 10 year classes of wild lake trout are now present in the lake-wide population. Wild lake trout now compose about 50% of the lake trout population in the main basin of Lake Huron. Rehabilitation has not progressed to the same degree in the North Channel or Georgian Bay.

The Lake Huron Technical Committee believes that successful restoration of lake trout in Lake Huron is possible in the not-too-distant future and that now is the time to consider something unthinkable even ten years ago - that stocking may no longer be a viable tool for managing lake trout in Lake Huron. Strategies to reduce stocking were not even considered in rehabilitation strategies on some of the Great Lakes; rather rehabilitation plans called for numerous experiments to optimize survival of stocked lake trout and potential reproduction by adults (Johnson et al. 2004, Eshenroder et al. 1984, Bronte et al. 2008, Markham 2008). The Lake Superior and Lake Huron lake trout rehabilitation plans do contain specific criteria for reducing stocking rates of lake trout once the rehabilitation process is successful, or unsuccessful (Hansen 1996, Ebener 1998). The stocking cessation criteria on Lake Superior include agency commitment, harvest control, wild-fish abundance, and stocked-fish survival. Although stocking could be discontinued based on any of the criteria, all four criteria were to be considered before action was taken on Lake Superior (Hansen 1996). The stocking reduction or cessation criteria in the Lake Huron Lake Trout Rehabilitation Plan were drawn from the Lake Superior experience and include; 1) stocked-fish survival, 2) wild-fish abundance, and 3) the proportion of wild fish in the adult population (Ebener 1998).

Stocking is such an integral part of fishery management and the lake trout rehabilitation process that weaning fisheries and managers from stocked fish takes considerable time. Managers fear that reducing stocking will set back the rehabilitation process and reduce future total allowable catches, which is the primary tool used to control harvests on Lake Huron. In some cases commercial fisheries welcome less stocking since they believe it will reduce by-catch issues, but they also fear the loss of income associated with reductions in stocking. The purpose of this Strategy is to describe and adopt criteria that will assist the LHC in determining when it is appropriate to reduce or discontinue lake trout stocking in all or portions of Lake Huron.

Rationale

Cessation of stocking is an inevitable outcome of successful lake trout rehabilitation. The elimination of stocking throughout Lake Superior that began in 1996 appears to have had no ill effects on the populations as abundance of wild stocks remains stable (see Sitar et al. 2010). The Lake Superior stocking cessation criteria were evaluated on a management unit basis and stocking of hatchery fish was first eliminated in Michigan and eastern Wisconsin management units, followed by northern Minnesota units. Stocking still occurs in several Lake Superior units where the appropriate management agency has determined that the cessation criteria have not been met, or where the political desire is to continue stocking to support fisheries. Ontario ceased stocking hatchery-reared lake trout into Lake Superior in 2013.

Stocking lake trout on self-sustaining populations can have undesired effects. The Ontario Ministry of Natural Resources Lake Trout Working Group synthesized data on lake trout populations across the Province and identified three major ways in which stocking may have a negative effect on wild lake trout stocks: 1) altering genetic integrity of the wild stock; 2) displacing wild fish from spawning sites; and, 3) increasing exploitation on wild stocks (Evans et al. 1991). From this synthesis Evans and Willox (1991) reported that supplemental stocking of lake trout on native, self-sustaining populations in Ontario inland lakes caused displacement of the wild stocks, and they recommended a moratorium on supplemental stocking to protect the genetic integrity of the self-sustaining wild stocks.

Lake trout stocking was terminated in Parry Sound of Lake Huron because the criteria for successful restoration were achieved. Abundance of wild spawning lake trout in Parry Sound increased after 1988 due to successful sea lamprey control, high stocking rates, and control of exploitation (Reid et al. 2001). Average age of mature females, abundance of wild lake trout, and proportion of wild fish in the population were established as criteria for successful restoration of lake trout in Parry Sound and all these criteria were met by 1997. Consequently, the Province of Ontario ceased stocking lake trout in Parry Sound that same year. Anecdotal information suggests the wild lake trout population in Parry Sound remains stable and self-sustaining. Based partly on the experience in Parry Sound, the current draft rehabilitation plan for Ontario waters of Lake Huron states that the need for stocking should be reviewed once wild lake trout make up 25% of the population and that stocking should be terminated when 50% of the population is made up of wild fish (http://www.mnr.gov.on.ca/stdprodconsume/groups/lr/@mnr/@letsfish/documents/document/stdprod_086681.pdf).

The buildup of adult spawning stocks in Lake Huron and the altered food web structure (Riley et al. 2008), which lead to the collapse of alewife (*Alosa pseudoharengus*) populations in Lake Huron, are affecting survival of stocked yearling lake trout in Lake Huron. He et al. (2012) reported very low relative survival (CPUE per number stocked) of the 2002 and 2003 year classes of stocked lake trout in Michigan waters of Lake Huron and survival of many year classes in Ontario waters has been poor for some time (Adam Cottrill, OMNR, Upper Great Lakes Management Unit, Owen Sound, Ontario, personal communication). He et al. (2012) concluded that it is unlikely that relative survival will increase substantially to levels observed during 1991-2001 and that future management of lake trout in Lake Huron should focus on protection of existing wild populations and increasing their recruitment. Recently stocked lake trout have regularly been observed in the stomachs of adult lake trout in Lake Huron (He et al. 2012) and it is likely that predation is the primary cause of declining relative survival of stocked lake trout.

Protocol Components

We propose to use three parameters for evaluating whether to reduce or discontinue lake trout stocking in Lake Huron. These parameters will provide a clear analysis of the status of both wild and stocked lake trout in Lake Huron, and the role that stocking may play in the rehabilitation process. The three parameters are:

1) Relative survival of stocked yearlings;
2) Recruitment of wild fish; and
3) Absolute and/or relative abundance of wild lake trout.

Relative Survival

Relative survival of stocked year-classes, expressed as the number of age-7 fish caught per 305 m (1,000 feet) of gill net per million stocked (CPE/R) during spring or summer graded mesh gill net surveys, evaluates the ability of stocked fish to survive and contribute to the adult population. In Lake Superior CPE/R declined from an average of 7 for the 1963 and 1964 year classes to only 1 for the 1980-1982 year classes (Hansen et al. 1994). The Lake Superior stocking protocol recommended that “stocking should be discontinued in an area where the survival index for stocked fish falls below 1.0 for three successive years” (Hansen et al. 1996). In Michigan waters of Lake Huron CPE/R values were never as large as in Lake Superior and exceeded 1.0 for only 6 of 34 year classes (**Figure 1**). The range of CPE/R values for age-7 lake trout in main basin waters of Lake Huron was 0.08 to 1.4 and averaged roughly 0.6 for the 1973 to 2006 year classes. Relative survival of the 2003-2006 year classes in the main basin of Lake Huron was the lowest observed in the time series, and survival of the 2006 year classes was the lowest observed, representing only 13% of the long-term average for all year classes.

In southern Ontario waters of Georgian Bay survival of stocked lake trout has been declining for decades. The CPE/R values at ages 3-6 in the Cape Rich survey site ranged from roughly 1 to 3.2 for the 1987-2000 year classes, thereafter survival declined nearly annually to between 0.02 and 0.08 for the 2005-2008 year classes in 2011 and 2012 (**Figure 2**). Survival index values in Georgian Bay also never approached the levels observed in Lake Superior. The CPE/R values at the Cape Rich site were even lower and less variable for age-6 fish (0.0 to 1.0) than for age-7 fish in Michigan waters of the main basin (**Figure 1**). Relative survival of age-6 lake trout never exceeded 1.0 at Cape Rich during 1994-2011.

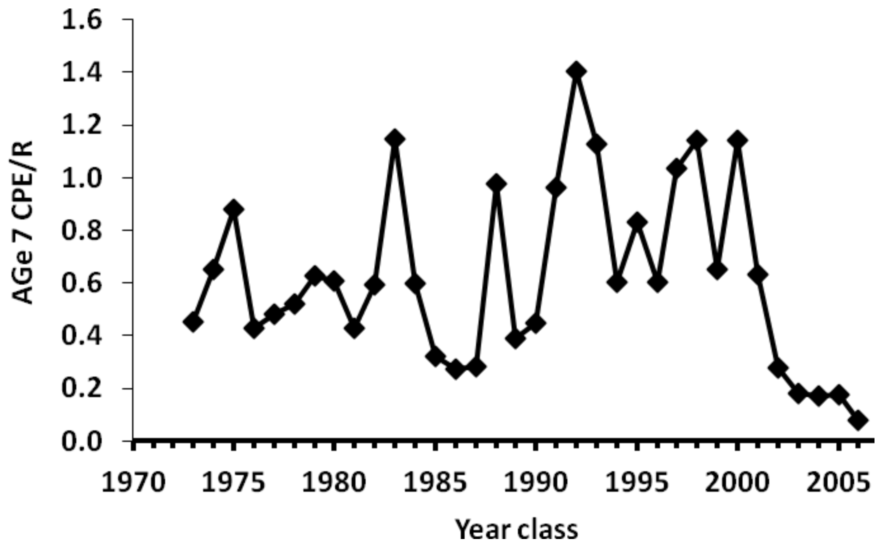

Figure 1. *Relative survival* of *the 1973-2006 year classes of lake trout at age-7 in the main basin of Lake Huron during 1980-2013.*

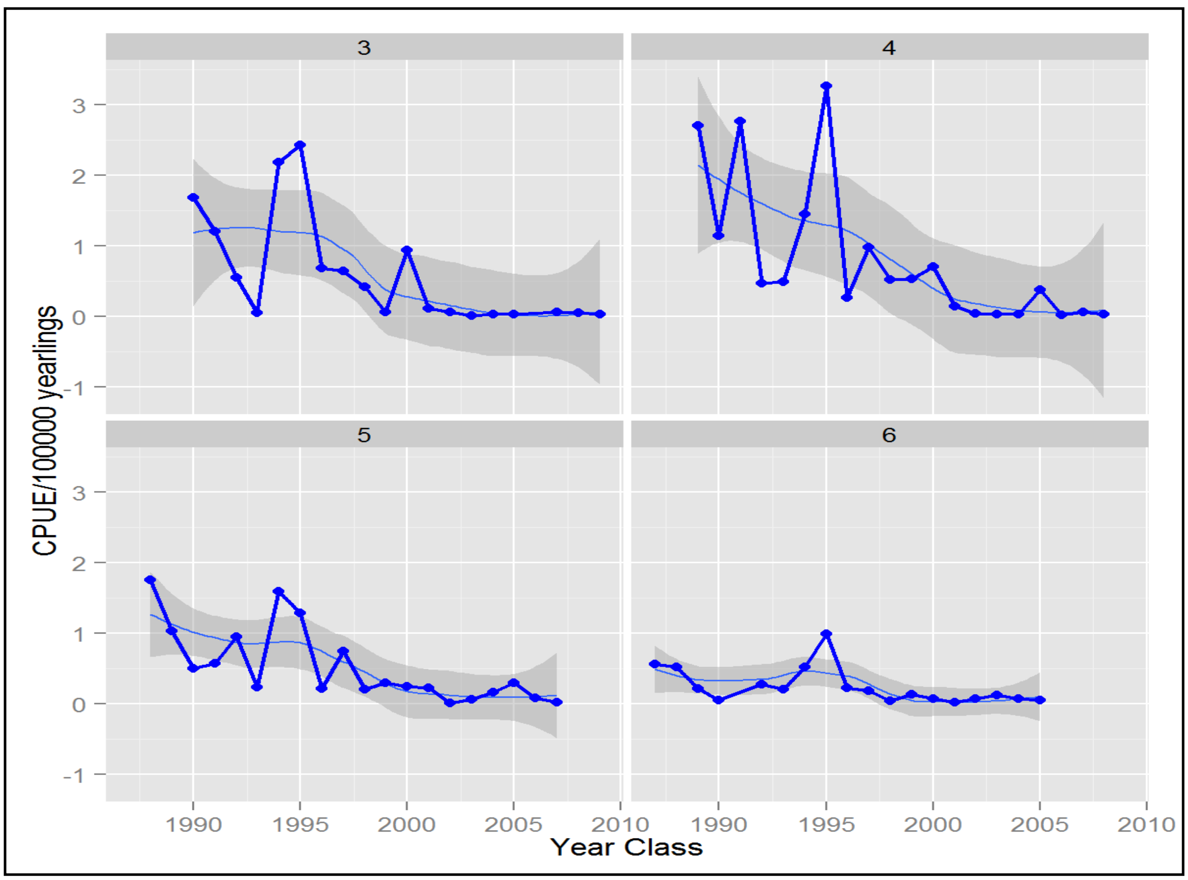

Figure 2. *Relative survival of the 1987-2009 year classes of lake trout at ages 3-6 at the Ontario Ministry of Natural Resources Cape Rich survey site in southern Georgian Bay during 1993-2012. Solid line and dots represent annual values, thin solid line represents predicted trend, and shaded area represents 95% confidence interval about trend line.*

Recruitment of Wild Fish

Recruitment of wild progeny to the spawning population is the true measure of success in lake trout rehabilitation. The U.S. Geological Survey's Great Lakes Science Center fall bottom trawl survey has regularly captured age-0 wild lake trout [1] throughout the main basin of Lake Huron since 2004 (**Figure 3**). During 2004-2011 the fall bottom trawl catch rate of age-0 wild lake trout has averaged roughly 0.3 fish per hectare, with annual catch rates varying from 0 to 0.7 fish per hectare. In 2012 density of age-0 wild lake trout increased eight-fold over the 2004-2011 average and indicates that recruitment to the adult population lake-wide should be substantial during 2017-2022.

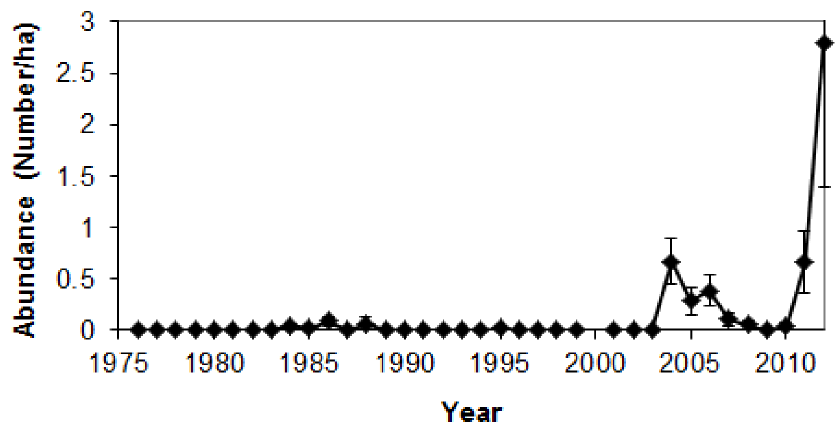

Figure 3. *Density of wild juvenile (YOY, < 125 mm) lake trout collected in fall bottom trawls from Lake Huron 1976-2012.Error bars are 95% confidence intervals.*

The 2003-2005 year classes first observed in the bottom trawl surveys have begun to make sizable contributions to the population of lake trout in the main basin of Lake Huron. In the Drummond Island Refuge of northern Lake Huron the 2003-2005 year classes of wild lake trout have been three-fold more abundant as previous year classes caught during fall graded-mesh gill net surveys (**Figure 4**). The presence of wild year-classes from 1989-2002 indicate that there has been some natural reproduction and subsequent recruitment to the Drummond Island population taking place since the early 1990s. The presence of the larger 2003-2005 year classes has meant that wild fish now make up 36-75% of survey and commercial catches of lake trout in MH-1 and northern Ontario waters of Lake Huron.

Abundance of Wild Adults

Trends in population abundance of wild lake trout have to be considered when developing a stocking reduction strategy in order to prevent population collapses. In the Drummond Island Refuge of MH-1 densities of adult wild lake trout began to increase in 2002, increased substantially during 2009-2013, and in 2013 made up nearly 50% of all spawners in that year (**Figure 5**). Abundance of hatchery spawners in the Drummond Island Refuge has been stable or slightly increasing since 2002 and the abundance of mature lake trout in the Refuge was higher during 2009-2013 than any time previous.

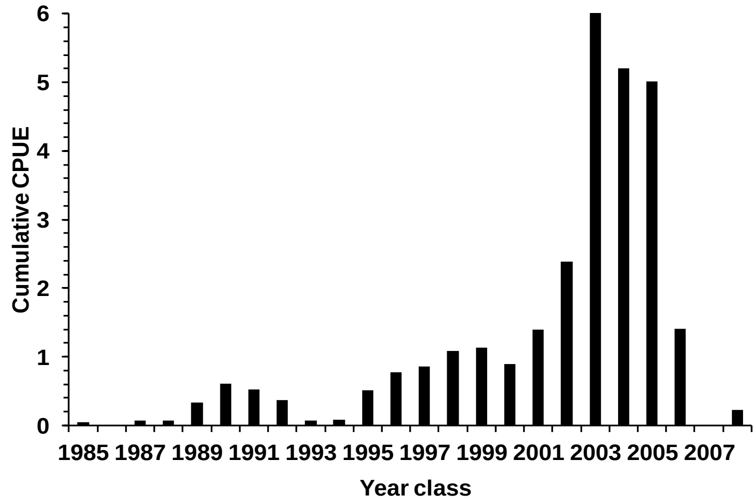

Figure 4. *Cumulative relative abundance at ages 2-14 of year classes of wild lake trout captured during graded-mesh gill net surveys in the Drummond Island Refuge of northern Lake Huron during October of 1991-2012.*

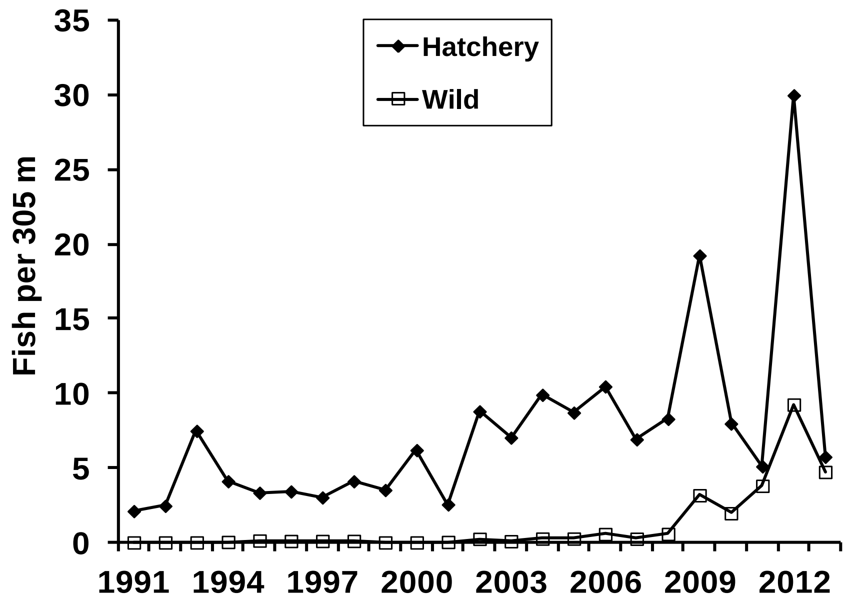

Figure 5. *Relative abundance of sexually mature hatchery and wild lake trout captured on spawning reefs with graded mesh gill nets in the Drummond Island Refuge during October 1991-2013.*

Abundance of wild lake trout varies considerably among the three basins in Ontario waters of Lake Huron based on monitoring of commercial fishery catches. In Ontario waters, abundance of wild lake trout during 2007-2012 was highest in the northern main basin (NMB) and southern main basin (SMB), followed by the North Channel, and Georgian Bay (**Figure 6)**. Catch rate of wild lake trout by the commercial fishery in Ontario's main basin averaged 2 fish per 305 m during 2008-2012 and was highest at about 4 fish per 305 m of gill net in 2011 and 2012. The trends in catch rate of wild fish in the main basin of Ontario are very similar to catch rates in the Drummond Island Refuge. Catch rate in the North Channel was lower than in the main basin but still averaged 1 fish per 305 m during 2008-2012.

In Georgian Bay catch rates of wild lake trout have been low and stable at 0.4 fish per 305 m during 2008-2012. Catch rate of wild lake trout was greater during 2008-2012 than during the previous 5-year time block in the main basin and North Channel, but less than the previous 5-year time block in Georgian Bay. Wild lake trout were more abundant than hatchery lake trout in the main basin and North Channel in 2012 (**Figure 6**).

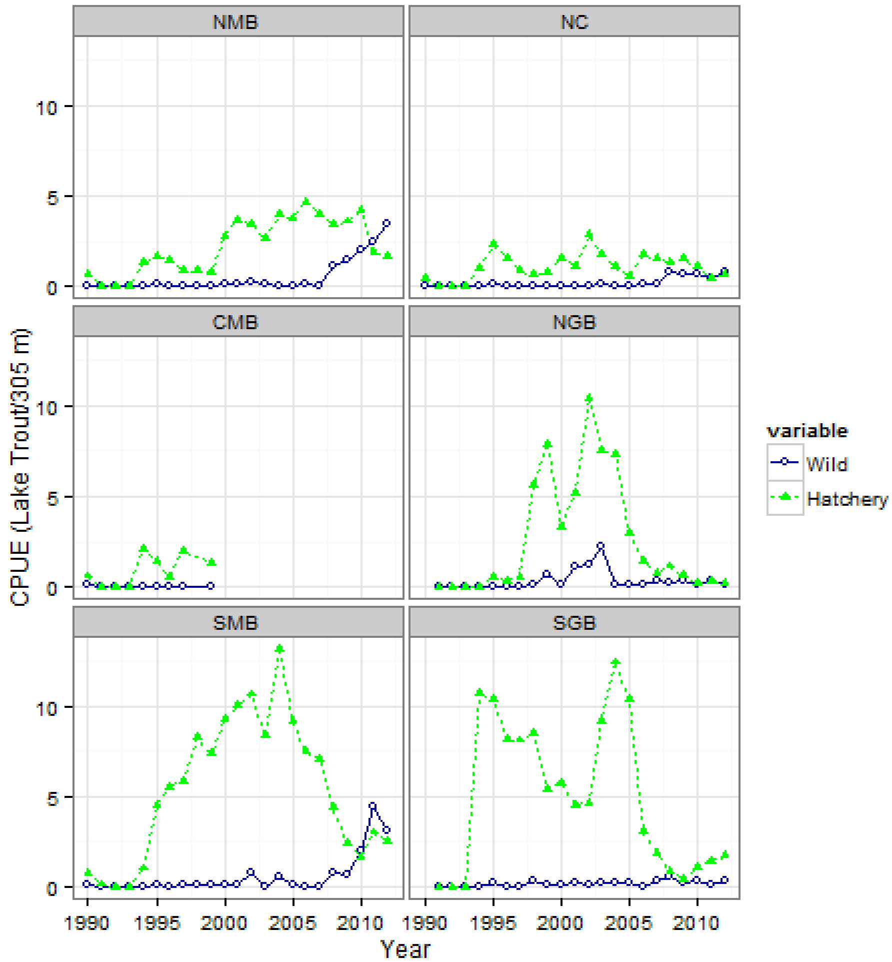

Figure 6. *Relative abundance (fish per 305 m) of hatchery and wild lake trout captured in Ontario Provincial commercial gill net fisheries targeting lake whitefish in the northern (NMB), central (CMB), and southern main basin (SMB), North Channel (NC), and northern (NGB) and southern (SGB) Georgian Bay during 1990-2012.*

The development of statistical catch-at-age models has allowed fishery managers to estimate absolute abundance and biomass in the main basin of Lake Huron. These abundance estimates are used to set harvest limits and address population dynamics issues such as stock and recruitment and food-web interactions. Spawning stock biomass of lake trout in the northern main basin averaged about two million pounds during 2003-2012 (**Figure 7**). In the north-central main basin spawning biomass was estimated to be around one million pounds during 2003-2012. In the southern main basin spawning biomass averaged nearly three million pounds during 2003-2011. Spawning biomass of wild lake trout in 2012 was estimated to be 700,000 pounds in the north main basin, 550,000 pounds in the north-central main basin, and 900,000 pounds in the southern main basin.

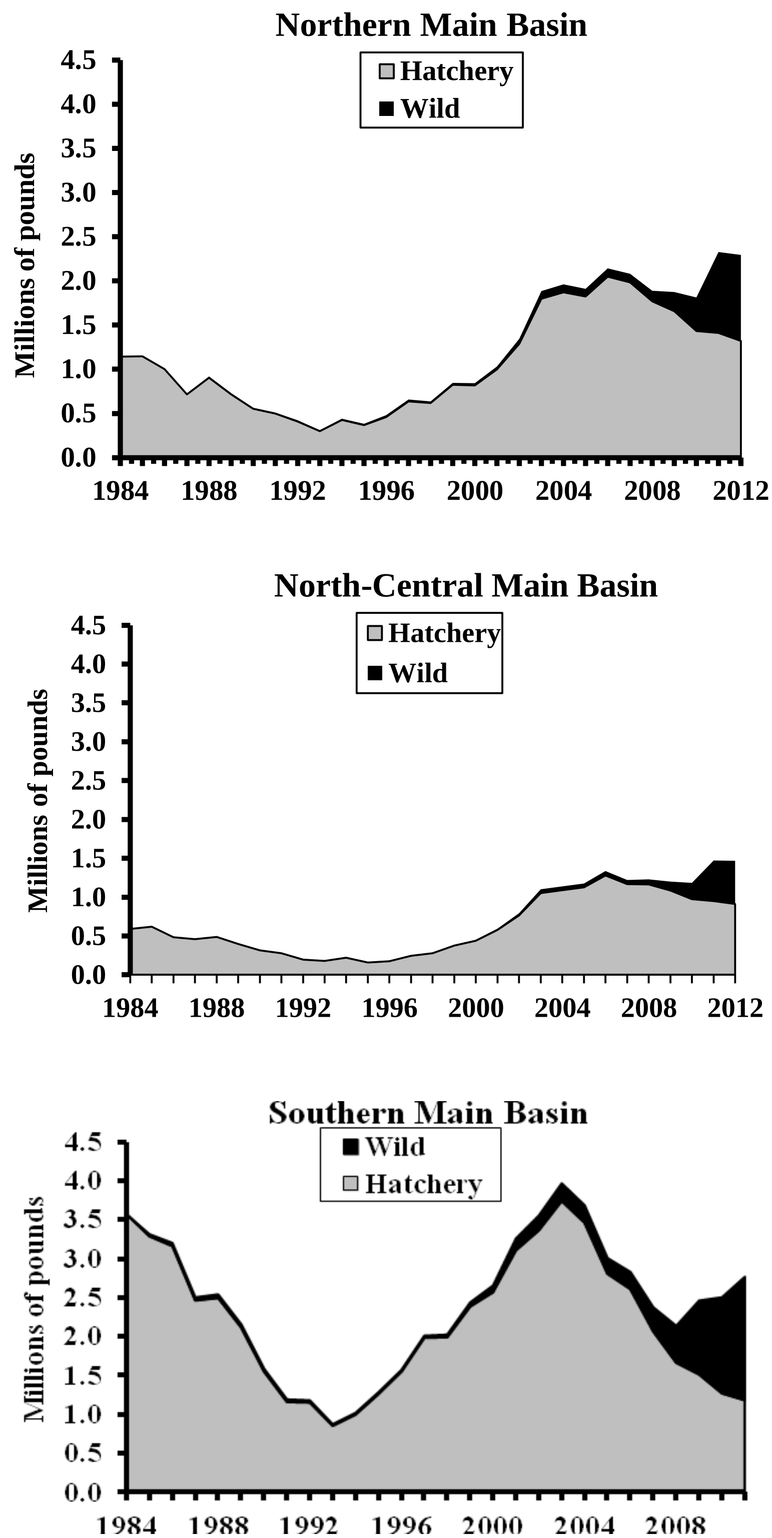

Figure 7. *Estimates of hatchery and wild lake trout spawning biomass in the north, north-central, and southern main basin of Lake Huron during 1984-2012 based on statistical catch-at-age analysis*.

Management Areas

We recommend that the decision to reduce or discontinue lake trout stocking should be made individually for each of six spatial areas in Lake Huron; three in the main basin, two in Georgian Bay, and the North Channel (**Figure 8**). Stock assessment models that include information from both Michigan and Ontario waters have been developed for each of the three units in the main basin of Lake Huron (see He et al. 2012). Boundaries of the three spatial units in the main basin roughly follow lake trout management unit and statistical district boundaries (Ebener 1998). The stock assessment models provide estimates of year class relative survival, abundance, and biomass, all of which are important for evaluating the need to stock. Information with which to evaluate relative survival of stocked year classes is extremely "noisy" when viewed on smaller spatial scales in the main basin.

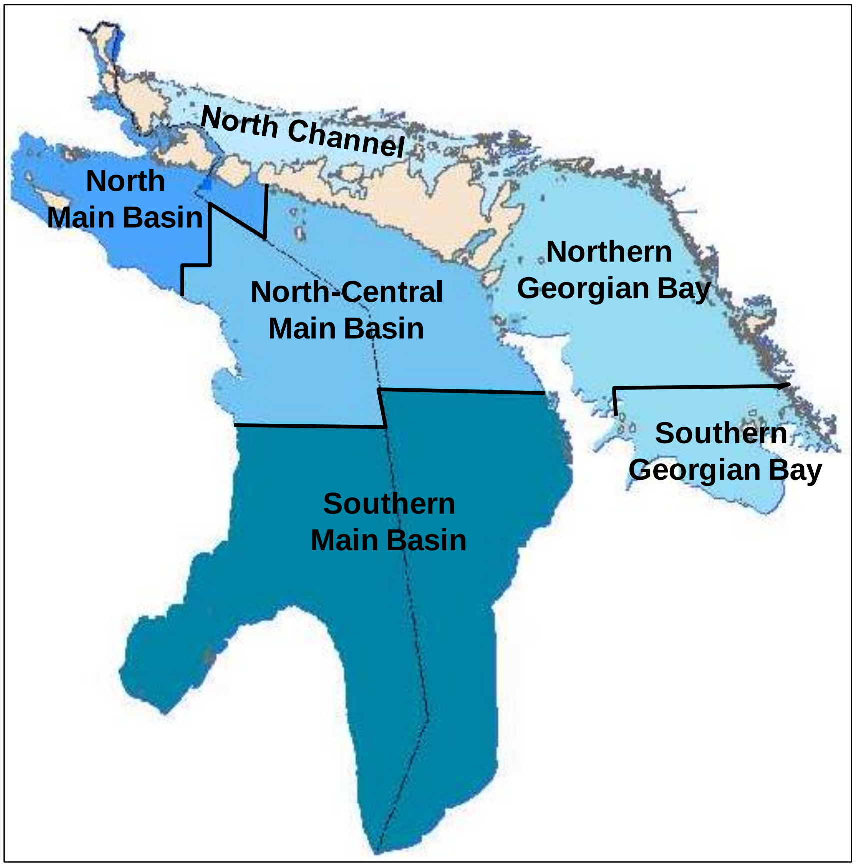

Figure 8. *Spatial areas in Lake Huron where lake trout stocking cessation decisions should occur.*

Ontario's current draft rehabilitation plan for Ontario waters includes 17 specific areas where stocking and lake trout rehabilitation efforts will be focused **(Figure 9**). Unfortunately, the Province of Ontario does not possess information on relative survival, spawning biomass, or wild recruitment for each of their 17 management units. Information on relative survival is only available for the southern Georgian Bay spatial area and abundance of wild fish is only available for the six larger spatial areas. In addition, we believe that the 17 management units proposed for Ontario waters are too small to encompass spatial distributions of lake trout. While the Province of Ontario can make decisions whether or not to stock lake trout in each management unit, the Lake Huron Technical Committee possesses the ability to evaluate lake trout population parameters only at the larger spatial scales identified in Figure 7.

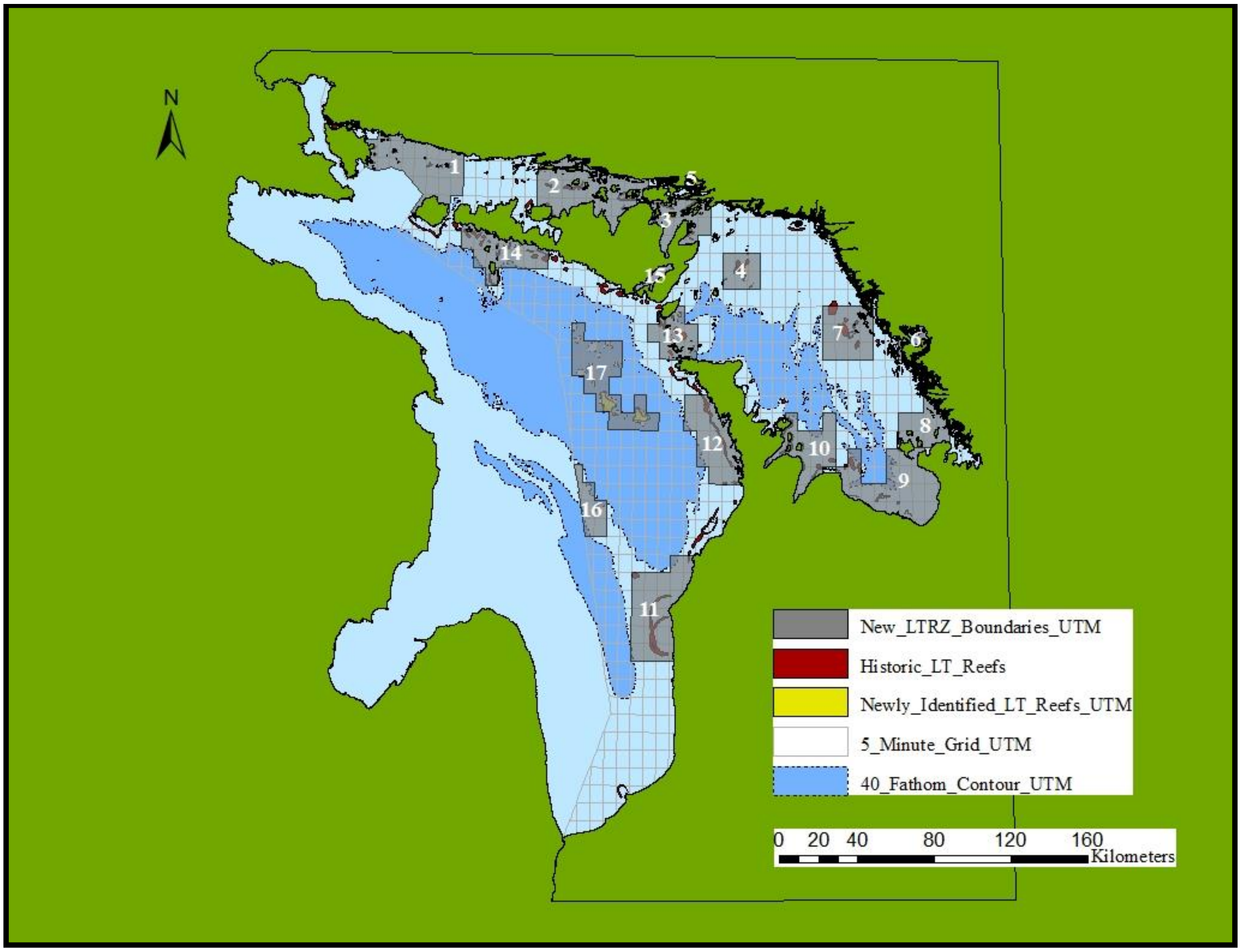

Figure 9. *Lake trout rehabilitation zones 1-17 in Ontario waters of Lake Huron.*

Use of the Stocking Strategy in the Decision Process

The decision to reduce or discontinue stocking should be made with a consensus of managers based on a common set of criteria, and input from technical staff and constituents. No single criteria or reference point should be used to judge changes to existing stocking practices, rather the integrated set of criteria outlined in this document should be used to guide the decision-making process. In this document we describe relative survival of stocked year classes, recruitment of wild lake trout, and relative or absolute abundance of wild adult lake trout as being the most appropriate criteria for evaluating lake trout stocking levels. We also illustrate the present status of each criterion in as many of the six spatial areas of Lake Huron as is possible given the available data.

Relative Survival of Stocked Fish. Trends in the CPUE at a given age per number stocked will be the first criterion used to evaluate the necessity of stocking hatchery lake trout. One index will describe the relative abundance of year classes of stocked lake trout at age-7 per million stocked in the main basin of Lake Huron. A second index will describe relative abundance of year classes of stocked lake trout at ages 3-6 in the Cape Rich area of southern Georgian Bay. Stocking is an effective rehabilitation tool only if it can re-establish spawning stocks of lake trout. Stocking of hatchery-reared lake trout over naturally reproducing populations can also have negative consequences and can be counter-productive. When the survival index of stocked lake trout falls below a level judged to be effective by researchers and managers for 3-5 years, reductions in lake trout stocking should be considered. Declines in relative survival of stocked fish should, however, be judged in combination with the two criteria discussed below.

Recruitment of Wild Fish. The recruitment criterion will consist of the catch per unit effort of age-0 lake trout in fall bottom-trawl surveys and the relative abundance of wild year classes represented in survey or commercial catches. These two indices will provide evidence of the scale of natural reproduction and the recruitment (integration of reproduction, survival, and growth) of these fish to the extant population. We suggest that when stable or increasing levels of reproduction result in the contribution of multiple year classes of wild age-5 and older lake trout to survey gear and fisheries, stocking reductions should be considered.

Abundance of Adult Fish. Estimates of the relative and/or absolute abundance of wild adult lake trout is the final criterion we propose to evaluate the necessity of stocking. These indices will consist of the catch per unit effort of mature spawning wild lake trout at multiple spawning sites around Lake Huron and statistical catch-at-age estimates of spawning biomass of wild lake trout in each spatial area of the main basin. Spawning stock biomass must reach levels judged to be sufficient for achieving the rehabilitation goals and for sustaining natural reproduction. Catch-at-age estimates of spawning biomass that is at least at levels observed during 2002-2004 when a measurable number of age-0 lake trout were captured in bottom-trawls, and year classes were abundant enough to recruit to survey gear and fisheries, may be viewed as sufficient for maintaining natural reproduction.

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