Lake trout

Formerly Indicator # 93

Overall Assessment

Status: Fair

Trend: Unchanging

Rationale: Self-reproducing populations are present only in Lake Superior and in one isolated area of Lake Huron. Populations in lakes Michigan, Erie, and Ontario are mostly below target levels of relative abundance and wild recruitment is limited or non-existent.

Lake-by-Lake Assessment

Lake Superior

Status: Good

Trend: Improving

Rationale: Natural reproduction of both nearshore (lean) and offshore (siscowet) populations is widespread and supports all populations. Most stocking has been discontinued and fisheries are well managed. Sea lamprey mortality has been increasing. All agencies committed to further restoration and conservation.

Lake Michigan

Status: Poor

Trend: Unchanging

Rationale: Little natural reproduction detected anywhere; no significant recruitment of wild fish to the population. Survival of stocked fished in northern Lake Michigan is poor due to high sea lamprey mortality and fishing resulting in inadequate parental stocks. Agencies are mixed on commitments to rehabilitation.

Lake Huron

Status: Fair

Trend: Improving

Rational: More than ten year classes of wild lake trout have been observed lake wide, and represent 20% of harvest and survey catches in recent years. Abundant year classes of wild lake trout are now entering the adult portion of the population and their presence on the spawning grounds should help stimulate more natural reproduction. All agencies committed to further rehabilitation and conservation.

Lake Erie

Status: Poor

Trend: Deteriorating

Rationale: Sea lampreys predation continues to suppress adult stocks despite higher stocking numbers and improved recruitment of young stocked fish in recent years. Most agencies committed to further rehabilitation and conservation.

Lake Ontario

Status: Mixed

Trend: Improving

Rationale: Sea lamprey predation was strongly related to a collapse in adult stocks during 2004-2005; however abundance has increased each year since 2007. Post-release survival of stocked fish and natural reproduction has remained low since the early 1990s. All agencies committed to further rehabilitation and conservation.

Purpose

- To estimate the relative abundance of both stocked and wild lake trout.
- To measure the success of rehabilitation through catch rates of wild fish
- To infer the control measures on fishing and sea lamprey predation through the age structure and abundance of mature fish.
- To infer the basic structure of the cold water predator community and the general health of the ecosystem

Ecosystem Objective

Self-sustaining, naturally reproducing populations that support target yields to fisheries are the goal of the lake trout rehabilitation program. Target yields approximate historical levels of lake trout harvest or levels adjusted to accommodate stocked naturalized introduced predators such as Pacific salmon. Targets, most centered on desired harvest expectations, are set by Lake Committees of the Great Lakes Fishery Commission in Fish Community Objectives (Horns *et al.* 2003, Eshenroder *et al.* 1999, DesJardin *et al.*1995, Ryan *et al.* 2003., Stewart *et al.* 1999), and are revised periodically. These targets are 1.8 million kg (4 million pounds) from Lake Superior, 1.1 million kg (2.5 million pounds) from Lake Michigan, 0.9 million kg (2.0 million pounds) from Lake Huron and 50 thousand kg (0.1 million pounds) from Lake Erie. Lake Ontario has no specific yield objective but has a population objective of 0.5 to 1.0 million adult fish that produce 100,000 yearling recruits annually through natural reproduction. The desired state will be for lake trout to serve as the primary top predator in Lake Superior and share this status with other native and established non-native predators in lakes Michigan, Huron, Erie and Ontario**.**

Ecological Condition

<u>Measure</u>

Trends in the relative abundance of stocked lean lake trout in lakes Huron, Michigan, Erie and Ontario, and wild lean lake trout in Lake Superior are displayed in Figure 1. Targets are set for most populations of lean lake trout as these are perceived to be biologically important to increase the probability of natural reproduction in lakes Huron, Michigan, Erie and Ontario and to maintain wild populations in Lake Superior. Target values are measured and expressed by relative abundances of all or a portion of the population in multiagency gill net surveys that are standardized within each lake. These measures are superior to harvest objectives, which are harder to evaluate and represent desired states that cannot no be easily tested for sustainability. Lake trout abundance dramatically increased in all the Great Lakes after initiation of sea lamprey control, stocking, and harvest control. Success to achieve population targets and ultimately to self-sustaining natural reproducing populations has been mixed among the lakes.

<u>Endpoint</u>

Desired states are populations that are self-sustaining through natural reproduction with minimal or no hatchery supplementation required, that support a sustainable harvest, and serve as a top predator. The resulting population size and sustainable yield compared to historical levels will likely be lower in most lakes since this apex trophic level is now shared by naturalized non-native predators that support a multi-billion dollar fishery.

<u>Background</u>

Historically lake trout were the keystone salmonine predator for most of the Great Lakes. Overfishing and predation by non-native sea lamprey, and to a limited extent other factors, destroyed nearshore lean populations and deep water siscowet lake trout populations, but many survived in Lake Superior and a few lean lake trout populations in Lake Huron (Lawrie and Rahrer 1972, Berst and Spangler 1972, Wells and McLain 1972, Hartman 1972, Christie 1972). Rehabilitation efforts through stocking and controls on fisheries and sea lamprey have been ongoing since the early 1960s (Hansen *et al.* 1995, Eshenroder *et al.* 1995, Holey *et al.* 1995, Cornelius *et al.* 1995, Elrod *et al.*

1995).

Status of lake Trout

Lake Superior

Wild lean lake trout populations have recovered from collapse in the 1950s due to an aggressive recovery program employing sea lamprey suppression, stocking of hatchery fish, and fishery restrictions (Hansen *et al.* 1995, Bronte *et al.* 2003). Recovery began with the buildup of large populations of hatchery lake trout which was superseded by wild fish. The transition to wild lake trout dominance began in the 1980s in Michigan waters and was subsequently followed in Wisconsin, then most recently in Minnesota. In Michigan waters, abundance and recruitment of most lake trout populations are near historic high levels with some indications of density-dependent growth declines (Wilberg *et al.* 2003, Richards *et al.* 2004, Sitar *et al.* 2010). The latest progress in recovery was the cessation of most stocking in Minnesota waters.

Siscowet is the most abundant form of lake trout in Lake Superior occupying deep water areas and have recovered from depressed levels in the 1950s (Bronte and Sitar 2008, Ebener *et al.* 2010). Recent harvest is low, though emerging industrial interest in extracting omega-3 fatty acid from siscowets may develop a demand. Sea lamprey wounding rates on siscowets are high, though the mortality inflicted may not be higher than that experienced by lean lake trout (Moody *et al.* 2010). Similar to leans, siscowets are at high levels and experiencing density-dependent effects.

Currently, wild lake trout abundance has generally remained level. Fishing mortality has been controlled in most areas of Lake Superior through regulations. Despite continued sea lamprey management, wounding rates on lake trout in some areas have increased above target levels since 1995 (Sitar *et al.* 2010). In the near-term, some decline in lake trout abundance is expected due to density-dependence effects.

Lake Huron

Sea lamprey wounding rate has decreased since 2000 from more than 20 wounds per 100 fish to less than 10 wounds per 100 fish. Age-7 catch per 1000 ft of gillnet per million stocked has been stable between 0.45 and 1.4 since 1991, except for the year classes stocked in 2003 and 2004 when there were dramatic changes to lower food webs in Lake Huron that caused a substantial reduction in abundance of alewives. Alewives were an important food of lake trout prior to 2004, but since then they have been nearly non-existent in the diet. Age at recruitment to commercial fishery and fishery independent survey gear have increased from age 5 prior to 2006 to age 7 by 2009, while size at age of lake trout has declined over the last decade. Both these changes are likely due to the impacts of food-web changes in combination with changes in seasonal and spatial distribution of juvenile lake trout.

Year classes of wild lake trout produced during 2003-2006 coincided with the reduction in consumption of alewives by adult lake trout suggesting that Thiamine Deficiency Syndrome (TDS) was a substantial impediment to rehabilitation of lake trout in Lake Huron. Reductions in TDS in combination with prior increases in abundance of adult lake trout and reductions in sea lamprey mortality created a fish community that was conducive to survival of larval lake trout and advancement of lake trout rehabilitation on Lake Huron.

Lake Michigan

Lake trout densities measured by spring assessment surveys remain below target in all management units and lake - wide. Few wild fish (with no fin clip) were recovered in assessment surveys (Bronte *et al.* 2007, Lake Trout Task Group 2010), which indicates that natural reproduction remains low even though fry from reproduction by stocked lake trout have been recovered (Jannsen *et al.* 2006). Recent events that should increase the probability of achieving the lake trout rehabilitation objectives include: 1) a revised implementation strategy for the rehabilitation of lake trout in Lake Michigan that concentrates stocking and other management efforts in the best habitat areas, 2) egg thiamin levels, thought be inadequate for hatching success and fry survival, have recently increased lakewide, and 3) sea lamprey numbers, which were above the targets levels for many years, have declined.

Elevated sea lamprey induced mortality, low adult stock size, and lack of sustainable reproduction (Bronte *et al.* 2003, 2007), continues to limit lake trout rehabilitation. Recommendations to advance recovery include minimizing adult mortality from fishing and lamprey, focus new hatchery production in refuge areas, restore a native forage base, and recast FCO for population characteristics rather than harvest levels.

Lake Erie

Directed efforts to restore lake trout in Lake Erie began in 1982. Recruitment of stocked fish was good but their survival to adulthood was poor due to excessive sea lamprey predation. Adoption of the original lake trout rehabilitation plan in 1985 (Lake Trout Task Group 1985) brought higher annual stocking targets, sea lamprey control, and standardized assessment programs to monitor the population. The lake trout responded quickly to the implementation of sea lamprey suppression and increased stocking, building a large population by 1990. However, these accomplishments were short lived as stocking numbers were reduced in 1996 due to concerns about a shortage of forage fishes (Einhouse *et al.* 1999) while at the same time sea lamprey control was relaxed (Sullivan *et al.* 2003). Adult lake trout abundance was quickly reduced to low levels by 2000 where it has since remained.

Overall lake trout abundance in Lake Erie has increased in more recent years due to adoption of a revised rehabilitation plan (Markham *et al.* 2008) that increased stocking numbers back to their original level. Recruitment of stocked fish, including Klondike strain lake trout, has been high. However, sea lamprey abundance remains high and above targets despite increased lampricide treatments, and this continues to suppress the adult lake trout population. Achievement of lake trout rehabilitation goals will continue to be hampered if sea lamprey abundance and wounding rates remain high and above target levels.

Lake Ontario

The abundance of hatchery-reared adult lake trout in Lake Ontario was relatively high during 1986-1998, but declined by more than 30% in 1999 due to reduced stocking and poor survival of stocked yearlings since the early 1990s (Elrod *et al.* 1995, Lantry and Lantry 2011). Adult abundance remained relatively stable during 1999-2004, but again declined by 54% in 2005 likely due to ongoing poor recruitment and mortality from sea lamprey predation. Enhanced control of sea lampreys and subsequent decreases in wounding on lake trout during 2008-2010 was followed by a sharp recovery in adult lake trout numbers that in 2010 was similar in abundance to 1999-2004 levels.

Although the abundance of adults reached a peak in 1986, appearance of naturally reproduced lake trout in assessment surveys occurred later after the abundance of large adult females exceeded target levels in 1992 (Lantry and Lantry 2011). Despite widespread catches of small numbers of natural recruits nearly every year during 1993-2010, a failure to achieve self-sustaining stocks has been attributed to the dense populations of alewives in Lake Ontario and an associated diet of lake trout that favors alewives (leading to Early Mortality Syndrome), the absence of suitable alternative deepwater preyfishes, and colonization of spawning reefs by invasive round gobies (Fitzsimons *et al.* 2003, Lantry *et al.* 2003, Schneider *et al.* 1997, Walsh *et al.* 2011). Recent meager prospects for restoration have been improved with the reappearance of deepwater sculpin in assessment catches (their abundance steadily increased during 2002-2010) (Lantry *et al.* 2007, Weidel *et al.* 2011) and the joint US and Canadian efforts currently underway to reestablish deepwater ciscoes. Both deepwater sculpin and deepwater ciscoes were historically important prey for lake trout.

Management Challenges/Opportunities

Continued and enhanced sea lamprey control is required basin-wide to increase survival of lake trout to adulthood. New sea lamprey control options, which include pheromone systems that increase trapping efficiency and disrupt reproduction, are being researched and implemented, and hold promise for improved control. Continued and enhanced control on exploitation is being improved through population modeling in most Lakes. Stocking densities need to be increased in some areas, especially in Lake Michigan and possibly Lake Ontario. All lake trout in US waters are now receiving coded-wire tags that, when recaptured, will contribute substantially to the knowledge base for better rehabilitation options. The use of alternate strains of lake trout from Lake Superior could be candidates for deep, offshore areas not colonized by traditional strains used for restoration. Introduction of such strains has been initiated in Lake Erie, will start soon in Lake Ontario and are being considered for Lake Michigan. Direct stocking of eggs, fry, and yearling on or near traditional spawning sites should be used where possible to enhance colonization. The need to restore native forage fish, such as cisco and deepwater ciscoes, is gaining momentum and seen as an important requirement to aid in bringing lake trout back to self-sustainability. This activity will require careful consideration of the transfer of diseases among lakes as well as the development of rearing and stocking strategies.

Comments from the author(s)

Reporting frequency should be every five years. Monitoring systems are in place, but in most lakes the measures do not directly relate to stated harvest objectives. Lake trout population-objectives may need to be redefined as endpoints in units measured by the monitoring activities, and are being incorporated into restoration guides and plans. The data time series we present are based on important population targets that can be measured with current assessment activities.

Assessing Data Quality

Data Characteristics	Strongly Agree	Agree	Neutral or Unknown	Disagree	Strongly Disagree	Not Applicable
1. Data are documented, validated, or quality-assured by a recognized agency or organization		x				
2. Data are traceable to original sources		x				
3. The source of the data is a known, reliable and respected generator of data		x				
4. Geographic coverage and scale of data are appropriate to the Great Lakes basin		x				
5. Data obtained from sources within the U.S. are comparable to those from Canada				x		
6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report		x				
Clarifying Notes:						

Acknowledgments

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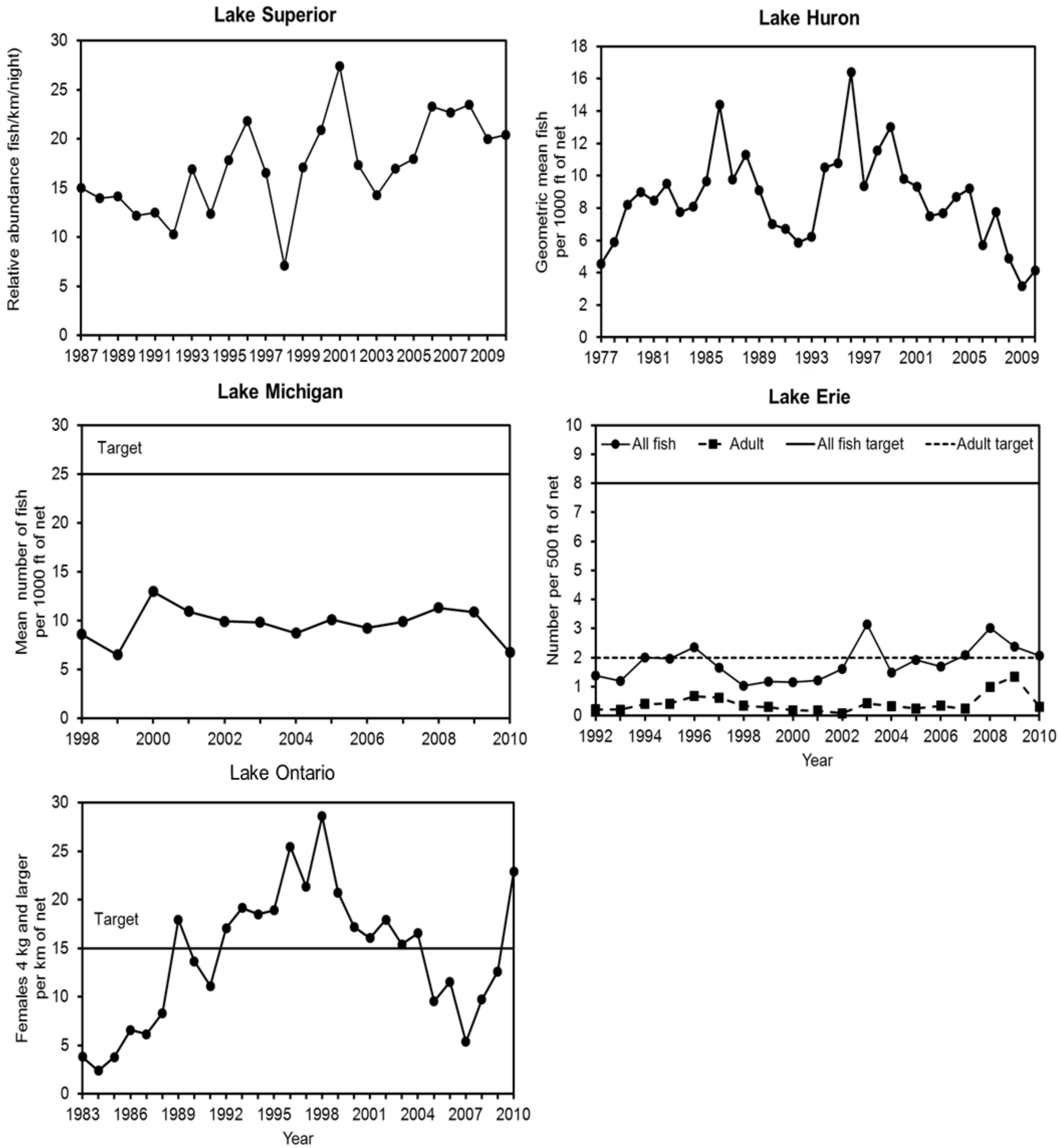
List of Figures

Figure 1. Relative abundance of lake trout in the Great Lakes. The measurements reported vary from lake to lake, as shown on the vertical scale, and comparisons among lakes may be misleading. Overall trends over time provide information on relative abundances for all or part of the population. Source: Data sources are from biological assessments conducted cooperatively by state, federal, tribal and provincial agencies, and are largely contained in non-peered reviewed reports to the Great Lakes Fishery Commission, Lake Committees.

Last Updated

State of the Lakes Ecosystem Conference (SOLEC) 2011



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