Sea Lamprey
Indicator #18

This indicator report was last updated in 2005.

Overall Assessment

Status: **Good/Fair**
Trend: **Improving**

Lake-by-Lake Assessment

Separate lake assessments were not included in the last update of this report.

Purpose
- To estimate the abundance of sea lamprey as an indicator of the status of this invasive species
- To infer the damage sea lamprey cause to the fish communities and aquatic ecosystems of the Great Lakes

Ecosystem Objective
The 1955 Convention of Great Lakes Fisheries created the Great Lakes Fishery Commission (GLFC) *"to formulate and implement a comprehensive program for the purpose of eradicating or minimizing the sea lamprey populations in the Convention area"* (GLFC 1955). Under the Joint Strategic Plan for Great Lakes Fisheries, all fishery management agencies established Fish Community Objectives (FCOs) for each of the lakes. These FCOs call for suppressing sea lamprey populations to levels that cause only insignificant mortality of fish in order to achieve objectives for lake trout and other members of the fish community (Horns *et al.* 2003, Eshenroder *et al.* 1995, DesJardin *et al.*1995, Ryan *et al.* 2003., Stewart *et al***.** 1999).

The GLFC and fishery management agencies have agreed on target abundance levels for sea lamprey populations that correspond to the FCOs (Table 1). Targets were derived from available estimates of the abundance of spawning-phase sea lampreys and from data on wounding rates on lake trout. Suppressing sea lampreys to abundances within the target range is predicted to result in tolerable mortality on lake trout and other fish species.

Lake	FCO Sea Lamprey Abundance Targets	Target Range (+/- 95% Confidence Interval)
Superior	35,000	18,000
Michigan	58,000	13,000
Huron	74,000	20,000
Erie	3,000	1,000
Ontario	29,000	4,000

Table 1. Fish Community Objectives for sea lamprey abundance targets.
Source: Great Lakes Fishery Commission

State of the Ecosystem

Background

Populations of the native top predator, lake trout, and other fishes are negatively affected by mortality caused by sea lamprey. The first complete round of stream treatments with the lampricide TFM, as early as 1960 in Lake Superior, successfully suppressed sea lamprey to less than 10% of their pre-control abundance in all of the Great Lakes. Mark and recapture estimates of the abundance of sea lamprey migrating up rivers to spawn are used as surrogates for the abundance of parasites feeding in the lakes during the previous year. Estimates of individual spawning runs in trappable streams are used to estimate lake-wide abundance using a new regression model that relates run size to stream characteristics (Mullett *et al.* 2003). Sea lamprey spend one year in the lake after metamorphosing, so this indicator has a two-year lag in demonstrating the effects of control efforts.

Status of Sea Lamprey

Annual lake-wide estimates of sea lamprey abundance since 1980, with 95% confidence intervals, are presented in Figure 1. The FCO targets and ranges also are included for each lake.

Lake Superior

During the past 20 years, populations have fluctuated but remain at levels less than 10% of peak abundance (Heinrich *et al. 2003*). Abundances were within the FCO target range during the late 1980s and mid-1990s. Abundances have trended upward from a

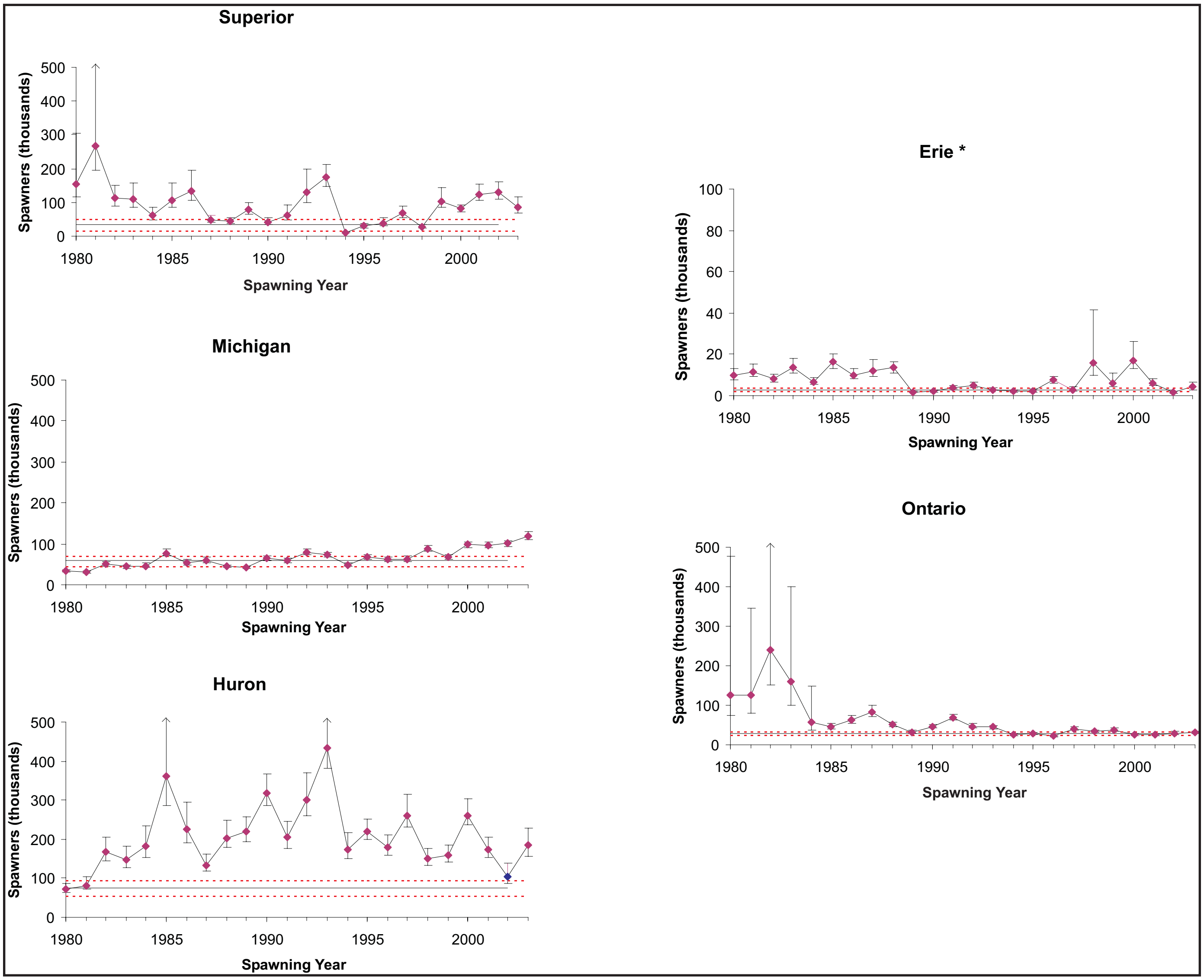

Figure 1. Total abundance of sea lampreys estimated during the spawning migration. Solid line and dashed line represent FCO target abundance and ranges, respectively.

*Note: the scale for Lake Erie is 1/5 that of the other four Lakes.

Source: Great Lakes Fishery Commission

low during 1994 and have been above the target range from 1999 through 2003. These recent increases in abundance have raised concern in all waters. Rates of sea lamprey markings on fish have shown the same pattern of increase. These increases appear to be most dramatic in the Nipigon Bay and north-western portion of the lake and in the Whitefish Bay area in the south-eastern portion of the lake. Survival objectives for lake trout continue to be met but lake trout populations could be threatened if these increases continue. In response to this increased abundance of sea lampreys, stream treatments with lampricides were increased beginning in 2001 through 2004. The effects of the increased treatments during 2001 may have contributed to the downward trend in the 2003 observation. The effects of additional stream treatments in 2002 and beyond will be observed in the spawning-run estimates during 2004 and following years.

Lake Michigan

The population of sea lamprey has shown a continuing, slow trend upward since 1980 (Lavis *et al.* 2003). The population was at or below the FCO target range until 2000. The marking rates on lake trout have shown the same upward trend past target levels during the recent years. Increases in abundance during the 1990s had been attributed to the St. Marys River. The continuing trend in recent years suggests sources of sea lamprey in Lake Michigan itself. Stream treatments were increased beginning in 2001 through 2004. This increase included treatment of newly discovered populations in lentic areas and treatment of the Manistique River, a large system where the deterioration of a dam near the mouth allowed sea lamprey access to nursery habitat. The 2003 spawning-phase population estimate did not show any decrease as a result of the increased treatments during 2001.

Lake Huron

The first full round of stream treatments during the late 1960s suppressed sea lamprey populations to levels less than 10% of those before control (Morse *et al.* 2003). During the early 1980s, abundance increased in Lake Huron, particularly the northern portion of the lake, peaking in 1993. Through the 1990s there were more sea lampreys in Lake Huron than all the other lakes combined. FCOs were not being achieved. The damage caused by this large population of parasites was so severe that the Lake Huron Committee abandoned its lake trout restoration objective in the northern portion of the lake during 1995. The St. Marys River was identified as the source of the increasing sea lamprey population. The size of this connecting channel made traditional treatment with the lampricide TFM impractical. A new integrated control strategy, including targeted application of a new formulation of a bottom-release lampricide, enhanced trapping of spawning animals, and sterile-male release, was initiated in 1997 (Schleen *et al.* 2003). As predicted, the spawningphase abundance has been significantly lower since 2001 as a result of the completion of the first full round of lampricide spot treatments during 1999. However, the population shows considerable variation and it increased during 2003. Wounding rates and mortality estimates for lake trout have also declined during the last three years. The full effect of the St. Marys River control program will not be observed for another 2 to 4 years (Adams *et al.* 2003). The GLFC has repeated lampricide treatments in limited areas with high densities of larvae during 2003 and 2004. These additional treatments are aimed at continuing the decline in sea lamprey in Lake Huron.

Lake Erie

Following the completion of the first full round of stream treatments in 1987, sea lamprey populations collapsed (Sullivan *et al.* 2003). Marking rates on lake trout declined and lake trout survival increased to levels sufficient to meet the rehabilitation objectives in the eastern basin. However, during the mid-1990s, sea lamprey abundance increased to levels that threatened the lake trout restoration effort. A major assessment effort during 1998 indicated that the source of this increase was several streams in which treatments had been deferred due to low water flows or concerns for non-target organisms. These critical streams were treated during 1999 and 2000. Sea lamprey abundance was observed to decline to target levels in 2001 through 2003. Wounding rates on lake trout have also declined.

Lake Ontario

Abundance of spawning-phase sea lamprey has shown a continuing declining trend since the early 1980s (Larson *et al.* 2003). The abundance of sea lamprey has remained stable in the FCO target range during 2000-2003.

Pressures

Since parasitic-phase sea lamprey are at the top of the aquatic food chain and inflict high mortality on large piscivores, population control is essential for healthy fish communities. Increasing abundance in Lake Erie demonstrates how short lapses in control can result in rapid increases in abundance and that continued effective stream treatments are necessary to overcome the reproductive potential of this invading species. The potential for sea lamprey to colonize new locations is increased with improved water quality and removal of dams. For example, the loss of integrity of the dam on the Manistique River, and subsequent production from this river, has contributed to the increase in sea lamprey abundance in Lake Michigan. Any areas newly infested with sea lamprey will require some form of control to attain target abundance levels in the lakes.

As fish communities recover from the effects of sea lamprey predation or over-fishing, there is evidence that the survival of parasitic sea lamprey may increase due to prey availability. Better survival means that there will be more residual sea lamprey to cause harm. Significant additional control efforts, like those on the St. Marys River, may be necessary to maintain suppression.

The GLFC has a goal of reducing reliance on lampricides and increasing efforts to integrate other control techniques, such as the sterile-male-release technique or the installation of barriers to stop the upstream migration of adults. Pheromones that affect migration and mating have been discovered and offer exciting potential as new alternative controls. The use of alternative controls is consistent with sound practices of integrated pest management, but can put additional pressures on the ecosystem such as limiting the passage of fish upstream of barriers. Care must be taken in applying new alternatives or in reducing lampricide use to not allow sea lamprey abundance to increase.

Management Implications

The GLFC has increased stream treatments and lampricide applications in response to increasing abundances during 2001 through 2004. The GLFC has targeted these additional treatments to maximize progress toward FCO targets. The GLFC continues to focus on research and development of alternative control strategies. Computer models, driven by empirical data, are being used to best allocate treatment resources, and research is being conducted to better understand and manage the variability in sea lamprey populations.

Comments from the author(s)

Targeted increases in lampricide treatments are predicted to reduce sea lamprey abundance to acceptable levels. The effects of increased treatments will be observed in this indicator two years after they occur. Discrepancies among estimates of different life-history stages need to be resolved. Efforts to identify all sources of sea lamprey need to continue. In addition, research to better understand lamprey/prey interactions, the population dynamics of sea lamprey that survive control actions, and refinement of alternative control methods are all key to maintaining sea lamprey at tolerable levels.

Acknowledgments

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