

**A Fisheries Management Implementation Strategy for the  
Rehabilitation of Lake Trout in Lake Michigan**

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## Introduction

Lake trout rehabilitation efforts have been occurring on Lake Michigan since the early 1960s (Holey et al. 1995). There has not been however any significant survival of wild lake trout past age-1. Prior to development of this Fisheries Management Implementation Strategy (Strategy), the Lake Michigan Lake Trout Task Group provided a critical review of possible impediments, broadly described as: poor survival of early-life stages, a lake-wide population of lake trout that is too low, and spawning aggregations that are too diffuse and in inappropriate locations (Bronte et al 2003). While much has been learned about this extirpated species in the past 5 decades, the goal of a self-sustaining population in Lake Michigan has remained elusive.

This Strategy is a fusion of recommendations in *A Guide for the Rehabilitation of Lake trout in Lake Michigan* (Bronte et al. 2008, referred to throughout as the "Guide"), fishery expectations set forth in the Fish Community Objectives (FCOs) for Lake Michigan (Eschenroder et al 1995a), management principles of *A Joint Strategic Plan for Management of Great Lakes Fisheries* (1997), and constituent considerations. As a historically important native species, great emphasis has been placed on rehabilitation of lake trout by all management agencies on Lake Michigan and the federal government. The reader is referred to the Guide for in-depth information on all parts of the lake-wide rehabilitation strategy.

Management agencies are responsible for providing recreational and commercial harvest opportunities while attempting to maintain, protect, and restore the sustainability of the fish community and ecology of Lake Michigan. Within the FCOs, the Salmon and Trout Objective for Lake Michigan is to:

*Establish a diverse Salmonine community capable of sustaining an annual harvest of 2.7 to 6.8 million Kg (6 to 15 million pounds), of which 20-25% is lake trout. Establish a self-sustaining lake trout population.*

Rehabilitation of lake trout in Lake Michigan while maintaining populations of other species throughout the Great Lakes will continue to be a challenging undertaking due to direct (e.g., predation) and indirect (e.g., changes in forage) impacts of exotic species and the inherent ecological instability they bring. The successful achievement of lake trout rehabilitation through the Strategy set forth in this document is a vital step to achieve the FCOs.

## Fisheries Management Goal

The process of fishery management includes not only concerns about the biology of fish and their habitats, but also economics, user attitudes and desires, and the interest of the general public (Krueger and Decker 1993). Consequently, these aspects need to be incorporated into management and regulatory actions which are intended to achieve established goals and objectives provided in this Strategy. The most effective management strategies are those conducive to observation and measurement, thereby strengthening future decision-making processes.

In the development of this Strategy, the LMC drew from technical recommendations provided in the Guide to advance lake trout rehabilitation within a realistic time frame. Some options presented in the Guide were deemed not possible or unsuitable to implement in the immediate future due to budgetary and socio-political constraints. Rehabilitation efforts in this Strategy are focused in prioritized areas to maximize the potential for targeted rehabilitation, and to advance our understanding of major biological impediments. "Lake-wide" rehabilitation may be pursued in the future based on the results of efforts in these prioritized areas, and when agencies might be better positioned to address other non-biological constraints.

The LMC has established the following interim rehabilitation goal:

*Reestablish in targeted high-priority areas and refuges of Lake Michigan a diversity of primarily lean lake trout populations predominately supported by natural reproduction that provide sustainable yields to recreational, commercial, and subsistence fisheries.*

This interim rehabilitation goal differs from the Guide in that it utilizes primarily lean strains, whereas the rehabilitation goal in the Guide is broader and recommends the use of lake trout strains that include morphotypes believed to be better suited to the deep water habitats of Lake Michigan. As discussed above, the LMC believes a step-wise approach to implementing recommendations in the Guide will receive broader support from participating agencies and publics, and ultimately prove more successful in advancing rehabilitation in Lake Michigan.

### **Key Aspects of the Implementation Strategy**

The following aspects represent groupings of technical recommendations found in the Guide. In some instances it was agreed that Guide recommendations should be fully implemented. For others, the LMC adopted specific recommendations, chose not to implement others, or altered some recommendations to balance fisheries management considerations with the biological basis of the Guide's recommendations. The reader should reference the Guide for additional background on the recommendations addressed in the sections below.

#### *Stocking - locations and numbers*

The number and location of stocking sites for rehabilitation are pared down from those recommended in the Guide to concentrate available hatchery fish in the areas believed to be most conducive for successful lake trout reproduction. First priority stocking areas include the northern refuge, mid-lake refuge, and Julian's reef. These areas were historically important for lake trout reproduction, and some afford some protection from fishing mortality. First priority stocking sites within or immediately adjacent to these areas are more heavily weighted to the rehabilitation effort but may provide for fishing opportunities due to movements of lake trout. Stocking of Inner and Outer Fox Trench along with MM-2 is deferred to allow for full Guide level recommended stocking rates and strain comparison objectives in the other first priority areas. Second priority sites are geared toward providing local fishing opportunities, as well as supplying fish for the rehabilitation effort. Second priority stocking locations in this Strategy include sites selected from the Guide's second and third priority stocking locations.

#### *Stocking - Strains*

Three strains will comprise the majority of fish stocked in the immediate future: Seneca; Lewis Lake; and Apostle Island. These strains were selected based on information gained through strain survival studies conducted over the past several years (Bronte et al. 2007), and constituency preference for lean forms of lake trout. The Seneca strain has demonstrated greater resiliency to lamprey induced mortality (Madenjian et al. 2004) and may colonize deep-water sites (Royce 1951). The Lewis Lake strain has an historic genetic link to Lake Michigan, and has demonstrated acceptable survival in Lake Michigan. The Apostle Island strain of Lake Superior appears particularly well suited to the shallow water reefs in the northern portion of Lake Michigan but is not performing as well as expected. This strain however is currently a significant portion of the Federal lake trout inventory.

The Klondike strain, recommended for stocking in the Guide, and under development in Federal hatcheries, is a moderately lean trout that inhabits deep-water reefs. Based in part on the preliminary positive results from stocking Klondike strain fish in Lake Erie, the LMC agrees that a limited stocking to test the success of this strain in Lake Michigan should be attempted in the near future, specifically in the Mid-Lake Refuge. Future consideration will also be given to the Parry Sound (Lake Huron) strain, a

remnant native Lake Huron lean strain that inhabits shallow waters. This strain will be used as a replacement for the Apostle Island strain in the Northern Refuge, as it has already shown good success in Lake Huron. Stocking requests for the Parry Sound strain will need to be made in concert with the Lake Huron Committee's existing request.

Siscowet lake trout are believed to have been historically present in Lake Michigan and an integral component of the native lake trout population; this form may be the best adapted to deep-water, offshore reefs. This form however is generally not preferred by commercial interests and has little support among the sport angling community due to its relatively high fat content. Lacking constituency support, the LMC has decided to defer use of this strain, and instead, concentrate near-term rehabilitation efforts on lean forms.

### *Stocking - Life stages*

The cornerstone of the stocking components of the rehabilitation effort will continue to be yearling lake trout. Fall fingerlings will be used primarily to foster sport fisheries and to study survival compared to yearlings in a few shore locations. Lake trout fry, which have not been utilized in the past, can be stocked at three locations to assess their efficacy in building adult populations, provided an adequate marking and evaluation protocol is developed. Egg stockings, which are labor-intensive and difficult to assess, were attempted under the 1985 Plan. No egg-stage stocking is included in this Strategy. The transfer of adults from other Great Lakes populations is not included because of disease concerns and costs.

### *Hatchery criteria*

All Guide level recommendations and actions are to be implemented.

### *Numbers of lake trout*

The maximum number of stocked lake trout is reduced in this Strategy, compared to the 1985 plan (6.7 million yearling fish), and is also less than the number recommended in the Guide. This Strategy prescribes 3.31 million yearlings and 550,000 fall fingerlings (3.53 million yearling equivalents) to meet rehabilitation needs in priority rehabilitation areas and continue to support fisheries lakewide. The Implementation Strategy is unprecedented compared to all previous stocking strategies in that it applies nearly 2/3 of all stocked lake trout primarily for rehabilitation efforts. The remaining hatchery-produced fish will be stocked in secondary rehabilitation zones to support local fishing opportunities as well as rehabilitation efforts. This judicious use of a limited number of stocked lake trout for fisheries will insure that the majority of hatchery produced fish are prioritized for rehabilitation purposes. If the LMC determines that future reductions in Lake Michigan predator stockings are necessary to maintain an appropriate or desired range of predator-prey ratios, reductions in predator stocking may include lake trout.

### *Timing and method of distribution*

All Guide level recommendations and actions are to be implemented, except those for adult lake trout.

### *Diversification of lake trout diet*

The Guide level recommendation for investigating strategies to restore or enhance lake herring is compatible with all established management plans.

### *Mortality controls*

Of the three sources of mortality (sea lamprey, harvest, and natural), sea lamprey and harvest represent the two most controllable sources. Lake trout mortality associated with sea lamprey predation remains one of the most serious impediments to rebuilding adult lake trout stocks throughout Lake Michigan. Increased efforts to reduce sea lamprey-induced mortality rates on lake trout to designated target levels as proposed by the Great Lakes Fishery Commission, and agreed upon by the LMC, are imperative for long-term success of lake trout rehabilitation in Lake Michigan. In order to help reduce sea lamprey-induced mortality, the LMC supports increased use of the Seneca strain lake trout. In Lake Huron (Eshenroder et al. 1995b, Madenjian et al. 2004) and Lake Ontario (Elrod et al. 1995, Schneider et al. 1996), this strain has been shown to be less affected by sea lamprey than other strains, perhaps due to its preference for deeper water habitats (Bergstedt et al. 2003).

One proactive strategy to reestablish an extirpated species could be to dedicate all available hatchery fish to the rehabilitation goal and provide lake trout complete protection from exploitation until self-sustaining stocks are established. Harvest alone, however, is not the only impediment and may not be the most important impediment to rehabilitation. Because recreational and commercial fisheries for lake trout provide important cultural activities for both state and tribal fishers the LMC has recognized and incorporated societal needs for harvest opportunities within this Strategy. In order to insure adequate progress is made toward the rehabilitation effort, agencies are encouraged to adopt and improve upon regulations for lake trout which promote reduced fishing mortality to achieve target mortality (exploitation) rates.

## **Strategy Actions**

### *Stocking*

- Lakewide salmonine predator stockings should be held to 2006 “baseline” levels, plus/minus 10% (6.1 million Chinook salmon equivalents), unless the LMC achieves consensus to go above this level. The LMC agrees that any increased predator stockings above the targeted 2006 baseline stocking targets (by species) will be allocated to lake trout until the lake trout maximum target is reached (3.31 million yearling and 550,000 fall fingerling lake trout annually for a total of 3.53 million yearling equivalents).
- Annual lake trout stocking will be initially limited to 2.74 million yearling equivalents plus or minus 10% unless consensus is achieved by the LMC to increase this number. The decision to increase above 2.74 million yearling equivalents will be based upon the Federal hatchery production and the consensus of the LMC utilizing decision support tools and information.
  - The USFWS expects full production capabilities by 2014 (3.53 million yearling equivalents).
  - A combination of the Salmonid Work Groups’ annual Red Flag analysis and any other new information useful for decision making will be employed by the LMC annually to evaluate predator stocking levels. The LMC shall make a decision regarding salmonine stocking levels annually at the fall Council of the Lakes Committee meeting.
- Stock priority rehabilitation sites in MM-3, WM-5, and Julian’s Reef at levels above Guide recommendations for those locations. East Beaver and the Charlevoix Group stocking locations will be stocked at rates of 25% and 50% higher, respectively, than Guide level recommendations for all three recommended strains. This adaptive stocking strategy will provide for immediate opportunities to study two enhanced stocking rates to overcome impediments in areas that lake trout studies and assessments are actively occurring. This Strategy utilizes the least number of fish while maintaining use of three strains.

- Stocking strategies for first priority areas (Tables 1 and 2) will be maintained in the event that hatchery inventories are less than the recommended maximum Strategy level.
  - Inventories which are expected to result in over 2.16 million yearlings, in order of priority, will be allocated to: 1) 40,000 yearlings to Indiana, 2) 50,000 fall fingerlings to Indiana, provide 510,000 fall fingerlings to Second Priority locations (Table 3), and then 4) the remainder of yearlings should be proportionately distributed among the other Second Priority locations, excluding Indiana (Table 3).
  - In the event inventories of yearling lake trout fall below 2.16 million fish, only First priority locations will be stocked, except that Wisconsin may re-allocate up to 100,000 yearlings from Wisconsin jurisdictional First Priority locations to Second Priority locations. Necessary reductions will come from reducing East Beaver and Charlevoix group stocking locations proportionally (Table 2), and proportionally thereafter.
  - Annual fall fingerling inventories below 550,000 fish will fulfill Indiana stocking requirements first and then be applied proportionately to all designated sites except study locations (tagged fish) which will receive the designated amount.
  - East Reef stocking allocations are deferred until the LMC reaches consensus to restart this site.

Table 1. Stocking instructions per given available inventory.

Available Hatchery Production	First Priority Sites	Second Priority Sites
2.16 – 3.31 million yearlings	Full stocking rate (2.16 million yearlings)	Priorities: 1) Stock 40,000 fish in IN  2) Distribute remaining fish over 2.21 million yearlings among jurisdictions in proportion to yearling stocking targets shown in Table 3 (excluding IN).
2.16 million yearlings	Full stocking rate (2.16 million yearlings)	No fish stocked
Below 2.16 million yearlings	Consult with the Lake Michigan Committee, Higher rates in East Beaver and Charlevoix Groups reduced proportionately initially	No fish stocked
550,000 fall fingerlings	None	Full stocking rates
Less than 550,000 fingerlings	None	Priorities: 1) Stock 50,000 fingerlings in IN  2) Distribute remainder of available fish among jurisdictions in proportion to fingerling stocking targets shown in Table 3 (excluding IN), except any study locations will receive its full stocking rate

- Mark all stocked fish, and support evaluation of experimental stocking efforts. Support mass marking initiative to allow for distinct marking of all lake trout stocked.
- Stock 200,000 yearling lake trout of the Klondike strain in the Mid-Lake Refuge when available in replacement of Seneca Lake strain and evaluate.
- Stock up to 480,000 yearling lake trout of the Parry Sound strain in the Northern Refuge when available in replacement of Apostle Island strain and evaluate.
- Stock sac fry (6.3 million in MM3 and MM4 per Guide recommended sites)

Hog Island	MM3	Fry	ON	2 mill
Dahlia Shoal	MM3	Fry	ON	4 mill
Ingalls Point	MM4	Fry	ON	300,000

Table 2. Prescribed stocking numbers for Lake trout yearlings in *First Priority areas*.  
 LLW = Lewis Lake; SLW = Seneca Lake; SAW = Apostle Islands<sup>1</sup>

<b>Northern Lake Michigan</b>							
	<b>Location</b>	<b>STATD</b>	<b>Stage</b>	<b>LLW</b>	<b>SLW</b>	<b>SAW</b>	<b>TOTAL</b>
<b>Annual Stocking</b>							
	West Beaver (Gull, Trout, Boulder, High island)	MM3	YR	160,000	160,000	160,000	480,000
	East Beaver complex (Hog, Dahlia, Ill Aux Galets)	MM3	YR	200,000	200,000	200,000	600,000
	Charlevoix Group (Irishman's, Big Reef, Fishermen's and Middle Ground)	MM3	YR	120,000	120,000	120,000	360,000
<b>Subtotal Northern Lake Michigan</b>				<b>480,000</b>	<b>480,000</b>	<b>480,000</b>	<b>1,440,000</b>
<b>Mid-Lake Michigan<sup>2</sup></b>							
	<b>Location</b>	<b>STATD</b>	<b>Stage</b>	<b>LLW</b>	<b>SLW</b>	<b>SAW</b>	<b>TOTAL</b>
<b>Annual Stocking</b>							
	Sheboygan Reef	WM5	YR	-	200,000	-	200,000
	Northeast Reef	WM5	YR	-	200,000	-	200,000
	Milwaukee Reef	WM5	YR	-	200,000	-	200,000
	East Reef (when approved)	WM5	YR	-	200,000	-	200,000
	Julian's Reef	IL	YR	60,000	60,000	-	120,000
<b>Subtotal Mid Lake Michigan (excluding East Reef)</b>				<b>60,000</b>	<b>660,000</b>	<b>0</b>	<b>720,000</b>
<b>Total-all First Priority areas (excluding East Reef)</b>				<b>540,000</b>	<b>1,140,000</b>	<b>480,000</b>	<b>2,160,000</b>

<sup>1</sup>Apostle Island strain will be replaced with Parry Sound strain when available for the Northern Refuge locations.

<sup>2</sup>Seneca Lake strain will be replaced with Klondike strain at one agreed upon WM5 location when this strain becomes available.



Table 3. Prescribed annual stocking levels for lake trout fall fingerlings and yearlings in *Second Priority areas*. Distribution shown below is subject to availability of lake trout yearlings from federal hatcheries. Indiana stocking locations will be filled first. Michigan and Wisconsin stocking allocations will be determined proportionately to availability. Site specific allocations will be determined annually by Michigan and Wisconsin in consultation with the USFWS prior to stocking whenever full allocations are not available. However, if Michigan's allocation is insufficient to stock all Second Priority areas within Michigan waters, MM-4 and MM-5 will be stocked first at target levels, or as otherwise agreed to by Michigan and CORA. SLW = Seneca Lake; SAW = Apostle Island; LLW = Lewis Lake

<b>Location</b>	<b>Jurisdiction</b>	<b>Statistical District</b>	<b>Stage</b>	<b>LLW</b>	<b>SLW or SAW</b>	<b>TOTAL</b>
Grand Haven	Michigan	MM7	FF		50,000	
Saugatuck		MM8	FF		100,000	
New Buffalo		MM8	FF		100,000	
Michigan City	Indiana	Indiana	FF		50,000	
Wind Point	Wisconsin	WM6	FF		50,000	
Manitowoc		WM4	FF		100,000	
Kewaunee		WM4	FF		100,000	
Elk Rapids	Michigan	MM4	YR	100,000		
Torch Lake		MM4	YR	100,000		
GTB Shoal		MM4	YR	60,000		
Old Mission		MM4	YR	80,000		
Good Harbor		MM5	YR		100,000	
Pointe Betsie		MM5	YR		100,000	
Manistee		MM6	YR		60,000	
Ludington		MM6	YR		80,000	
Grand Haven		MM7	YR		20,000	
Holland		MM8	YR		40,000	
New Buffalo		MM8	YR		20,000	
Michigan City	Indiana	Indiana	YR		40,000	
Sturgeon Bay	Wisconsin	WM3	YR		80,000	
Kewaunee		WM4	YR		20,000	
Wind Point		WM6	YR		50,000	
Annual Total			YR	340,000	610,000	950,000
			FF		550,000	550,000
yearling equivalents (@0.4 yr/ff)						1,170,000

## *Regulations*

- Promote angler retention of smaller, younger lake trout and release of larger, older lake trout.
- Adjust local harvest regulations if appropriate when mortality rates exceed target levels.

## *Studies*

- Compare survival and movement of stocked fall fingerlings and yearlings at nearshore locations, using coded wire tags.
- Continue long-term strain and reef evaluation at the West and East Beaver reef groups, the Charlevoix group, Sheboygan, Northeast, East, and Milwaukee Reefs.
- Compare enhanced stocking rates at the West and East Beaver reef groups, and the Charlevoix group.
- Experiment with stocking spring fry at densities >500 per m<sup>2</sup> at specified reef locations (Table 3) upon LMC agreement of an appropriate marking protocol and evaluation.
- Investigate lake trout diets to provide data for predator-prey models, and potential vectors for thiamine deficiency syndrome.

## **Evaluation**

### *Evaluation Objectives*

Strictly defined evaluation objectives for lakewide rehabilitation can be found in the Guide. The objectives listed below are established as interim targets in order to assess progress toward targeted rehabilitation based on the Strategy.

1. Increase the average catch-per-unit-effort (CPUE) to >25 lake trout/1000 feet of graded mesh gill net (2.5-6.0 inch) over-night set lifted during spring stock assessments pursuant to the lakewide assessment in MM-3, WM-5, and at Julian's Reef by 2019.
2. Increase the abundance of adults to a minimum catch-per-effort of >50 fish/1000 ft of graded large-mesh (4.5-6.0 inch) gill net fished on spawning reefs in MM-3, WM-5, and at Julian's Reef by 2019.
3. Significant progress should be achieved towards attaining spawning populations that are at least 25% females and contain 10 or more age groups older than age-7 in first priority areas stocked prior to 2007. These milestones should be achieved by 2032 in areas stocked after 2008.
4. Detect a minimum density of 500 viable eggs/m<sup>2</sup> (eggs with thiamine concentrations of >4 nmol/g) in previously stocked first priority areas. This milestone should be achieved by 2025 in newly stocked areas.

Annual progress reports from the Lake Michigan Lake Trout Working Group will be provided in March of each year. Progress reports will be structured to determine progress toward meeting the Evaluation Objectives set forth in this Strategy. The report should identify whether objectives have been met and provide any possible reasons for success or failure. A complete evaluation of the entire Strategy should be completed by the Lake Michigan Technical Committee and reported to the LMC by April 15, 2020.

## **Strategy Revision**

The LMC will conduct a comprehensive review of the Strategy evaluation provided by the Lake Michigan Technical Committee. By October 1, 2020, the LMC shall adopt a new or revised Strategy. Interim (prior to 2020) modifications to the Strategy may be implemented, by consensus of the LMC, if circumstances warrant such modifications. Any modifications to the Strategy will be documented by the LMC.

Approved by the Lake Michigan Committee, January 2011



Steven R. Robillard, Chair

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