# 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 (Eschenroeder et al 1995a), management principles of the Joint Strategic Plan for Management of 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 also, 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 in the immediate future or inappropriate due to budgetary and socio-political constraints. Rehabilitation efforts will be focused in prioritized areas to maximize the potential for targeted rehabilitation initially, and to advance our understanding of major biological impediments. “Lake-wide” rehabilitation will 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 lean lake trout populations predominately supported by natural reproduction that provide sustainable yields to recreational, commercial, and subsistence fisheries.*

This rehabilitation goal differs from the Guide in that it utilizes only lean strains, recognizing other factors recognized by agencies managing the multi-species fishery of Lake Michigan. The Guide goal is broader and recommends the use of lake trout strains that include morphotypes better suited to deep water habitats.

## 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, in an effort 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 for 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 for rehabilitation: 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.

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. Future consideration should also be given to the Parry Sound (Lake Huron) strain, a remnant native Lake Huron lean strain that inhabits shallow waters. 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. As such, Siscowets could potentially have less impact than lean lake trout on forage available to other salmonids in the fish community. 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 forego any potential rehabilitation success that may be derived from this strain, and instead, rely on lean forms which might not be as physiologically suited to the cold deep-water areas.

### *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, will be stocked at three locations to assess their efficacy in building adult populations, provided an adequate marking and evaluation protocol is developed. Egg stocking, which is labor-intensive and difficult to assess, was 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 also less than the number recommended in the Guide. This Strategy prescribes 3.31 million yearlings and 550,000 fall fingerlings to meet rehabilitation needs in priority rehabilitation areas and continue to support fisheries lakewide. The Implementation Strategy is unprecedented compared to all previous stocking efforts in applying nearly 2/3 of all stocked lake trout primarily for rehabilitation efforts and only 1/3 of stocked fish to primarily support local fishing opportunities and secondary rehabilitation sites. The judicious use of a limited number of stocked lake trout for fisheries will insure that significant forward movement toward rehabilitation occurs, and that the maintenance of other naturalized species (salmonids) important to current management efforts under the FCOs and Joint Strategic Plan are continued. 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 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 important and 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 is 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 be not 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, within this strategy, incorporated societal needs for harvest opportunities. 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 further maintain low angling mortality.

## Strategy Actions

*Stocking*

- Stock a maximum of 3.31 million yearling and 550,000 fall fingerling lake trout annually.
- Increase stocking on priority rehabilitation sites in MM-3, WM-5, and at Julian's Reef.
    - East Beaver and the Charlevoix Group stocking locations will be stocked at 25 and 50% higher rates 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 all three strains.
- Stocking strategies for first priority areas (Table 1 and 2) will be maintained in the event that hatchery inventories are less than the recommended maximum Strategy levels. If inventories are less than these levels, the following adjustments to stocking strategies will be applied:
    - Inventories over 2.36 million yearlings will be applied proportionately to all secondary areas (Table 3) up to 3.31 million fish.
    - In the event inventories of yearling lake trout fall below 2.36 million fish, but not less than 2.12 million, only first priority locations will be stocked. Necessary reductions will come from reducing East Beaver and Charlevoix group stocking locations proportionally. (Table 3). This will maintain all first priority areas at minimum Guide level recommendations for stocking densities and in support of evaluation studies. Distribution of inventories below 2.12 million fish will need approval from the LMC.
    - Annual fall fingerling inventories below 550,000 fish will be applied proportionately to all designated sites except study locations (tagged fish) which will receive the designated amount.

Table 1. Stocking instructions per given available inventory.

| Table 1. | | |
|---|---|---|
| | | |
| **Available Hatchery Production** | **First Priority Sites** | **Second Priority Sites** |
| 2.36 – 3.31 million yearlings | Full stocking rate | Distribute remaining fish available after stocking First Priority sites equally |
| | | |
| 2.12 – 2.36 million yearlings | Higher rates in East Beaver and Charlevoix Groups reduced proportionately | No fish stocked |
| | | |
| Below 2.12 million yearlings | Consult with the Lake Michigan Committee | Consult with the Lake Michigan Committee |
| | | |
| 550,000 fall fingerlings | None | Full stocking rates |
| | | |
| Less than 550,000 fingerlings | None | Stock proportionately to all sites except any study locations will receive full stocking rate |

- Stock 200,000 yearlings annually at East Reef (WM-5) beginning in 2012.
- 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 a limited number of the Klondike strain at a single location in the near future and evaluate this strain.
- Stock a limited number of the Parry Sound strain in the future and evaluate this strain.
- 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

**Northern Lake Michigan**

| Location | STATD | Stage | On/off reef | LLW | SLW | SAW | TOTAL |
|---|---|---|---|---|---|---|---|
| **Annual Stocking** | | | | | | | |
| West Beaver (Gull, Trout, Boulder, High island) | MM3 | YR | ON | 80,000 | 80,000 | 80,000 | 240,000 |
| | | YR | OFF | 80,000 | 80,000 | 80,000 | 240,000 |
| East Beaver complex (Hog, Dahlia, Ill Aux Galets) | MM3 | YR | ON | 100,000 | 100,000 | 100,000 | 300,000 |
| | | YR | OFF | 100,000 | 100,000 | 100,000 | 300,000 |
| Charlevoix Group (Irishmans, Big Reef, Fishermens and Middle Ground) | MM3 | YR | ON | 60,000 | 60,000 | 60,000 | 180,000 |
| | | YR | OFF | 60,000 | 60,000 | 60,000 | 180,000 |
| **Subtotal Northern Lake Michigan** | | | | **480,000** | **480,000** | **480,000** | **1,440,000** |

**Mid-Lake Michigan**

| Location | STATD | Stage | On/off reef | LLW | SLW | SAW | TOTAL |
|---|---|---|---|---|---|---|---|
| **Annual Stocking** | | | | | | | |
| Sheboygan Reef | WM5 | YR | ON | - | 100,000 | - | 100,000 |
| | | YR | OFF | - | 100,000 | - | 100,000 |
| Northeast Reef | WM5 | YR | ON | - | 100,000 | - | 100,000 |
| | | YR | OFF | - | 100,000 | - | 100,000 |
| Milwaukee Reef | WM5 | YR | ON | - | 100,000 | - | 100,000 |
| | | YR | OFF | - | 100,000 | - | 100,000 |
| East Reef (Begin 2012) | WM5 | YR | ON | - | 100,000 | - | 100,000 |
| | | YR | OFF | - | 100,000 | - | 100,000 |
| Julians Reef | IL | YR | ON | 30,000 | 30,000 | - | 60,000 |
| | | YR | OFF | 30,000 | 30,000 | - | 60,000 |
| **Subtotal Mid Lake Michigan (2008-2011, excluding E. Reef)** | | | | **60,000** | **660,000** | **0** | **720,000** |
| **Subtotal Mid Lake Michigan (2012, including East Reef)** | | | | **0** | **860,000** | **0** | **920,000** |
| **Total-all First Priority areas** | | | | **540,000** | **1,140,000** | **480,000** | **2,160,000** |

| | | | | |
|---|---|---|---|---|
| **(2008-2011, excluding East Reef)** | | | | |
| **Total – all First Priority areas (2012, including East Reef)** | **540,000** | **1,340,000** | **480,000** | **2,360,000** |

**Table 3. Prescribed stocking levels for lake trout yearlings in *Second Priority areas*. Distribution shown below is subject to availability of lake trout yearlings from federal hatcheries.**

SLW = Seneca Lake; SAW = Apostle Island; LLW = Lewis Lake

| | | | | | STRAIN | | |
|---|---|---|---|---|---|---|---|
| Stocking Frequency | Jurisdiction | Statistical District | Stocking sites | Age | LLW | LLW, SLW, or SAW | |
| Annually | Michigan | MM4 | Elk Rapids | yearlings | 100,000 | -- | |
| | | | Torch Lake | yearlings | 100,000 | -- | |
| | | | GTB Shoal | yearlings | 60,000 | -- | |
| | | | Old Mission | yearlings | 80,000 | -- | |
| | | | | | | | |
| | | MM5 | Good Harbor | yearlings | -- | 100,000 | |
| | | | Point Betsie | yearlings | -- | 100,000 | |
| | | | | | | | |
| | | MM6 | Manistee | yearlings | -- | 60,000 | |
| | | | Ludington | yearlings | -- | 80,000 | |
| | | | | | | | |
| | | MM7 | Grand Haven | yearlings | -- | 20,000 | |
| | | | | | | | |
| | | MM8 | Saugatuck | yearlings | -- | 40,000 | |
| | | | New Buffalo | yearlings | -- | 20,000 | |
| | | | | | | | |
| | Indiana | Indiana | Michigan City | yearlings | -- | 40,000 | |
| | | | | FF | -- | 50,000 | |
| | | | | | | | |
| | Wisconsin | WM3 | Sturgeon Bay | yearlings | -- | 80,000 | |
| | | WM4 | Kewaunee | yearlings | -- | 20,000 | |
| | | WM6 | Wind Point. | yearlings | -- | 50,000 | |
| | | | | | | | |
| | Michigan | MM7 | Grand Haven | FF | -- | 50,000 | |
| | | MM8 | Saugatuck | FF | -- | 100,000 | |
| | | MM8 | New Buffalo | FF | -- | 100,000 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Wisconsin | WM6 | Wind Point | FF | -- | 50,000 | |
| | | WM4 | Manitowoc | FF | -- | 100,000 | |
| | | WM4 | Kewaunee | FF | -- | 100,000 | TOTAL |
| | | | Annual Total | Yearlings | 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 near shore locations, using coded wire tags.
- Continue long-term strain and reef evaluation at the West and East Beaver reef groups, the Charlevoix group, Sheboygan, North East, East and Milwaukee Reefs.
- Compare enhanced stocking rates at the West and East Beaver reef groups, and the Charlevoix group.
- Compare strain survival of “on reef” vs. “off reef” stockings at the West and East Beaver reef groups, the Charlevoix group, Sheboygan, North East, East, Milwaukee and Julian's Reefs.
- Experiment with stocking spring fry at densities >500 per $m^2$ 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.

## 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 2015.
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 2020.
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/$m^2$ (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 objectives, whether objectives have been met, and provide any possible reasons for success or failure. If objective one is not met by the specified year, the LMC must reach consensus on adoption of any future stocking strategy. A complete evaluation of the entire Strategy should be completed by the Lake Michigan Technical Committee/Lake Michigan Lake Trout Working Group and reported to the LMC by December 2019.

## Strategy Revision

The LMC will conduct a comprehensive review of the Strategy evaluation provided by the Lake Trout Working Group. By April 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 XX/XX/XXXX

Stuart T. Shipman: Chair

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