Lake Michigan Rehabilitation Strategy Review

A report to the Lake Michigan Committee in response to the charge to evaluate the Lake Trout Implementation Strategy

Prepared by:

Charles Madenjian	Chair; U.S. Geological Survey, Ann Arbor, MI
Charles Bronte	U.S. Fish and Wildlife Service, New Franken, WI
Kevin Donner	Little Traverse Bay Bands of Odawa Indians, Harbor Springs, MI
Jory Jonas	Michigan Department of Natural Resources, Charlevoix, MI
Matt Kornis	U.S. Fish and Wildlife Service, New Franken, WI
Steve Lenart	Michigan Department of Natural Resources, Charlevoix, MI
Laura Schmidt	Wisconsin Department of Natural Resources, Milwaukee, WI
Ted Treska	U.S. Fish and Wildlife Service, New Franken, WI

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The lake trout (*Salvelinus namaycush*) rehabilitation effort on Lake Michigan began shortly after populations crashed in the mid-1950s and it has continued uninterrupted through the present. Since 2011, rehabilitation has been directed by *A Fisheries Management Implementation Strategy for the Rehabilitation of Lake Trout in Lake Michigan* (Implementation Strategy) (Dexter et al. 2011). Success has been elusive for much of the rehabilitation period on Lake Michigan. However, recent observations of increased lake trout abundance and natural recruitment in several regions of the lake provide positive feedback that the management recommendations and studies contained in the Implementation Strategy are beginning to work.

Included in the Implementation Strategy is a recommendation for evaluation of the complete plan by the Lake Michigan Technical Committee (LMTC) by April 15, 2020. According to the Implementation Strategy, the evaluation provided by the LMTC then will be reviewed by the Lake Michigan (LMC) and used to help guide the Committee's decision to retain the existing Implementation Strategy or adopt a new or revised one by October of the same year.

The LMC requested that the LMTC oversee an evaluation of the Implementation Strategy and provide a written report to the LMC by the April 15, 2020 deadline. Considerations for the evaluation include:
1. Addressing the four evaluation objectives outlined on page 9 of the Implementation Strategy,
2. A status update for the five studies included in the Implementation Strategy (also on page 9),
3. LMTC recommendations about next steps/revision for the Implementation Strategy (e.g., regarding continuation/conclusion of studies, additional data needs, changes in priority stocking sites, changes in stocking densities and guidelines for reducing the rate of stocking related to increasing natural recruitment),
4. Lake trout egg thiamine is included in the Implementation Strategy's Evaluation Objectives and Studies sections and should be part of the evaluation report, and
5. The LMC encourages the LMTC to adhere to the proposed deadline. However, if you foresee issues or impediments in adhering to the deadline, please communicate those with the LMC.

In the following pages, each of these five considerations will be covered. We are attaching the 2019 Lake Michigan Lake Trout Working Group Report to this report, because this report covers Consideration 1. We represent a subgroup of the Lake Michigan Lake Trout Working Group (LTWG), and we have been tasked by the LMTC to prepare this evaluation. Our evaluation has been vetted through the LMTC, as the preliminary results of our evaluation were presented at both the winter 2020 meeting of the LMTC on January 23, 2020 in Michigan City, Indiana, and at the summer 2020 virtual meeting of the LMTC on July 22, 2020.

Consideration 1. Addressing the four evaluation objectives outlined on page 9 of the Implementation Strategy.

Each year, the LTWG prepares an annual report on the progress of lake trout rehabilitation in Lake Michigan. All four evaluation objectives are addressed in detail in each annual report. A brief summary is provided below; please see the attached copy of the 2019 Lake Michigan Lake Trout Working Group Report (LTWG 2020) for more details. Briefly:

(1) Evaluation Objective 1. Increase the average catch-per-unit-effort (CPUE) to ≥ 25 lake trout per 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. This objective was achieved in the Southern Refuge in 2018 and 2019 (25 and 34.5 fish per 1000 feet, respectively). However, this objective has not been achieved at all other locations during 2010-2019. CPUE ranged from 5 to 20 fish per 1000 feet in 2019 at these other locations.

(2) Evaluation Objective 2. Increase the abundance of adults to a minimum catch-per-effort of 50 fish per 1000 feet of graded mesh gill net (4.5-6.0 inch) fished on spawning reefs in MM-3, WM-5, and at Julian's Reef by 2019. This objective was met at all three locations during 2017-2019. At WM-5 and Julian's Reef, this objective was achieved in most years during 1998-2019.

(3) Evaluation Objective 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. Since 1998, the percentage of females captured during the fall spawner surveys has generally exceeded the 25% benchmark at most sites, on an overall average basis. However, spawner age distributions in MM-3, MM-4, MM-6, and WM-3 did not meet the abovementioned age group criterion in 2019. In the past, the age group criterion has been met in MM-6.

(4) Evaluation Objective 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. Egg deposition rates have remained well below the target of 500 eggs/m^2 at four northern sites throughout the time series. In general, egg thiamine levels have increased during 1998-2018, with egg thiamine concentration exceeding 4 nmol/g at most locations and in most years since 2009. In some years, egg thiamine concentrations substantially varied between locations within the lake.

Consideration 2. A status update for the five studies included in the Implementation Strategy.

The five studies specified in the Implementation Strategy include:

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

Status update on Study 1 (Compare survival and movement of stocked fall fingerlings and yearlings at nearshore locations, using coded wire tags)

Based on coded wire tag recoveries from the recreational fishery during 2012-2018 for lake trout stocked in southeastern Lake Michigan (MM-7, MM-8, and Indiana), mean recovery rate of fall fingerling lake trout was 22.1 (± 10.2) recoveries per 100,000 fish stocked. This region was the only area of Lake Michigan where stocking location of fall fingerlings could be controlled for, as other tag lots of fall fingerlings were stocked throughout the lake. In contrast, mean recovery rate of spring yearling lake trout was 65.9 (± 19.4) recoveries per 100,000 fish stocked. The ratio of mean spring yearling recovery rate to mean fall fingerling recovery rate was equal to 3.0. This ratio represents an estimator of the ratio of spring yearling survival to fall fingerling survival. Thus, 1 spring yearling = 3.0 fall fingerlings. Our estimate for Lake Michigan lake trout is similar to the estimate for Lake Ontario lake trout. Elrod et al. (1988) estimated that, in terms of survival, 1 spring yearling was equal to 2.4 fall fingerlings for Lake Ontario lake trout. Pycha and King (1967) documented even poorer survival of fall fingerlings relative to spring yearling survival for Lake Superior lake trout, as 1 spring yearling was the equivalent of 3.9 to 6.7 fall fingerlings in Lake Superior.

Lake Michigan lake trout movement studies have been conducted by U. S. Fish and Wildlife Service (USFWS) researchers. Movement matrices have been developed, and a USFWS station report with movement matrices is attached to this evaluation. Movement of fall fingerlings appeared to be consistent with movement of yearlings, based on the available data. Of the 58 recoveries of fall fingerlings stocked in MM-7, MM-8, and Indiana waters, 54 of these fish (93%) were recovered in MM-7, MM-8, and Indiana waters (Kornis et al. 2020a). Similarly, 68 to 97% of yearling lake trout were recovered in their stocking unit or an adjacent statistical district, depending on tag lot and stocking location. See Kornis et al. (2020a) for details.

Status update on Study 2 (Continue long-term strain and reef evaluation in northern Lake Michigan at the West and East Beaver reef groups and the Charlevoix group, and in southern Lake Michigan at Sheboygan, Northeast, East, and Milwaukee Reefs)

Jory Jonas has led the effort to report to the LMC on the performances of the various lake trout strains stocked into Lake Michigan. This evaluation includes a region-by-region analysis. The main findings of this report include:

- Seneca Lake and Lewis Lake strain fish had the highest contributions to lake trout catch in surveys and fisheries.
- Seneca Lake strain contributed to wild recruitment at a greater rate than expected based on number stocked; Lewis Lake strain contributed to wild recruitment about as much as would be expected; and Green Lake and Lake Superior lean strain (i.e., Marquette, Apostle Islands, and Isle Royale strains) contributions to wild recruitment were less than expected.
- More years of observation are required to assess the contributions of Lake Superior Klondike (humper) and Parry Sound strains to wild recruitment.
- Lake Superior Klondike (humper) strain fish had high rates of return, but very low dispersal relative to other strains; Lewis Lake strain fish had slightly higher dispersal rates than other strains.
- The primary management recommendation was to continue to stock and maintain the Lewis Lake and Seneca Lake strains of lake trout.

• A secondary recommendation was that further evaluation of the Lake Superior Klondike (humper) strain is warranted, given this strain's unique ecological and genetic attributes.
The report was submitted to the LMC in August 2020; please see this report for more details. The two remaining tasks of the strain evaluation subgroup include a summary of future research needs, data gaps, and information needs, as well as a synthesis of potential forces and changes that may have led to natural reproduction by lake trout in Lake Michigan; these tasks should be completed by summer 2021.

Status update on Study 3 (Compare enhanced stocking rates at the West and East Beaver reef groups, and the Charlevoix group)
During 2010-2019, annual stocking rate of lake trout into MM-3 of Lake Michigan averaged 1.468 million yearlings per year (Fig. 1). Reefs stocked in MM-3 included those in the Charlevoix group (Fisherman's Island, Big Reef, Irishman's Ground, and Middle Ground), East Beaver Island group (Hog Island Reef, Ile aux Galets, Dahlia Shoal, and Inner Fox Trench), and West Beaver Island group (Boulder Reef, Gull Island Reef, Trout Island Shoal, and High Island). Annual stocking rates during 2010-2019 in the Charlevoix group, East Beaver Island group, and West Beaver Island group averaged 0.393, 0.553, and 0.522 million yearlings per year, respectively (Fig. 1). The overall stocking rate target for MM-3 during 2010-2019 of 1.44 million yearlings per year, as prescribed by Dexter et al. (2011), was successfully attained.

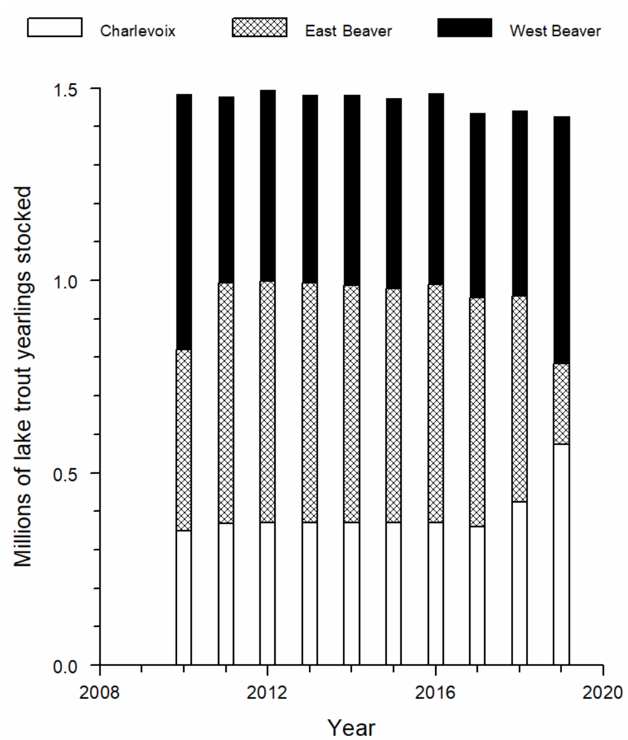

Fig. 1. Annual stocking rate of yearling lake trout into MM-3 of Lake Michigan, 2010-2019.

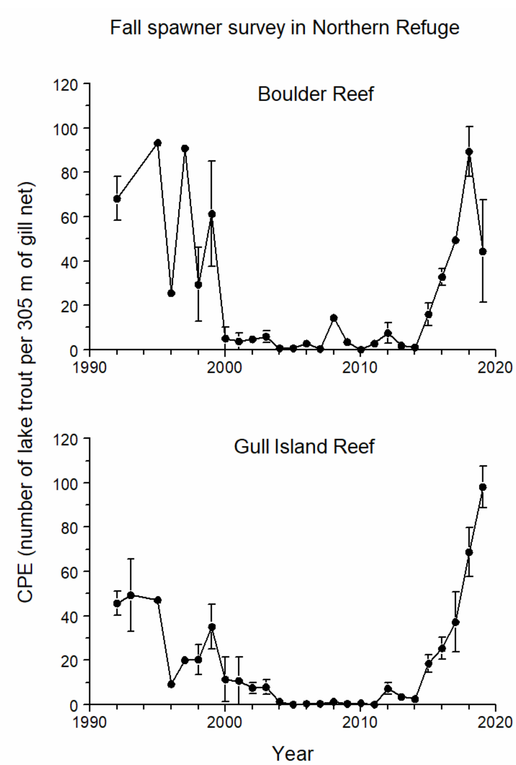

Fig. 2. Catch per effort (CPE) of lake trout in the Northern Refuge of Lake Michigan, 1992-2019, based on fall spawner survey.

Enhanced stocking rates within the Northern Refuge and neighboring offshore areas, beginning in 2010, combined with a concomitant reduction in adult lake trout annual mortality rate from > 60% to < 50% (Modeling Subcommittee of the Technical Fisheries Committee 2019), led to a dramatic increase in the abundance of lake trout spawners in the Northern Refuge of Lake Michigan during 2014-2019 (Fig. 2). Annual stocking rate of yearling lake trout into the Northern Refuge and adjacent offshore areas roughly doubled between the 1995-2009 and 2010-2019 periods. Madenjian and Desorcie (2010) attributed the 10-fold decline in spawner lake trout abundance in the Northern Refuge between the 1991-1999 and 2000-2008 periods to a 45% decrease in stocking rate beginning in 1995. These researchers further predicted that a doubling of the stocking rate would lead to a greater than 10-fold increase in spawner lake trout abundance in the Northern Refuge. Consistent with that prediction, spawner lake trout abundance in the Northern Refuge increased by more than 10-fold between the 2000-2014 period and 2019 (Fig. 2). These results are consistent with the hypothesis that predation by burbot (*Lota lota*) on newly stocked lake trout plays an important role in regulating adult lake trout abundance in the Northern Refuge. If so, then stocking rate must be sufficiently high to "swamp the predators" so that a reasonably high abundance of spawner lake trout on these offshore reefs in northern Lake Michigan can be attained. Kornis et al. (2019) also noted that relatively high mortality on adult lake trout from fishing and sea lamprey (*Petromyzon marinus*) contributed to low survival of adult lake trout from the 1994-2003 year-classes in northern Lake Michigan; therefore, the reduction in mortality during 2010-2017, as illustrated in Fig. 3, also contributed to the observed increase in abundance of mature lake trout. Note that the drop in total annual mortality between 2014 and 2015 in Fig. 3 was partly due to increased recruitment to the lake trout population of ages 6-11 that was brought about by the abovementioned lake trout stocking rate increase.

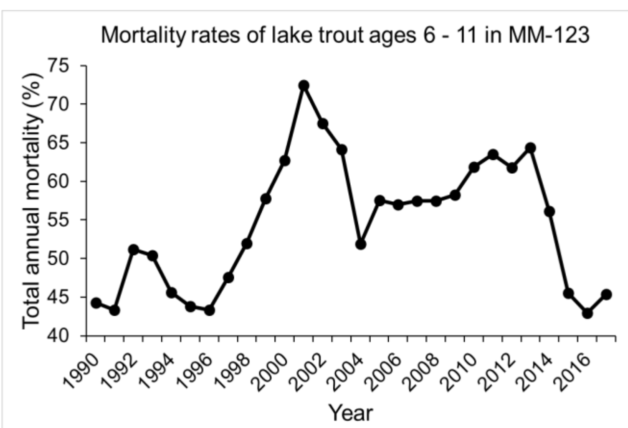

Fig 3. Estimated total annual mortality of lake trout ages 6-11, by year, in MM-123 from 1990 to 2017. Data provided by the Modeling Subcommittee of the Technical Fisheries Committee (2018).

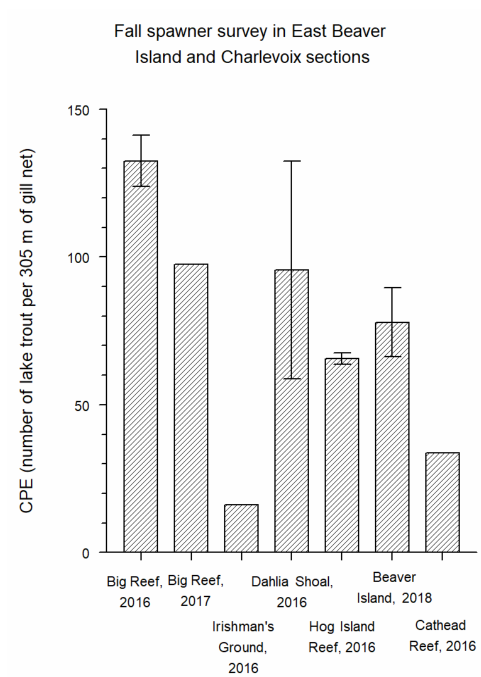

Fig. 4. Catch per effort (CPE) of spawner lake trout on reefs in East Beaver Island and Charlevoix groups, 2016-2018.

We would expect the abundance of adult lake trout in the Northern Refuge to undergo a drastic decrease if stocking rate in the Northern Refuge and its neighboring offshore waters were to be substantially reduced, unless natural reproduction by lake trout in the Northern Refuge were to surge.

Enhanced stocking in MM-3 also led to relatively high abundances of spawner lake trout on reefs in the East Beaver Island and Charlevoix groups (Fig. 4). CPE of spawner lake trout during fall 2016 exceeded 130 fish per 305 m of gill net on Big Reef and approached 100 fish per 305 m of gill net at Dahlia Shoal. Spawner lake trout abundances exceeded 50 fish per 305 m of gill net at Hog Island Reef and Beaver Island. During 2005-2014, spawner lake trout abundances on reefs in the East Beaver Island and Charlevoix groups were well below 5 fish per 305 m of gill net. Thus, the enhanced lake trout stocking rates, accompanied by reduced adult mortality, had a profound effect on spawner lake trout abundances in these sections of the lake.

Status update on Study 4 (Experiment with stocking spring fry at densities > 500 per m^2 at specified reef locations upon LMC agreement of an appropriate marking protocol and evaluation)

No experiments with stocking spring fry at densities > 500 per m^2 at specified reef locations have been performed. No such experiments are being planned for the near future.

Status update on Study 5 (Investigate lake trout diets to provide data for predator-prey models, and potential vectors for thiamine deficiency syndrome)

Three journal articles have recently been published on Lake Michigan lake trout diet composition, based on examination of stomach contents, and results from all three studies indicate alewives (*Alosa pseudoharengus*) predominate the diet of subadult and adult lake trout in Lake Michigan (Happel et al. 2018; Luo et al. 2019; Leonhardt et al. 2020). Happel et al. (2018) evaluated diet composition of lake trout captured in the 2011 lakewide spring gillnet survey. Although results suggested some regional variation, alewives were the dominant prey in most regions and, on average, represented roughly 65% of the subadult and adult lake trout diet in Lake Michigan in 2011. Luo et al. (2019) documented a seasonal shift from a spring diet consisting primarily of round gobies (*Neogobius melanostomus*) to a diet of mainly alewives during the summer and fall in northeastern Lake Michigan during 2016. Averaging across the seasons of spring, summer, and fall, alewives represented 61%, by wet weight, of lake trout diet, while round gobies accounted for 32% of the diet. Moreover, Luo et al. (2019) concluded that for a given season, diet composition did not significantly differ between gillnet-caught lake trout and lake trout caught by recreational anglers. Based on sampling both angler-caught and gillnet-caught lake trout from all regions of the lake during spring, summer, and fall of 2015 and 2016, Leonhardt et al. (2020) estimated that, on average, 54% of the diet was alewives and 31% of the diet was round gobies. However, the spring samples were given undue weight in computing theses averages. If equal weighting was given across all three seasons, alewives would represent between 60% and 70% of the lake trout diet (B. Leonhardt, U.S. Geological Survey, personal communication). Results from a recent stable isotope study indicated that although alewives constituted the bulk of the diet for all species of Lake Michigan salmonines, diet overlap between lake trout and Pacific salmonine species was sufficiently low such that competition for food between lake trout and Pacific salmonines was not apparent (Kornis et al. 2020b). An ongoing diet study led by Brian Roth (Michigan State University) began in 2017 and is now funded by the Great Lakes Fishery Trust. Stomachs of both angler-caught and gillnet-caught lake trout from all regions of Lake Michigan during the spring, summer, and fall months are examined by researchers at Michigan State University, and results are compiled into an electronic database. Preliminary findings from this ongoing study have thus far been consistent with results from the Luo et al. (2019) and Leonhardt et al. (2020) studies.

Alewives can interfere with natural reproduction by lake trout in two ways (Madenjian et al. 2008). First, alewives have been shown to feed on lake trout fry (Krueger et al. 1995). Second, a diet rich in alewives can lead to thiamine deficiency complex (TDC) in lake trout (Fitzsimons et al. 1999; Ladago et al. 2016). A low level of thiamine, the B1 vitamin, in adult female lake trout leads to a low level of thiamine passed on to lake trout eggs. If the thiamine concentration in lake trout eggs is sufficiently low, a proportion of the eggs may not hatch. Further, the survival of the lake trout fry that successfully hatch may be impaired, although Ladago et al. (2016) showed that early feeding by lake trout fry can quickly restore thiamine concentration in the fry to an adequate level.

Consideration 3. LMTC recommendations about next steps/revision for the Implementation Strategy.

Given that lake trout populations have been restored in Lake Superior and nearly restored in Lake Huron (Hansen 1999; Johnson et al. 2015), comparisons between Lake Michigan and Lakes Superior and Huron may be useful in gauging progress toward lake trout restoration in Lake Michigan. Lake trout stocking density in northern Lake Michigan exceeded 2 yearling equivalents per hectare of habitable area during 2010-2018 (Fig. 5). Here, habitable area is defined as surface area of the lake corresponding with bottom depth ≤ 80 m deep. Lake trout

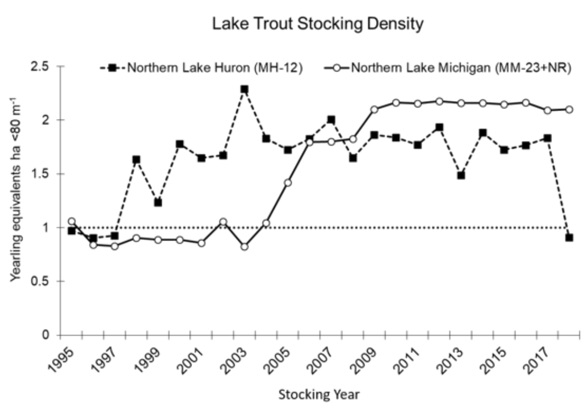

Fig. 5. Lake trout stocking density in northern Lake Huron and northern Lake Michigan, 1995-2018.

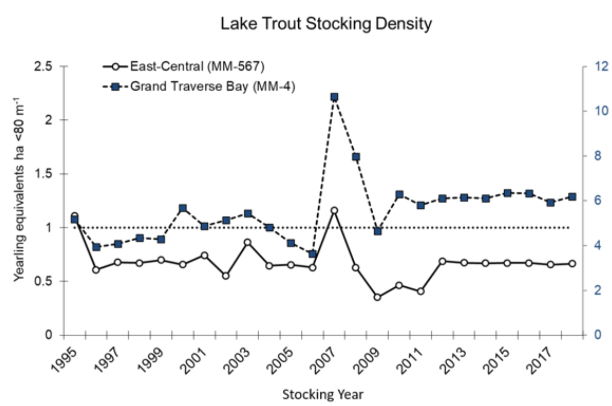

Fig. 6. Lake trout stocking density in east-central Lake Michigan and Grand Traverse Bay, 1995-2018. Left y-axis is for east-central Lake Michigan, and right y-axis is for Grand Traverse Bay.

stocking density in northern Lake Huron was greater than 1.5 yearling equivalents per hectare of habitable area in most years during 1995-2018. Lake trout stocking density in Grand Traverse

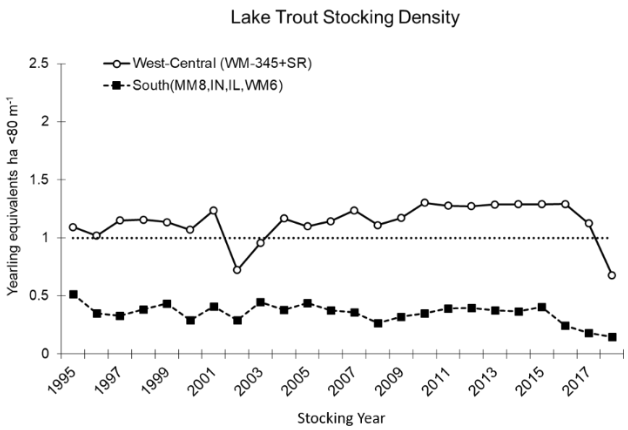

Fig. 7. Lake trout stocking density in west-central and southern Lake Michigan, 1995-2018.

Bay (MM-4) averaged about 6 yearling equivalents per hectare of habitable area during 1995-2018 (Fig. 6). In east-central Lake Michigan, west-central Lake Michigan, and southern Lake Michigan, lake trout stocking densities during 2006-2018 were well below those in northern Lake Michigan (Figs. 5-7). Adult survival and wild recruitment are both higher in southern and western areas of Lake Michigan than in northeastern Lake Michigan (Kornis et al. 2019; LTWG 2020).

Biomass density of female spawner lake trout in Lake Superior exceeded a value of 0.5 kg per hectare of habitable area during 1995-2018 (Fig. 8). Similarly, female spawner lake trout

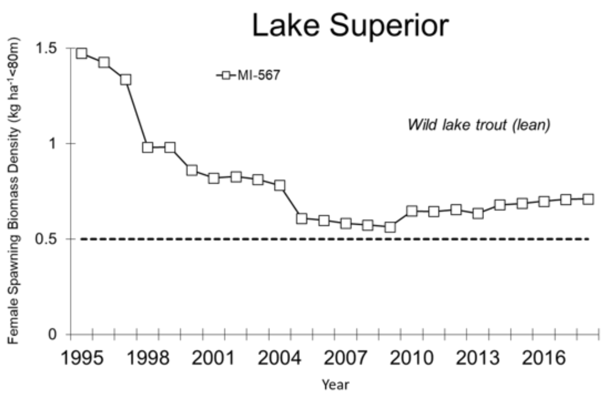

Fig. 8. Biomass density of female spawner lake trout in Lake Superior, 1995-2018.

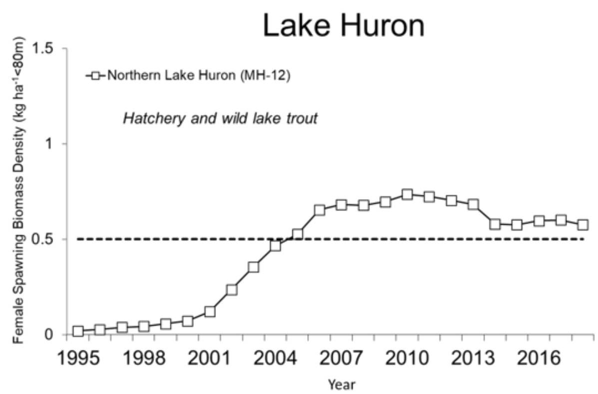

Fig. 9. Biomass density of female spawner lake trout in northern Lake Huron, 1995-2018.

biomass density in northern Lake Huron was greater than 0.5 kg per hectare of habitable area during 2005-2018 (Fig. 9). Biomass density of female spawner lake trout in Grand Traverse Bay of Lake Michigan exceeded 0.5 kg per hectare of habitable area in most years during 1995-2018 (Fig. 10). In east-central Lake Michigan, biomass density of female spawner lake trout was equal to 0.5 kg per hectare of habitable area in 2017 and 2018. Female spawner lake trout biomass density in northeastern Lake Michigan tripled during 2012-2018 as it has trended toward the 0.5 kg per hectare of habitable area benchmark (Fig. 10). Biomass estimates were generated from statistical catch at age (SCA) models fit to lake trout catch and effort data (Modeling Subcommittee of the Technical Fisheries Committee 2019).

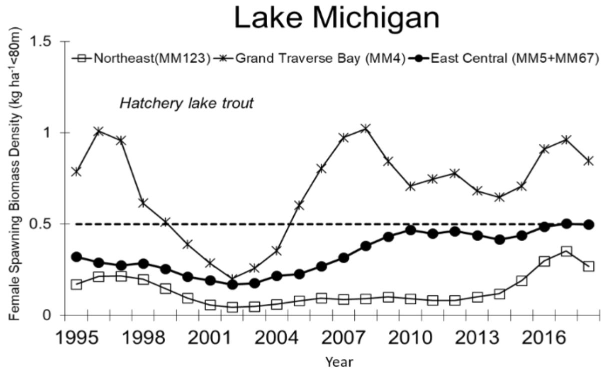

Fig. 10. Biomass density of female spawner lake trout in three regions of Lake Michigan, 1995-2018.

CPE of age-7 lake trout per million fish stocked in northern Lake Huron averaged over the 1990-2002 year-classes approached a value of 2 fish per 1000 feet of gill net per million fish stocked (Fig. 11). Similarly, CPE of age-7 lake trout per million fish stocked in east-central Lake Michigan averaged over the 2001-2011 year-classes approached a value of 2 fish per 1000 feet of gill net per million fish stocked (Fig. 12). In contrast, mean CPE of age-7 lake trout per million fish stocked in Grand Traverse Bay over the 2000-2011 year-classes exceeded a value of 4 fish per 1000 feet of gill net per million fish stocked. We acknowledge that some caution should be exercised in comparing Grand Traverse Bay with other areas, due to the relatively high vulnerability to capture and relatively high stocking density in Grand Traverse Bay. CPE of age-7 lake trout per million fish stocked in northeastern Lake Michigan increased about 10-fold between the 2008 and 2011 year-classes (Fig. 12). This increase corresponded with the substantial increase in lake trout stocking rate and a decline in adult lake trout mortality rate in northeastern Lake Michigan, further corroborating the contention that stocking rate must be

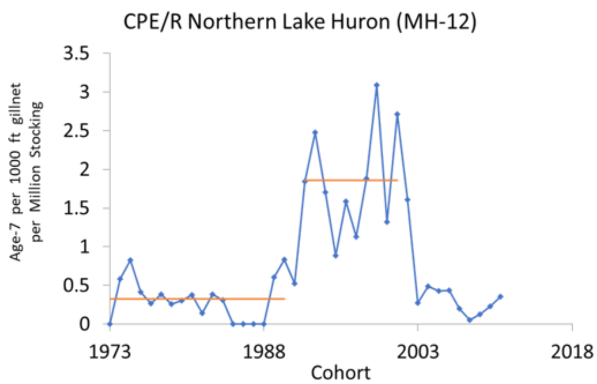

Fig. 11. Catch per effort (CPE) of age-7 lake trout per million fish stocked in northern Lake Huron for 1973-2011 year-classes. Graph provided by Ji He, Michigan Department of Natural Resources.

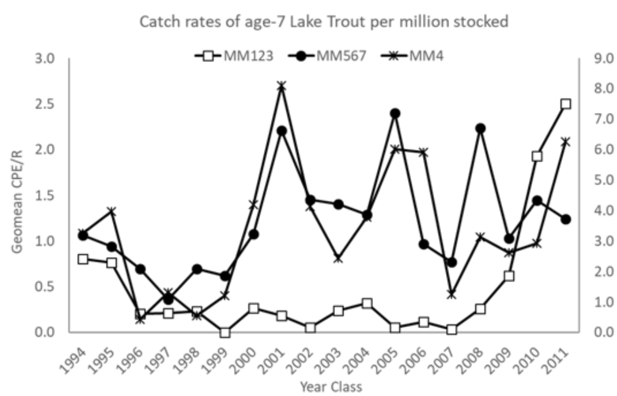

Fig. 12. Catch per effort (CPE) of age-7 lake trout per million fish stocked in three regions of Lake Michigan for 1994-2011 year-classes. Left y-axis is for northeastern and east-central Lake Michigan, and right y-axis is for Grand Traverse Bay.

sufficiently high and mortality rate sufficiently low to attain relatively high spawner abundance in this area of Lake Michigan. CPE of age-7 lake trout per million fish stocked for the 2011 year-class in northeastern Lake Michigan was equal to 2.5 fish per 1000 feet of gill net per million fish stocked (Fig. 12).

Because lake trout stocking rate appears to have a strong effect on lake trout spawner density in the Northern Refuge, we recommend that the stocking rate in the Northern Refuge and neighboring offshore areas be maintained, and that a sufficiently low mortality rate is targeted, to promote sustained levels of lake trout spawner density similar to or greater than those observed during recent years. Based on the long-term temporal trends observed in the Northern Refuge (Fig. 2), a reduction in stocking rate can result in a disproportionately greater reduction in lake trout spawner density in the Northern Refuge of Lake Michigan (Madenjian and Desorcie 2010). Maintaining relatively low adult annual mortality rates (< 50%) is also important in maintaining high spawner abundance and in facilitating a buildup of multiple cohorts of older-aged spawners. The adult lake trout population in the Northern Refuge is still relatively young compared with most other areas of Lake Michigan and Lake Huron. To date, natural reproduction by lake trout in the Northern Refuge has been minimal (Madenjian and Desorcie 2010; LTWG 2020). Thus, maintaining the high stocking rate and a relatively low adult annual mortality rate are critical to maintaining the relatively high lake trout spawner density and promoting natural reproduction by the adult lake trout population.

One additional data need is to re-estimate lake trout energy density in Lake Michigan so that more accurate estimates of lake trout growth conversion efficiencies (GCEs) can be generated. In turn, these new estimates of GCEs can be used to improve the accuracy of predictions by the Lake Michigan predator-prey model, which is used to guide management decisions for the salmonine fisheries of Lake Michigan (Tsehaye et al. 2014). Energy densities of lake trout from Lake Michigan have not been determined since the early 1970s (Stewart et al. 1983). Energy density of lake trout is a required input for lake trout bioenergetics modeling, which is the tool used to estimate GCEs for lake trout. Given the profound changes in the Lake Michigan food web during the past 50 years (Madenjian et al. 2002, 2015; Bunnell et al. 2018), re-estimation of lake trout energy density is certainly warranted. A new regression relationship of lake trout energy density as a function of lake trout weight will need to be developed. Lake trout over a wide range of sizes will need to be sampled, and whole-fish homogenates prepared for caloric analysis. Optimally, samples from all regions of the lake should be used in developing this regression relationship.

Consideration 4. Lake trout egg thiamine is included in the Implementation Strategy's Evaluation Objectives and Studies sections and should be part of the evaluation report.
At most locations in Lake Michigan, mean thiamine concentration in eggs of lake trout has increased during 1996-2018, with thiamine concentrations well exceeding the threshold level of 4 nmol/g by the late 2000s (LTWG 2020). Thiamine concentrations below this level are associated with elevated risk of egg and larval mortality. At two locations in Lake Michigan, namely Milwaukee and Waukegan, egg thiamine concentrations declined from the early 2000s to 2018, with thiamine concentration near the threshold level of 4 nmol/g in 2018.

Don Tillitt, a research toxicologist at the U. S. Geological Survey Columbia Environmental Research Center, is now in-charge of determining thiamine concentrations in eggs of lake trout from Lake Michigan. He plans on providing the egg thiamine concentration data to the LTWG in a timely manner during the upcoming years.

Consideration 5. The LMC encourages the LMTC to adhere to the proposed deadline. Completion of this evaluation report was delayed due to complications brought about by the COVID-19 epidemic.

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