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Lake Huron Salmon and Trout Management Plan: The Beginning of a New Era

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Introduction

The fisheries of the Great Lakes experience extensive fluctuations of both collapse and expansion. These changes have been described as having distinct periods for salmon and trout populations. First, the *indigenous* period was categorized as the pre-1850s, followed by a *transitional* period after 1850 and into the 1960s. These two periods describe the fish community changes from endemic fish stocks that were once abundant and stable, but then transitioned into rapid changes or declines from human-induced impacts (Kocik and Jones 1999; Claramunt et al. 2013). The apotheosis of the *transitional* period is characterized by a combination of underregulated fishing and invasive species introductions and expansion, most notably the Sea Lamprey *Petromyzon marinus* during the 1930s through the 1950s. The *transitional* period resulted in a complete disruption of the food web combined with the decline or extinction of many native fishes and the near collapse of the entire Great Lakes fishery (Smith 1968; Wells and McLain 1972; Keller et al. 1990).

In Lake Huron, the *transitional* period meant the loss of the native fish predators, most notably Lake Trout *Salvelinus namaycush*, followed by an expansion of invasive prey fishes, including Rainbow Smelt *Osmerus mordax* and Alewives *Alosa pseudoharengus*. Sea Lamprey control in the Great Lakes started in Lake Huron toward the end of the *transitional* period. The program was initiated because of concerns from fishers and natural resource agencies, which led to increased study of the Sea Lamprey life history and the development of tools to diminish their recruitment (Applegate and Smith 1951). Basin-wide control of Sea Lamprey in Lake Huron was fully initiated in 1970, and the control program had an immediate impact on the fisheries, with approximately 85% reduction in Sea Lamprey numbers (Morse et al. 2003).

Concurrent with the basin-wide control of Sea Lampreys, large-scale stocking of predators in Lake Huron was initiated to develop a valuable fishery (Tody and Tanner 2002) while simultaneously addressing the adverse ecological and economic effects of invasive prey fishes (Krueger et al. 1995). The stakeholder and management agency's response to these changes marks the beginning of a period that is defined as the *rebuilding* period for Lake Huron in this plan. During this period, which included the late 1960s through the 1980s, fisheries management embraced aggressive actions to promote the *rebuilding* of the Lake Huron fishery. In addition to Sea Lamprey control, intensive stocking of salmon and trout were made annually.

In 1968, Lake Huron was stocked with Brown Trout *Salmo trutta* (45,000), Chinook Salmon *Oncorhynchus tshawytscha* (265,000), Coho Salmon *Oncorhynchus kisutch* (402,000), and Steelhead *Oncorhynchus mykiss* (70,000) for a total stocking of nearly 800,000 predators into the Michigan waters of Lake Huron (Figure 1). Lake Trout were added to the stocking plan in 1972, increasing the total predator stocking level to 1.31 million. In 1973, the total increased to 3.97 million and peaked at 8.44 million in 1986 (Figure 1). The increased stocking of predators during the *rebuilding* period was intended to restore the Lake Huron fishery while simultaneously providing opportunities for recovery of native predators such as Lake Trout and Walleye *Sander vitreus*.

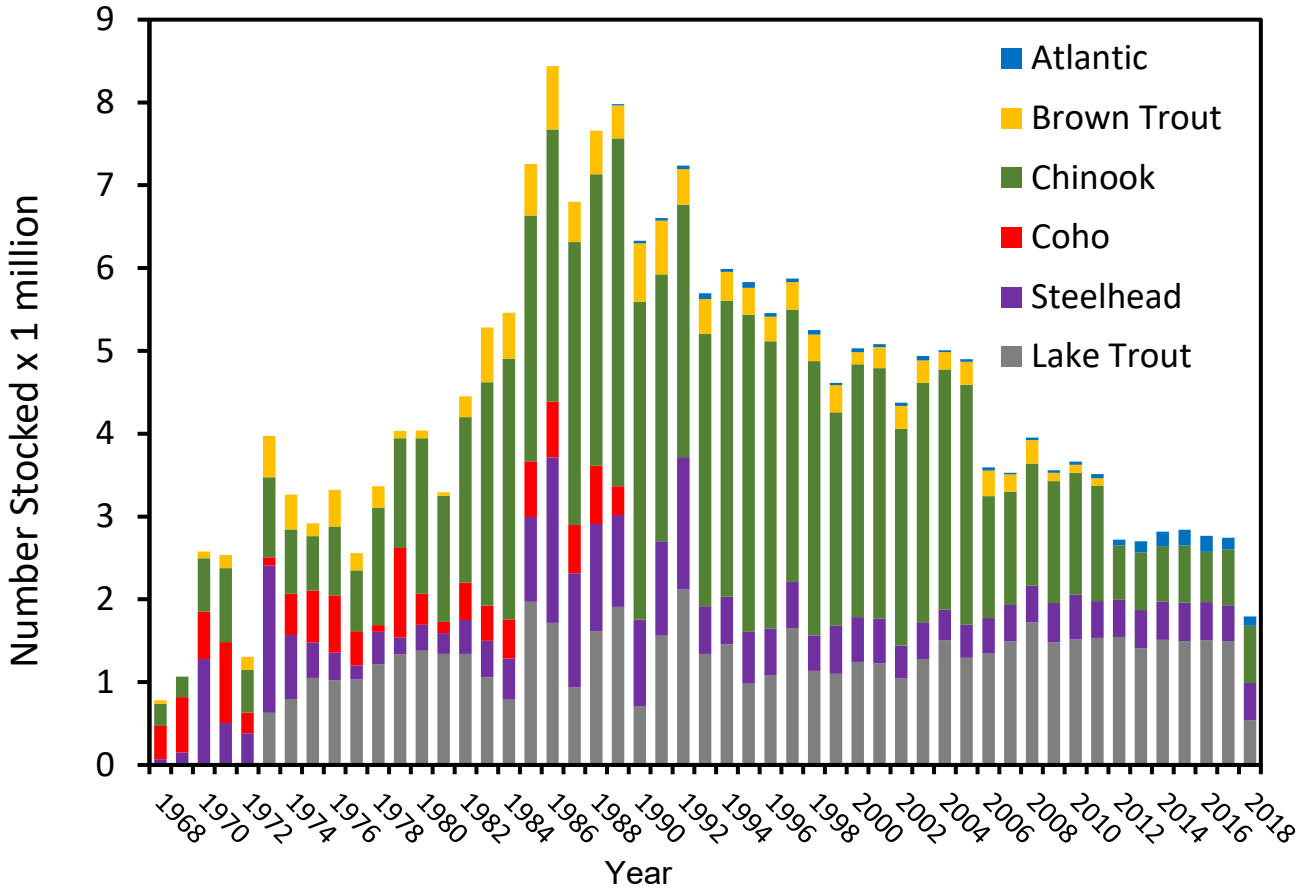

FIGURE 1. Salmonine stocking history (numbers of fish) in Michigan's waters of Lake Huron, 1968–2018.

Following the peak stocking of salmonine predators in 1986, Lake Huron experienced a fourth period best described as the food web *disturbance* period beginning in the 1990s and continuing through the 2010s. During this period, managers realized the system limits as the numbers of fish stocked were not equating into returns to the fisheries. Most significantly, a top-down regulated food web was turned upside down by the invasion of dreissenid mussels, initially zebra mussels *Dreissena polymorpha* and later quagga mussels *Dreissena rostriformis*. The mussels are highly prolific and are extremely efficient at filtering nutrients, like algae and plankton, which prevents energy from flowing up the food web to prey fish and ultimately predators. The impacts from zebra and quagga mussels on the lower trophic level productivity of the Lake Huron food web were extreme and disrupted the entire open water food web. It may represent one of the largest perturbations observed since the invasion of Sea Lamprey (Bunnell et al. 2018). As clearly shown in surveys of prey fish biomass, there was a peak in prey fish biomass of almost 370 kilotons (kt = 1,000 metric tons) by 1986. Still, there was a steady decline during the 1990s, concurrent with the expansion of dreissenid mussels, and by 2002 the prey fish biomass index was under 100kt (Figure 2). After 2002, the prey fish biomass index continued to decline and was under 20kt by 2015. During the most recent period (2010–2017), the prey fish declined by 90% of the average biomass in the 1990s. Although the impacts from mussels were observed in most of the Great Lakes, argumentatively, the food web and the fishery it supported in Lake Huron were the most impacted across the Great Lakes.

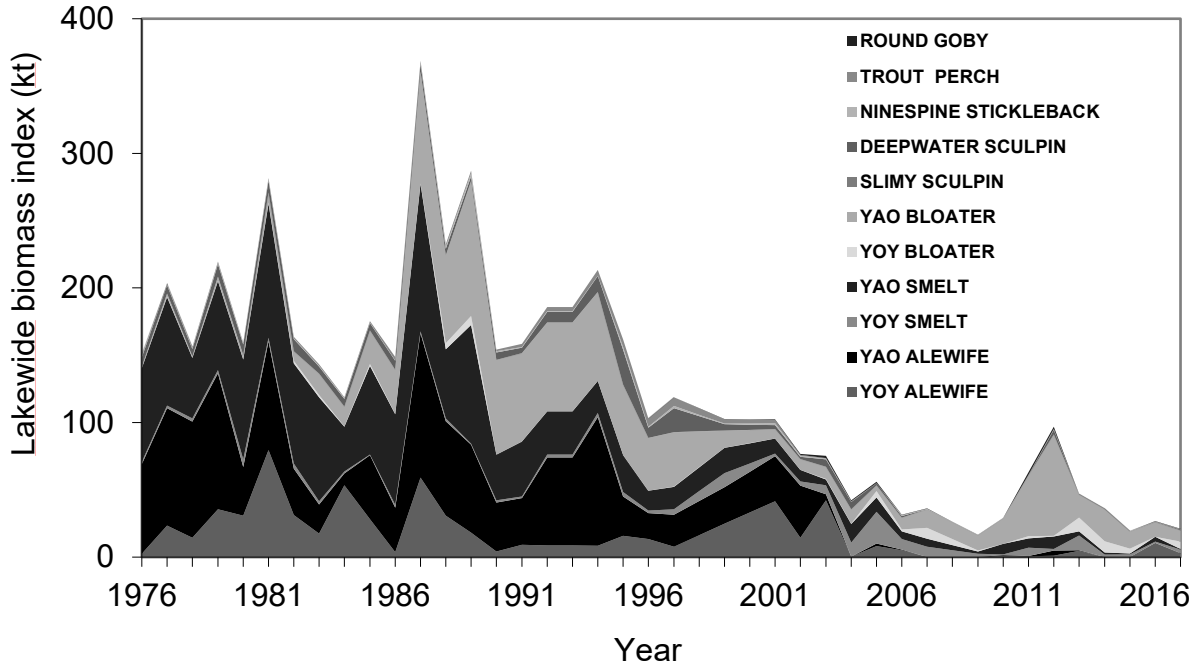

FIGURE 2. Offshore demersal fish community biomass in the main basin of Lake Huron, 1976–2017. Valid data were not collected in 1992, 1993, 1998, 2000, and 2008; biomass estimates for those years represent interpolated values. YAO denotes yearling and older; YOY denotes young-of-year (Reprinted from Riley et al. 2019).

In addition to the decline in nutrients and fish production, the mussels have substantially impacted water clarity. In Lake Huron, water clarity has increased by over 60% since the mussel introduction (Bunnell et al. 2018). It has been hypothesized, and there is supporting information as well, that predators of Great Lakes prey fish have had an increased search efficiency, thereby adding stress to the already declining prey fish levels. The increased predation efficiency can rapidly deplete the prey fish populations. Alewives in Lake Huron, once a dominant prey species, have declined by 99% and remain at record low levels since 2005. Fish predators that are reliant on Alewives, such as salmon, declined soon after and have contributed to a loss of approximately 4 million angler hours annually on Lake Huron.

During the food web *disturbance* period, the availability of nutrients to support the salmonine fish community was extremely limited because the nutrients were sequestered in massive dreissenid mussel beds on the lake bottom. The subsequent invasion of the Round Goby *Neogobius melanostomus,* a natural predator to the mussels in their native range, magnified the impact of the disrupted flow of energy through the Lake Huron food web. After the mussels sequestered the nutrients, the rapid expansion of the Round Goby established a pathway back to prey fish, albeit on the bottom (benthic) instead of open water (pelagic). Some nearshore predators (e.g., Smallmouth Bass *Micropterus dolomieu* and Walleye) were able to flourish because the mussel-goby pathway is hypothesized as being the major flow of nutrients during the food web *disturbance* period. However, the effects on the salmonine community were much more variable. Since the dominant prey species shifted from Alewives to Round Goby, Lake

Trout responded favorably through increased natural reproduction, although not at levels necessary to support the fisheries lake-wide. During the *rebuilding* period, Lake Trout reproduction was limited by spawning adult biomass and thiamine deficiency syndrome, which causes egg mortality and is indirectly caused by adult Lake Trout consuming high concentrations of Alewives. Lake Trout are effective benthic predators, and Round Goby quickly replaced Alewives in the Lake Trout diets. In some measures, Round Gobies replaced Alewives as the main prey species in Lake Huron during the *disruption* period. The Alewife-Round Goby dynamic played out differently for each species of salmon or trout. For example, Chinook Salmon are highly selective to pelagic prey species and, therefore, declined proportionally with Alewives. Atlantic Salmon *Salmo salar*, Brown Trout, Coho Salmon, and Steelhead had intermediate responses that either related to prey selection or from the presence of other survival bottlenecks (e.g., post-stocking survival).

The intent of this plan is to build off of previous periods and provide a guiding document that hopes to enter the Lake Huron fisheries into a new era; one that will take into account the history of the fishery but not be constrained by it. An era that will recognize both our lack of control over rapid changes in the ecosystem as well as a recognition that our actions (or lack of responsive actions) can exacerbate undesirable outcomes. An era that understands both the role of specificity by certain predators as well as the generality for others as being important components of the food web. An era that embraces both the recovery of native predators and prey, and the role of naturalized salmonines and their prey in the fish community and fishery. An era where stakeholders input is vital in shaping the fishery, and a time where managers can respond quickly to changes by implementing meaningful actions. Last, an era that looks to maximize the lakes potential while framing the expectations in outcomes that are grounded in sustainability and balance. By way of definition, the beginning of this era is now, and it is defined by the mission statement in this plan.

Mission Statement for Managing Lake Huron's Salmon and Trout Fishery

A sustainable and diverse salmon and trout fishery that maximizes the lake's production potential to provide exceptional fisheries for communities across the lake.

Major Issues Facing Lake Huron

Implementing actions that support the Mission Statement for the Salmon and Trout Management Plan in Lake Huron will need to address the major issues facing the fishery, ecosystem, and sustainable use. As a precursor to establishing goals and actions, the major issues are articulated as follows:

- The lake has changed rapidly, and invasive species have had and are having a significant impact on it. Management has been unable to adapt quickly and effectively to promote system and fishery stability.
- Major spatial differences between the northern, mid, and southern parts of the lake impact stocking success, prey fish production, and fishery dynamics. In general, dreissenid mussels appear to have impacted the mid-section the most.
- Diversification of the predator community is needed but can be limited by the survival of some species (e.g., Brown Trout), hatchery production (e.g., Atlantic Salmon), and social constraints (e.g., Coho Salmon).
- Supporting a diversification of the prey base is needed. However, there are questions about whether the Cisco reintroduction program will be adequate and able to help address this need in Lake Huron.
- Resources for managing Lake Huron have been declining, and stakeholders support a long-term funding plan for the basin that allocates resources for surveys, creel, fish production, and management at appropriate levels.
- Lake Huron management should include both a biological evaluation component as well as an economic evaluation to better link fishery changes with economic impacts.
- Cormorant management is necessary and should be balanced with prey fish production similar to salmon and trout stocking and harvest, also recognizing threats to local nearshore fisheries.

Potential Pitfalls or Issues That Could Cause Lake Huron's Salmon and Trout Plan to Fail

- Disagreement and concerns about general management concepts and philosophies.
- Keeping momentum through the plan development and implementation.
- Species-specific approach versus community approach.
- Negativity infiltrating the process between stakeholders, managers, and the unaffiliated-average angler.
- Tribal fisheries management and 2020 negotiations.
- Uncertainty and lack of data.
- DNR funding and commitment.
- Hatchery capacity.
- Economic impacts.
- High uncertainty and variability in natural recruitment estimates presents challenges for evaluating stock status and predicting fishery trends.

- Commercial fishers' consideration, interaction with Lake Whitefish *Coregonus clupeaformis* management goals.
- Lake Trout goals may limit our ability to "maximize" the lake potential.
- Build it and they WON'T come (anglers will not take advantage of the new opportunities).
- New AIS introductions (e.g., invasive carps).
- Commitment and challenges to future Sea Lamprey control.
- Individual stakeholder bias and port-specific interests.
- Scaling up of the plan (to other jurisdictions or basins).
- Cormorant management.
- Conflicting goals for Lake Huron (e.g., FCOs and Lake Trout rehabilitation).
- Lake Huron's history, an individual personal legacy and dogma.

Goals

The Mission Statement frames the overall vision of the management plan as having a sustainable and diverse salmon and trout fishery. However, the major issues facing Lake Huron can only be addressed by developing specific goals to achieve said mission. To make progress towards that outcome, the following four goals were established:

Goal 1. Develop, expand, and maintain a diverse salmon and trout fishery.

Goal 2. Maximize fish production potential recognizing the dynamics in prey fish production, abundance, and diversity.

Goal 3. Provide exceptional fisheries across the lake and fishing communities.

Goal 4. Promote a sustainable and balanced Lake Huron ecosystem through adaptive fisheries management.

In development of the goals, input from stakeholders reflected a broad range of values and expectations for the Lake Huron fishery. For example, stakeholders expressed a desire for a diversity of salmon and trout species, both in the fishery and the fish community. However, they also expressed a desire to maintain the Lake Trout and Walleye fishery in its current status. Angler opportunity and access were expressed as important tenants of the management plan and recognized as major drivers in garnishing stakeholder support in management actions in support of the plan. Also recognized by stakeholders was a desire to manage for a balanced fishery and ecosystem, while also protecting and enhancing the viability of ecosystem function. The actions in this plan should work to build and support a balanced and healthy ecosystem with a diverse species portfolio and sustainable fishery.

Relationship to Other Mission Statements and Goals for Lake Huron

As part of the Great Lakes Fishery Commission Strategic Plan, each lake has developed a vision for fisheries management termed Fish Community Objectives (FCOs). The Lake Huron Fish Community Objectives for salmonines (salmon and trout) are to "establish a diverse salmonine community that can sustain an annual harvest of 2.4 million kg with Lake Trout the dominant species and anadromous (stream-spawning) species also having a prominent place". The Prey Objective is to "maintain a diversity of prey species at population levels matched to primary production and predator demands." By prey, DesJardine et al. (1995) included Deepwater Ciscoes *Coregonus johannae*, sculpin species *Cottus spp.*, Lake Herring *Coregonus artedi*, Rainbow Smelt, Alewife, Gizzard Shad *Dorosoma cepedianum,* Spottail Shiners *Notropis hudsonius*, Emerald Shiners *Notropis atherinoides*, juvenile Lake Whitefish, and Yellow Perch *Perca flavescens*. The "balance" implied in the prey objective is normally achieved by manipulation of predator numbers through harvest control and stocking, but care is needed that neither harvest nor stocking is taken to an extreme. This plan is consistent with other fisheries management plans for Lake Huron because it aims to manage for a diverse salmon and trout community that (1) provides diverse and sustainable fishing opportunities and (2) is in balance with prey fish levels.

The goals for the Lake Huron Salmon and Trout Management Plan are also consistent with Michigan Department of Natural Resources Fisheries Division Strategic Plan 2023–2029 (https://www.michigan.gov/dnr/managing-resources/fisheries/annual-reports). Specifically, the plan for managing salmon and trout fisheries in Lake Huron supports Goal 1 (Ensure healthy aquatic ecosystems and sustainable fish populations), Goal 3 (Improve and build strategic resource partnerships), and Goal 4 (Develop strategically focused assessment and decision support tools).

Through the implementation of this plan, stakeholder involvement and strategic actions taken could also serve to meet Goal 5 (Foster efficient division operations) in the Fisheries Division Strategic Plan. However, stakeholder input throughout the planning process recognized severe limitations in the baseline assessment and evaluation needed to support a successful plan. Therefore, it is expected that some increased level of investment will be needed upfront, in support of the plan, before efficiencies could be realized.

Management Actions and “Gathering the Givens”

Great Lakes fisheries management can be a very dynamic, complex, and challenging endeavor. Development of a management plan or strategy could fail quickly if uncertainty exists about the environment, the actions needed to be implemented, or the cost-benefit of management is too high. The recognition of the major issues facing Lake Huron exemplifies the uncertainty in the fish community and whether these issues will prohibit managers from implementing actions that will result in the desired outcomes. Included as a part of the plan's development was an exercise of gathering the givens, which may be comparable to a modeler making an assumption

to fit a function or relationship to a dataset. These givens helped to limit debate during the development of the plan when data were limited, surveys were lacking, or future predictions were uncertain. They include four major themes:

- Dreissenid mussels were not a nutrient dead end, that nutrients will flow through the Lake Huron fishery, albeit in potentially alternate pathways, and that Round Gobies are an important prey item in the new pathway.
- During 2012 to 2017, the food web in Lake Huron was stable and a balanced predator-prey dynamic was evident and could serve as a benchmark for management.
- Control and prevention of aquatic invasive species (AIS) will be effective and continue to be funded at appropriate levels, especially for ongoing Sea Lamprey control, and to prevent new AIS from entering Lake Huron (e.g., invasive carps).
- The Department of Natural Resources will fund fisheries management at levels appropriate to implement the plan including surveys, fish stocking and marking, and management. It will also include all current facilities (e.g., Swan River weir) and potentially the development of new infrastructure or personnel to accomplish the plan.

Once the givens were established, the management actions were discussed in three basic categories including regulation changes, habitat management, and stocking.

Regulation Changes

Lake Huron salmon and trout regulations are typically not commonly used as a management tool to regulate the fishery with the exception of Lake Trout. In the Great Lakes, bag limits and fishing season regulations are more likely to be rooted in social preferences for the fishery than in biological controls on fishing exploitation. For Michigan's waters of the Great Lakes, the general regulation for trout and salmon is that it is open all year with a few exceptions for certain species. Also, there is a standard minimum size limit of 10-inches and a combined bag limit of five total in any combination but no more than three of any one species, except up to five Coho, Chinook, and Pink Salmon *Oncorhynchus gorbuscha* for most of Michigan's waters of the Great Lakes.

However, statistical districts manage Lake Trout mainly because of harvest limits in the northern region of the lake (MH-1 and 2) based on allocations with the 1836 Tribes. For example, in 2019, the daily bag limit in MH-1 was reduced from three to two fish based on estimated allocation to the state fishery. For the other northern unit, MH-2, the daily bag limit remained consistent with the rest of Lake Huron (i.e., MH 3–6) at three fish per angler per day. In addition to reduced bag limits, both northern units (MH-1 and 2) have a seasonal closure to protect spawning Lake Trout. In those units, the season closes in October and reopens on January 1, whereas the remaining portion of the lake is open to Lake Trout fishing all year. Last, all statistical districts have a minimum size limit of 15 inches for Lake Trout compared to 10 inches for other salmonines.

Fishing regulations, especially recreational fishing limits, have a limited ability to regulate fish populations. The limitations can be associated with low exploitation rates from recreational fisheries, compensation with other mortality sources, or biological bottlenecks to fish production

(e.g., low recruitment). Recreational fisheries are also concentrated in areas that are both conducive to fishing and have high catchability of desirable fishes. At small scales, such as small lakes or ponds, regulations for recreational fishing can be proactive and help to guide fisheries. At large scales, such as the Great Lakes, recreational fishing regulations are often reactive and have more social than biological impacts. For this reason, the Lake Huron salmon and trout management plan will not explore options for changing fishing regulations. Instead, the plan recognizes that regulations may be used by fisheries managers in reaction to changes in the fishery, albeit with expected limited use and effectiveness.

Habitat Management

It is well accepted that the management of critical fisheries habitat could have substantial influences on either progress toward or away from reaching the goals or vision in this plan for management of salmon and trout in Lake Huron. Management of fisheries habitat can include everything from water quality (e.g., physical, chemical, and biological parameters) to reconnecting tributaries to the main basin (e.g., barrier removal). This plan does not address specific habitat management actions because of the connectedness of fisheries habitat to other management agencies and jurisdictions. Plans for healthy habitats include the EPA Lakewide Management Plan, the Water Quality Agreements, and the goals for fisheries habitat as part of the Great Lakes Fishery Commission. Also, aquatic habitat management is an indirect way of managing fisheries. This plan will help to inform the outcomes of those plans as they relate to changes in the fishery and fish community.

Stocking Strategy

Because of the limitations with fishing regulations and the indirect impact of aquatic habitat modification for managing Salmon and Trout in Lake Huron, an effective stocking strategy is the most proactive and direct action to address Goals 1–4 and move the fishery toward fulfillment of the mission statement. One of the pitfalls in the development of a fish stocking strategy is that they tend to be focused on single species and targets for that species will be grounded in the objectives for returns or recovery for that single species. However, the single species approach often fails to recognize the importance of the fish community and the interactions between other species that are either stocked, managed, or influential with the target species for which the stocking strategy has been developed.

Furthermore, fish community-based stocking programs are rarely implemented because each species may be reared to various life stages (e.g., fry, fall fingerling, or spring yearlings), once stocked individual species likely compete for resources, and biotic interactions are difficult to predict and measure (e.g., spatial distribution or diet overlap). However, the four goals identified in this plan are all based on a strategy that is at the fish community and food web level. Therefore, a complementary stocking strategy should include all species, their relative consumptive demand, and role or feeding niche in the food web. The plan defines each predator by a predator equivalency ratio (PER) for each species based on consumption models and salmon and trout strategies in the Great Lakes to address a community-based strategy. Each unit is estimated from a constant (PER = 1.0) based on the predator with the highest consumption over

an average life span, which is Chinook Salmon for Lake Huron (Table 1). Therefore, the relative consumption of the other predator species is derived by comparing the average consumption of a different predator species to the Chinook Salmon consumptive demand.

TABLE 1. Species, predator equivalency ratio, and factors considered in the stocking strategy for Lake Huron.

Species	Predator Equivalency Ratio	Catchability	Cost-effectiveness	Feeding Ecology	Movement-Straying	Wild Recruitment Potential	Social-Economical Benefits
Atlantic Salmon	2.4	Medium	Not available	Highly Diverse	Medium	Low	High
Brown Trout	2.2	Low	Low	Moderately Diverse	Low	Low	Medium–Low
Chinook Salmon	1.0	High	High	Pelagic Prey Only	High	High	High
Coho	3.2	Medium	Medium	Moderately Diverse	Medium	Medium	Medium–High
Lake Trout	2.3	High	Medium	Benthic Prey	Low	High	Medium–Low
Steelhead	2.4	Medium	Medium	Moderately Diverse	Medium	Medium	Medium–High

For example, Coho Salmon are typically stocked as yearlings compared to Chinook Salmon, which are stocked as fingerlings or age-0 smolts. Chinook Salmon also tend to live 1–4 years in Lake Huron, depending on growth and sex, whereas the majority of Coho Salmon will return the following fall after stocking. Even though Chinook and Coho Salmon can have a high degree of diet overlap, a typical Chinook Salmon will live three times as long as a Coho Salmon and reach much larger sizes based on growth and life history characteristics. The PER estimated for Coho Salmon is 3.2, which based on consumption equivalents is defined as roughly three stocked Coho Salmon equate to one stocked Chinook Salmon. When incorporated into a stocking strategy at the fish community level, the PER can be very useful as it will allow managers to (1) calculate the total consumption demand level (CDL) for all predators, (2) manage the consumption demand upfront prior to stocking, and (3) allow for flexibility in stocking different species or sites without altering the predator-prey balance at a given CDL.

In addition to the consumption demand, each species life history characteristics were qualified in relationship to the Mission Statement and Goals (1–4) in the plan. This includes species-specific catchability (also defined as a perceived return to the fishery), cost-effectiveness, feeding ecology, potential to move or stray from the stocking location, potential for wild recruitment, and the overall perception of the social-economic benefits of having that species in the overall strategy. The individual life history of each species, however, will not be covered in this plan. Instead, there are several other publications that describe life history characteristics, either in Lake Huron or in the other Great Lakes, that were utilized in the development of this plan.

Predator Demand Levels

One of the "givens" defined in this plan is that the fish community during the 2012–2017 period appeared to have stabilized after the major declines in the pelagic prey and salmonine fishery during the early 2000s. In the 2012–2017 period, stocking was at approximately 2.75 million trout and salmon and was comprised of approximately 1 million Lake Trout, 0.7 million Chinook Salmon, and 1 million of all other species combined. The historical stocking level could then be converted to a total consumption demand by multiplying the number of fish stocked by the PER. The stocking pattern in Figure 1 can be used as the historical basis for developing management levels based on total consumption and will be termed CDL (expressed in millions). Based on historical stocking patterns, the levels are defined as: level 1 at 1.25 million predator equivalency (PE) (2018–2020), level 2 at 1.5 PE (2012–2017), level 3 at 2.5 PE (2006–2011), and level 4 at 4.0 PE (2000–2005) (Table 2).

TABLE 2. Numbers of fish stocked and associated consumption demand levels (CDL) in millions. The predator equivalency (PE) is the number of fish stocked multiplied by the associated ratio (PER) from Table 1. For example, if all the fish stocked at CDL 1 were Chinook Salmon only, then the total number of fish and PE is the same at 1.25 million.

Species	CDL 1		CDL 2		CDL 3		CDL 4	
	Number	PE	Number	PE	Number	PE	Number	PE
Atlantic Salmon	0.18	0.08	0.18	0.08	0.25	0.10	0.25	0.10
Brown Trout	0.00	0.00	0.01	0.00	0.01	0.00	0.01	0.00
Chinook Salmon	0.70	0.70	0.75	0.75	1.50	1.50	2.90	2.90
Coho	0.10	0.03	0.10	0.03	0.10	0.03	0.10	0.03
Lake Trout	0.54	0.23	1.00	0.43	1.32	0.57	1.50	0.65
Steelhead	0.55	0.23	0.55	0.23	0.55	0.23	0.55	0.23
Total	2.07	1.27	2.59	1.52	3.73	2.44	5.31	3.92
Historic Levels (based on)	2 (2018-2020)		2.75 (2012-2017)		3.5 (2006-2011)		4.75 (2000-2005)	

Because the historical stocking levels (1–4) captured the range of prey availability, an overall stocking strategy will be to decide on a stocking level based on an up-to-date understanding of prey fish trends, predator diets, and predator growth rates (Figure 3). Once these metrics are evaluated and a stocking level selected, individual species ratios and specific stocking sites can be evaluated for change. The stocking level should be reviewed at a minimum of a five-year period and would benefit if it could be aligned with the State of the Lake analysis as part of the five-year Great Lakes Fishery Commission reporting cycle through the Lake Huron Committee and Lake Huron Technical Committee process.

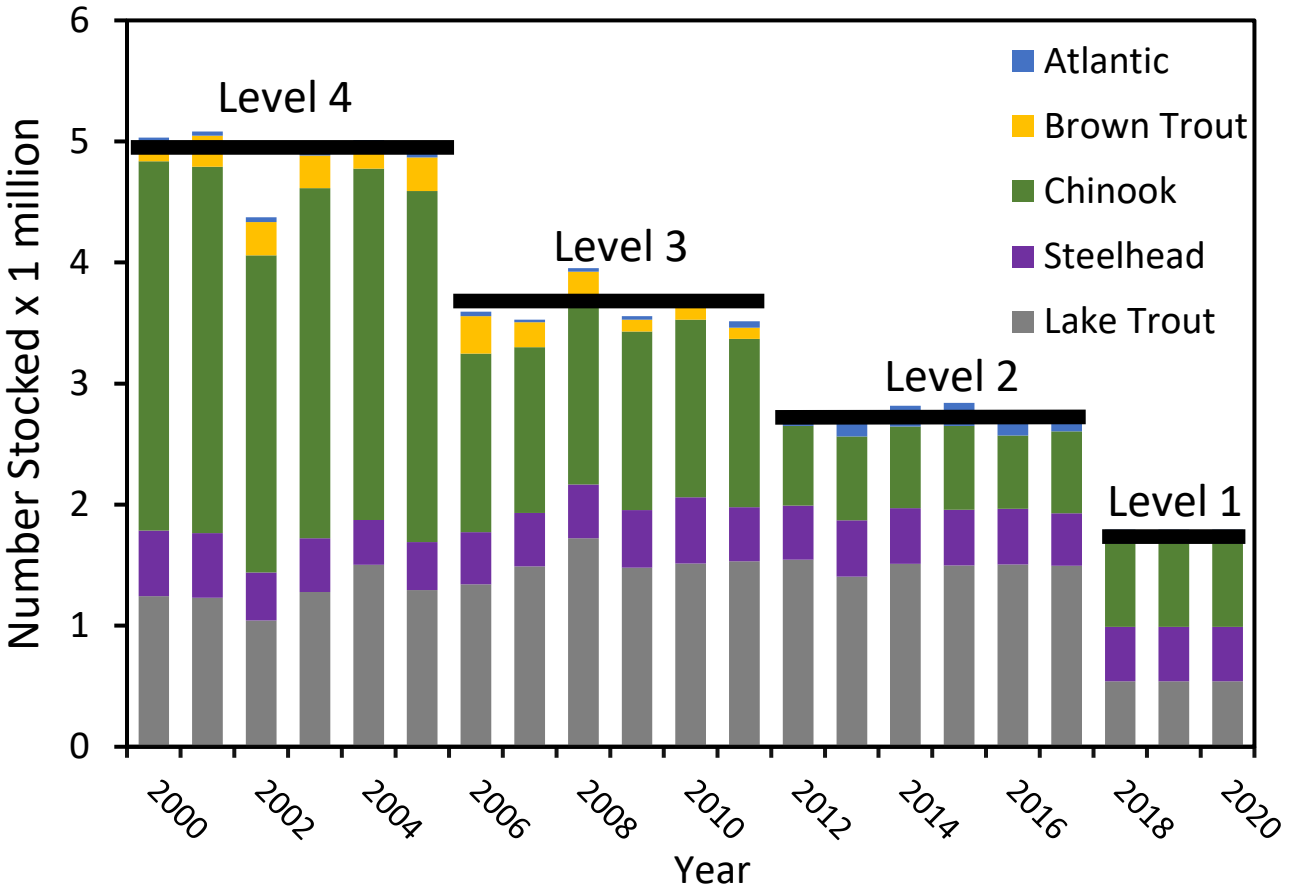

FIGURE 3. Stocking levels 1–4 during 2000 to 2020 defined by total number of fish and associated consumption demand based on predator equivalents.

Species and Site Stocking Allocations within a Stocking Level

Species-specific stocking levels could be determined or changed annually based on multiple factors, assuming that total predator equivalents for a given level are not exceeded. Factors could include variables that increase or decrease the availability of a species designated in the stocking plan. With single species stocking strategies, targets are often not met or exceeded as fish production levels can vary with mortality during rearing and the ability to quantify fish biomass during production. Single species stocking strategies tend to allow for a deviation, often at 10% of the target, before management consultation is required. With a community-based approach and total CDL identified, individual species targets could vary with a wider range and the site locations could include primary and secondary priority sites should fish production levels change. However, managers should estimate the total number of predator equivalents and consider annual changes within the desired level. Stocking sites may also be rotated or changed annually based on other objectives, again provided that the total CDL is not excessively exceeded.

Management Plan Summary

The State of Lake Huron Report (SOL) is completed every five years as a measure towards meeting Fish Community Objectives for the Lake Huron fishery. The last SOL Report for Lake Huron was completed in 2018 using data from 2012 to 2017. Environmental and habitat priorities are described in the Lakewide Action and Management Plan (LAMP), which was informed by the Cooperative Science and Monitoring Initiative (CSMI). CSMI is a bi-national effort instituted under the Science Annex of the 2012 Great Lakes Water Quality Agreement to coordinate science and monitoring activities in one of the five Great Lakes each year, on a rotating basis, to generate data and information for environmental management agencies. The CSMI year for Lake Huron has been coordinated to occur the last year in the 5-year GLFC reporting cycle (e.g., 2022 is the next CSMI year for Lake Huron). As this plan was being developed in 2019, the 2018 SOL and LAMP were used to set the current stocking policy (Level 2). The next SOL report will be released in 2023 based on data from 2018–2022.

The SOL and CSMI will provide information on food web production, prey fish biomass, and other indicators of the overall predator-prey balance. Harvest can then be compared to overall goals in the Fish Community Objectives as part of the 5-year stocking policy setting process (Figure 4; Riley and Ebener 2020). Changes to the 5-year stocking level can be determined as part of SOL and LAMP process, but implemented within Michigan's jurisdiction of Lake Huron (set in 2019, revisit in 2023; Figure 5). The stocking level will inform the policy for the next five years, but species-specific changes could be made annually using the PER with Chinook Salmon (PER =1) without changes to the overall consumption demand.

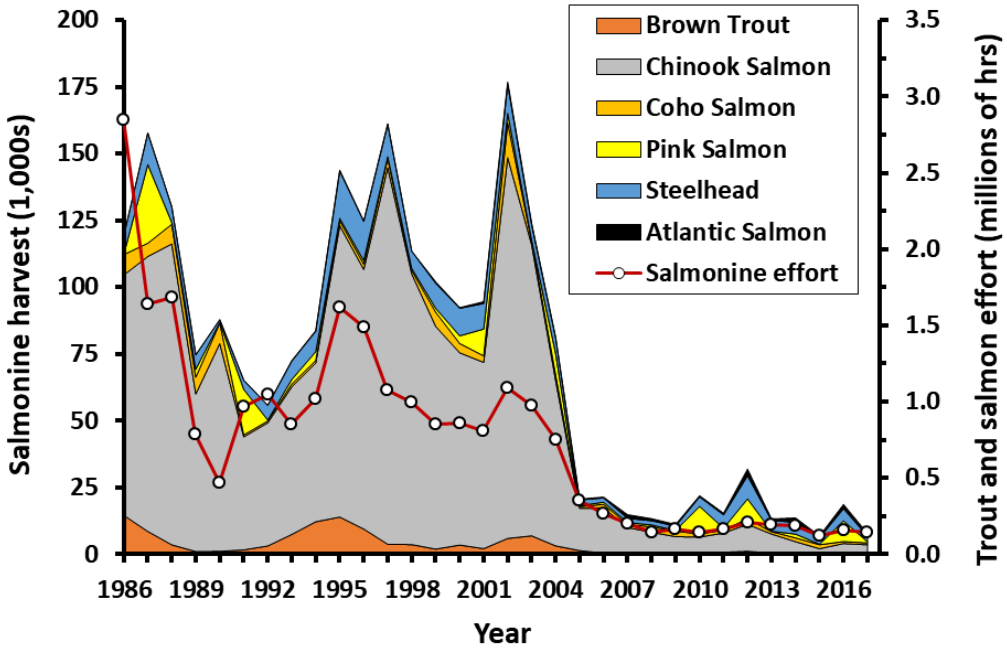

FIGURE 4. Recreational-fishery harvest of salmonines (area colors) other than Lake Trout and the number of angler hours (red line and white circles) targeted at trout and salmon in the Michigan waters of Lake Huron during 1986-2017. (Riley and Ebener 2020)

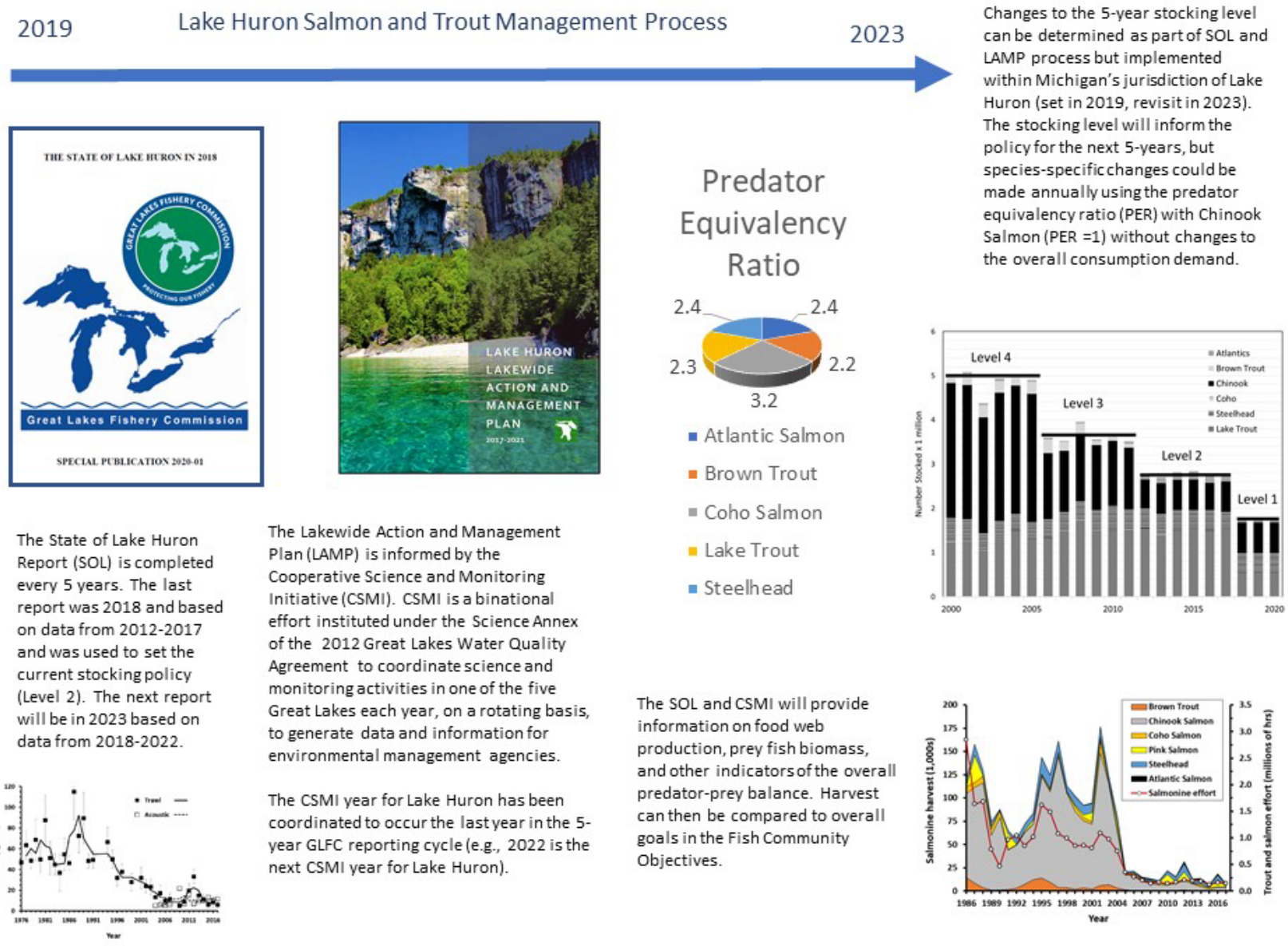

FIGURE 5. Lake Huron salmon and trout management planning process. Changes to the 5-year stocking level can be determined as part of SOL and LAMP process but implemented within Michigan's jurisdiction of Lake Huron.

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