

# **FISHERY RESEARCH PRIORITIES FOR THE GREAT LAKES**

## **Great Lakes Fishery Commission**

Version October 31, 2008

This listing was compiled based on input from the lake committees and their technical committees and from discussions within the Council of Lake Committees (for more information go to <http://www.glf.com/lakecom.php>) and the Great Lakes Fish Health Committee (<http://www.glf.com/boardcomm/fhealth/fhealth.php>). Order of listing does **not** imply relative ranking of priorities for the Fishery Research Program funding.

### **I. Basinwide Priorities**

#### **II. Lake-specific Priorities**

- A. Lake Ontario Priorities**
- B. Lake Erie Priorities**
- C. Lake Huron Priorities**
- D. Lake Michigan Priorities**
- E. Lake Superior Priorities**

#### **III. Fish Health Committee Priorities**

### **I. Basinwide Priorities (updated October 2004)**

The following four high priority research questions should help the Great Lakes Fishery Commission in selecting proposals that are submitted to the Fishery Research Program. These priority questions (in no specific order) are:

- What are the most cost-effective ways to prevent further introduction of invasive species?
- What are the primary impediments to and options for rehabilitating indigenous species such as lake trout, walleye, yellow perch, lake sturgeon, ciscoes, and American eel?
- What levels of prey production are necessary to support stocked and naturally produced predators?
- How have invasive species affected indigenous species, disrupted food web dynamics, and altered trophic transfer in the Great Lakes?

### **II. Lake-specific Priorities**

#### **A. Lake Ontario**

The Lake Ontario ecosystem is extremely dynamic, and has experienced rapid and significant change in the last decade. The following research priorities were developed by the Lake Ontario Technical Committee, and are presented in the framework of "Fish Community Objectives for Lake Ontario" (Stewart et al. 1999, [http://www.glf.com/pubs/SpecialPubs/Sp99\\_1.pdf](http://www.glf.com/pubs/SpecialPubs/Sp99_1.pdf)). Please note that the current fish community objectives (FCO) document was prepared in 1997, and recent/ongoing disruptions in food web dynamics have rendered some objectives obsolete. The order in which research priorities appear does not connote order of priority.

## 1. Nearshore Fish Community

The nearshore fish community will be composed of a diversity of self-sustaining native fish species characterized by:

- a. Maintenance of existing walleye populations and expansion of walleye populations into favorable habitats
  - What are the impacts of thiamine deficiency on walleye?
  - Other than the Bay of Quinte, are there other sources of walleye recruitment to the Eastern Basin and other area of Lake Ontario?
  - Can walleye spawning runs be re-established in Eastern Basin tributaries, and is there adequate forage to sustain additional recruitment from restoration efforts?
- b. Maintenance of existing yellow perch populations and expansion of yellow perch populations into favorable habitats
- c. A population recovery of the lake sturgeon sufficient for its removal from New York's list of threatened species
  - Where are the primary sources of lake sturgeon recruitment to Lake Ontario, and can they be enhanced and/or better protected from perturbations?
  - How will round goby colonization affect growth and contaminant levels in lake sturgeon?
- d. Population levels of smallmouth bass, largemouth bass, and sunfishes attractive to anglers
  - How will round goby colonization affect growth and contaminant levels in smallmouth bass?
- e. Increasing numbers of American eels consistent with global efforts for their rehabilitation
  - What local and global management actions are necessary to ensure the future of American eels in the Lake Ontario/St. Lawrence River system?
  - How can we increase passage of American eels into Lake Ontario, and how can we improve survival of out-migrating adults?

Also:

- Continued study of holistic models (gaming/risk analysis), with respect to long-term focus on alternate states/management in the nearshore ecosystem
- Specific to areas colonized by double-crested cormorants (DCC), what is an acceptable level of cormorant predation (feeding days) that will not adversely impact sportfishing quality (model development)?
- What lethal and non-lethal control alternatives can be used to manage DCC numbers?
- Causal mechanisms of Type-E botulism outbreaks in Lake Ontario; links to exotic species?
- Impacts of round goby colonization (egg predation on native species, food web/energy flow implications (includes contaminant loading, changes in fish growth/behavior/movements/angler catch rates, potential implications for long term fish assessment data series).
- Efficacy of implementing water level control/fish passage in wetland habitats to improve habitat/fish recruitment
- Impacts of submerged aquatic vegetation control on embayment fish communities

- Fish health issues – *Heterosporis*, etc.

## 2. Offshore Pelagic Fish Community

The offshore pelagic fish community will be characterized by:

- a. A diversity of salmon and trout
  - Nutrient deficiency impacts, particularly with respect to thiamine, on trout and salmon species including reproductive success, behavioral, neurological, etc.
  - Tributary mouth habitat/water clarity influence on predation of juvenile salmonids
- b. Chinook salmon as the top predator
- c. Abundant populations of rainbow trout (steelhead)
- d. Fishable populations of coho salmon and brown trout
- e. Populations of Atlantic salmon at levels consistent with investigating the feasibility of restoring self-sustaining populations
  - Atlantic salmon strain evaluations for reintroduction programs
- f. Amounts of naturally reproduced (wild) salmon and trout, especially rainbow trout, that are consistent with fishery and watershed plans
  - Contribution of wild vs. stocked salmonines (also, development of cost-effective batch marking/mark reading techniques, refinement of stable isotope techniques)
- g. A diverse prey-fish community with the alewife as an important species
  - Determine causal mechanisms of exotic species impacts on lower food webs (*Dreissenids*, *Cercopagis*, *Echinogammarus*, *Neogobius*, etc.)
  - Impacts of *Diporeia* and *Mysis* declines on alewife condition/survival, as well as the bioenergetic impacts on predator species?
  - What are the food web mechanisms that influence thiaminase and related conditions such as Early Mortality Syndrome?
  - Refinement of hydroacoustic preyfish assessment techniques/interpretation

Also:

- Fish health issues – atypical *Furunculosis*, etc.

### 3. Offshore Benthic Fish Community

The offshore benthic fish community will be composed of self-sustaining native fishes characterized by

- a. Lake trout as the top predator
  - causes for continued lake trout decline and low survival including egg predation (possible link to gobies), contaminants, thiamine deficiency related to prey and thiaminase, dreissenid colonization and other mechanisms reducing success of or act of natural reproduction
  - Food web changes and resulting changes in biomagnification, Poly brominated diethyl ether (PDBE's): impacts on humans, impacts on lake trout reproduction.
- b. A population expansion of lake whitefish from northeastern waters to other areas of the lake
  - Impacts of dreissenid colonization on whitefish bioenergetics
  - Sustainability of lake whitefish in Lake Ontario
  - Stock discrimination
  - Early life history, growth and survival
- c. Rehabilitated native prey fishes
  - Investigations to advance native prey-fish reintroduction initiatives, particularly bloater/deep water ciscoes. Also, investigations into use of historic lake herring spawning sites (Chaumont Bay, Irondequot Bay, etc.)
  - Feasibility of restoration of extirpated species given recent changes in environment, food web, predator-prey complex, and the predominance of alewife.

Also:

- Impacts of *Cercopagis* blooms on juvenile smelt/other species
- What are the impacts of round goby colonization on slimy sculpin, log perch, others?
- Impacts of dreissenid colonization on other benthic invertebrates/benthic food webs

### 4. Others:

- Relationship between lipid content vs. wet weight for fish condition analysis
- Coastal GAP Analysis – characterization of coastal segments and fish communities
- Tributary GAP Analysis – habitat assessment/mapping/GIS layer development; development of correlation models for habitat/fish species
- Substrate characterization of Niagara Bar; significance to fisheries
- Sediment mapping
- Development of offshore bioenergetics model that is holistic with respect to the offshore ecosystem

**B. Lake Erie** (organized based on Lake Erie Fish Community Goals and Objectives  
[http://www.glf.org/pubs/SpecialPubs/Sp03\\_2.pdf](http://www.glf.org/pubs/SpecialPubs/Sp03_2.pdf))

These Lake Erie Fisheries Research Priorities were developed to encourage progress towards meeting the published Lake Erie Fish Community Objectives (FCO's). We wish to emphasize here that specific FCO's must be interpreted in the context of the developed Goals for Lake Erie and the Guiding Principles used to frame specific objectives. Interested researchers should review the Lake Erie Fish Community Goals and Objectives (Ryan et al. 2003 link to [http://www.glf.org/pubs/SpecialPubs/Sp03\\_2.pdf](http://www.glf.org/pubs/SpecialPubs/Sp03_2.pdf) ) for additional background information concerning these research priorities.

Research priorities for Lake Erie will be updated annually. Copies of the most recent set of research priorities for Lake Erie are available through the chair of the Lake Erie Committee (Mr. Roger Knight, Ohio Department of Natural Resources).

**Bold font** indicates the highest priorities and *italics font* indicates medium priorities. Remaining priorities are lower priorities.

**Ecosystem Conditions Objective**

- *How can we best monitor, manage, and maintain optimum mesotrophic conditions in the west, central, and nearshore east basin?*
- *How can we best develop bathy/thermographic (and other habitat) maps that facilitate our understanding of the size, dynamics, and impact of river or tributary plumes in Lake Erie?*
- *How can we best describe important habitat characteristics, complete mapping of Lake Erie habitat, and distribute this information to managers, researchers, stakeholders, and the public?*
- How can we best map or model known disease dynamics in Lake Erie?

**Productivity and Yield Objective**

- **What are appropriate biological reference points and fisheries reference points for fished populations and how can they be estimated?**
- **How can we best describe, map, evaluate and maintain suitable nearshore habitats that can support high quality fisheries for smallmouth bass, northern pike, muskellunge, yellow perch, and walleye using hydroacoustics/GIS software?**
- What is the influence of size or slot limits on fish population dynamics?
- What is the impact of fishing sanctuaries on fish populations of interest and are the goals of sanctuaries being met?
- How can we optimize the potential for sustainable harvests of highly valued fish species?
- What changes in catchability have occurred in the commercial and sport fisheries operating on Lake Erie over time?
- What are the spatial and temporal dynamics of invasive species in Lake Erie and what are their impacts on desired fisheries productivity and yields?

### **Nearshore Habitat Objective**

- **How can we best describe, map, evaluate and maintain suitable nearshore habitats that can support high quality fisheries for smallmouth bass, northern pike, muskellunge, yellow perch, and walleye using hydroacoustics/GIS software?**
- *How can we best describe important habitat characteristics, complete mapping of Lake Erie habitat, and distribute this information to managers, researchers, stakeholders, and the public?*

### **Western Basin Objective**

- **What are the stock structures of walleye, yellow perch, smallmouth bass and other desired fish?**
- **How can we identify, rehabilitate, conserve, or protect locally adapted stocks?**
- *How can we best provide sustainable harvest of desirable fish species of fish?*
- What are the stock/spawner-recruitment relationships in desired fish populations?
- What are the natural mortality (M) rates in desired fish populations?
- What are the limiting factors and causes leading to reduced or lost recruitment of desired fish species and what are the solutions to remedy this lost recruitment?

### **Central Basin Objective**

- **What are the stock structures of walleye, yellow perch, smallmouth bass and other desired fish?**
- **How can we identify, rehabilitate, conserve, or protect locally adapted stocks?**
- *How can we best provide sustainable harvest of desirable fish species of fish?*
- What are the stock/spawner-recruitment relationships in desired fish populations?
- What are the natural mortality (M) rates in desired fish populations?
- What are the limiting factors and causes leading to reduced or lost recruitment of desired fish species and what are the solutions to remedy this lost recruitment?

### **Eastern Basin Objective**

- **What are the stock structures of walleye, yellow perch, smallmouth bass and other desired fish?**
- **How can we identify, rehabilitate, conserve, or protect locally adapted stocks?**
- *How can we best provide sustainable harvest of desirable fish species of fish?*
- What are the stock/spawner-recruitment relationships in desired fish populations?
- What are the natural mortality (M) rates in desired fish populations?

- What are the limiting factors and causes leading to reduced or lost recruitment of desired fish species and what are the solutions to remedy this lost recruitment?
- How can we best restore self-sustaining populations of lake trout to historic levels of abundance in the east basin?

#### **Fish Habitat Objective**

- *What are the best methods for evaluation, protection, and enhancement of fish habitat throughout the Lake Erie watershed?*
- How can we update the Great Lakes Spawning Atlas to reflect recent changes in the Lake Erie basin?

#### **Genetic Diversity Objective**

- **What are the stock structures of walleye, yellow perch, smallmouth bass and other desired fish**
- **How can we identify, rehabilitate, conserve, or protect locally adapted stocks?**

#### **Food Web Structure Objective**

- How can we best manage the food web structure of Lake Erie to optimize production of highly valued fish species?

## C. Lake Huron

A review of the fish community objectives for Lake Huron (link [http://www.glfrc.org/pubs/SpecialPubs/Sp95\\_1.pdf](http://www.glfrc.org/pubs/SpecialPubs/Sp95_1.pdf)) and the Lake Huron State of the Lake Report ([http://www.glfrc.org/pubs/SpecialPubs/Sp95\\_2.pdf](http://www.glfrc.org/pubs/SpecialPubs/Sp95_2.pdf)) provides a useful context for the questions listed below.

**The LHTC has identified 5 “Issues”, or major subject areas, which we feel need to be addressed in Lake Huron. Under each of these Issue Categories is a list of Research Priority questions along with some examples. HIGH priority items are bolded and MEDIUM items italicized. Finally, we summarize by identifying three broad research areas that capture the LHTC’s leading priorities for research in 2008-09. These three chosen HIGH PRIORITY research areas are purposefully rather broad so as not to constrain unnecessarily the scope of potential research proposals. Researchers submitting proposals for funding are urged to look at the Research Issues list for insights into some specific research questions the LHTC considered in the process of developing the HIGH PRIORITY Research List for 2008-09.**

### **Research Issues:**

#### ISSUE: Impediments to Lake Trout Rehabilitation

The LHTC is concerned that impediments exist which are limiting, delaying, or preventing lake trout rehabilitation efforts in Lake Huron waters. The nature of the impediments, the level of their impacts, and how to deal with them are all questions the LHTC would like to see addressed.

#### 1) What are the major existing impediments to lake trout rehabilitation in Lake Huron? [**HIGH**]

Examples:

- What factors may be affecting declining size of lake trout at older ages? Is this related to diet? And/or to shift in distribution to colder temperature regimes?
- What is the relative contribution of declining growth to changes in lake trout spawning stock biomass. What other factors are contributing to changes in spawning biomass?
- What level of recruitment is required in order to promote and sustain lake trout populations? What factors limit recruitment of hatchery and wild fish?
- What effect is EMS having on the ability of lake trout to naturally reproduce in Lake Huron?

#### 2) Is there one life stage which is more critical to lake trout rehabilitation than any other life stage? [*Medium*]

Examples:

- What is the variation in rates of egg deposition, fry emergence, and fry survival on historically productive lake trout spawning reefs and what factors contribute to this variation.
- What is the variability in post-stocking survival of hatchery lake trout and what factors (stocking density, prey availability for adults, exotic species) influence survival rates?

#### 3) Are there specific life history information gaps which are limiting our ability to rehabilitate lake trout? [*Medium*]

Examples:

- What is the level of lake trout hooking mortality by size category? (This is directly related to existing lake trout population models in Lakes Huron, Michigan, and Superior.)
- What is the natural mortality of lake trout, by age group, in Lake Huron?
- What is the spatial definition, physical description, and present utilization of current and historic lake trout spawning reefs in Lake Huron today and how are they being utilized for spawning?
- Is declining prey availability and size having an adverse effect on lake trout age at maturation, spawning capacity?

ISSUE: Effects of Invasive Species on Indigenous Species

While indigenous species still exist in Lake Huron, they continue to be threatened by an ever expanding number of invasive nuisance species. The LHTC needs to know what impacts invasive species are having or may have on Lake Huron indigenous species.

- 1) How might round gobies affect the sustainability or recovery of native species in Lake Huron? **[HIGH]**  
Examples:
  - How do they affect lake whitefish production in Lake Huron?
  - Are round gobies having a negative effect on reproductive success of native species in Lake Huron?
  - How does the consumption of round gobies contribute to thiamine levels in lake trout?
  - What are the densities of round gobies in Lake Huron?
  - Is bioaccumulation of contaminants affected by predator switching to newly invasive species?
- 2) Do alewives and smelt have negative impacts on the recovery/existence of indigenous species in Lake Huron. **[HIGH]**  
Examples:
  - If so, what types of interactions exist between these species?
  - Are alewives and smelt having any impact on the ability of lake herring to recover in Lake Huron
  - What are alewife biomass estimates in proximity to successful spawning sites for lake herring? Other spring-hatching species?
- 3) What life stage of indigenous species is most likely to be impacted by invasive species in Lake Huron *[Medium]*  
Examples:
  - Are Dreissenid mussels and declining Diporeia affecting lake whitefish diet, growth, maturation, and body condition?
  - Is there an EMS phenomenon in walleye progeny from brood that consume a thiaminase-rich diet such as alewives?
  - What impact are exotics (principally Dreissenid mussels) having on spawning habitat of native fish species in Lake Huron?
  - What is the lethality of attack from sea lampreys, by species and size group on Chinook salmon, lake whitefish, walleye, bloater chub?

ISSUE: The carrying capacity of Lake Huron

In order to manage Lake Huron fish communities more effectively, it is necessary that we know what the carrying capacity of the lake is and how carrying capacity changes with changes to individual fish communities and populations.

1) What is the abundance of Chinook salmon in Lake Huron and what determines it? [*Medium*]

Examples:

- What is the extent of natural reproduction of Chinook salmon in Lake Huron and where is it occurring? What is the variability from year to year, from location to location?
- Is Chinook reproduction auto-regulated and, if so, how is it related to the prey abundance in the lake?
- To what extent has “benthic shift” caused by Dreissenid colonization reduced production of Chinook and other pelagic fish in Lake Huron?
- What is the spatial extent of Chinook shoal spawning in Lake Huron and what amount of production, if any, comes from these sites?
- What is the genetic make up of naturally reproducing Chinook salmon in Lake Huron? How much and how fast is genetic drift occurring?
- What is the best way to evaluate natural reproduction of Chinook salmon in Lake Huron? What is the error rate of oxytetracycline mark detection? What is the error rate in assigning age classes, using vertebrae, scales, and other structures, to Lake Huron’s slow-growing Chinook salmon?
- What is the extent and variation of inter-lake migration of Chinook salmon originating in Lake Huron? Originating in Lake Michigan?

2) Has production potential changed in Lake Huron and has there been a shift in production/pathways? How is energy being moved to fish? [**HIGH**]

Examples:

- Has primary productivity changed in Lake Huron and, if so, why, where, and to what degree?
- How do changes in lower food web pathways (particularly with respect to Dreissenid colonization) affect fish populations?
- Are there essential nutrients that are missing/sequestered (not channeled to fish, i.e. mussel colonies)?
- What is amphipod production in Lake Huron and has it changed in recent years?
- To what degree are episodes of hyperproductivity in the near-shore zone (especially Saginaw Bay) functions of foodweb change or nutrient inputs (rising nutrient loading from the watershed)? Can we design an index of biological integrity (for example, burrowing mayfly abundance) as a tool in monitoring nearshore trophic state?

3) Has the carrying capacity of Lake Huron tributaries and spawning shoals changed in such a way as to affect overall fish production in the lake? [*Medium*]

Examples:

- Which rivers/streams still maintain lake sturgeon natural reproduction and what is the magnitude of the production? How variable is it from year to year?
- Does shoal spawning of lake sturgeon still occur in Lake Huron and if so, to what extent?
- What are the sources of wild walleyes in Saginaw Bay? Do the outer shoals have the potential to contribute to the population?
- Can micro-chemical analysis be used to identify natal sources of fish?
- What are the sources of wild walleyes in the St. Mary’s River? What is the magnitude of natural reproduction?
- What is the sediment contribution of tributaries to Saginaw Bay and what are the consequences for habitat quality and walleye reproduction?

- 4) What are abundance, distribution, and composition of Lake Huron's prey base. **[HIGH]**. (Recent increases in effort by USGS appear to be adequately addressing elements of this issue.)

Examples:

- What are the abundance, distribution, and composition of Lake Huron's prey base as determined by hydro acoustic assessment? Does this agree with estimates using other techniques?
- Remnant populations of lake herring exist in Lake Huron. Where do they exist and what factors allow them to persist in some areas and not in others?
- Can the cisco (lake herring) be expanded beyond its current range in order to become a major prey item in Lake Huron?
- What is the cause of the recent dramatic decline in deepwater bloater populations? Are sex ratios in bloater populations a useful indicator of stress?
- Is prey fish availability in Lake Huron adequately represented with bottom trawling and hydroacoustics? What is the biomass of prey fish on hard substrates (that are not currently sampled)? What is the location and extent of these hard-substrates in Lake Huron?

ISSUE: Habitat

Habitat degradation and manipulation is an on-going issue in the Great Lakes. Knowing what types and amounts of habitat are available at different points in time is critical to understanding the ecosystem as a whole.

- 1) What is the quantity and quality of fisheries habitat in Lake Huron and its tributaries?

*[Medium]*

Examples:

- How accurate are current tributary classifications? (Ground truthing of GIS classification data.)
- Are there specific habitat types that are in short supply and thus impeding the survival/recovery of native fish species in Lake Huron?
- What is the status of the littoral fish community in the St Mary's River and how does it vary with shoreline type and anthropogenic development?
- If you reclaimed an inner bay reef in Saginaw Bay, would it be used by spawning walleyes or other species (whitefish for example) and actually produce fry?
- If fish passage were restored to rivers with barriers what levels of walleye and lake sturgeon reproduction could be expected?
- Where is the most critical spawning habitat for lake sturgeon in the Lake Huron watershed, what percentage is above dams or other man-made barriers, and what percentage is inundated by impoundments and therefore not available even if fish passage is provided?
- What risk does dam removal pose in increasing the range and production of invasive species, including Dreissenids, gobies and sea lampreys, in tributaries to Lake Huron? Would the positive benefits of dam removal on desirable species be significantly eroded by competition with or predation by exotics? Can fish passage be engineered so as to more selectively pass non-jumping native species while minimizing risk of passage by invasives?
- What levels of fish production can be expected from rehabilitated Saginaw Bay and St. Mary's River?
- Has reef spawning habitat quality been influenced by colonization of the reefs by dreissenids? What is the extent and exact location of these reef habitats?

- 2) What is the high resolution surficial geology of Lake Huron? *[Medium]*

Examples:

- Can maps be developed to identify geological features, in particular bedrock outcroppings, as they relate to lake whitefish and lake trout distribution and spawning habitat?

ISSUE: Sea lamprey control

Sea lamprey control has been the foundation for rehabilitation of Great Lakes fisheries. Yet, certain sea lamprey control measures have unintended consequences to native species. Building barriers to sea lamprey spawning migrations may reduce reliance on TFM (and nontarget mortality of fish) but it may also inhibit reproduction of native potamodromous fishes. There is a need to continue to develop sea lamprey control methods that minimize effects on nontarget species while maximizing effectiveness of sea lamprey control. The Lake Huron Technical Committee believes this research area should be funded by the GLFC sea lamprey control research program.

- 1) What are the risks of TFM treatment options designed to reduce incidental kills of nontarget fish, relative to potential increased survival of sea lampreys and increased sea lamprey depredation rates on adult sturgeon and other species? [*Medium*]
- 2) If barriers are removed to restore passage of desirable fish species, how much would the spawning and larval habitat for sea lampreys be increased and what level of production would be expected? Could the potentially destructive impacts of increased sea lamprey production be mitigated using other control methods, such as lampricide application? [*Medium*]
- 3) Are there barrier designs that would allow passage of nonjumping fish, such as sturgeons, suckers, and walleyes, while preventing passage of sea lampreys? [**High**]

**High Priority Research List for 2008-09, Lake Huron Technical Committee**

- 1) What are the chief impediments during early life stages to lake trout rehabilitation. What are the effects of alewives, dreissenids, round gobies, rusty crayfish, and other egg/fry predators on early life stage (from egg stage to recruitment to the fisheries) survival? What are the effects of thiamine deficiency on reproductive success?
- 2) How have lower foodweb linkages (nearshore/offshore, pelagic/benthic, primary to secondary, for example) been affected by dreissenid colonization, and how have those changes influenced fish production, with particular emphasis on species with recreational, commercial, and heritage values?
- 3) How can agencies optimize their investments in fish passage improvements, particularly with respect to dams that presently prevent upstream migration of lake sturgeon, walleyes, and other fish identified in the Fish Community Objectives as in need of restoration/enhancement? Are there ways of doing so while limiting passage of undesirable species? What percentage of spawning habitat, particularly for lake sturgeon, is inundated by the impoundments of these dams and therefore can only be made available by dam removal?

**D. Lake Michigan** (organized based on their Fish Community Objectives  
[http://www.glf.org/pubs/SpecialPubs/Sp95\\_3.pdf](http://www.glf.org/pubs/SpecialPubs/Sp95_3.pdf))

The Lake Michigan Priority Research Needs were developed to encourage progress towards meeting Lake Michigan Fish Community Objectives (FCOs). We emphasize that the specific FCOs need to be interpreted in the context of the Goals and Guiding Principles within which they were framed. Interested researchers should review the FCOs (Eshenroeder et al. 1995), as well as the latest version of the State of Lake Michigan document (Holey and Trudeau 2005), for additional background information concerning these research priorities. Priorities are updated annually; copies of the most recent priority list, the Fish Community Objectives, and the State of Lake Michigan report are available on the GLFC web site ([www.glf.org](http://www.glf.org)), from the chairperson of the Lake Michigan Committee (Jim Dexter – Michigan DNR), or from the chairperson of the Lake Michigan Technical Committee (Brad Eggold - Wisconsin DNR). **The current list priority research questions identified by the Lake Michigan Committee and Technical Committee are indicated below**, but any innovative research project that clearly will advance the achievement of FCOs will be given serious consideration for support by the LMC, even if not included on the specific list of priority research questions.

<b>Priority Rank</b>	<b>Research item</b>	<b>Objective</b>
1	What contributions do naturalized fish make to the lakewide salmonine abundances, production, forage demand, and annual yield?	Salmonine
2	What levels of salmonine production and yield are achievable without threatening the biological integrity of the Lake Michigan fish community? The biological integrity of the salmonine community would be considered threatened if high levels of forage demand substantially increased the risk of a collapse of the salmonine fishery as was experienced in the late 1980s.	Salmonine
3	What indices would best provide an early warning sign that the forage demand of the salmonine community is near to exceeding the capacity of the Lake Michigan system?	Salmonine
4	What is the annual and regional variation in thiamine levels of lake trout and the relationship between thiamine and EMS?	Salmonine
5	What is role of alewife in controlling other planktivores?	Planktivore
6	What steps can be taken to rehabilitate native planktivores (e.g., lake herring, emerald shiners)?	Planktivore
7	What are the population-level and fishery implications of changes in whitefish condition and/or energetic status in Lake Michigan (see lake whitefish workshop priorities)?	Benthivore
8	What should the harvest policy be for yellow perch in Lake Michigan, taking into account our understanding of the system and the inherent unpredictability of the system?	Inshore Fish
9	What is the relationship between observed wounding indices (from both spring and fall observations) and the actual mortality	Sea Lamprey

	experienced by lake trout, Chinook salmon, and other host species?	
10	What is the level of yoy production and mortality at the Midlake Reef?	Salmonine
11	What are the specific positive and negative effects of exotic species introductions on the Lake Michigan ecosystem?	Other Species
12	What are the best strategies for prevention of new introductions of exotic species in Lake Michigan?	Other Species
13	Do changes in species and biomass composition within inshore and/or open-water zooplankton and deepwater invertebrate populations influence prey fish biomass? If so, to what degree?	Planktivore
14	What strains (lake trout) are contributing to spawning (i.e. eggs and fry recovered)?	Salmonine
15	What are the risks and expected benefits associated with using a diversity of control methods (lampricides, barriers, sterile males, pheromones) and what would be the appropriate levels of effort to maintain sea lamprey abundance at or below target levels?	Sea Lamprey
16	What is the role of spawning stock abundance in determining yellow perch recruitment in Lake Michigan?	Inshore Fish
17	Is the current wounding target level of 5 wounds per 100 lake trout appropriate to the Lake Michigan fishery?	Sea Lamprey
18	Do zooplankton density, size structure, and / or taxonomic composition limit recruitment of yellow perch?	Inshore Fish
19	What need is there for sturgeon passage in various Lake Michigan tributaries (both upstream and downstream) and what technology's can be successfully employed to meet these needs?	Benthivore
20	What are the environmental factors impeding progress toward achieving the Fish Community Objectives for Lake Michigan?	Physical Habitat
21	What are current rates of recruitment (population trajectory) for existing populations of lake sturgeon in Lake Michigan?	Benthivore
22	Where is the important lake bottom habitat – near-shore and reef structures?	Physical Habitat
23	What should the proper protocols for identifying and cataloging critical fish habitat be?	Physical Habitat
24	What is the stock structure of the other fish species comprising the Lake Michigan fish community?	Other Species

## E. Lake Superior

A review of the fish community objectives for Lake Superior (link to [http://www.glf.org/pubs/SpecialPubs/Sp03\\_1.pdf](http://www.glf.org/pubs/SpecialPubs/Sp03_1.pdf)) and the Lake Superior State of the Lake Report ([http://www.glf.org/pubs/SpecialPubs/Sp94\\_1.pdf](http://www.glf.org/pubs/SpecialPubs/Sp94_1.pdf)) provides a useful context for the priorities listed below.

- 1) What are the sustainable levels of whitefish, lake herring (cisco), and lake trout that can be harvested from Lake Superior?
- 2) Is physical habitat limiting achievement of specific fish-community objectives?
- 3) What are the impediments to rehabilitation of depleted native species such as walleye, brook trout, lake sturgeon, and shortjaw in Lake Superior?
- 4) What is the production potential of important fishes (i.e. lake trout forms, cisco, lake whitefish, deepwater ciscoes, *Mysis*) in Lake Superior? More specifically, the LSTC is interested in knowing what the production potential is of nearshore and offshore waters, what is the source of energy for production of these two areas, and what is the extent of energy transfer between trophic levels and across habitats (tributaries, embayments, nearshore, and offshore)?
- 5) What is the ecology of cisco during their first year of life?
- 6) What is the structure and function of the offshore fish community in Lake Superior?
- 7) What would be surplus production dynamics of siscowet populations and what are the ecosystem implications of substantially increasing the harvest of siscowets?

### **III. Fish Health Research Priorities**

#### **A. Top Research Priorities**

1. How can we non-lethally sample coldwater and coolwater fish for pathogens both in wild and fish culture situations?
2. How severely does Thiamine Deficiency Complex impact important Great Lakes fish stocks and what can be done to minimize the effect?
  - a. What is the effect of Thiamine Deficiency Complex on wild fish populations?
  - b. How can we simply and cheaply determine the level of thiamine in larval, juvenile and adult fish?
3. What is the host susceptibility and pathogenicity for the Lake Ontario strain of VHS?
4. Why do new fish diseases or pathogens emerge (e.g. Piscirickettsia, Heterosporis, Epizootic Epitheliotropic disease (EEDv), etc.) and how do we best detect them, conduct surveillance, organize data, identify the potential for them to negatively impact important culture or feral stocks, and how do we develop the means to control, minimize or dilute these diseases or pathogens?
  - a. What is the best and most cost-effective epidemiological protocol for us to analyze new or emerging diseases?
  - b. What practical screening technique can be used to identify the EED virus?
5. What specific factors allow the progression of pathogens to become harmful diseases at the population level in important fish stocks in the Great Lakes, as well as in the culture system?
  - a. How severely is botulism impacting important Great Lakes fish stocks and what can be done to minimize the effect?
  - b. How severe is infectious pancreatic necrosis (IPN), what is the best screening technique and how do we develop the means to control, minimize or dilute the disease or pathogen?

#### **B. General Research Priorities**

##### **1. Methods and measures**

- a. Identifying and validating predictive indicators of health.
- b. Improved methods for sampling/counting fish and pathogens.
- c. Validated methods for classifying health and exposure of individual fish and populations

- d. Integrated health information management and health policy research and development.

## **2. Population Ecology of Disease**

- a. What are the population regulating effects of disease?
- b. Transmission dynamics.
  - i. Aspects of the agents (ex. microbial ecology)
  - ii. Aspects of host interactions.
  - iii. Descriptive ecology (what is there and where is it?)

## **3. Ecological determinants of health**

- a. How do management decisions affect the manifestation of fish health and disease?
  - i. Exotics, stocking practices, toxins.
- b. How do non-anthropogenic variables affect the same?
  - i. Climate, nutrition, genetics etc.
- c. Can management effectively respond to major ecosystem disruptions?

## **4. Research Development and Support**

- a. Training of highly qualified individuals
- b. Pre-planning workshops
- c. Outbreak/response capacity (need to see the events and investigate)
- d. Need to think about how to move forward in a multi-risk, multi-disciplinary fashion?

# **C. Specific Research Priorities**

## **1. Nutritional determinants of health**

- a. Role of lipids in determining and predicting health status
- b. Role of thiaminase producing organisms in Great Lakes ecosystems
- c. What changes in nutrient cycles have zebra mussels caused?
- d. Modeling the outcomes in shifts in nutrient stores due to invaders
- e. What is the relation of parental nutrition to reproductive success?
- f. What is the role of feed formulations (Abernathy vs Private Label formulations), feed manufacturing methods (steam pelleting vs extrusion), fish meal and oil substitutions due to dwindling world supply, and contaminated feed ingredients in post-stocking survival, migratory behavior and reproductive success of hatchery reared salmonids.
- g. How can we cheaply determine the level of thiamine in fish?

## **2. Disease ecology**

- a. What is the nature and significance of differences in susceptibility to specific diseases between different fish species?
- b. What is the source of Renibacterium in the whitefish subfamily?
- c. How do fish stocked disease-free become infected with Renibacterium?
- d. What is the role of piscivorous fish in the transmission of fish diseases?
- e. What are the vectors and movements of Large Mouth Bass virus and Heterosporis?
- f. What are the interactions and dynamics of populations of Aeromonas salmonicida and fish populations?
- g. How are diseases transmitted within and between species?
- h. What affects the virulence of IPNV?
- i. What is the host susceptibility and pathogenicity for Lake Ontario strain VHS?

### **3. Surveillance and descriptive epidemiology**

- a. What are the geographic ranges of important pathogens?
- b. Can we develop sentinel salmon broodstock as predictive indices of EMS/TDC?
- c. What is the species distribution of important pathogens and what do they do?
- d. What are the pathogens and parasites found in the Baltic-Caspian that can be moved in ballast water?
- e. What are the reservoirs of disease agents in lake ecology?
- f. What is the nature of gonad development of fish influenced by sewage outflow (estrogen mimics issue)?

### **4. Testing and Sampling**

- a. EEDv diagnostic tool
- b. Can non-lethal methods for all pathogens be developed?
- c. Development and application of sampling and testing wild fish (field methods).
- d. Statistical sampling approaches for wild fish pathogens.
- e. What is the fate of hatchery released fish post-stocking in the lakes?

### **5. Disease Control**

- a. When should salmonids not be moved past barriers (from a disease perspective)?
- b. Do the supposed advantages of broodstock culling for Renibacterium outweigh possible genetic losses?
- c. Can immunostimulants be protective against BKD in hatcheries?
- d. Does vaccination in hatcheries increase pathogen virulence?
- e. Controlling parasites in the Great Lakes: Why isn't Whirling Disease a problem here?

## **6. Disease causation and impacts**

- a. Cancers versus colds – How to differentiate diseases that are themselves a big concern versus those that simply reveal underlying stressors?
- b. Stress mediated diseases.
- c. What are the impacts of energy pathways on BKD transmission?
- d. What are the nitrate levels in the Great Lakes and how do they influence fish health?
- e. What are the causes of natural mortality and how do we accurately estimate the amount of mortality – natural and otherwise – in wild fish?