

LAKE ERIE



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Lake Erie Lakewide Management Plan (LaMP) Technical Report Series

Degradation of Fish Populations

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4.1 Approach

The IJC listing criteria states that fish populations are impaired, “when fish management programs have identified degraded fish populations. In addition, this use will be considered impaired when relevant, field-validated, fish and wildlife bioassays with appropriate quality assurance/quality controls confirm significant toxicity from water column or sediment contaminants”.

Toxic contaminant impairment to fish is partially addressed in the Fish Tumors or Other Deformities assessment. However, the LaMP has identified a comprehensive assessment of impairments to fish reproduction (including impacts due to toxics and endocrine disruptors) as a gap. An assessment of fish reproduction has been placed on the LaMP parking lot for action in the future. Consequently, this assessment will focus on aspects of degraded fish populations that are not toxics related.

On Lake Erie, the Lake Erie Committee (LEC) of the Great Lakes Fishery Commission represents the 5 fishery management programs on Lake Erie. The LEC has defined degraded fish populations through the Lake Erie Fish Community Goals and Objectives which are endorsed by all 5 programs. Based on input from LEC member agencies, the following terms of reference were developed for assessment of the Lake Erie fish community:

- 1) A healthy fish community is defined as consisting of not only “commodity” or “highly-valued” species, but other necessary species as well, so as to lend balance and stability to the entire community.
- 2) Impairment to the beneficial use of Lake Erie fishes occurs when economically viable fisheries are unsustainable due to unhealthy conditions in the fish community.
- 3) Impairment is assessed in relation to the following issues:
 - *Biodiversity* (i.e., loss of native species);
 - *Harvestable Surplus Fish Production*;
 - *Keystone Predators* (species whose predatory actions can structure the overall aquatic community);
 - *Food Web Dynamics* (stability, structuring, efficiency of energy transfer)
 - *Forage Fish Availability*; and
 - *Reproduction* (physiology, loss of habitat, early life stage mortality).
- 4) Consistent with all of the "ecological" impairment assessments, these issues are assessed in relation to the following benchmarks:
 - examination of historical and current status of key fish species;

- evaluation of the fish community relative to Fish Community Goals and Objectives, as established by the Lake Erie Committee, Great Lakes Fishery Commission; and
- Food web function - factors (i.e., predation, weather, lake trophic status) that have structured the fish community of Lake Erie historically (i.e., across “ecological eras”) and comparisons of Lake Erie fish community dynamics to those of other water bodies.

Assessments were based on field data (where available) along with synthesis of information from the scientific literature. Impairment conclusions that are speculative, i.e., are based on our best professional judgment but lack conclusive supporting evidence, are italicized (see Table 2).

4.2 Historical and current status of key fish species

A number of fish species were identified as important “commodity” species or as species that contribute significantly to the ecology of the community. Background population “status” reports were generated for 28 species (or groups of species) to examine changes in populations over time. In general, five “ecological eras” were examined: a) pre-1900; b) 1900-1930; c) 1930-1972; d) 1972-1986; and e) 1986-present.

Both historical and current abundance trends for 26 species are summarized and grouped in Table 1 according to thermal and feeding preferences (i.e., position in the food chain) that characterize the ecological role of each species in the fish community. Species not included in this summary were the non-native trout and Pacific salmon species and several others classified as threatened, endangered, special concern, extirpated, or extinct. These species were excluded from this summary due to insufficient information at the species level.

Historically, fish population declines were most apparent for planktivores, piscivores, and for cold-water fishes, and were least evident for benthivorous, warm-water species (Table 1). Populations of many benthivores increased in recent years. Historically, the most significant stresses on the Lake Erie fish community were fishery exploitation, habitat degradation (especially from cultural eutrophication), and exotic species, but the relative importance of these factors varied among species.

From this exercise, impairments to beneficial use (Table 2) included a loss of native species (sauger, blue pike, lake trout, lake herring) that reduced biodiversity, surplus fish production, and overall community stability. The loss of lake herring also reduced prey fish availability to top (keystone) piscivores. Degradation and loss of spawning/nursery habitat led to reproductive failures for many fish species.

Table 4.1. **Thermal preference and foraging guild for selected Lake Erie fish species.**

| | Thermal Preference | | |
|--------------------|--|---|--|
| | Warm nearshore* | Cool offshore** | Cold open deepwater*** |
| <i>Piscivore</i> | white bass (-) ↓ smallmouth bass (0) ↑ largemouth bass (0) ↑ | walleye (0) blue-pike, sauger (-) esocids (-) ↑ | lake trout (-) burbot (-) ↑ sea lamprey (-) |
| <i>Planktivore</i> | gizzard shad (-) ↓ white perch (-) ↓ | emerald shiner (-) spottail shiner (-) alewife (-) | rainbow smelt (-) ↓ lake herring (-) |
| <i>Benthivore</i> | bigmouth buffalo (+) ↑ smallmouth buffalo (+) ↑ freshwater drum (0) channel catfish (0) ↑ carp (0) | yellow perch (-) ↑ lake sturgeon (-) ↑ round goby (+) ↑ | lake whitefish (-) ↑ sculpins (-) ↓ |

+ = current abundance above **historical** average;
0 = current abundance near **historical** average;
- = current abundance below **historical** average;

Arrows indicate increasing or decreasing trend in abundance for **recent** years.

Species in bold type = native populations are no longer present. Only Lake Trout populations are currently being rehabilitated through stocking.

* = ≥ 27 C; ** = 18-27 C; *** = less than 18C

4.3 Fish community relative to the Fish Community Goals and Objectives (FCGO)

In January 1999, the Lake Erie Committee (LEC) of the Great Lakes Fishery Commission formalized a set of FCGO with several guiding principles:

- preference to self-sustaining indigenous species over naturalized species;
- prevention of non-indigenous species introductions;
- maintenance and restoration of fundamental habitats;
- preservation of biodiversity;
- sustenance of economically-valuable fisheries; and
- Lake Erie's biological limit to productivity.

The objectives encompass:

- a west-east gradient in productivity;
- sustainable harvest of 50-60 million lbs. of high-valued fish species annually;
- nearshore habitat and associated fisheries;
- riverine and estuarine habitats and fish stocks that use them;

- sustainable harvests for high-value fish species in each basin;
- contaminant issues of human consumption and reproductive inhibition in fish;
- fish habitat throughout the watershed;
- genetic diversity;
- rare, threatened, and endangered species; and
- prey base and food web structure.

The current status of fish species (Table 1) relative to FCGO suggests impairment of beneficial use (Table 2) due to loss of native species (sauger, blue-pike, lake trout, lake herring, pike, and muskellunge) which in turn has reduced biodiversity and fish community stability. Surplus production for fisheries (comparing the '80s to the '90s) is impaired for several species, including walleyes and yellow perch. Per the FCGOs, the combination of non-indigenous species and changes in lake productivity and water transparency has impaired overall food web structure, prey fish availability, and the behavior of walleyes. Loss of fish habitat has affected reproduction for several species, including walleyes and lake trout.

4.4 Food web function of the Lake Erie fish community

Analyses of the food web within Lake Erie's basins were undertaken to examine the effects of non-indigenous species, native predators, and environmental changes on overall system structure. The fish community has become progressively astatic from west to east, owing to inefficient transfer and loss of energy through the pelagic food web, due to competition between non-indigenous and native fish species, over-winter mortality on non-indigenous species, and loss of potentially stabilizing effects from top piscivores. The community has also been affected by the loss of nearshore habitat that is critical to reproductive success for many species, including top predators like sauger, northern pike, and muskellunge.

These ecological changes have impaired the biodiversity of the Lake Erie fish community through the loss of predatory function both in nearshore and pelagic areas of the lake. The presence of non-indigenous species (i.e., gizzard shad and alewife) has severely impaired efficient transfer of energy from primary producers to top predators, resulting in energy being "lost" to important fish species. As a result, the fish community has become increasingly susceptible to further perturbations. Loss of nearshore habitat to human development or activities adversely affects system function and impairs reproduction of many fish species (i.e., sauger, northern pike, and muskellunge) that serve as top predators in the community.

4.5 Impairment Conclusion

All systems have natural variability. However, the fish community of Lake Erie suffers from an unnaturally high level of instability, due to the combination of changes in lake productivity, inefficient use of energy within the food web (due to the introductions of non-indigenous species and loss of native species), and loss of critical nearshore habitat. Some members of the pristine Lake Erie fish community are gone (i.e., blue pike,

sauger), constituting the loss of fishery opportunity (an impairment to beneficial use). Because the community is unstable (hence unpredictable), sustenance of extant fish populations and associated fisheries is uncertain, and constitutes another impairment to the beneficial use of Lake Erie fishes. The full degree of current impairment, and the extent to which current impairment can be reversed, can only be assessed after ecosystem objectives have been identified. And finally, due to instability of the lake system and the changing conditions in the lake, the impairment information in this report is subject to change.

Table 4.2. Impairment of the Lake Erie fish community, as identified from three approaches: 1) a historical comparison of fish population status, 2) achievement of fish community goals and objectives (FCGO) developed by the Lake Erie Committee of Great Lakes Fishery Commission, and 3) Food web function. Items in italics are speculative. N/A= not applicable.

| Item | Comments | Historical | FCGO | Food Web Function |
|--|---|--|---|--|
| Biodiversity | Loss of native stocks | Impaired due to losses | Impaired due to losses | Impaired due to losses and addition of exotics |
| Harvestable Surplus Fish Production | 1990s versus 1980s | N/A | Impaired for walleyes, yellow perch, smelt, white bass | Changes have occurred with fish community succession |
| | Pre-1980 | Impaired - loss of lake herring, blue-pike, sauger, lake trout | N/A | N/A |
| Keystone Predators (species whose predatory actions can structure the overall aquatic community) | Walleye | Some stocks are impaired due to limited spawning habitat | Impaired as light spatially and temporally limits habitat volume and predatory function relative to '80s | <i>Reduced predatory function due to habitat limitation may be an impairment</i> |
| | Lake Trout | Impaired - loss of native stocks | Impaired due to lack of natural reproduction | Profundal predatory function restored through stocking |
| | Northern Pike and Muskellunge | Impaired - stocks reduced due to loss of habitat | N/A | Impaired - reduced nearshore predatory function |
| | Sauger and Blue Pike | Impaired – no native stocks remaining | N/A | Impaired : loss of predatory function |
| Food Web | Stability, Structuring, and Efficiency of energy transfer | N/A | Impaired due to presence of exotics, loss of biodiversity (including vector species), and lack of full piscivore assemblage | Impaired due to presence of exotics, loss of biodiversity (including vector species), and lack of full piscivore assemblage. <i>Native fish community was more resilient than current community.</i> |
| Forage Fish Availability | Soft-rayed more important than spiny to piscivores | Impaired: loss of species (lake herring) | Impaired: low diversity and productivity decline | Impaired: exotics (clupeids) less stable than native fishes |
| Reproduction | Reproductive physiology | N/A | N/A | <i>Thiaminase and goiterogens issues</i> |
| | Loss of habitat | Impaired: loss of spawning and nursery habitat | Impaired: loss of spawning and nursery habitat | Impaired: loss of spawning and nursery habitat |
| | Impingement and entrainment effects on fish eggs/larvae | <i>Potential impairment on local stocks</i> | N/A | N/A |