STATE OF LAKE HURON: CURRENT AND FUTURE

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The fish community of Lake Huron has changed dramatically over this five-year reporting period and shows signs of more change soon to come. Major shifts in predator and prey biomass and community structure have moved the community in the direction envisioned in the FCOs (DesJardine et al. 1995). The reasons for the changes are not fully understood, but their existing and potential impacts have been reviewed in earlier sections, and we summarize them in this overview.

Predator-Prey Issues

Indigenous predator species, such as lake trout and walleye have increased in abundance in Lake Huron, and, by the end of the five-year period, lake trout dominated the reported yield from the salmonine community, just as envisioned in the FCOs. Lake trout stocking has remained relatively unchanged since 1992, suggesting that the increased abundance is due to increased survival. Mortality on lake trout due to sea lamprey has decreased (primarily due to treatment of the St. Marys River), and improved management practices have decreased the likelihood of overfishing of lake trout. Increases in the recruitment of wild-born indigenous species, including lake trout, are encouraging, as is the increased natural-based recruitment of introduced predators, such as Chinook salmon. Declining abundance of some predators, most notably Chinook salmon and burbot, suggests a decline in total predator abundance because the increased abundance of lake trout and walleye has not fully compensated for the declines in Chinook salmon and burbot. Overall, however, the fish community appears to have

moved closer to the FCO of a system dominated by indigenous top predators.

Simultaneous with the decline in overall abundance of top predators, the abundance of dominant prey species declined, too, substantially altering previously existing predator-prey interactions. Alewives, in particular, became almost undetectable in 2004. The large lakewide decline in abundance of this species is notable because the alewife was formerly the most-utilized prey by the lake's top predators. The decline in prey biomass has had a negative effect on growth of top predators, thereby reducing the likelihood of achieving predator yield objectives. However, for a variety of reasons, declines in the abundance of the alewife and smelt appear to be having positive effects on other fishes and may, in fact, be promoting especially the recovery of native species other than the walleye and lake trout and a more ecologically balanced fish community. The improved recruitment of native species, apparently in response to the decline of the alewife population, is broader than some would predict (Madenjian et al. 2008), but the timing of these events is striking and unlikely to be coincidental.

Strong year-classes of several prominent species, in particular those with pelagic larvae, were produced in 2003 and 2004. Yellow perch and walleye year-classes in 2003 were the biggest on record in the main basin. The 2003 year-class of lake whitefish also appears to have been of record size in the main basin. Moreover, the near elimination of the alewife from the lake trout diet should markedly reduce the effects of early mortality syndrome on this species and, thereby, increase its reproductive success. The decline in alewife abundance also opens a potential niche for native pelagic fishes. Increased bloater recruitment in 2003 and 2004 and increasing cisco abundance in recent years point towards a negative interaction between native and introduced planktivores. The resurgence of native predators and prey fishes in the face of declining non-indigenous prey indicates substantial progress towards achievement of the lake's FCOs.

Yield-Based Fish-Community Objectives

While the new composition of the fish community can be viewed as positive, the sustainable yield levels specified in the FCOs for all species, particularly for predators, appear to be increasingly unrealistic. The total reported yield declined during the 2000-2004 period and, by 2004, was at about 60% of the FCO of 8.9 million kg. The reported salmonine yield averaged 1.0 million kg during the 2000-2004. Even after doubling the reported recreational Chinook salmon yield to acknowledge substantial extractions by the Ontario

recreational fishery, the adjusted average yield of salmonines of 1.6 million kg was well below the 2.4-million-kg FCO. Likewise, lake trout yield averaged about 0.5 million kg during 2000-2004, as compared with the desired range of 1.4 to 1.8 million kg. Increases in walleye recruitment in Saginaw Bay have not, as of 2004, translated into increased fishery yields. The average walleye yield of 0.2 million kg since 2000 is well below the FCO of 0.7 million kg. Lake whitefish continued to dominate the commercial fishery, and coregonine yields during the 2000-2004 period remained steady near the FCO of 3.8 million kg. Lake trout, Chinook salmon, and lake whitefish populations have all shown declines in growth and condition, suggesting that, under current ecological conditions, substantial increases in the abundance of these species are unlikely, and, even if such increases were possible, would not lead to correspondingly large increases in yields.

Historical-yield levels might now not be sustainable for reasons discussed in detail by Bence et al. (2005): first, the historical yields (1912-1940), upon which the FCOs are based, might not have been sustainable back then; and, second, the current prey-fish community is less likely to be able to harness the primary and secondary productivity of the lake than was the more-diverse historical prey-fish community dominated by coregonines. These concepts led Bence et al. (2005) to recommend intensive efforts to restore a more-diverse coregonine community, particularly of the cisco and of deepwater ciscoes. With respect to the cisco, this recommendation was made in an earlier section. Here we endorse the broader recommendation from Bence et al. (2005), involving reintroduction of deepwater cisco species, to better utilize the lake's productivity.

The growing and now dominant concern regarding potential yield reflects a situation where bottom-up factors have led to the decreased primary and secondary productivity available to fishes. Concerns about how declines in populations of *Diporeia* spp. (hereafter, diporeia as a common name) would impact the achievement of FCOs were previously expressed by Bence et al. (2005) and Mohr and Ebener (2005b). During 2001-2004, the pattern of declines in diporeia populations, while dreissenid mussels proliferated, has become even more evident. Hecky et al. (2004) proposed a linkage between these changes and *Cladophora* spp. blooms, which foul nets and directly interfere with fishing. Furthermore, recent surveys suggested that phytoplankton and zooplankton in the offshore pelagia of Lake Huron reached unusually low levels by 2004. Zooplankton groups showing the largest declines were, unfortunately, those most often consumed by fishes. While the causes of the changing lower-trophic levels are poorly understood, the import of such changes to achievement of objectives is unmistakable.

Although comparing current yields with the historical benchmarks used in the FCOs is illustrative, we believe that a primary emphasis on such comparisons is misplaced. From first principles, one would expect a range of sustainable yields that can be supported by a given fish population or by an aggregate of populations comprising multiple species. When populations are depleted or overfished, they can sustain little yield without further declines, but this is also true when populations are abundant and strong compensation is occurring, and, thus, peak sustainable yields occur at intermediate population sizes. Historically, much fishery management focused on maintaining fish populations near levels that maximized sustainable yields, while, more recently, this goal has been modified to account for competing ecological and economic objectives (usually towards higher levels of fish abundance and somewhat lower yields). This issue is recognized in the FCOs themselves, which, in the introduction, states that quantitative yield objectives "are viewed—not as targets—but as an indication of [fish] community response" (DesJardine et al. 1995). We believe this kind of thinking should become more explicit, so that new quantitative FCOs incorporate target abundance levels within the feasible range and/or define harvest policies that specify acceptable exploitation rates, given abundance. Fishery managers may wish to strive toward ecological states that allow higher sustainable yields at given abundance levels. When incorporating this suggestion into new FCOs, however, we believe one also needs to consider to what extent and through what means yield curves can be altered.

Ecosystem Integrity

The species present in Lake Huron in 2004 were essentially the same as reported in the 1999 state of the lake report, and the status of at-risk species has not changed either. Lake sturgeon abundance has increased slightly, but much more progress is needed before this species can be delisted, especially in Michigan waters. Unfortunately, invasive species continue to expand their range in Lake Huron. By 2004, the round goby had spread outside the main basin into southern Georgian Bay and the North Channel. The rusty crayfish also continued to expand its range and is now found in all three basins. While both of these species (especially round goby) are more common in the diets of native predators, the long-term impacts they are having on the whole fish community are still poorly understood and need to be a priority research topic. Steps also need to be taken to reduce the likelihood of new invasions. Agencies need to better recognize the ecological and economic impacts of existing invasive species to become more diligent about halting new introductions.

Substantial genetic research and evaluation have occurred during the past five years, in particular with respect to recovering native species: walleye, lake sturgeon, and lake trout. Genetic monitoring is likely critical as populations recover from low population sizes.

Notwithstanding a substantial effort to summarize available information on essential fish habitat, we believe little progress has been made on the recommendations of Bence et al. (2005) with regard to fish habitat and biodiversity. Those recommendations included identifying better defined or high-priority habitats in need of protection or at-risk populations with specialized habitat needs. Bence et al. (2005) also argued that the no-net-loss habitat objective was not realistic, and the habitat and species diversity FCOs would benefit from revision.

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