Abundances of the Bethic Amphipod Diporeia spp.

Formerly Indicator #123

Overall Assessment

Status: Poor

Trend: Deteriorating

Rationale: Abundances of the benthic amphipod Diproeia spp. continue to decline in Lake Michigan, Lake Huron, and Lake Ontario. Abundances in Lake Superior are variable but overall trends are stable. Diporeia are currently extirpated or very rare in Lake Erie.

Lake-by-Lake Assessment

Lake Superior

Status: Good

Trend: Unchanging

Rationale: Long- term monitoring of populations in deeper regions of the lake indicate that, although substantial interannual variability can occur, there are not directional trends in abundances of *Diporeia* in the lake. Other studies have shown abundances in shallower regions remain high.

Lake Michigan

Status: Poor

Trend: Deteriorating

Rationale: *Diporeia* abundances continue to decline in Lake Michigan. A lakewide survey in 2010 indicated that *Diporeia* are now rarely found at depths < 90 m (297 ft.) over the entire lake (Fig. 1). At depths > 90 m, abundances in 2010 were lower by 66 % compared to abundances found in 2005. While the trend remains downward at these deeper depths, more intensive temporal surveys (yearly) indicate that the rate of decline has slowed in recent years.

Lake Huron

Status: Poor

Trend: Deteriorating

Rationale: *Diporeia* abundances continue to decline in Lake Huron. The most recent survey lakewide survey occurred in 2007, and abundances were lower by 93 % compared to a similar survey in 2000. Long- term monitoring of abundances on a more limited spatial scale indicated that in 2009 *Diporeia* were rarely found at sites < 90 m, and abundances at sites > 90 m were trending downward.

Lake Erie

Status: Poor

Trend: Deteriorating

Rationale: Because of shallow, warm waters, *Diporeia* are naturally not present in the Western and most of the Central basins. *Diporeia* declined in the Eastern basin beginning in the early 1990s and have not be found since 1998.

Lake Ontario

Status: Poor

Trend: Deteriorating

Rationale: *Diporeia* abundances continue to decline in Lake Ontario. Based on limited sampling in 2009 – 2010, abundances were 97 % lower than abundances found in 1995. In 2010, *Diporeia* were completely gone from most areas of the lake at depths less than 150 m, and were absent for the first time at a deep mid-lake site (Fig. 2). . It is obvious that the deep, offshore region of Lake Ontario is no longer providing a refuge for *Diporeia*. Limited spatial data indicated a population was still surviving near the Niagara River at depths between 80 and 110 m.

Purpose

- To provide a measure of the biological integrity of the offshore regions of the Great Lakes by assessing the abundance of the benthic macroinvertebrate *Diporeia*

Ecosystem Objective

The ecosystem goal is to maintain a healthy, stable population of *Diporeia* in offshore regions of the main basins of the Great Lakes, and to maintain at least a presence in nearshore regions.

Ecological Condition

This glacial-marine relic was once the most abundant benthic organism in cold, offshore regions (greater than 30 m (98 ft) of each of the lakes. It was present, but less abundant in nearshore regions of the open lake basins, but naturally absent from shallow, warm bays, basins, and river mouths. *Diporeia* occurs in the upper few centimeters of bottom sediment and feeds on algal material that freshly settles to the bottom from the water column (i.e., mostly diatoms). In turn, it is fed upon by most species of Great Lakes fish; in particular by many forage fish species, which themselves serve as prey for the larger piscivores such as trout and salmon. For example, sculpin feed almost exclusively upon *Diporeia*, and sculpin are eaten by lake trout. Also, lake whitefish, an important commercial species, feeds heavily on *Diporeia*. Thus, *Diporeia* was an important pathway by which energy was cycled through the ecosystem, and a key component in the food web of offshore regions. The importance of this organism is recognized in the Great Lakes Water Quality Agreement: Supplement to Annex 1 – Specific Objectives (United States and Canada 1987).

On a broad scale, abundances are directly related to the amount of food settling to the bottom, and population trends reflect the overall productivity of the ecosystem. Abundances can also vary somewhat relative to shifts in predation pressure from changing fish populations. In nearshore regions, this species is sensitive to local sources of pollution.

Diporeia populations are currently in a state of dramatic decline in Lake Michigan (Figure 1), Lake Ontario (Figure 2), and Lake Huron, and they are completely gone or very rare in Lake Erie. The population in Lake Superior, although highly variable, remains unchanged. Initial declines were first observed in all lake areas within two to three years after zebra mussels (*Dreissena polymorpha*) or quagga mussel (*Dreissena bugensis*) first became established. These two species were introduced into the Great Lakes in the late 1980s via the ballast water of ocean-going ships. Reasons for the negative response of *Diporeia* to these mussel species are not entirely clear. One hypothesis is that dreissenid mussels are out-competing *Diporeia* for available food. That is, large mussel populations filter food material before it reaches the bottom, thereby decreasing amounts available to *Diporeia*. However, evidence suggests that the reason for the decline is more complex than a simple decline in food because *Diporeia* have completely disappeared from areas where food is still settling to the bottom and where there are no local populations of mussels. Also, individual *Diporeia* show no signs of starvation before or during population declines. Further, *Diporeia* and *Dreissena* apparently coexist in some lakes outside of the Great Lakes (i.e., Finger Lakes in New York).

Management Challenges/Opportunities

The continuing decline of *Diporeia* has strong implications to the Great Lakes food web. As noted, many fish species rely on *Diporeia* as a major prey item, and the loss of *Diporeia* will likely have an impact on these species. Responses may include changes in diet, movement to areas with more food, or a reduction in weight or energy content. Implications to populations include changes in distribution, abundance, growth, recruitment, and condition. Recent evidence suggests that fish are already being affected. For instance, growth and condition of an important commercial species, lake whitefish, has declined significantly in areas where *Diporeia* abundances are low in Lake Michigan, Lake Huron, and Lake Ontario. Also, studies show that other species such as alewife, slimy sculpin, and bloater have been affected. Management agencies must know the extent and implications of these changes when assessing the current state and future trends of the fishery. Any proposed rehabilitation of native fish species, such as the reintroduction of deepwater ciscoes in Lake Ontario, requires knowledge that adequate food, especially *Diporeia*, is present.

Comments from the author(s)

Because of the rapid rate at which *Diporeia* populations have declined in many areas, and their significance to the food web, agencies committed to documenting trends should report data in a timely manner. The population decline has a defined natural pattern, and studies of food web impacts should be spatially well coordinated. Also, studies to define the cause of the negative response of *Diporeia* to *Dreissena* should continue and build upon existing information. With an understanding of exactly why *Diporeia* populations are declining, we may better predict what additional areas of the lakes are at risk. Also, by better understanding the cause, we may better assess the potential for population recovery if and when dreissenid populations stabilize or decline.

Assessing Data Quality

Data Characteristics	Strongly Agree	Agree	Neutral or Unknown	Disagree	Strongly Disagree	Not Applicable
1. Data are documented, validated, or quality-assured by a recognized agency or organization	X					
2. Data are traceable to original sources	X					
3. The source of the data is a known, reliable and respected generator of data	X					
4. Geographic coverage and scale of data are appropriate to the Great Lakes basin	X					
5. Data obtained from sources within the U.S. are comparable to those from Canada	X					
6. Uncertainty and variability in the data are documented and within acceptable limits for this indicator report	X					
Clarifying Notes:						

Acknowledgments

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List of Figures

Figure 1. Distribution and density (number per square meter) of the amphipod *Diporeia* spp. in Lake Michigan in 1994/95, 2000, 2005, and 2010. Small crosses indicate location of sampling sites. Source: Great Lakes Environmental Research Lab, National Oceanic and Atmospheric Administration. USA.

Figure 2. Distribution and density (number per square meter) of the amphipod *Diporeia* spp. in Lake Ontario in 1995, 2003, 2005, 2007, and 2009/10. Averages derived from all stations sampled that year; small crosses indicate stations not visited. Source: Great Lakes Lab. for Fisheries & Aquatic Sciences, Fisheries and Oceans, Canada.

Last Updated

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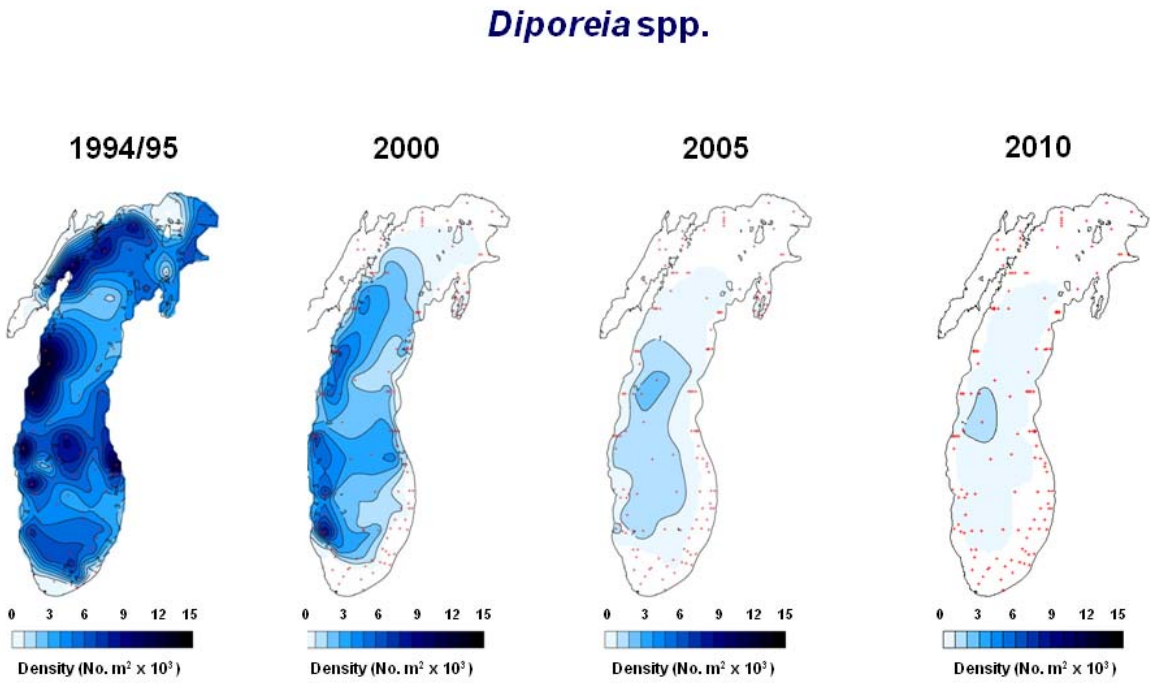

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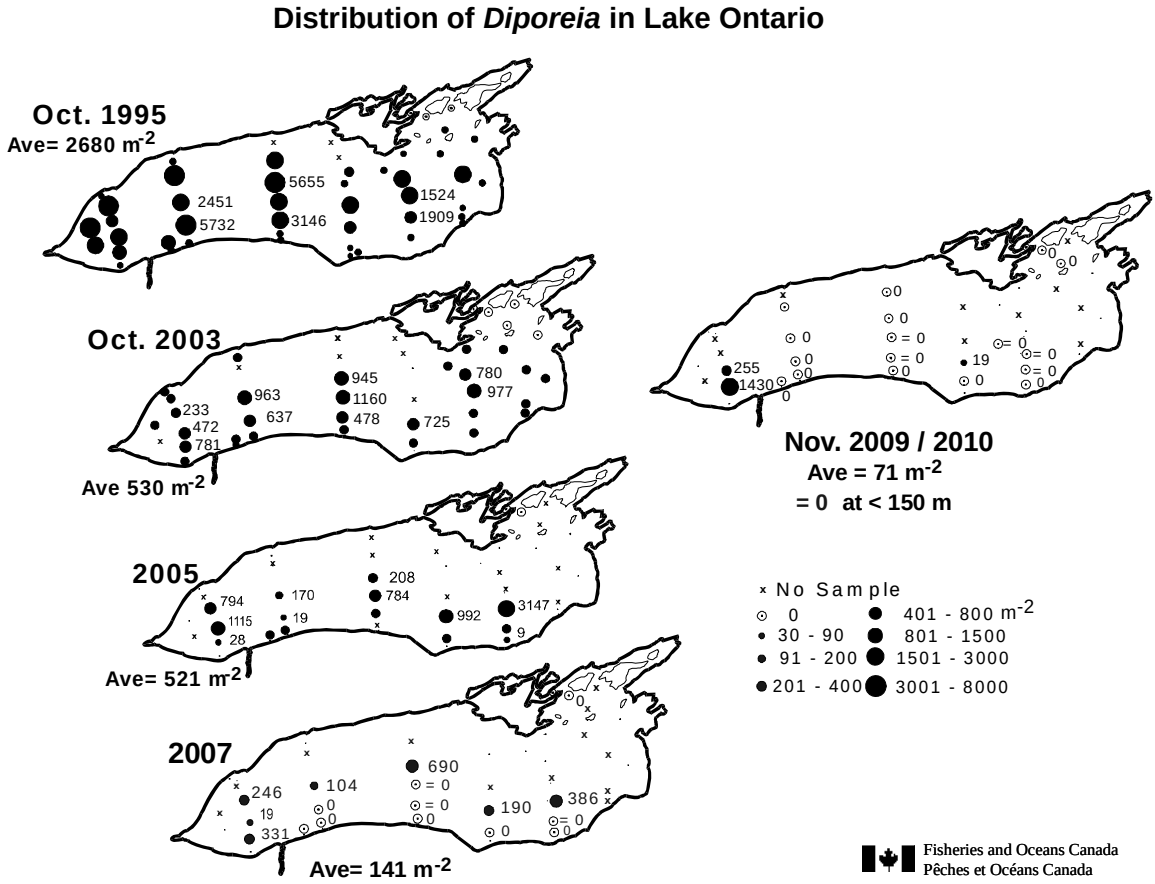

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