Hexagenia

Indicator #122

Assessment: Mixed, Improving

Purpose

- To assess the distribution, abundance, biomass, and annual production of the burrowing mayfly (*Hexagenia*) in mesotrophic Great Lakes habitats.

Ecosystem Objective

Historically productive Great Lakes mesotrophic habitats, e.g., western Lake Erie; the Bay of Quinte, Lake Ontario; Saginaw Bay, Lake Huron; and southern and Green Bay, Lake Michigan, should be restored and maintained as balanced, stable, and productive elements of the Great Lakes ecosystem with *Hexagenia* as the dominant, large, benthic invertebrate.

State of the Ecosystem

Background

Hexagenia is used as an indicator of ecosystem health because it is intolerant of pollution and is thus a good reflection of water and lakebed sediment quality in mesotrophic Great Lakes habitats, where it was historically the dominant, large, benthic invertebrate and an important item in diets of many nearshore fishes. *Hexagenia* nymphs live for 1 or 2 years in surface sediments in the Great Lakes, emerging as sexually mature adults for a period of only hours to a day or so to mate and the females to deposit eggs before dying (Figure 1, Figure 2).

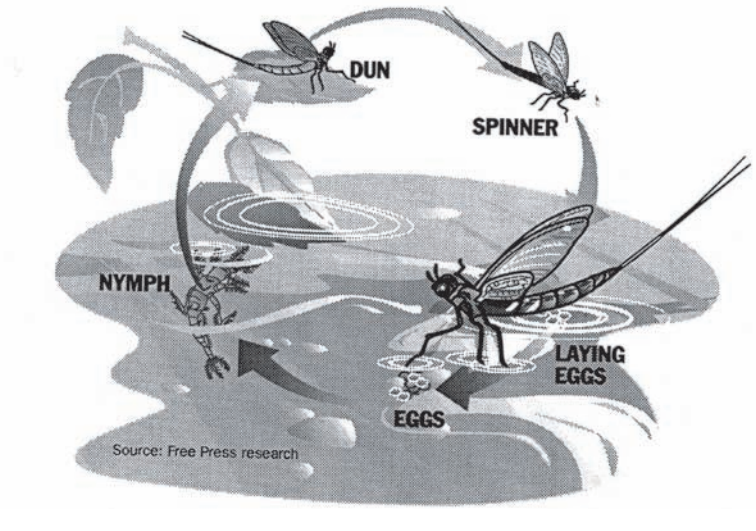


Figure 1. Hexagenia life cycle.
Source: Drawn by Martha Thierry, courtesy of the Detroit Free Press

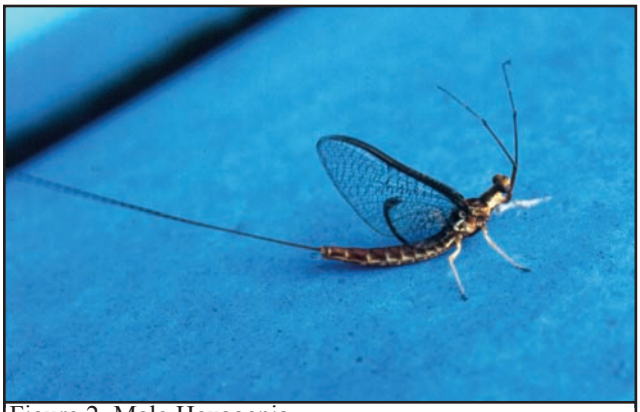
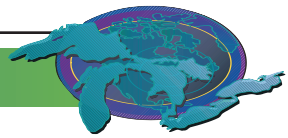


Figure 2. Male Hexagenia.
Source: U.S. Geological Survey, Great Lakes Science Center

Status of *Hexagenia*

Major declines in the abundance of *Hexagenia* and low abundance or absence in some Great Lakes habitats where they were historically abundant have been linked to eutrophication and low dissolved oxygen in bottom waters and to pollution of sediments by metals and petroleum products. For example, *Hexagenia* was abundant in the western basin of Lake Erie in the 1930s and 1940s but an extensive mortality occurred in 1953. The population there recovered in 1954, but extirpation followed throughout the western basin by the early 1960s (reviewed in Schloesser *et al.* 2001). Improvements in water and sediment quality in historical *Hexagenia* habitat following the imposition of pollution controls in the 1970s were not immediately followed by the recovery of *Hexagenia* populations (Krieger *et al.* 1996). Surveys in spring 2001 indicated that; no recovery of *Hexagenia* occurred in Saginaw Bay, little recovery occurred in Green Bay, and a near-full recovery occurred in western Lake Erie (Edsall *et al.* 2002). In addition, Canadian biologists report the recovery of *Hexagenia* in the Bay of Quinte, Lake Ontario indicating pollution control programs have significantly improved the health of that habitat (personal communication Ron Dermott, Canadian Center for Inland Waters, Burlington, Ontario). However, *Hexagenia* was extirpated in polluted portions of the St. Marys and Detroit Rivers by the mid-1980s, and no recovery has yet been reported for some of these areas.

The recovery of *Hexagenia* in western Lake Erie is a sentinel event, which shows clearly that properly implemented pollution controls can bring about the recovery of a major Great Lakes mesotrophic ecosystem. With its partial recovery, the *Hexagenia* population in western Lake Erie will probably reclaim its functional status as a primary agent in sediment bioturbation and as a trophic integrator directly



linking the detrital energy resource to fish, and particularly the economically valuable yellow perch-walleye community. The partial recovery of *Hexagenia* in western Lake Erie also helps remind us of one outstanding public outreach feature associated with using *Hexagenia* as an indicator of ecosystem health — the massive swarms of winged adults that are typical of healthy, productive *Hexagenia* populations in areas of historical abundance in the Great Lakes. These swarms are highly visible to the public who use them to judge the success of water pollution control programs and the health of Great Lakes mesotrophic ecosystems.

Pressures

The virtual extirpation and delayed recovery of the *Hexagenia* population in western Lake Erie was attributed to the widespread, periodic occurrence of anoxic bottom waters, although little evidence existed to support low oxygen persistence over the past 25 years. However, recent research has documented sporadic anoxia in portions of the western basin, and some data indicate different oxygen demand of sediments with and without recolonized mayfly nymphs (Bridgeman *et al.* In review; Schloesser *et al*. 2001; unpublished data, Schloesser). Most point-source inputs are now controlled, but in-place pollutants in lakebed sediments and non-point pollution appear to be a problem in some areas. Paved surface runoff, spills of pollutants, and combined sewer overflows also pose a major problem in some urban and industrial areas. Phosphorus loadings still exceed guideline levels in some portions of the Great Lakes and loadings may increase as the human population in the Great Lakes basin grows.

The effects of non-native species on *Hexagenia* and its usefulness as an indicator of ecosystem health are unknown and may be problematic. It has been postulated that the colonization of the western basin of Lake Erie by the zebra mussel (*Dreissena polymorpha*) and the recovery of *Hexagenia* are linked causally, but no specific mechanism has yet been proposed. Support for zebra mussel as a major factor in the recovery of *Hexagenia* in the western basin is perhaps eroded by the fact that Saginaw Bay, Lake Huron, is also heavily colonized by the zebra mussel, but the *Hexagenia* population there, which collapsed in 1955-1956, still has not shown signs of recovery.

Management Implications

Management activities that would foster the restoration and maintenance of *Hexagenia* populations in mesotrophics areas of the Great Lakes include:

- Regulation of point sources and non-point sources of pollution and sharply reduced spills of pollutants that enter nearshore waters to improve and maintain Great Lakes water and sediment quality consistent with the environmental requirements of healthy, productive populations of *Hexagenia*.

- Continuation of the development and application of technology and practices designed to restore lakebed and riverbed sediment quality in Areas of Concern (AOCs) and critical *Hexagenia* habitat areas that have problem levels of persistent, in-place pollutants.

- Development of a monitoring program to collect baseline data for *Hexagenia* populations in all major, historical, Great Lakes mesotrophic habitats so that changes in ecosystem health can be monitored and reported, management strategies evaluated and improved, and corrective actions taken to improve ecosystem health and to judge progress toward reaching interim and long term targets and goals.

- Implementation of monitoring protocols involving sampling in late spring, immediately prior to the annual emergence of adults.

- Research to describe the interactions between *Hexagenia* and introduced aquatic species and the effect of those species, if any, on the utility of *Hexagenia* as an indicator of ecosystem health.

- Determination of the most important limiting factor to recovery mayfly populations in nearshore waters of the Great Lakes.

- Development of predictive tools to estimate when mayfly populations will return to mesotrophic waters where they have not yet returned.

Acknowledgments

Author: Don W Schloesser, U.S. Geological Survey, Great Lakes Science Center, Ann Arbor, MI, dschloesser@usgs.gov.

Sources

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