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Toxicity of waters from the Rochester Embayment Area of Concern to the plankton species *Pseudokirchneriella subcapitata* and *Ceriodaphnia dubia*

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ABSTRACT

The lower Genesee River and Rochester Embayment of Lake Ontario are a designated Area of Concern (AOC) under the binational Great Lakes Water Quality Agreement. The "degradation of phytoplankton and zooplankton populations" or plankton Beneficial Use Impairment (BUI) was classified as unknown and in need of further assessment in this AOC because water quality data suggested plankton communities could be effected and community data were either unavailable or indicated impacts. The plankton BUI may now be obsolete because local contaminant sources have been largely eliminated. The present study was conducted between July 2013 and August 2014 to assess the BUI-removal criteria: "AOC plankton bioassays confirm that toxicity in ambient waters (i.e., no growth inhibition) is not significantly higher than comparable non-AOC controls". Acute and chronic toxicity of waters from 13 sites were quantified seasonally using standardized bioassays with the green alga *Pseudokirchneriella subcapitata* and water flea *Ceriodaphnia dubia* to test the hypothesis that toxicity of waters from AOC sites was not higher than that of waters from comparable non-AOC reference sites. Survival and reproduction of *C. dubia* did not differ significantly between site types, systems, or months. The growth of *P. subcapitata* did not differ between site types, but differed among systems and months. All results indicate that waters from AOC sites were no more toxic to both plankton species than waters from reference sites. Assuming test species represent natural plankton assemblages, water quality should not negatively affect survival and growth of resident plankton populations in the Rochester Embayment AOC.

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Introduction

During the 1970s and 80s, the governments of Canada and the United Stated committed to restore the physical, chemical, and biological integrity of Areas of Concern (AOC) throughout the Great Lakes under the Great Lakes Water Quality Agreement (GLWQA) (*http://www.epa.gov/greatlakes/glwqa/1978/index.html*). An AOC is a geographic area that fails to meet the general or specific objectives of the agreement where such failure has caused or is likely to cause impairment of beneficial uses or of the area's ability to support aquatic life. The Rochester Embayment and 9.6 km of the lower reach of the Genesee River at Rochester, New York (Fig. 1) was designated as one of 43 AOCs with likely or known impairment to beneficial uses caused mainly by past municipal and industrial pollution (NYSDEC, 1993a, 1993b). The "degradation of phytoplankton and zooplankton populations" or the plankton Beneficial Use Impairment (BUI) was designated as "unknown" and in need of further assessment in the Rochester Embayment AOC because water quality data suggested their communities were likely impacted and because plankton data were unavailable or indicated their communities were affected. Nutrients, polychlorinated biphenyls (PCBs), mirex, dioxin, pathogens, oil and grease, and silt/sediment were identified as the pollutants that impair aquatic life in the lower 18.8 km of the Genesee River (NYSDEC, 2003). This report noted that the significant silt and sediment load was natural and that anthropogenic contaminants originate from: (a) various industrial and municipal point sources and combined sewage overflows (CSOs) in the metropolitan Rochester area, (b) nonpoint urban and agricultural runoff, (c) contaminated sediments, and (d) inactive hazardous waste sites (NYSDEC, 2003). Although contaminated, sediments from the Genesee Harbor are dredged by the U.S. Army Corps of Engineers every other year and disposed in the Rochester Embayment about 3 km northeast of the river's mouth; re-suspended contaminants could potentially impact water quality and plankton communities in the AOC (NYSDEC, 1993b). Other studies identified phenols and eutrophication as possible sources for reduced survival and growth of *Ceriodaphnia dubia* in toxicity tests done during 1989–90 (NYSDEC, 1993b). Although they were not the focus of this investigation, contaminated sediments could also affect water quality (and toxicity) under some circumstances (e.g., flood flows). Concentrations of dichlorodiphenyltrichloroethane (DDT), dieldrin, mercury, and PCBs exceeded acceptable (standards or guidance) levels in some sediment samples collected from the Lower Genesee River or

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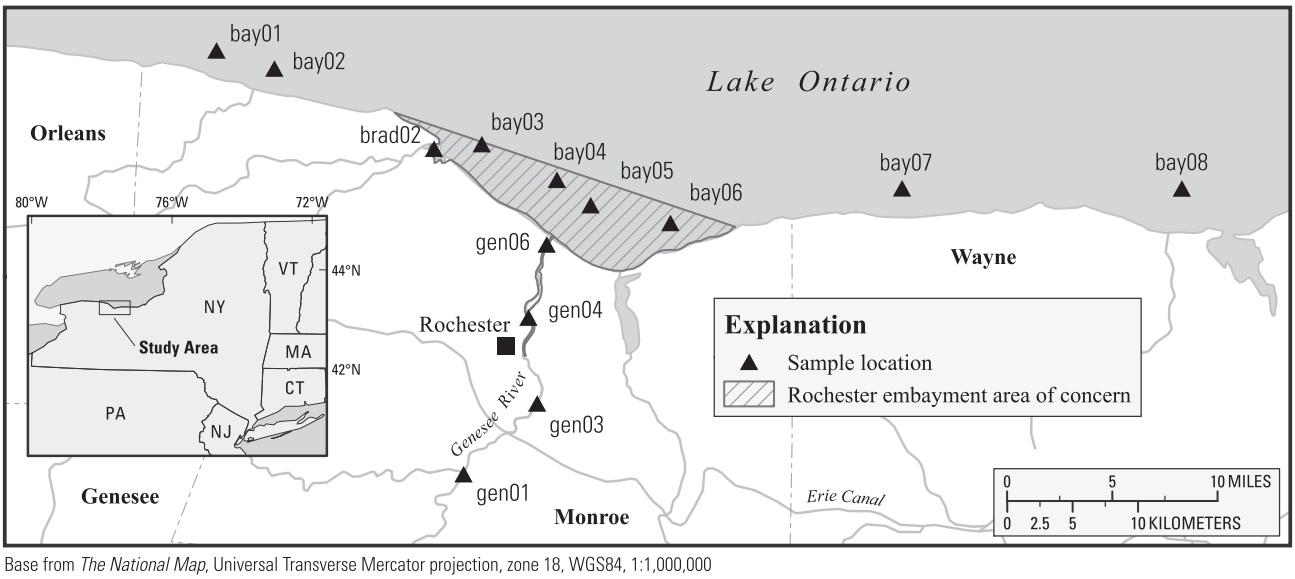

Fig. 1. Map of AOC and reference sites sampled in or near the Rochester Embayment and Genesee River AOC.

Rochester Embayment between 1973 and 1990 (NYSDEC, 1993b). A more recent investigation detected low levels of dieldrin, endrin, DDT, and methoxychlor and concentrations of cadmium and zinc that exceeded probable effect levels at several sites in the Lower Genesee River as well as high concentrations of cadmium, copper, nickel, zinc, DDT, and PCB 1260 in Braddock Bay (NYSDEC, 2007). Over the past three decades, declines in the quantity of waste water discharges and (or) decreases in contaminants from permitted wastewater dischargers (NYSDEC, 1993a, 2011) suggest that the quality of local waters has improved and that the plankton BUI may be outdated in this AOC.

Since the 1980s, Remedial Action Plans (RAPs) were developed by local Remedial Action Committees to guide restoration efforts and remove existing BUIs from each of the 43 AOCs. The Rochester Embayment RAP was developed by the Monroe County Department of Health and includes an ecosystem approach to AOC assessment and remediation, recognizing that the entire Genesee River watershed drains into the Embayment (NYSDEC, 1993b). The RAP established specific criteria in the Rochester Embayment AOC for delisting (restoring and protecting) the "degradation of phytoplankton and zooplankton populations" BUI. These criteria have been modified since their inception and most currently state that: (1) "AOC plankton bioassays confirm that toxicity in ambient waters (i.e., no growth inhibition) is not significantly higher than comparable non-AOC controls," or (2) "ambient water samples of AOC waters comparable to non-AOC control sites cause no toxicity to zooplankton and phytoplankton" (personal communication with Charles Knauf, 4/12/2013). Detailed background information on the Rochester Embayment AOC and the RAP can be found in the report "December 2011 Addendum to Stage I and II Remedial Action Plans" (NYSDEC, 1993a, 2011). Unfortunately, current information needed to assess water toxicity and the health of plankton communities are unavailable; thus, the status of the plankton BUI in this AOC remains unknown.

The U.S. Geological Survey, New York State Department of Environmental Conservation, and American Aquatic Testing initiated a study in 2013 to evaluate the toxicity of ambient waters from across the Rochester Embayment AOC to the green alga *Selenastrum capricornutum* and water flea *C. dubia* in order to determine if the plankton BUI should be removed in this AOC. *Pseudokirchneriella subcapitata* is the currently accepted taxonomic nomenclature for *S. capricornutum* (*http://www.fritschalgae.info/Selenastrum.html*) and is used for the remainder of the present paper. Both plankton species are very sensitive to toxins and widely distributed in ponds, marshes, and lakes across most of the United States and Canada (USEPA, 2002a; WDNR, 2004). Standardized toxicity tests (bioassays) have been developed for each species and are commonly used to assess the levels of nutrients or toxins in freshwater environments (USEPA, 2002b). Both species were exposed in the laboratory to seasonal (summer 2013, fall 2013, and spring 2014) water samples from 13 sites and monthly (July 2013 through August 2014) water samples from two sites to assess current toxicity at sites from inside and outside of the AOC. The main objective of the present paper is to determine if the phytoplankton and zooplankton beneficial use is impaired or not impaired in part or in all of the Rochester Embayment AOC. Plankton toxicity data are summarized and evaluated specifically to test the hypothesis that waters at sample locations in the Genesee River and Rochester Embayment AOC are no more toxic to plankton than are waters from reference (control) sites located outside the AOC.

Methods

Toxicity was assessed in waters collected from 7 AOC and 6 control sites located inside and outside the Genesee River and Rochester Embayment AOC (Fig. 1, Table 1). There were only two basic criteria for all study site locales; they had to be either within or outside the AOC (George and Boyd, 2007; IJC, 1991). All control sites (referred to as reference sites hereafter) were located outside of the AOC; they were intended to provide a gauge, not necessarily of pristine (or non-toxic) water-quality conditions, but of the prevailing water quality conditions (whether good or poor) in comparable sites from across the region. Because reference sites only needed to be outside the AOC, riverine sites were selected to capture the urban influence from Rochester and a more rural influence upstream from the city. Study sites in the Genesee River portion of the AOC were selected both upstream and downstream of likely point and non-point sources of contaminants. Because waters of the lower river mix well, and there are no major tributaries in the short (9.6 km) AOC river segment, the water quality from one site at the mouth (gen06) was expected to represent worst-case water quality (and toxicity) conditions within the entire AOC. A second AOC-river site (gen04), located upstream of the metropolitan area, was sampled to: (a) provide a second (replicate) AOC site and (b) evaluate potential spatial differences in water toxicity that may be linked to local contaminant sources (e.g., CSOs) in the city proper. Two reference sites in the river were located about 5 km (gen03) and 10 km (gen01) upstream of gen04. The furthest downstream AOC site (gen06) and the furthest