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Lyngbya wollei in western Lake Erie

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ABSTRACT

We report on the emergence of the potentially toxic filamentous cyanobacterium, *Lyngbya wollei* as a nuisance species in western Lake Erie. The first indication of heavy *L. wollei* growth along the lake bottom occurred in September 2006, when a storm deposited large mats of *L. wollei* in coves along the south shore of Maumee Bay. These mats remained intact over winter and new growth was observed along the margins in April 2007. Mats ranged in thickness from 0.2 to 1.2 m and we estimated that one 100-m stretch of shoreline along the southern shore of Maumee Bay was covered with approximately 200 metric tons of *L. wollei*. Nearshore surveys conducted in July 2008 revealed greatest benthic *L. wollei* biomass (591 $g/m^2 \pm 361$ g/m^2 fresh weight) in Maumee Bay at depth contours between 1.5 and 3.5 m corresponding to benthic irradiance of approximately 4.0–0.05% of surface irradiance and sand/crushed dreissenid mussel shell-type substrate. A shoreline survey indicated a generally decreasing prevalence of shoreline *L. wollei* mats with distance from Maumee Bay. Surveys of nearshore benthic areas outside of Maumee Bay revealed substantial *L. wollei* beds north along the Michigan shoreline, but very little *L wollei* growth to the east along the Ohio shoreline.

Introduction

The filamentous cyanobacterium *Lyngbya wollei* (Farlow ex Gomont) Speziale and Dyck is a freshwater nuisance alga in the southeastern United States (Speziale and Dyck, 1992). *L. wollei* is commonly found from North Carolina to northern Florida where it is usually described as growing in mats along the bottom of ponds and reservoirs or, in larger water bodies, in shallow, protected embayments (Speziale and Dyck, 1992; Cowell and Botts, 1994; Stevenson et al., 2004). Recently, molecular phylogenetic analysis of southern populations indicates that *L. wollei* encompasses at least two species (Joyner et al., 2008). In southern states, *L. wollei* mats may become perennial (Speziale and Dyck, 1991) and typically become apparent in summer when mats float to the surface where they may become a nuisance by clogging waterways (Beer et al., 1986). Reports of *L. wollei* are not limited to the south. Descriptions of floating *Lyngbya* mats (probably *L. wollei*) in New England ponds date to the nineteenth century (Speziale and Dyck, 1992). Recently, *L. wollei* infestations have been reported in two shallow lakes in Whiteshell Provincial Park near Winnipeg, Manitoba (Winnipeg Free Press 2003) where it is believed that the cyanobacterium was accidentally introduced by boats and trailers that are transported to southern states during winter. In the Great Lakes region, *L. wollei* has recently been found to dominate the benthic macroalgae in a section of the St. Lawrence River that is influenced by the discharge of nearby nutrient-rich tributaries (Vis et al., 2008). In addition to the nuisance caused by large mats, North American blooms of *L. wollei* have been found to produce paralytic shellfish toxins (PSTs) (Carmichael et al., 1997; Onodera et al., 1997), but to date the Lake Erie strain has not been reported to contain PSTs.

In 2006, large shoreline mats of a filamentous cyanobacterium fitting the description of *L. wollei* appeared in western Lake Erie. Genetic and morphological analyses of this material indicated that Lake Erie *L. wollei* could be grouped with one of the distinct *L. wollei* subclusters (OTU3) found in the Florida panhandle region (J. Joyner, personal communication). While it remains uncertain whether the nuisance strain is an introduced form of *L. wollei* from southeastern U.S.A., or a strain previously recorded in Lake Erie, *Plectonema wollei* (Taft, 1942), the sudden appearance, size and endurance of the mats has caused great concern among shoreline property owners, beach managers, and public officials. In this report, we provide observations on the location, size, and biomass of shoreline mats and nearshore growing regions.

Materials and methods

Samples of the cyanobacterial mats along the shoreline and bottom of Maumee Bay were collected between April 2007 and July 2008 (Fig. 1). Identification of *L. wollei* in Lake Erie was made using the description by Speziale and Dyck (1992). Cell and filament dimensions were measured using a Leica compound microscope at 400×. Initial assistance in identification was provided by R. Lowe at

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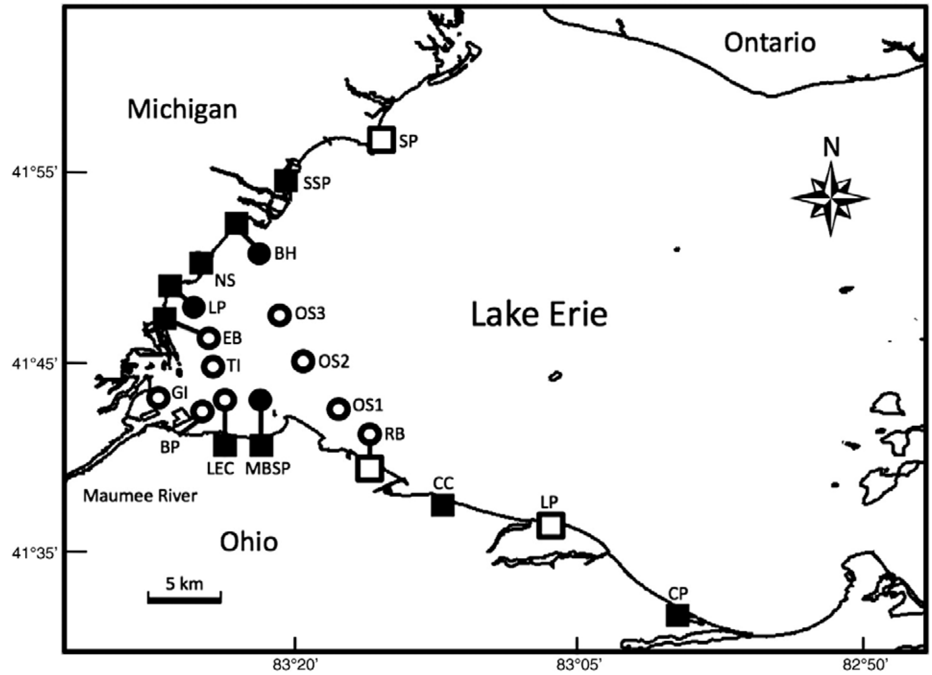

Fig. 1. Locations of shoreline survey (squares) and benthic samples (circles) in western Lake Erie in 2008. Closed symbols represent presence of *L. wollei* and open symbols represent absence. Lines represent transects with several additional samples collected across depth contours. Sites counterclockwise along the shore: Stony Pont (SP), Sterling State Park (SSP), Bolles Harbor (BH), North Shore (NS), Luna Pier (LP), Erie Beach (EB), Bayshore Plant (BP), Lake Erie Center (LEC), Maumee Bay State Park (MBSP), Reno Beach (RB), Crane Creek (CC), Locust Point (LP), Camp Perry (CP). Additional lake sites: Grassy Island (GI), Turtle Island (TI), Offshore (OS 1–3).

Bowling Green State University and later confirmed by preserved samples sent to B. Speziale (B. Speziale, Clemson University, personal communication).

A survey for the presence of *L. wollei* along the shoreline of southwestern Lake Erie was conducted in June and July 2008 along an 87 km stretch of shoreline from Stony Point, Michigan to Port Clinton, Ohio (Fig. 1). Beaches and other publicly accessible locations were surveyed visually and if filamentous algae were present, samples were collected for later identification. Benthic surveys for submerged *L. wollei* mats were conducted from small boats in July 2008 at 12 locations in or adjacent to Maumee Bay (Fig. 1). At several nearshore locations, a series of bottom samples were collected in transects perpendicular to the shoreline (indicated by lines in Fig. 1) along a range of bottom contours ranging from 0.5 m to 5 m in depth. The presence of *L. wollei* mats was detected using a benthic rake, and an Ekman grab sampler. The benthic rake was used to identify the presence of *L. wollei* beds at depths up to 3.5 m. If *L. wollei* was detected, 5 grab samples were collected at the location. *L. wollei* from each grab sample was separated from sediments using a sieve bucket (Wildco, 500 um mesh) for later biomass determination. At depths >3.5 m, grab samples only were collected. At the location that probably had the densest growth of *L. wollei* (Bolles Harbor 2), the thickness of the *L. wollei* bed prevented penetration by either an Ekman or a petite Ponar dredge. Samples from each location were examined using a compound microscope to identify algal filaments. *L. wollei* fresh wet was determined by pressing extraneous water from samples and then weighing. Dry weight was determined by drying samples at 65 °C to a constant weight.

Subsurface irradiance measurements, which are used here to calculate typical benthic irradiance in Maumee Bay were made at various locations in Maumee Bay and western Lake Erie between May and October of 2002–2005 as part of a water quality monitoring program. Measurements were made using an integrating quantum radiometer (LI-188B, Li-Cor, Inc.) equipped with a spherical sensor. The average irradiance just beneath the water surface (0 m) was calculated from all measurements ($N=112$) and the average extinction coefficient for photosynthetically active radiation (K_{PAR}) for nearshore areas was calculated using only measurements taken within Maumee Bay or adjacent regions that are frequently subject to the turbid conditions of the Maumee River plume ($N=61$).

The size and volume of the *L. wollei* mat along a 100 m relatively sheltered section of shoreline near the University of Toledo Lake Erie Center (Fig. 1, LEC) was estimated using a 60-m tape measure and graduated 1.3 m dowel rods to probe the thickness of the mat. A grid pattern was established along the shore with the thickness of the mat probed every 2 m. A post-hole digger was used in several locations to verify that the dowel rods accurately gauged mat thickness. Volume was calculated by dividing the mat into sections (ridges and low areas), multiplying mat thickness by surface area of the sections, then summing over the sections. Fresh biomass of the mat was estimated by weighing 12 L buckets full of cyanobacteria to determine *L. wollei* biomass per liter.

Results

Shoreline mats

Shoreline residents along southern Maumee Bay reported that mats of filamentous algae first appeared on their property following an unusual period from August 28 to September 2, 2006 when strong winds blew from the northeast for 6 consecutive days. During this period, wind speeds averaged 23 km/h (NOAA Databuoy Station SBI01)). The strong northeasterly winds temporarily elevated water levels in Maumee Bay to 50–100 cm above the season average (NOAA Station 9063085, Toledo) and caused extensive wave action along the shoreline. When the lake calmed and the water receded on September 2, mats of *L. wollei* were left behind on the shore. Shoreline areas protruding into the lake were not affected, while coves received large mats. We calculated that the 100 m shoreline in a small cove (sheltered on three sides) near the Lake Erie Center (Fig. 1, LEC) received approximately 200 metric tons of *L. wollei*.

The appearance of this large biomass over the course of a few days suggests that *L. wollei* had been growing unnoticed in Maumee Bay for