



Sediment quality at select sites in the St. Marys River Area of Concern

Barbara J. Keller ^{a,*}, Richard C. Back ^b, Judy Westrick ^a, Marshall Werner ^a, Barbara Evans ^c, Ashley Moerke ^c, Greg Zimmerman ^c, Derek D. Wright ^a, Emily Grenfell ^a, Johnna Courneya ^a

^a Department of Chemistry, Lake Superior State University, 650 West Easterday Avenue, Sault Ste. Marie, MI 49783, USA

^b Department of Biological Sciences, State University of New York at Oswego, Oswego, NY 13126-3599, USA

^c Department of Biology, Lake Superior State University, 650 West Easterday Avenue, Sault Ste. Marie, MI 49783, USA

ARTICLE INFO

Article history:

Received 6 July 2009

Accepted 20 December 2010

Available online 15 March 2011

Communicated by Erik Christensen

Index words:

St. Marys River

Area of Concern

Sediments

Metals

ABSTRACT

The St. Marys River is the sole surface outlet from Lake Superior, flowing over 100 km to Lake Huron, and forming part of the international border between Canada (Ontario) and the United States (MI). The river system has been severely impacted by modifications to the hydrology as well as local industrial and municipal discharges, and was designated in 1985 as an Area of Concern (AOC). Since that time, sediments on the Canadian side of the river have been systematically re-sampled, but the US side of the river has received less attention. This paper discusses two recent projects, one completed in 2003 and one completed in 2005, that sought to revisit a variety of sediment localities within the St. Marys River to update sediment contaminant data, and to expand sampling into additional areas of interest on the US side of the border: Munuscong Lake at the southern end of the AOC, and the Little Rapids adjacent to Sugar Island. The primary focus was on surficial sediment contamination, particularly metals shown to be elevated during previous sampling (chromium, nickel, copper). Results show that while Cr, Ni and Cu contamination remains slightly elevated in surficial sediments at some sites in the St. Marys River, the overall trend shows metal concentrations declining to levels consistent with background levels in sediments found in Lake Superior, Whitefish Bay and the St. Marys River.

© 2011 International Association for Great Lakes Research. Published by Elsevier B.V. All rights reserved.

Introduction

The St. Marys River forms an international boundary between the United States and Canada and is located between the extreme eastern end of Michigan's Upper Peninsula and northern Ontario. The river plays a vital role in the local and national economies of both countries. As part of a series of Great Lakes connecting channels, the St. Marys has historically been, and continues to be, vital to shipping and industry in this region. Major industries on the St. Marys have included the Northwestern Leather Co. tannery (now the Cannelton Industries superfund site) which discharged chromium and other metals into the river until it burned in 1958, Essar Steel-Algoma, a major integrated steel producer, St. Marys Paper, and Union Carbide, which closed in 1962. As a result, the river system has been severely impacted by modifications to the hydrology and also by local industrial and municipal discharges.

The river was designated in 1985 as one of 14 Areas of Concern (AOCs) within the Great Lakes Basin for which Remedial Action Plans (RAPs) were developed. As the AOC moves toward delisting, decisions regarding sediment contamination and any use impairment regarding dredged sediments and degradation of benthos at United States (US)

sites within the AOC will largely rely on 20-year-old data. While this alone does not forestall the RAP process with respect to sediment contamination, a couple of recent developments do warrant re-investigation and expansion of previous work.

Stage 1 of the Remedial Action Plan (RAP) for the St. Marys River AOC, completed in 1991 (St. Marys River RAP Team, 1991), broadly described the environmental conditions in the river and the associated habitats and identified specific use impairments. Based on the sampling of 125 stations within the river system during 1985, the Stage 1 specifically characterized spatial distribution of heavy metal contamination of the river sediments (Nichols et al., 1991; Upper Great Lakes Connecting Channels Study (UGLCCS), 1989). While areas of localized concentrations of heavy metals in sediments were predominantly located on the Canadian side of the border, one fairly localized depositional zone on the US side, an embayment called Munuscong Lake, was shown to have elevated chromium, nickel, and copper associated with silt/organic sediments.

As the St. Marys AOC moves toward the implementation of Stage 2 (St. Marys River RAP team, 2002), which presents a strategy to remediate the beneficial use impairments identified in Stage 1, several questions remain regarding sediment contamination. First, while the Canadian stations have been systematically re-sampled (e.g. Arthur and Kauss, 1999; Kauss, 1999a,b; Kauss and Hamdy, 1991; Kauss and Nettleton, 1999; Milani and Grapentine, 2006), the US sites have not received as much attention. While there has been work on the US side

* Corresponding author. Tel.: +1 906 635 2267.
E-mail address: bkeller@lssu.edu (B.J. Keller).

of the border associated with the Cannelton Industries site in the upper river (Tannery Bay) and limited sampling of the upper river and Waishkey Bay by the Bay Mills Indian Community, no systematic sampling of the lower river has occurred until these 2003 and 2005 studies that are presented here.

In the mid-1990s, earthen levees in the nearshore region of Munuscong Lake were purposely breached, thereby changing the hydrology and likely transporting a pulse of sediment to the lake. These dykes were originally constructed to provide waterfowl hunting opportunities, and retained much of the fine clay derived from the Munuscong River and Little Munuscong River watersheds. These shallow areas undoubtedly also collected organic-rich sediments. The composition, fate and impact of these sediments in Munuscong Lake and the lower St. Marys River are unknown. The original 1985 sampling of the AOC included 9 stations in the Munuscong Lake. No systematic study of sediments has been done since this time in the lake, which is vital to walleye spawning and currently heavily utilized by recreational anglers.

Secondly, a recurrent impairment in the St. Marys AOC is habitat loss, in particular the limited area of open rapids which now exists. Stage 2 of the RAP calls for the restoration of the rapids areas in the river. Over the last few years, there has been local interest in re-establishing flow through an area of the river historically known as “The Little Rapids.” This largely shallow, rocky area is currently all but excluded from the river flow by a causeway which connects a ferry landing and small island to the larger Sugar Island. A historical account of the flow through this area of the river, and subsequent modifications is given by *Arbic (1992)*. More flow could be introduced to this area either by installing more culverts or by replacing the causeway, in whole or part, with an open span bridge. Fisheries biologists have suggested that allowing more flow through this area would create spawning habitat for walleye, lake sturgeon and lake whitefish while expanding recreational fishing opportunities on the US side of the border (Pers. Comm. J. Waybrant, Michigan Department of Natural Resources, Newberry, MI). Currently, access to existing rapids below the compensating gates, and the angling opportunities they afford is limited to the Canadian side of the river. The Little Rapids was not previously sampled during the RAP process. Information on sediment contamination at this site has important implications for future restoration plans.

The studies described here had two main objectives: 1) to expand sampling of surficial sediments into two areas on the US side of the St. Marys River which were previously undersampled (Munuscong Lake) or not sampled (Little Rapids) during the Upper Great Lakes Connecting Channels Study (*Upper Great Lakes Connecting Channels Study (UGLCCS), 1989*), and 2) to revisit representative areas in the river proper to ascertain current conditions of surficial sediments in consideration of the period of time that has passed since the UGLCCS sampling. The expansion into the Munuscong Lake and Little Rapids area will provide contaminant information for two areas which may play a significant role in the restoration of habitat along the St. Marys River.

Materials and methods

Field sampling and site locations

Sampling of the surficial sediments was accomplished during September of 2003 and during June in 2005, using a Petite Ponar grab. Surficial sediment samples were well mixed and collected directly into acid-cleaned, wide-mouthed polypropylene sample jars. The advantage to using the Petite Ponar grab sampler is that it is relatively easy to use and allows hand deployment from a small boat. A disadvantage of using the grab sampler is that there is uncertainty in the depth of the sediment collection. Typical penetration using a Petite Ponar sampler ranges from 5 to 15 cm depending on the type of

sediment (*United States Environmental Protection Agency, 2009*) so variances in the depth of sampling are a limitation to this study. However, the previous studies which are referenced for comparison in this study also used this type of sampler, so there is consistency in the collection of sediment samples.

For the 2003 sampling, 10 samples were collected from the main channels of the St. Marys River, 10 samples from the Little Rapids area of the river, and 20 samples from Munuscong Lake (*Fig. 1*). Sample sites were selected to avoid areas that were directly affected by dredging, which is regularly employed in the St. Marys River to maintain safe navigation within the shipping channel. Areas of historic industrial activity have been concentrated in the upper river and, with the exception of the Union Carbide facility which was located between sites 1 and 2, are upriver from the selected sampling sites.

Sediment sampling occurred on board the R/V *Mudpuppy*. Clean gloves were donned and worn by the samplers at each collection site. The ponar sampler was rinsed clean with site water between samples. Samples were kept in the dark on ice while in the field, returned to the lab within 6 h of collection, and stored at 4 °C until further processing. Samples for total phosphorus (TP) analyses were immediately prepped and shipped to Trace Analytical Laboratories, Muskegon, MI.

The surficial sediment samples for the 2005 study were collected at nine coastal marsh sites, Cedar Point (CP), Ashmun Bay (AB), Mission Creek outflow (MC), Cook Island (CI), Palmers Point (PP), Churchville Point (CHP), Whipple Point (WP), Nine Mile Marsh (NM), and the Charlotte River outflow (CR) (*Fig. 2*). Each coastal marsh site spanned a 100 m transect running parallel to the shore line and a 50 m perpendicular transect located at the mid-point of the shoreline transect. Sediments were collected in triplicate using clean technique at the 50 m point of the perpendicular transect. The ponar sampler was rinsed clean with site water between each sample. Each sample was well mixed, and placed directly into acid-cleaned, wide-mouthed amber I-Chem sample jars for metals analysis, Teflon vials for Hg (mercury) and MeHg (methylmercury), and polypropylene mini-centrifuge tubes for TC (Total Carbon)/TN (Total Nitrogen). Samples were kept in the dark on ice while in the field, returned to the lab within 6 h of collection, and stored at 4 °C until further processing.

Sample preparation

Samples from both studies were dried to constant mass at 65 °C, and homogenized using a ceramic mortar and pestle. The Hg and MeHg and TC/TN samples were shipped to UW-Madison and UW-Milwaukee, respectively, for analysis. Metals samples from both studies were analyzed at Lake Superior State University (LSSU). The homogenized samples were prepped and analyzed using the analytical methods listed below.

Analytical methods

Specific procedures used by LSSU or its subcontractors during this project included: Metals were analyzed at LSSU using SW-846 (*United States Environmental Protection Agency, 1986*), Method 3051A – *Microwave Assisted Acid Digestion of Sediments, Sludges, Soils, and Oils*; SW-846, Method 6020A – *Inductively Coupled Plasma-Mass Spectrometry*. Mercury and methylmercury were analyzed at the University of Wisconsin–Madison using SW-846, Method 7471B – *Mercury in Solid or Semisolid Waste (Manual Cold-Vapor Atomic Absorption Fluorescence Technique)*. Total organic carbon (TOC)/total organic nitrogen (TON) was analyzed at the University of Wisconsin Milwaukee as follows: TOC/TON was determined by standard Carbon/Hydrogen/Nitrogen (CHN) analysis on a Perkin Elmer 2400 Series II CHNS/O Analyzer. Total phosphorus (TP) was determined by Trace Analytical following EPA method 6010.

Download English Version:

<https://daneshyari.com/en/article/4399119>

Download Persian Version:

<https://daneshyari.com/article/4399119>

[Daneshyari.com](https://daneshyari.com)