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MONITORING EXPOSURE OF BROWN BULLHEADS AND BENTHIC MACROINVERTEBRATES TO SEDIMENT CONTAMINANTS IN THE ASHTABULA RIVER BEFORE, DURING, AND AFTER REMEDIATION

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Abstract: In 2007, approximately 420 500 cubic meters of contaminated sediment were removed from the Ashtabula River by dredging. The primary objective of the present study was to monitor contaminant exposure in fish and macroinvertebrates before, during, and after dredging. This was done by measuring tissue concentrations of polychlorinated biphenyl (PCB) and polycyclic aromatic hydrocarbon (PAH) in brown bullhead catfish (*Ameriurus nebulosa*) and in benthic macroinvertebrates, assessing changes in DNA damage in fish liver and blood, and scoring external and histopathological lesions and anomalies in the fish. In surficial sediment PCBs and PAHs were also quantified in conjunction with the biological sampling. The results show a significant reduction in contaminant levels in both fish and macroinvertebrates following dredging, indicating the effectiveness of the remediation in reducing exposure of biota to the primary contaminants of concern. Similarly, DNA damage levels in fish collected from the Ashtabula River significantly declined following dredging; however, a similar reduction in DNA damage over time was seen in fish collected from a reference site (Conneaut Creek), making interpretation difficult. Macroinvertebrate PCB concentrations were reflective of the sediment concentrations in the areas where Hester-Dendy samplers were deployed for macroinvertebrate collection. The present study demonstrates that these methods can be used to evaluate and assess the effectiveness of remediation techniques at contaminated sediment sites. *Environ Toxicol Chem* 2015;34:1267–1276. Published 2015 SETAC. This article is a US government work and, as such, is in the public domain in the United States of America.

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INTRODUCTION

International disquiet over contaminated sediments is increasing because sediments serve as long-term sinks for contaminants of concern such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and other persistent, hazardous chemicals. In the Great Lakes region of the United States and Canada, large areas impacted by contaminated sediment accumulation pose a threat to human health and the environment. Depending on their toxicity and physical and chemical properties, contaminants of concern can accumulate in much higher concentrations in sediments compared with the overlying water and can continue to contaminate the water column for many years after the source of contamination has been removed. Some sediment contaminants also bioaccumulate in tissues of benthic organisms and biomagnify up the food chain to impact higher trophic organisms, including humans.

The Ashtabula River lies in extreme northeast Ohio, flowing north into Lake Erie's central basin at the city of Ashtabula (Figure 1). The Ashtabula River is representative of many of the tributaries around the Great Lakes, with contaminated sediments serving as a source of persistent organic contaminants and heavy metals for the lakes themselves. As a result of the contamination of sediment with hazardous chemicals and other beneficial use impairments, the lower 3.22-km section of the river was designated a Great Lakes area of concern by the International Joint Commission based on 6 beneficial use impairments (out of a possible 14; www.epa.gov/glnpo/aoc). The Ohio Department of Health has posted a fish consumption advisory for this area since 1983 because of elevated tissue concentrations of PCBs. The PCBs and other contaminants of concern are thought to have originated primarily from concentrated industrial development east of the Ashtabula River along Fields Brook, a stream that drains into the Ashtabula River in the upper Turning Basin [1]. A Comprehensive Environmental Response, Compensation, and Liability Act cleanup of Fields Brook was completed in 2003 to remove this source of contamination [2]. Subsequently, extensive biological monitoring was undertaken on the Ashtabula River in 2003 and 2005 by the Ohio Environmental Protection Agency, the Ohio Department of Natural Resources, the US Geological Survey, and the US Fish and Wildlife Service as part of a Natural Resource Damage Assessment [3,4]. The results of the monitoring indicated continued impairment of biological communities as well as a decline in selected fish health parameters. The findings, along with a plan already under way by the Ashtabula River Partnership to clean up the river [5], led to a decision in 2006 by the US Environmental Protection Agency's (USEPA's) Great Lakes National Program Office to undertake environmental dredging of a 1.77-km stretch of the lower river within the area of concern. In 2007, approximately 420 500 m^3 of contaminated sediments were removed by dredging between the Turning Basin above Fields Brook and the Fifth Street Bridge (Figure 1).

The present study employed biological methods in conjunction with sediment chemistry to determine whether the removal

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