The Biomonitoring of Great Lakes Populations-III Program: The Milwaukee Angler Project

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Editor's Note:

As part of our continued effort to highlight innovative approaches to improve the health and environment of communities, the *Journal* is pleased to publish regular columns from the Agency for Toxic Substances and Disease Registry (ATSDR) at the Centers for Disease Control and Prevention (CDC). ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. The purpose of this column is to inform readers of ATSDR's activities and initiatives to better understand the relationship between exposure to hazardous substances in the environment, its impact on human health, and how to protect public health.

The conclusions of this column are those of the author(s) and do not necessarily represent the official position of ATSDR or CDC.

Background

The Great Lakes ecosystem has been contaminated by industrial, agricultural, and other human activities. Both Canada and the U.S. have been mitigating this historical contamination across the Great Lakes. Particularly, the U.S. established the Great Lakes Restoration Initiative (GLRI) in 2009 to accelerate and coordinate efforts to protect and restore the Great Lakes region. GLRI provided funds to the Agency for Toxic Substances and Disease Registry (ATSDR) to establish the Biomonitoring of Great Lakes Populations (BGLP) Programs in 2010. In these programs, ATSDR and state health departments conducted a series of cross-sectional studies to assess body burden levels of legacy and emerging contaminants among populations with potential high exposure in the Great Lakes

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region. The programs also aimed to use biomonitoring data to inform and guide public health actions to protect Great Lakes populations from harmful exposure (Wattigney et al., 2017; Wattigney, Irvin-Barnwell, Li, Davis, et al., 2019).

The first two programs, BGLP-I (2010–2015) and BGLP-II (2013–2018), were conducted in collaboration with health departments in Michigan, Minnesota, and New York, targeting six populations near eight areas of concern (AOC) (Figure 1). Results from these two programs indicated that some target populations had a higher body burden of heavy metals and persistent organic pollutants compared to national estimates (Savadatti et al., 2019; Wattigney, Irvin-Barnwell, Li, & Ragin-Wilson, 2019). The final program, BGLP-III, was completed in June 2020 in collaboration with the Wisconsin Department of Health Services (WI DHS).

Biomonitoring of Great Lakes Populations-III Overview

The BGLP-III program, known locally as the Milwaukee Angler Study, targeted two adult populations near the Milwaukee Estuary AOC that spans seven counties in the most densely populated area of Wisconsin that is home to approximately 1.3 million people. The state has issued fish advisories to allow anglers to benefit from eating fish while reducing their exposure to contaminants, primarily heavy metals, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) (U.S. Environmental Protection Agency, 2020). Previous research, however, found that immigrant populations had scarce knowledge on local fish consumption advisories and were more likely to consume contaminated fish (Liu et al., 2018). In addition, past studies in Wisconsin using convenience samples of at-risk angler populations have reported increased body burdens of PCBs associated with Great Lakes fish consumption (Christensen et al., 2016; Turyk et al., 2015). Therefore, the BGLP-III program targeted two populations with potentially high exposure: licensed anglers living in proximity to the Milwaukee Estuary AOC and Burmese refugees who are known to eat a substantial amount of fish from this area. All study activities were approved by the federal Office of Management and Budget (control # 0923–0056).

The program designed statistical sampling strategies tailored for each target population: respondent driven sampling (RDS) for the Burmese refugees and stratified random sampling from the state fish license database for the licensed anglers. The Burmese refugee population recruitment was carried out effectively via RDS. Mail recruitment of randomly selected fish license registrants, however, encountered a substantially lower than expected response rate over a prolonged period and had to be supplemented with additional recruitment strategies, including e-mail recruitment, peer recruitment by study participants, and shoreline recruitment at fishing venues. Though the multiple recruitment methods led to a nonstatistically representative sampling of the licensed angler population, the additional efforts ensured that the program met the recruitment goal in the project timeline.

Upon enrollment, participants completed a questionnaire that included demographic information, residential history, job history, lifestyle factors, dietary intake, smoking history, recreational activities, reproductive history (women), fish advisory awareness, fish consumption (focusing on fish species and locally caught fish), and fish cooking practices.

Participants also completed a clinic visit to provide body measurements and blood and urine specimens.

The Centers for Disease Control and Prevention's Division of Laboratory Sciences conducted chemical measurements on the biological samples for six classes of contaminants:

- blood metals (cadmium, lead, manganese, selenium, and total mercury);

- serum PCBs (26 congeners);

- serum persistent chlorinated pesticides (8 analytes);

- serum brominated flame retardants (10 compounds);

- serum per- and polyfluoroalkyl substances (9 substances); and

- urinary PAH metabolites (8 analytes).

Recruitment Outcomes and Fish Advisory Awareness

Although comprehensive analysis of the questionnaire and biomonitoring data is still in progress, we present key recruitment and fish advisory awareness results here. From August 2017–May 2019, the program sent out 39,909 screening surveys to licensed anglers and received 2,239 responses, of which 949 met eligibility criteria, and 396 participants completed the study (questionnaire, clinic visit, and biological samples). For the Burmese target population, recruitment via RDS started in May 2018 and surpassed the recruitment goal by the end of data collection in November 2018 ($N = 103$).

Licensed anglers were mostly male (80.1%), older (51.7% were 50 years), White (86.2%), well educated (88.2% with a bachelor's degree or higher), and had lived in the Milwaukee area for >20 years (77.5%). In contrast, the Burmese refugees were primarily female (67.0%), younger (61.2% were 39 years), less educated (90.3% with a high school education or less), low income (all available responses reported family income <$50,000), and newcomers (58.3% lived in the U.S. for 5 years, 51.5% lived in Milwaukee for 4 years) (Table 1).

Most licensed angler participants were aware of fish advisories for fish caught in Wisconsin (72.8%) or Milwaukee (60.1%). Far fewer participants, however, reported following the Wisconsin fish advisories (27.0%) or Milwaukee fish advisories (42.9%) very closely. Among Burmese participants, few had heard about fish advisories for fish caught in Wisconsin (11.7%) or Milwaukee (3.4%). Approximately one half of the Burmese respondents reported eating parts of the fish that tend to have higher accumulation of bioaccumulative and persistent contaminants (e.g., PCBs). These results highlight the need to improve education and outreach by incorporating strong community engagement, culturally relevant health education materials, and language translation.

Targeted Education and Outreach

Following the results of this program, WI DHS produced a Milwaukee-specific fish advisory that was translated into Burmese and Karen, two common languages among Burmese

refugees (Figure 2). The advisory details what fish are least contaminated in the area and offers best practices for fish cleaning and preparation. WI DHS partnered with the International Institute of Wisconsin to participate in community meetings with Burmese refugees, distribute materials on safe-fish consumption, and respond to any questions. They also created an informational video translated into Burmese that the International Institute of Wisconsin can continue to use for educational purposes beyond BGLP-III. For licensed anglers, WI DHS distributed materials at fishing expositions and held a virtual meeting in June 2020 to discuss results of the study. WI DHS also held an educational seminar on safe-fish consumption at the Milwaukee Consortium for Hmong Health and distributed materials to community members.

In conclusion, the BGLP-III program identified gaps in fish advisory awareness and fish consumption behaviors, as well as measured the body burdens of a large panel of legacy and emerging contaminants in two susceptible populations in Milwaukee, Wisconsin. ATSDR continues to collaborate with WI DHS on data analyses and report/publication preparation. The results generated from this program will continue to guide public health actions on safe-fish eating, balancing the benefit of fish consumption with reducing and preventing harmful chemical exposure in Great Lakes populations.

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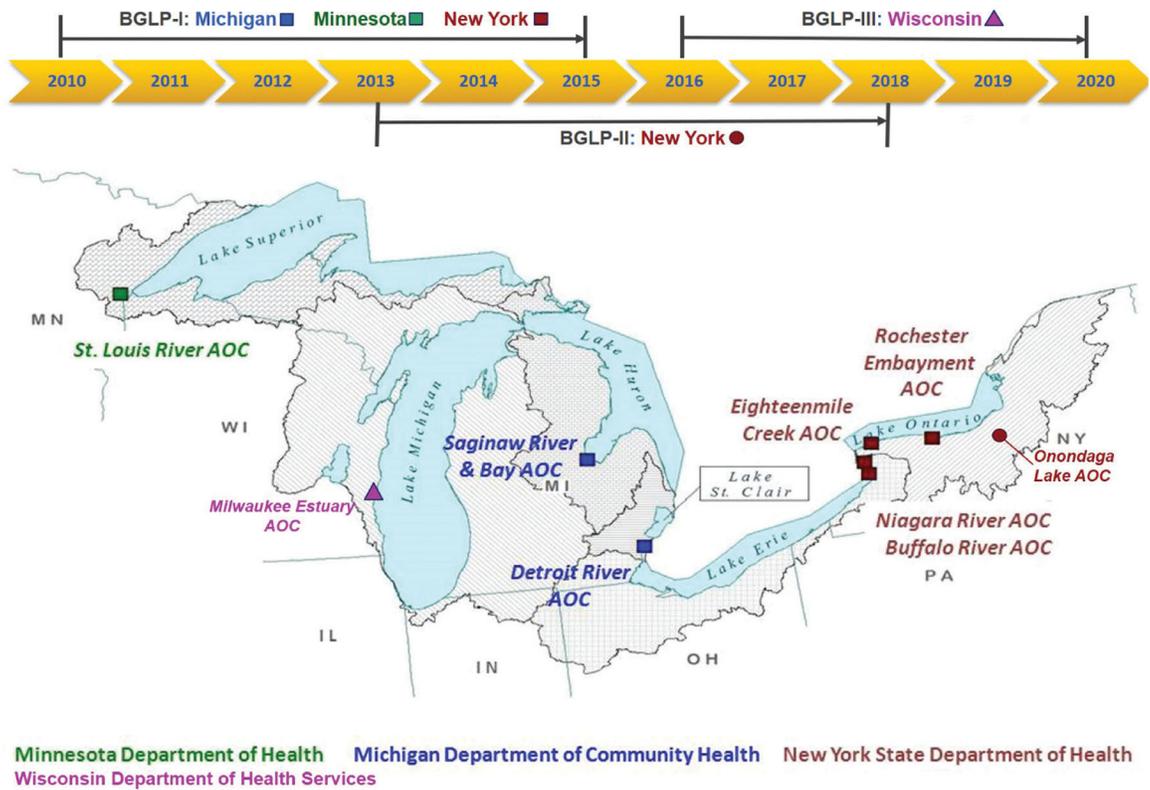
FIGURE 1.
Collaborators, Locations, and Timeline of the Biomonitoring of Great Lakes Populations I–III Programs
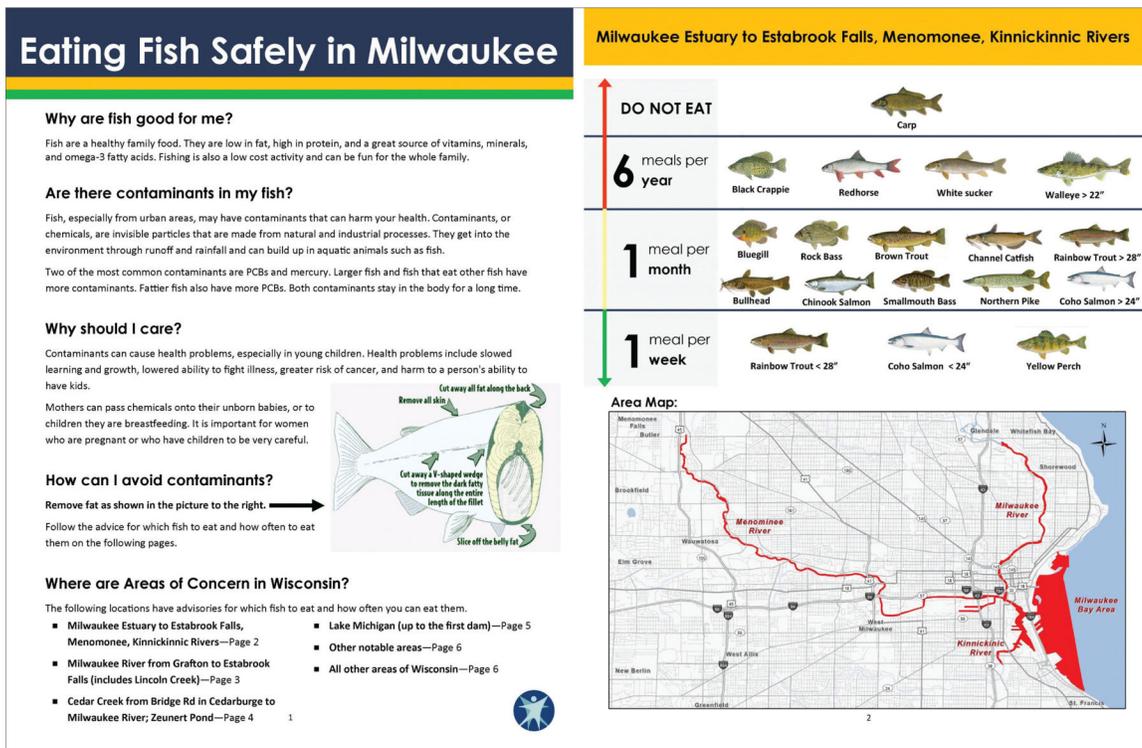AOC = area of concern; BGLP = Biomonitoring of Great Lakes Populations.

FIGURE 2.
Fish Advisory Developed in the Biomonitoring of Great Lakes Populations-III Program
Shown in the figure are two of the six pages. The fish advisory was also translated into
Burmese and Karen.

TABLE 1

Key Demographic Characteristics of Target Populations for the Biomonitoring of Great Lakes Populations-III Program

Characteristic	Licensed Anglers ($n = 396$) # (%)[*]	Burmese Refugees ($n = 103$) # (%)[*]
Age (years)		
18–29	45 (11.7)	24 (23.3)
30–39	75 (19.5)	39 (37.9)
40–49	66 (17.1)	24 (23.3)
50	199 (51.7)	16 (15.5)
Sex		
Male	314 (80.1)	34 (33.0)
Female	78 (19.9)	69 (67.0)
Race		
White	337 (86.2)	0 (0)
Black or African American	32 (8.2)	0 (0)
Asian	10 (2.6)	103 (100)
Education		
High school or less	45 (11.5)	93 (90.3)
Bachelor's degree or some college	259 (66.0)	7 (6.8)
Postgraduate degree	87 (22.2)	0 (0)
Household income		
<$25,000	27 (6.9)	47 (45.6)
$25,000–<$50,000	73 (18.7)	39 (37.9)
$50,000–<$100,000	132 (33.8)	0 (0)
$100,000	112 (28.6)	0 (0)
Lived in the Milwaukee, Wisconsin, area (years)		
	1–20: 88 (22.5)	0–4: 53 (51.5)
	21–40: 119 (30.4)	5: 50 (48.5)
	41: 184 (47.1)	–
Awareness of fish advisories		
Wisconsin fish advisory	286 (72.8)	12 (11.7)
Milwaukee fish advisory	235 (60.1)	5 (3.4)

[*]
Responses of "Don't know" and "Prefer not to answer" were used in the analysis but are not presented in this table.