Sanitary and Environmental Surveys Protect Human Health and Water Quality at Great Lakes Beaches

A report submitted to the
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Health Professionals Advisory Board
in collaboration with the
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Acknowledgements

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Front cover: Great Lakes beach, photo via Canva

Executive Summary

Beaches are important for recreational and economic purposes. Beaches are also water quality symbols, influencing public perceptions about the state of aquatic ecosystems. Beach advisories and closures represent significant potential for human health risks, and they have caused numerous beneficial use impairments in Great Lakes Areas of Concern, as well as adverse impacts on local economies. This white paper presents the results of a collaboration between the International Joint Commission's Health Professionals Advisory Board (HPAB) and the Great Lakes Beach Association (GLBA) to assess the binational extent, experience and effects of Great Lakes Beach Sanitary Surveys (BSS) in the United States and equivalent Environmental Health and Safety Surveys (EHSS) in Canada. These surveys are meant to be conducted at beaches each year to understand environmental and human health risks affecting recreational waters. The HPAB viewed the prevalence of the use of beach surveys as one measure of how "swimmable" Great Lakes beaches are. While the results of this white paper may be of broad interest to the beach-going public and government agencies, the recommendations are directed towards beach owners, managers/operators and custodians.

Survey questionnaire

A working group comprised of HPAB and GLBA members distributed a BSS/EHSS questionnaire to beach managers around the Great Lakes. A total of 34 responses were received from beach programs and groups in each Great Lakes state in the United States (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin) and from Ontario, Canada. Three US tribes and two community science groups also completed the questionnaire. There were 23 responses from the United States and 11 from Canada.

BSS/EHSS prevalence

Most beach programs/groups responding to the questionnaire (68 percent) conducted BSS/EHSS annually. However, at least 26 percent of respondents stated they did not regularly perform annual BSS/EHSS, indicating this activity is still often not applied across the Great Lakes basin. Many respondents indicated they used the results of BSS/EHSS to investigate sources of fecal pollution at beaches. However, only 29 percent of beach programs indicated they knew all the fecal pollution sources impacting their beaches. In addition, relatively few beach programs indicated they had followed up on BSS/EHSS to conduct expanded *E. coli* surveillance, microbial source tracking studies, or investigations of waterborne pathogens or algal blooms. Follow up actions were more common in the United States than Canada or by US tribes.

Beach threats and remedial actions

Most beach monitoring programs around the Great Lakes identified Canada geese (85 percent of programs), gulls (74 percent), stormwater runoff (74 percent), runoff from parking lots (59 percent) and algal blooms (58 percent) as sources of fecal pollution and potential health threats at beaches. Sewage (44 percent), dog fecal droppings (41 percent) and dangerous currents (32 percent) were also commonly reported. Waterfowl control actions after BSS/EHSS were the

most common mitigation activity (65 percent of programs). Beach landscaping (50 percent) and sand grooming (47 percent) were also common mitigations. Case studies are described to show how these mitigations led to improved beach water quality and beneficial economic impacts on local economies.

About 65 percent of beach programs indicated they shared their BSS/EHSS data with the public; this was much more common in the United States. Only 9 percent of beach management programs indicated they used BSS/EHSS data from community/citizen science groups. The COVID pandemic impacted beach programs with 65 percent of respondents indicating problems such as reduced staff, less water sampling and less lab capacity.

Recommendations are provided to strongly encourage use of BSS/EHSS, ensure beach programs have sustainable resources (financial and trained staff) for BSS/EHSS, and ensure BSS/EHSS are completed to provide guidance before follow-up studies or mitigation actions. Clear funding mechanisms are needed to follow up on BSS/EHSS outcomes. Beach programs should better engage with community science and Indigenous groups to expand capacity for BSS/EHSSs, communicate experiences through the GLBA, and make BSS/EHSS data more accessible to the public.

Key recommendations

1. **For the next iteration of recreational water quality guidance, or by 2026, provinces, states and other agencies should explicitly provide comprehensive BSS/EHSS survey forms/checklists to public health units, health departments and appropriate tribal and First Nation agencies for implementation by beach managers.**

2. **Reliable and long-term funding is needed to advance BSS/EHSS follow-up studies and mitigation actions. Local, state/provincial, Canadian and US federal governments and other agencies should consider dedicating discretionary funds in two key areas for 2025-2030 to advance mitigation efforts to reduce beach closures and improve beach access and water quality under the Great Lakes Water Quality Agreement.**

   a) Identify or create targeted funding sources to follow up on BSS/EHSS outcomes and investigate potential health threats such as fecal pollution source tracking or algal blooms.

   b) Identify or create targeted funding sources to follow up on outcomes from BSS/EHSSs and health threat investigations, for completing beach remedial actions necessary to move from pollution response to a pollution prevention approach for protecting public health.

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List of Acronyms

BSS	beach sanitary survey
EHSS	environmental health and safety survey
GLBA	Great Lakes Beach Association
HPAB	Health Professionals Advisory Board
USEPA	US Environmental Protection Agency

1.0 Introduction

This white paper presents the results of a collaboration between the International Joint Commission's Health Professionals Advisory Board (HPAB) and the Great Lakes Beach Association (GLBA). This public health initiative assesses the binational extent, experience and effects of Great Lakes Beach Sanitary Surveys in the United States and equivalent Environmental Health and Safety Surveys in Canada. Annual sanitary surveys are meant to be conducted each year by beach owners, operators or custodians to help identify, understand and prioritize environmental and human health risks affecting Great Lakes beaches and recreational waters. Canada and the United States also propose routine sanitary surveys, meant to be conducted at the time of water sample collection. Both Canada and the United States provide guidance and checklists for inspecting beaches as part of these surveys. While the results of this white paper may be of broad interest to the beach-going public and government agencies, the recommendations are directed towards beach owners, managers/operators and custodians.

1.1 Importance of Great Lakes recreational water quality

The quality of recreational water is an important nexus between human health and beneficial uses of the Great Lakes. This issue is closely linked to longstanding efforts by HPAB to assess water quality and present evidence for policies to maintain water quality and human health in transboundary water basins. Beaches are important water quality symbols for the public, with public perceptions of poor water quality extending well beyond beach areas. Beach closures have caused numerous beneficial use impairments in Great Lakes Areas of Concern, and beach advisories and closures represent significant potential for health risks. Great Lakes beach closures have been estimated to cause an economic loss of US$1,274 to $37,030 per day (CDN$1,720 to $49,990 per day) (Rabinovici et al. 2004). While not quantified in the Great Lakes, human illnesses were estimated to result in 627,800 to 1,479,200 excess gastrointestinal illnesses, with a public health cost of US$21 to $51 million (CDN$28 to $69 million) each year at Los Angeles and Orange County Beaches in California (Given et al. 2006). Across the United States, swimming, paddling, boating and fishing are now estimated to account for more than 90 million cases of gastrointestinal, respiratory, ear, eye and skin-related illnesses per year, with an annual cost of US$2.9 billion (CDN$3.9 billion) (DeFlorio-Barker et al. 2018).

The Great Lakes Water Quality Agreement identifies several human health objectives, including that waters should allow for swimming and other recreational uses. In 2014, the HPAB convened an expert workshop to identify a small set of human health indicators that could reflect the health objectives of the Great Lakes Water Quality Agreement (HPAB 2014). These proposed indicators would monitor progress towards protecting human health and restoring the waters of the Great Lakes. One of the indicators selected for recreational waters was prevalence of the use of sanitary and environmental/health surveys at beaches, and results on pollution sources determined from these surveys. The prevalence of these surveys across beaches was viewed as one measure of knowledge regarding Great Lakes beaches and how "swimmable" they are.

Sanitary and environmental/health surveys can provide valuable data to help beach program managers and public health officials identify sources of beach water pollution, characterize the magnitude of pollution, and identify priority locations for water testing and remedial actions. Therefore, it is important to ascertain the status and opportunities of efforts to conduct beach sanitary and environmental/health surveys at recreational beaches.

1.2 What are beach sanitary and environmental health and safety surveys?

A Beach Sanitary Survey (BSS), used by the US Environmental Protection Agency (USEPA), or Environmental Health and Safety Survey (EHSS), used by Health Canada, is a systematic survey of the safety and sources of pollution that could impact recreational waters. These surveys can be conducted on an annual basis, such as before or after each bathing season. The surveys can also be conducted on a routine basis at the time of each water sample collection at a beach. The surveys are recommended best practices for managing health risks for recreational waters.

There are many benefits from conducting a BSS or EHSS. These include: identification of unrecognized fecal pollution sources (e.g., sewage); identification of other health hazards such as harmful algae blooms or dangerous water currents; documentation of baseline conditions of water quality and pollution sources for a new beach; contribution of data and information for development of predictive models for fecal indicator bacteria and early warning postings of beaches; documentation of trends and improvements in water quality from remedial actions; a database of data/information for sharing with other beach managers, public health officials, stormwater/wastewater managers, nongovernment organizations, academic researchers; documentation in support of beach designations such as Blue Flag qualifications.

In the United States, the USEPA published guidelines for conducting a BSS to investigate the sources of fecal contamination to a water body (USEPA, 2021, 2008). These guidelines were finalized after a 2007 study of their application across 61 Canadian and US beaches demonstrated a 60 percent improvement in the identification of pollution sources impacting beaches (David Rockwell, USEPA, personal communication). Routine BSSs are designed to collect data of immediate interest as part of the water sample collection process (e.g., hydro-meteorological parameters, water quality and bather density/activity). The annual BSS tool is meant to cast a broader net (e.g., watershed or beach-shed characteristics and physical beach conditions). The USEPA recently developed a BSS application (for mobile phones) for marine and fresh waters to facilitate data collection and export for use in predictive models and for sharing within or between agencies (USEPA 2022).

In Canada, Health Canada published guidelines for conducting EHSS for investigating recreational waters (Health Canada 2012), and these are being updated. These surveys are described as a comprehensive search for, and assessment of, existing and potential water quality hazards (biological, chemical and physical) and their associated risks to the health and safety of the public at designated beach areas. They are recommended as part of a multi-barrier approach to provide a foundation for implementing a risk management plan for recreational waters. Health

Canada recommends that an EHSS be conducted on an annual basis just before the start of the swimming season.

In Ontario, the Ministry of Health and Long-Term Care's public health standards for public beaches and waterfronts were published in the Recreational Water Protocol (Ontario Ministry of Health and Long-Term Care 2019). The province's protocol identifies the minimum expectations for public health programs and services at beaches and waterfronts. Ontario's Operational Approaches for Recreational Water Guideline (Ontario Ministry of Health and Long-Term Care 2018) provides direction on how the province's boards of health must approach the public health requirements outlined in the Recreational Water Protocol. The Seasonal Program Planning requirements instruct boards of health to establish procedures to conduct annual environmental surveys and a data review before the start of the bathing season to "collect and assess environmental conditions that may influence recreational water quality" (Ontario Ministry of Health and Long-Term Care 2018). The Pre-season Assessment of Public Beaches requires boards of health in Ontario to identify factors that may predict influences on water quality by reviewing and analyzing historical water sampling data and observations. Boards of Health are also required to record observations of environmental factors that influence recreational water quality using the routine Field Data Report.

In the United States, the ability to perform routine and annual BSS is often tied to eligibility for receipt of state and/or federal funding associated with recreational water quality monitoring (e.g., annual Beaches Environmental Assessment and Coastal Health Act allocations from the US federal government passed through state agencies to local authorities).

1.3 Development of beach sanitary and environmental health and safety surveys

In 2003, the USEPA conducted a National Health Protection Survey of Beaches wherein many beach managers reported they did not know the source(s) of contaminants that led to beach advisories and closures (Brenner 2004). In a 2004 Great Lakes Beach survey, 90 percent of the respondents cited unknown sources of pollution impacting beaches (USEPA 2008). This presented an important opportunity to improve risk assessment for recreational waters as well as set up a framework for coordinating the relevant data with other water quality efforts throughout the Great Lakes basin.

In 2005, the US Great Lakes Regional Collaboration Strategy was released (Great Lakes Regional Collaborative 2005). This was a consensus-driven document aimed at achieving preservation and restoration of the Great Lakes and connecting waterways. Achievement of a 90 to 95 percent reduction in bacterial, algal and chemical contamination at all local beaches was one of the primary goals set forth in the Coastal Health Chapter. Steps to achieve this included: identifying indirect pollution sources capable of adversely impacting Great Lakes coastal health, educating communities regarding their environmental impact, and remediating all potential indirect pollution sources through identification, estimation of relative contribution (based on historical data and sanitary inspection) and remediation of these sources. The 2006 development

of a beach sanitary survey tool was the first actionable item undertaken by the USEPA in response to Great Lakes Regional Collaboration Strategy recommendations.

In a similar manner, Health Canada recommended that sanitary surveys be carried out in their 1983 recreational water quality guidelines (Health Canada 1983). The 1992 guidelines recommended that an annual "environmental health assessment" be carried out prior to each beach bathing season (Health Canada 1992). These guidelines were further elaborated in 2012 with a comprehensive checklist for conducting Environmental Health and Safety Surveys for investigating recreational waters (Health Canada 2012). The 2012 Guidelines for Canadian Recreational Water Quality, Third Edition, recommends a multi-barrier approach to management of recreational beaches including the use of Environmental Health and Safety Surveys to identify pollution sources (Health Canada 2012). The need to address beaches and bacteriological contamination within the Great Lakes and St. Lawrence River basins has been reinforced in the recently released Canadian Great Lakes Action Plan 2030 (Great Lakes and St. Lawrence Collaborative 2020).

2.0 Methods

A work group comprised of Thomas Edge, Matthew Dellinger, and Jennifer Boehme (HPAB) and Shannon Briggs, Julie Kinzelman and Gabrielle Parent-Doliner (GLBA) deployed cross-sectional questionnaires to a population of Great Lakes beach owners, operators or custodians. The questionnaires aimed to capture all state and provincial agency perspectives from their representatives associated with the Great Lakes Beach Association and determine how many entities carry out beach surveys, and if/how the surveys have helped better understand and remediate environmental and health risks at beaches. These individuals reported their sanitary survey and environmental monitoring activities on behalf of their agencies or offices. Therefore, beach manager respondents, representing multiple beaches, serve as the unit of comparison.

Questionnaires were developed and distributed in three phases. In the first phase, the HPAB reached out to the GLBA and public health units around the Great Lakes to initiate a study on the prevalence of beach sanitary surveys around the basin. In the second phase, a work group of representatives from the HPAB and the GLBA was established to develop a preliminary questionnaire to engage beach managers across the Great Lakes. The survey was designed to reach state and provincial representatives in the GLBA and gather perspectives from as many beach programs as possible. Therefore, the work group also engaged organizations conducting BSS/EHSSs through broader online networks and listservs. The preliminary questionnaire was provided to GLBA beach managers at the 2019 IAGLR Conference in Saginaw Bay, Michigan, via a MailChimp email campaign to US and Ontario beach managers, via Google listservs such as "BEACHNET" and the Great Lakes Information Network. The questionnaire was launched on the website of the GLBA in the fall of 2020 (greatlakesbeachassociation.org).

While the BEACHNET listserv enabled communication out to about 1,000 individuals associated with Great Lakes beach research and monitoring activities, it should be noted that most individuals would not be beach managers with relevant responsibilities for conducting

beach sanitary surveys. Rather, the objective was to receive responses from a finite number of beach managers, which include Ontario's public health units, Conservation Authorities, Ontario Parks, US Great Lakes state and park beach managers, First Nations and Tribal government agencies, and community based-water monitoring groups. In Ontario, there are 34 public health units, 30 of which monitor public beaches. Ontario Parks monitors beaches at official provincial parks. In the United States, the eight Great Lakes states have either departments of environmental management or health that manage official Beaches Environmental Assessment and Coastal Health Act Grant beach monitoring. State parks, universities and county environmental and public health departments also monitor beaches.

Based on responses from the first questionnaire, a more detailed second questionnaire queried respondents on the types of surveys deployed, the identification of known contaminant sources, whether remediation was pursued, and more detail on the frequency of surveys and remedial actions. In addition, the work group gathered stories and other information about how conducting beach surveys led to outcomes like fewer beach closures or increased tourism at a local beach. The second questionnaire was released on the GLBA website in early 2021,[1] and the work group shared the questionnaire by email using MailChimp, on listserv channels (Great Lakes Information Network, BEACHNET) and online publications, including the International Joint Commission's newsletter.[2] The work group also directly connected by phone or email with government agencies and beach managers at the state and local level to pursue some representation from First Nations and Tribal governments agencies, all eight US states in the basin, and the province of Ontario.

The detailed responses from the second questionnaire are summarized in a technical document (HPAB and GLBA, 2022). Questionnaire responses were collected through a Google form by the work group and captured in spreadsheets. These were analyzed by the team and are available in full in the associated technical document (HPAB and GLBA, 2022).[3] The technical document presents all questionnaire results, as well as detailed jurisdictional breakdown of the results by country, state/province, and tribe affiliation. Results are presented as summary statistics including qualitative data on types of contaminant sources, challenges to remediation and monitoring, as well as reported priorities to improve beach water quality. The data from the technical document, which covers the second questionnaire, are summarized in this report. These results were presented to the Board of the Great Lakes Beach Association in a webinar on December 5, 2022.

[1] The Great Lakes Beach Association hosted the questionnaire on their website at: greatlakesbeachassociation.org/beach-sanitary-survey.
[2] The International Joint Commission newsletter article can be accessed at: ijc.org/en/what-environmental-surveys-can-tell-us-about-human-health-and-water-quality-great-lakes-beaches.
[3] The technical report can be accessed at: ijc.org/sites/default/files/HPAB_BeachSurveys_TechnicalReport_2023.pdf

3.0 Results

3.1 Questionnaire respondent characteristics

Through online survey submissions and individual follow-up, responses were obtained from each state and provincial representative of the GLBA. Additional online submissions were solicited from 34 Ontario Public Health Units, Ontario Parks, eight state Public Health and Environmental Management Departments, state parks, as well as county public health bodies resulting in 11 and 20 additional responses respectively. The total of 34 responses were received from beach monitoring programs in every Great Lakes state in the United States (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin) and from Ontario, Canada. Through online survey submission and direct communication, survey responses were also obtained from three US tribes, of which one tribe is one of the three Great Lakes tribes who receive funding under the US Beaches Environmental Assessment and Coastal Health Act.

The questionnaire asked respondents to report on how many beaches were covered by their beach monitoring programs. A tally of responses indicated a total of 1,155 monitored beaches: 328 in Canada, and 827 US beaches (**Table 1**). There are a total of 815 beaches monitored by the municipal and county health units in Ontario, as well as the province's Ontario Parks (Parent-Doliner 2017). Of these, 328 are covered here, representing 40 percent of the province's officially monitored beaches. In the United States, approximately 1,140 beaches are monitored by state parks and state and county bodies (HPAB and GLBA, 2022). This survey captured representation from responses for 827 beaches, which is 72 percent of US Great Lakes monitored beaches. There is no tally of the total number of beaches monitored by community-based monitoring groups in the Great Lakes. The survey includes 12 sites in Ontario monitored by community-based monitoring groups.

Twenty-one beaches monitored by tribal governments in the US Great Lakes are represented in the survey, including the eight monitored by the Bad River Band, a USEPA Beaches Environmental Assessment and Coastal Health Act Grant recipient.

The questionnaires indicated that 68 percent of the respondents were from the United States (23 respondents); Canada accounted for 32 percent of responses (11 respondents). Respondents included Ontario health units, the provincial parks department, US state beach monitoring programs, county beach programs and state university-based beach monitoring programs. Two Canadian community-based water monitoring groups also completed the questionnaire. The responses from the three US tribes are reported separately in this white paper, where possible, and when their responses are included with those from the United States it will be clearly noted throughout. There were no responses from Canadian First Nations.

Table 1. State/Province breakdown with number of questionnaire responses and number of beaches.

State/Province	Number of survey responses	Number of beaches covered by surveys
Ontario	11	328
Illinois	1	21
Indiana	1	24
Michigan	3	435
Minnesota	1	36
New York	1	6
Ohio	1	25
Pennsylvania	3	32
Wisconsin	12	248
TOTAL	**34**	**1,155**

3.2 BSS/EHSS survey prevalence

The questionnaire responses indicate that 23 out of 34 (68 percent) beach monitoring programs around the Great Lakes basin conducted annual BSS/EHSS surveys each year (**Figure 1**). Nine (26 percent) beach monitoring programs indicated they did not conduct annual surveys, while two (6 percent) programs indicated they were unsure whether surveys were completed each year. On a jurisdictional basis, 10 beach monitoring programs in Canada (91 percent) indicated they conducted annual EHSS, compared to two programs associated with tribes (67 percent), and ten programs in the United States (50 percent). Responses ranged from a lack of annual surveys for some state and tribal beach monitoring programs, to a high percentage of beach monitoring programs conducting annual beach surveys in Ontario (91 percent) and Michigan (100 percent). These results, while generally encouraging, suggest at least 26 percent of beach monitoring programs still do not conduct annual surveys to understand potential health risks from changing

environment/conditions around beaches. There is also an uneven prevalence of these surveys around the Great Lakes.

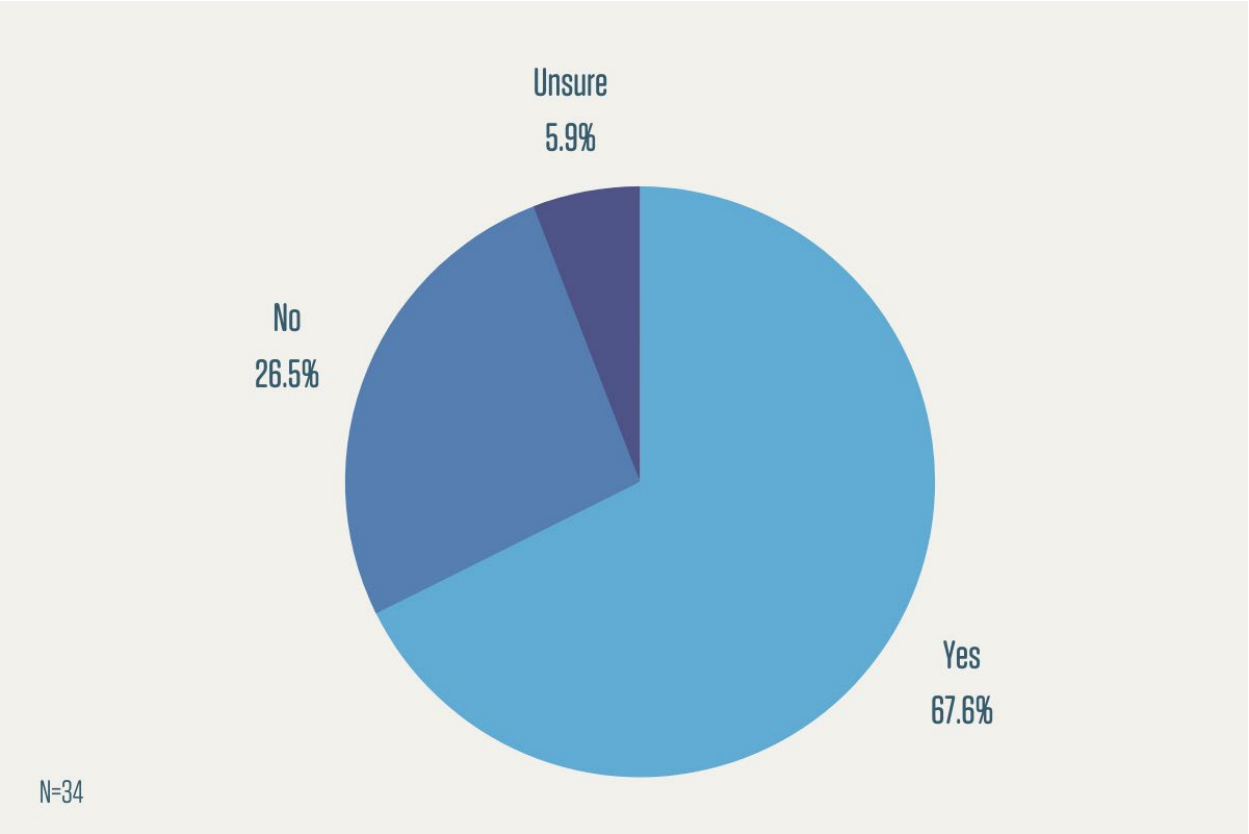

Figure 1. Pie chart of all Great Lakes responses (34) to the question "Does your beach monitoring program conduct annual BSS/EHSS every year, ahead or at the end of swim season?"

Most Great Lakes beach monitoring programs (56 percent) responded that they were following USEPA 2021 guidance for conducting annual sanitary surveys, while 26 percent were following Ontario Ministry of Health and Long-Term Care 2018 guidance, followed by US state guidance and requirements (24 percent) and Health Canada 2012 Guidelines for Recreational Water Quality (3 percent). Thirty-two (94 percent) Great Lakes beach programs indicated they performed more simplified BSS associated with routine water sample collection. The data from these annual and routine surveys can be useful to track, document and assess environmental changes if the data are properly collected and stored.

Many Great Lakes beach monitoring programs (44 percent) indicated they conduct comprehensive BSS/EHSS at each beach annually. Other programs do less-detailed annual surveys, or perform annual surveys more sporadically (e.g., when a beach is first established or when there is any major change of conditions around a beach). Several beach monitoring programs indicated their annual and routine survey efforts have been limited by a shortage of staff and funding.

3.3 BSS/EHSS identification of threats

When fecal indicator bacteria levels exceeded relevant water quality thresholds designated for the protection of public health, 59 percent of beach monitoring programs across the Great Lakes reported using BSS/EHSS surveys to investigate sources of fecal pollution. The use of these surveys varied across programs in tribal (33 percent), the United States (70 percent), and Canadian (73 percent) respondents. The surveys were reported to have found previously unrecognized sources of fecal pollution for 38 percent of beach monitoring programs around the Great Lakes.

However, questionnaire responses indicated that only 29 percent of beach monitoring programs across the Great Lakes knew all the fecal pollution sources impacting their beaches (**Figure 2**). A larger proportion of programs indicated they did not know or were unsure of all the fecal pollution sources impacting their beaches; Canada (45 percent), tribes (33 percent), and the United States (60 percent).

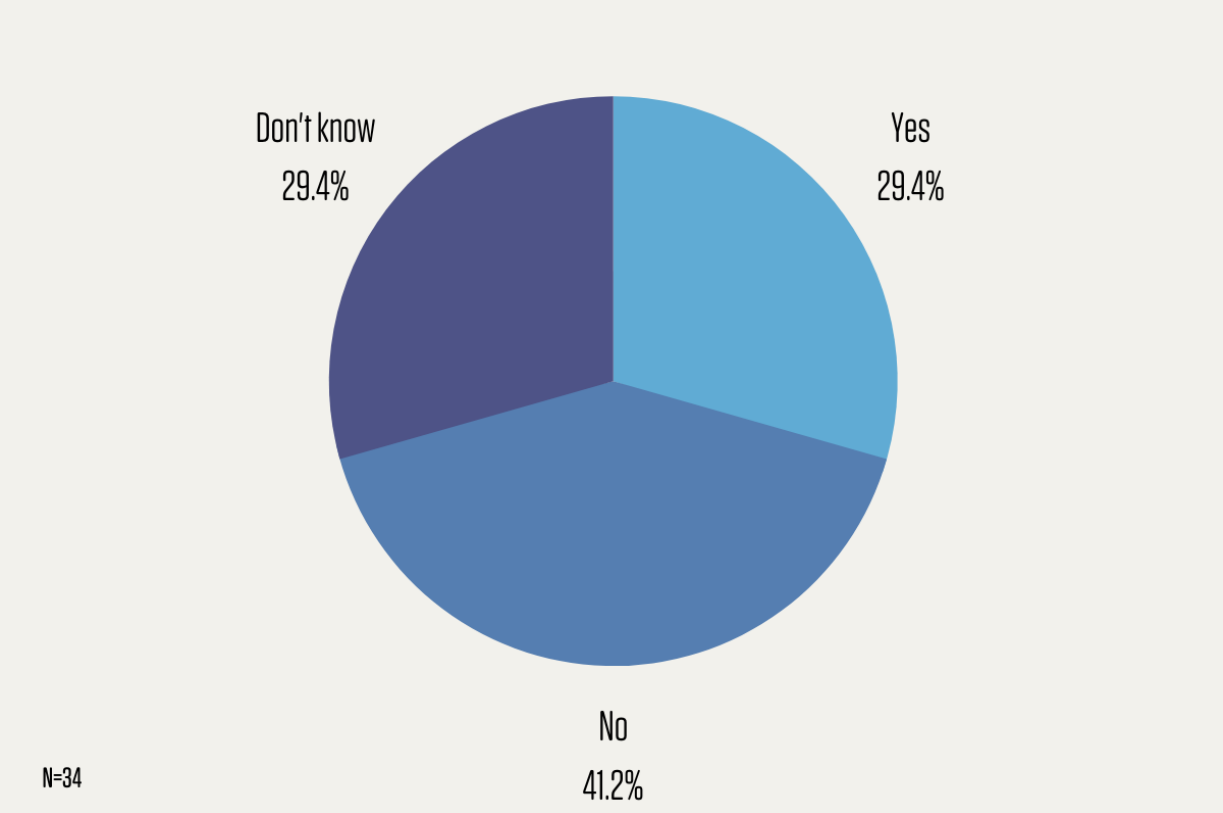

Figure 2. Great Lakes beach program responses to whether all fecal pollution sources impacting their beach(es) are known.

Despite this lack of knowledge of fecal pollution sources, relatively few programs indicated they had followed up on BSS/EHSS to conduct expanded *E. coli* surveillance [Canada (18 percent), United States (35 percent) and tribes (67 percent)] or to conduct microbial source tracking

studies [Canada (36 percent), United States (60 percent) and tribes (33 percent). Follow up microbial source tracking studies were less prevalent for beaches in Canada than the United States. Similarly, few beach monitoring programs had followed up on sanitary surveys to conduct waterborne pathogen studies in Canada (0 percent), the United States (30 percent) or tribal areas (0 percent).

Bird fecal droppings, stormwater and parking lot runoff, and sewage were generally the most commonly identified fecal pollution source for beach programs across Canadian, United States, and tribal jurisdictions. Fecal droppings from Canada geese (85 percent) and gulls (74 percent), as well as stormwater runoff (74 percent) were identified as the most widespread potential health threats by beach monitoring programs across the Great Lakes (**Figure 3**). Runoff from parking lots (59 percent), algal blooms (58 percent), sewage contamination (44 percent) and dog fecal droppings (41 percent) were also commonly reported health threats, while dangerous currents (32 percent) and cattle fecal waste (24 percent) were less common. Industrial pollution (15 percent), swine fecal pollution (9 percent) and poultry fecal waste (6 percent) were the least commonly reported potential health threats.

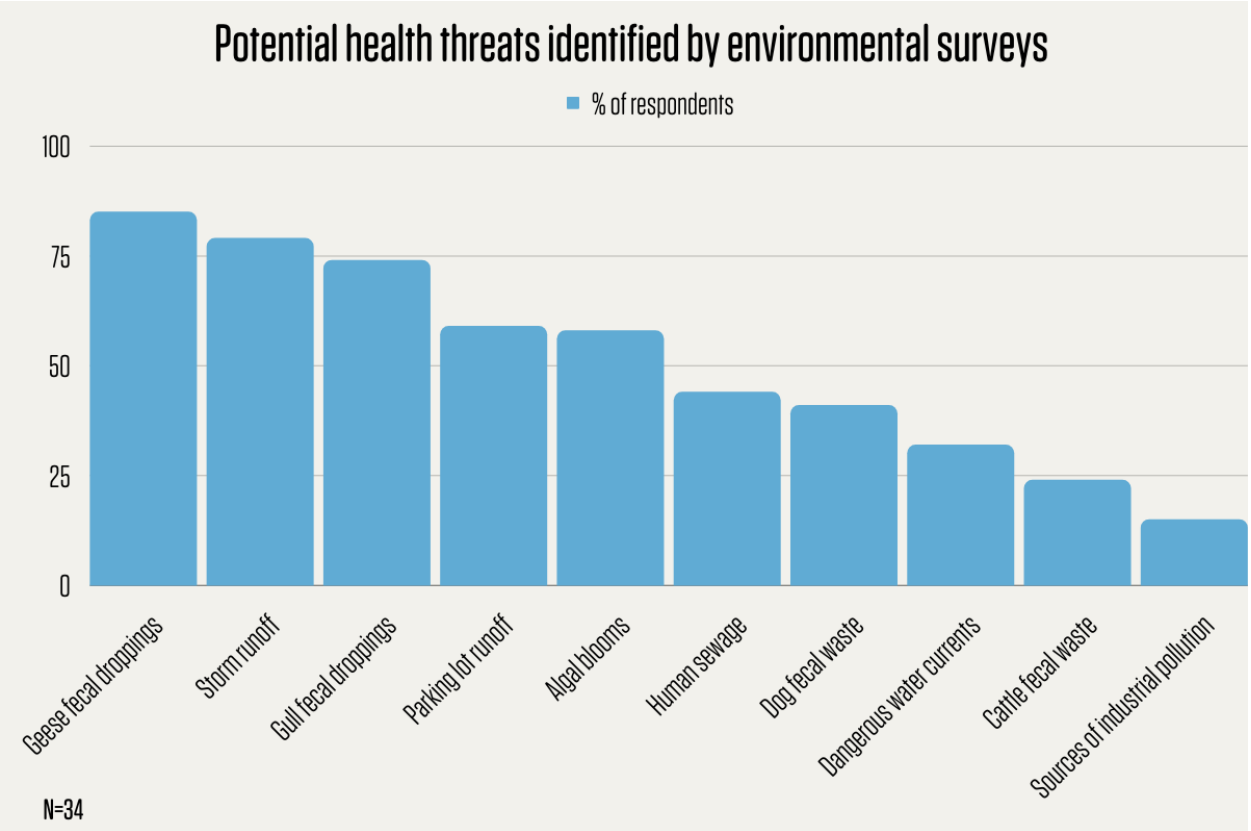

Figure 3. Bar chart of top 10 potential health threats respondents identified by environmental surveys.

Algal blooms were identified as a potential health threat by 58 percent of beach monitoring programs around the Great Lakes. This potential threat was reported across beach programs in

Canada (73 percent) and the United States (60 percent), but not in tribal areas. Note that the three tribal respondents were associated with rural northern Wisconsin and Michigan Tribal reservations. Algal blooms were identified as a potential threat in Ontario and all state jurisdictions except Minnesota. Despite this widespread concern about algal blooms, few beach monitoring programs indicated they had followed up on sanitary surveys with studies to detect harmful algae or cyanobacteria in Canada (9 percent), the United States (25 percent) or tribal areas (0 percent). While the questionnaire did not have a question about threats from *Cladophora* mats washing ashore, these concerns have been growing at some beaches in recent years (Verhougstraete et al. 2010).

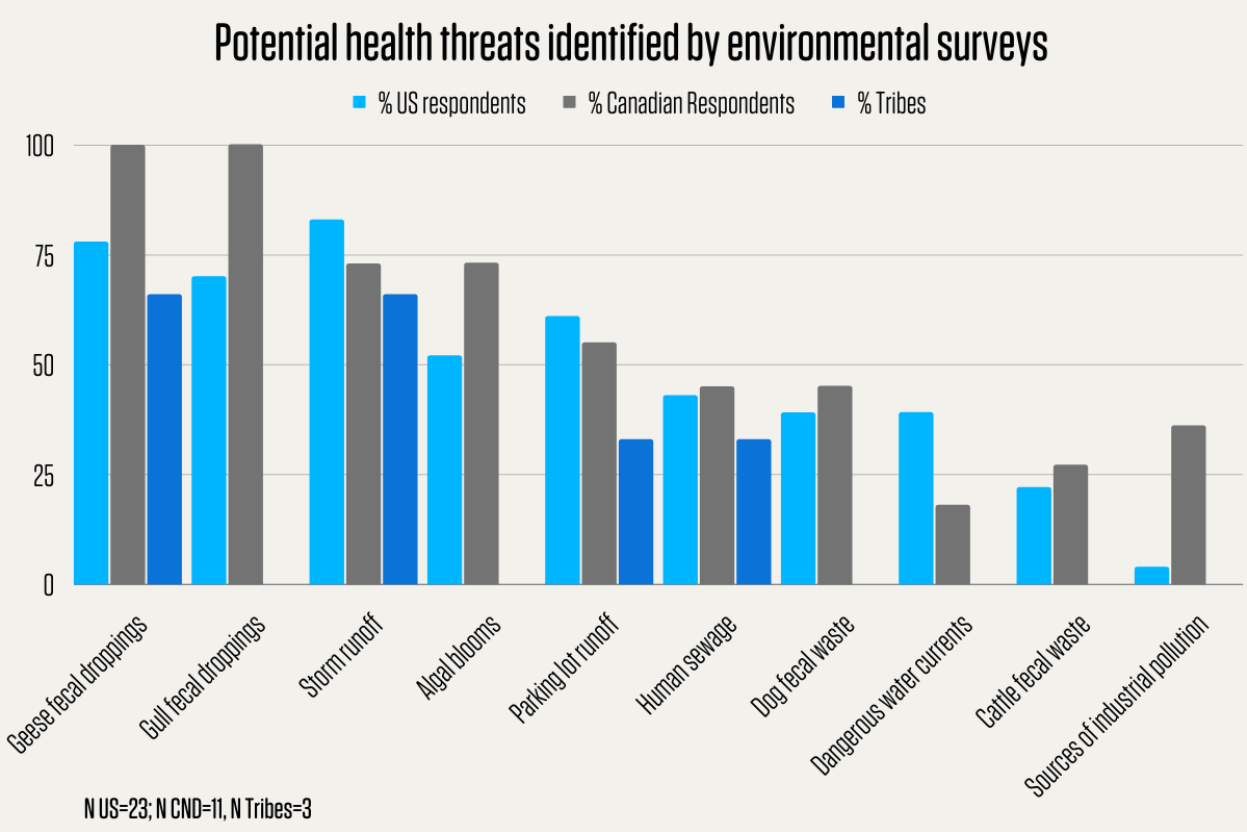

Figure 4. Bar chart of top 10 potential health threats that respondents identified by environmental surveys, with jurisdictional breakdown.

As with the previously reported metrics, storm/parking lot runoff, bird droppings, sewage and algal blooms remain commonly reported health threats across all jurisdictions (**Figure 4**). Dangerous currents were identified as a potential health threat by 32 percent of beach monitoring programs around the Great Lakes. This potential threat occurred across beach programs in Canada (18 percent) and the United States (45 percent) but was not identified in Tribal areas. Dangerous currents were identified as a potential threat in Ontario, Illinois, Indiana, Michigan, Minnesota and Wisconsin.

3.4 BSS/EHSS guided remedial actions

The majority of the respondents, 65 percent (22), reported that surveys had led to beach remedial actions (**Figure 5**). This aligns closely with the number of organizations that reported conducting BSS/EHSS annually (67.6 percent, in **Figure 1**). Thirty-two percent (11) reported "No", and 3 percent (1) did not respond.

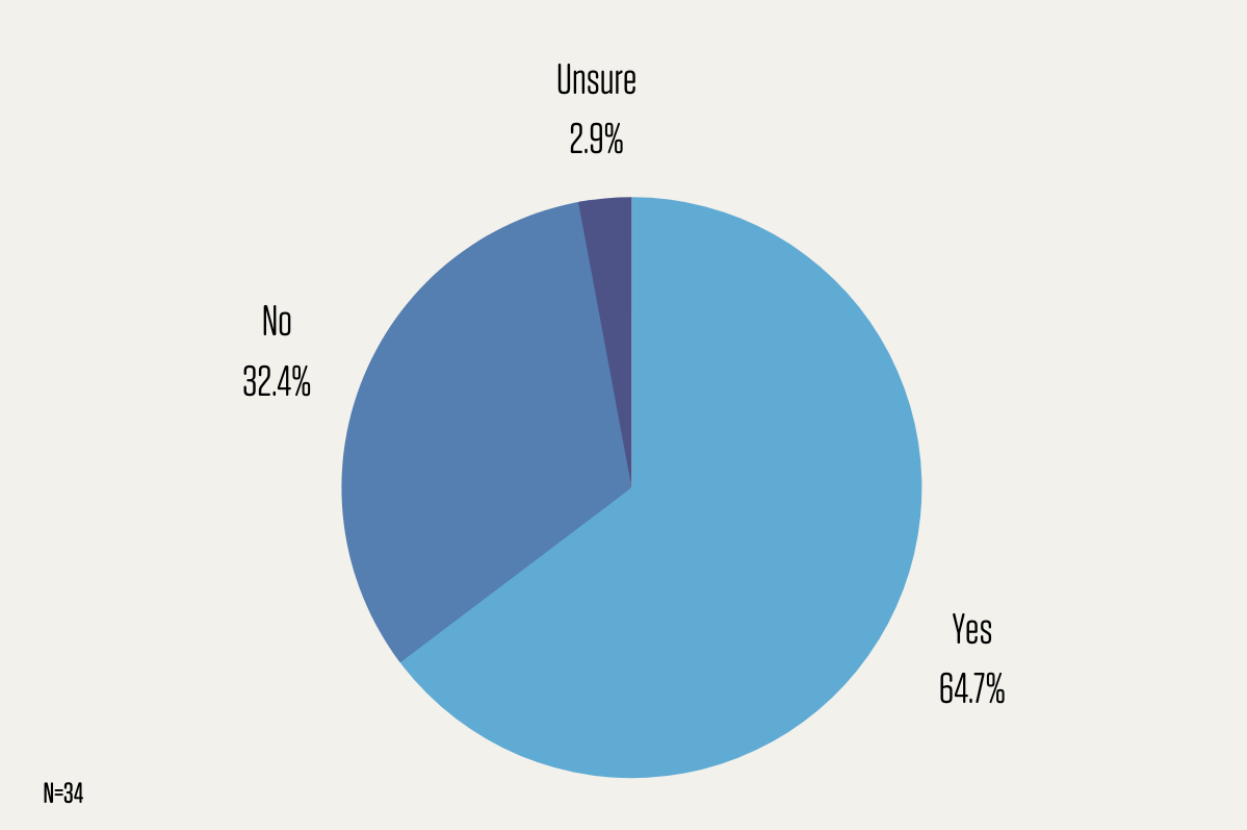

Figure 5. Pie chart of whether or not BSS/EHSS have led to beach remedial actions.

Jurisdictionally, 15 (65 percent) of US respondents reported the surveys had led to beach remedial actions, and 8 (35 percent) responded they had not. Responses were nearly identical in Canada, with 7 (64 percent) of respondents reporting that, yes, the surveys led to beach remedial actions, and 4 (36 percent) reporting "No." US tribes reported lower numbers, with 1 (33 percent) answering "Yes" and two (67 percent) saying "No."

Those who reported that the surveys had helped recommend mitigation activities were asked to specify which activities had been undertaken from the following list: wastewater infrastructure upgrades, waterfowl control actions, pet control actions, beach landscaping, sand grooming, enhanced garbage/waste management, farm best management practices and/or land use changes. Waterfowl control actions were by far the most common mitigation activity, with 65 percent (22) of respondents identifying this as a recommended mitigation activity (**Figure 6**). Beach landscaping (50 percent) and sand grooming (47 percent) were also common, followed by

enhanced garbage/waste management. Only 29 percent of respondents reported that surveys recommended wastewater infrastructure upgrades, despite stormwater runoff being identified as one of the most widespread potential health threats (74 percent beach monitoring programs across the Great Lakes).

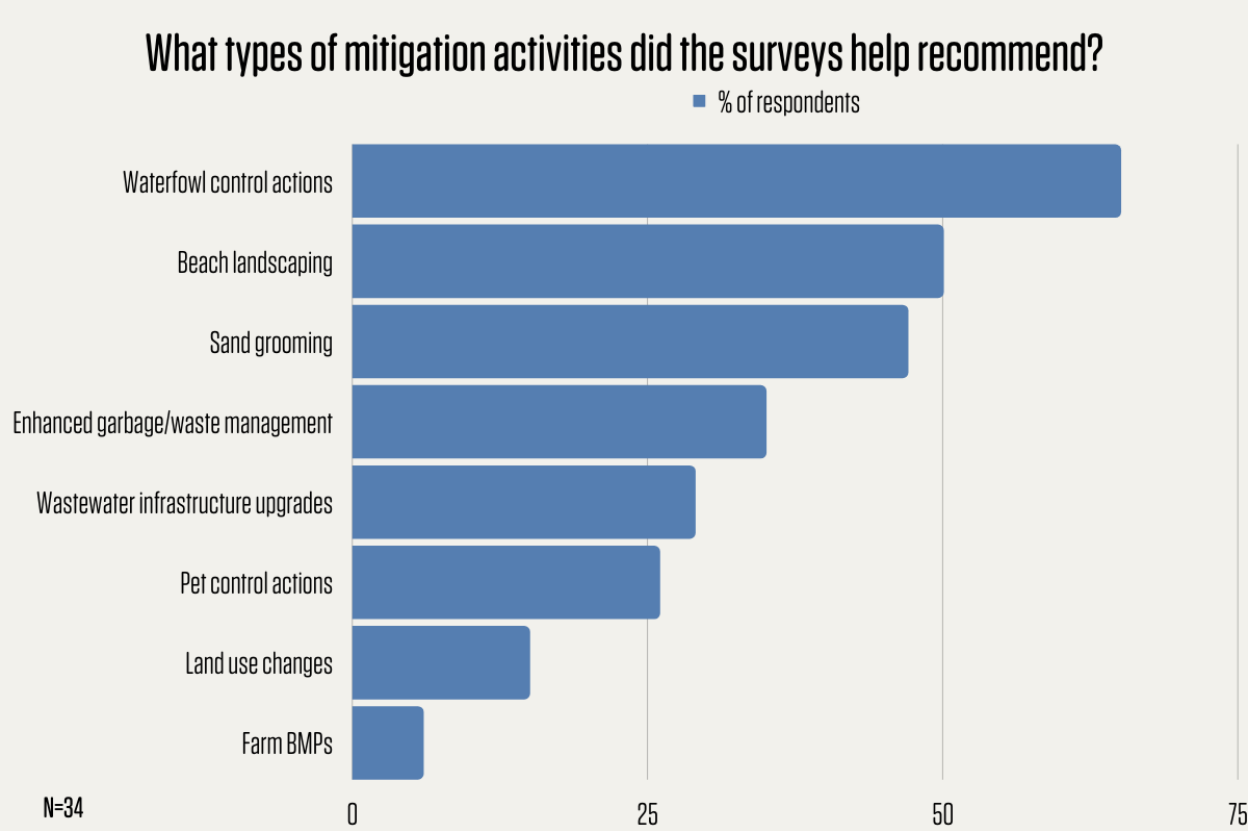

Figure 6. Row chart of the types of mitigation activities the surveys helped recommend.

Short answer responses were received from 23 respondents to the questions: "What proportion of recommended mitigation activities have been performed? What types of recommended mitigation activities have been performed?" Answers were highly localized and ranged from zero percent to 100 percent of recommended mitigation activities being performed. Answers described the types of remediation as complete beach remediation, and smaller activities, such as plantings and beach clean-ups. Respondents who reported that little or no remediation activities had been performed, noted that funding was the main obstacle.

When mitigation activities were performed, 19 respondents described the changes they detected in subsequent monitoring or surveys. Short answer responses were received from the 19 respondents. Thirteen respondents reported very positive changes to the beach environment and adjacent surface water quality. Descriptions of these improvements included reduction of waterfowl numbers and waterfowl waste on beaches. A decrease in fecal indicator bacteria concentration was noted by five respondents. Significant surface water quality improvement and a reduction in beach advisories was noted by five respondents, including one who noted the

changes were dramatic enough to award them the Blue Flag designation. Daily beach grooming and waterfowl deterrent measures (e.g., dog program, Eagle Eyes, wildlife-proof trash cans, no handfeeding messaging, and ordinances) were reported to have the most impact on reducing *E. coli* levels and the number of samples exceeding Indiana's recreational water quality criteria. Conversely, two respondents noted that there were no improvements, or minimal improvements, and three respondents reported that changes were unknown.

Finally, beach managers were asked: "When mitigation activities were completed, were changes in beach utilization and/or local economic impact measured (or estimated)?" Short answer responses were received from the 21 respondents who engaged in mitigation activities. Thirteen respondents did not reply (38 percent). The impact of mitigation was measured or estimated by only 6 percent (2 respondents). Thirty-five percent (12 respondents) responded that they did not measure the impact, and six percent (2 respondents) did not know whether or not they did. Fifteen percent (5 respondents) responded "other" and provided a short answer; one noted there were "less complaints on the closures or advisories."

3.4.1 Case studies of successful beach remediation

Case study 1: Bluffer's Park Beach (Toronto, Ontario)

Photo credit: Tom Edge

Bluffer's Park Beach in Toronto, Ontario often had beach postings through the 1980s and 1990s exceeding 80 percent of the bathing season. EHSSs were completed and used to guide dye and smoke testing of local sewage infrastructure, expanded *E. coli* surveillance, and a microbial source tracking study to identify the source of fecal pollution causing beach postings. These efforts provided multiple lines of evidence to identify the importance of bird fecal droppings, and

runoff from an adjacent wetland and parking lot as important sources of *E. coli* contamination. Starting in 2006, bird control efforts, the engineering of a berm to control runoff onto the beach, and wetland and dune restoration actions led to immediate improvements in water quality. Since these remedial actions, Bluffer's Park Beach has been posted for swim advisories less than 20 percent of each bathing season, and it was awarded a Blue Flag[1] accreditation in 2011 (Edge et al. 2018).

Case study 2: North Beach (Racine, Wisconsin)

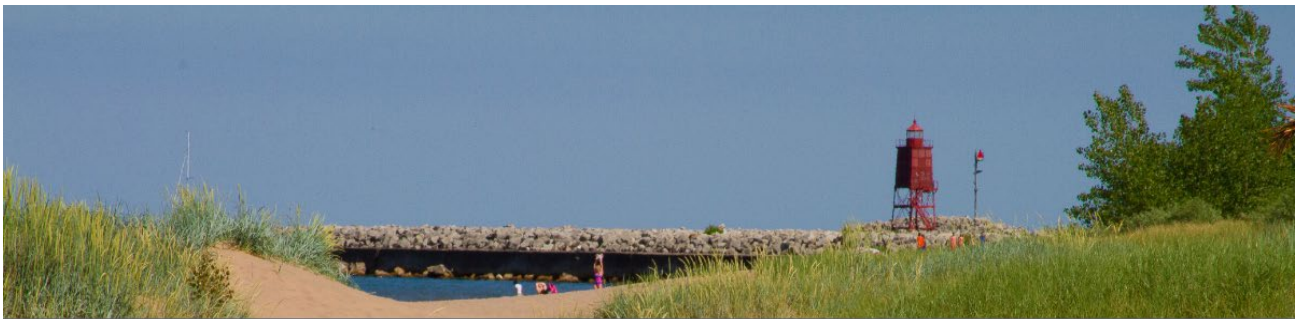

Photo credit: Julie Kinzelman

The City of Racine, Wisconsin Public Health Department Laboratory conducted a BSS to identify pollution sources and guide development of altered management practices, including ecologically appropriate beach modifications (frequently relying on restoration of native vegetation and coastal habitat) and the redesign of a major stormwater outfall, to improve recreational water quality. Resulting improvements, co-implemented and managed by the Departments of Public Health, Public Works, and Parks, Recreation, and Cultural Services, reduced water quality advisories from 66 percent of available swimming days in 2000 to less than 10 percent in subsequent years. Improvement in water quality restored public confidence, increased use (120,000-plus visits annually), and expanded the role of the beachfront in the local economy (approximately US$5 million (CDN$6.8 million annually). Ongoing routine and annual BSS indicate that the stormwater infrastructure, topographical and plant community modifications are resilient to lake level fluctuations/climate change (Kinzelman et al. 2020).

[1] More information about Blue Flag beach accreditation is available at: swimdrinkfish.ca/blue-flag.

Case study 3: Samuel Myers Park (Racine, Wisconsin)

Photo credit: Julie Kinzelman

In 2010 the US Great Lakes Restoration Initiative provided funding for BSS to be conducted at 50-plus beaches in the state of Wisconsin, including Samuel Myers Park. Field data and laboratory analysis not only revealed sources of microbial pollution (e.g., stormwater runoff, avian fecal waste, beach sands) but also habitat degradation and the emergence of invasive *Phragmites* and other plant species which threaten beaches, coastal wetlands and associated freshwater estuaries. Comprehensive BSS data was utilized to guide restoration including the use of bioswales, rain gardens, wetlands and dunes, in addition to other naturalized and coastal engineering measures to improve recreational water quality. Improvement in surface water quality is integral to, and a function of, public health protection, habitat restoration and ecosystem function. Specific actions included: increasing the height of breakwater to prevent or reduce shoreline erosion; regrading the beach to establish steeper slopes to increase stormwater runoff infiltration capacity; removing/replacing invasive species with native vegetation, including trees, to improve habitat, enhance stormwater capture, and increase carbon sequestration; and establishing a designated offshore swimming area.

As of 2021, 60,000-plus units of native vegetation and approximately 350 trees have been planted. Samuel Myers Park is now the number two birding hotspot in Racine County, with 38 new species observed within this migratory bird flyway since restoration began. Water quality has improved, and the decades long swim ban has been removed. Carbon sequestration at tree maturity is equivalent to the permanent removal of 3.5 cars from use. Nature-based coastal solutions have increased site resiliency to fluctuating lake levels/coastal storms. (Magee et al. 2021).

3.5 Citizen science opportunities

Respondents were asked to provide a short answer about what gaps in knowledge (regarding the need for, the importance of, and health impact of fecal contamination and other aspects of

environmental surveys) could beach users or citizen scientists contribute directly. Of the 34 respondents, 18 provided short written answers with their ideas. A range of opportunities were highlighted and are available in the full technical document.

While there were many opportunities highlighted where respondents thought the public could step in and contribute, relatively few programs reported active community/citizen science partnerships. This also includes a general dearth of data collected from community-based water monitoring programs. When asked if there is relevant data that could be provided directly to beach managers through partnerships with beach users or citizen scientists, 41 percent (14 respondents) answered "Yes," 12 percent (4 respondents) answered "No," 44 percent (15 respondents) answered "Maybe," and one (3 percent) did not answer. Further, only 18 percent of respondents were aware of BSS/EHSS conducted by citizen scientists, with the vast majority, 82 percent (28 respondents) reporting they were not aware. The trend continued with responses for whether or not respondents engage with citizen science programs directly, with only 9 percent (3 respondents) answering "Yes," 47 percent (16 respondents) replying "No" to this question, and 44 percent did not respond. Similarly, when asked whether citizen-based monitoring data was utilized, only 9 percent (3 respondents) said "Yes," with 65 percent (22 respondents) saying they did not use citizen science data, and 26 percent did not respond to this question.

Those who reported use of citizen science data listed purposes including the following: to inform remediation activities; to share with the public; to trigger investigation. One respondent indicated some citizen-based data is "collected and utilized by the state department of natural resources; primarily on tributaries."

3.6 Sharing data

Respondents were asked whether or not their BSS/EHSS data is distributed externally, with the public. Sixty-five percent (22 respondents) reported "Yes" while 29 percent (10 respondents) reported "No." Two respondents (6 percent) did not provide an answer. However, there were big differences between jurisdictions. Whereas 74 percent of the US respondents reported their BSS/EHSS data were distributed publicly, only 45 percent of Canadian beach programs share their data with the public. Two of the three responding tribes (66 percent) reported sharing their data publicly (**Figure 7**).

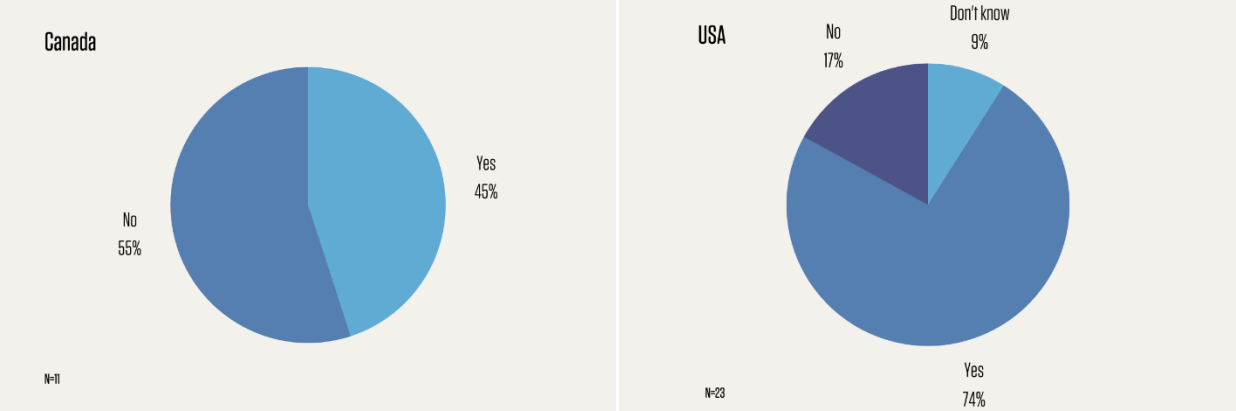

Figure 7. Responses to the question: "Is your beach environmental survey data distributed externally/publicly?"

Of the 22 respondents who reported that their BSS or EHSS are distributed externally, they reported sharing their surveys using the following methods (**Figure 8**):

- Shared directly with request or (upon request): 5 respondents
- Open data portal, with raw, machine readable, and accessible data: 6 respondents
- Accessible from website: 9 respondents
- EPA's WQX portal: 2 respondents
- Annual reports: 2 respondents

Not depicted in Figure 8: One respondent also noted that: "Prior to May 2021, BSS data was made available to the public via the BeachGuard website; however, with the advent of [Indiana Department of Environmental Management's] BeachAlert, the legacy beach sanitary survey data is now available on request."

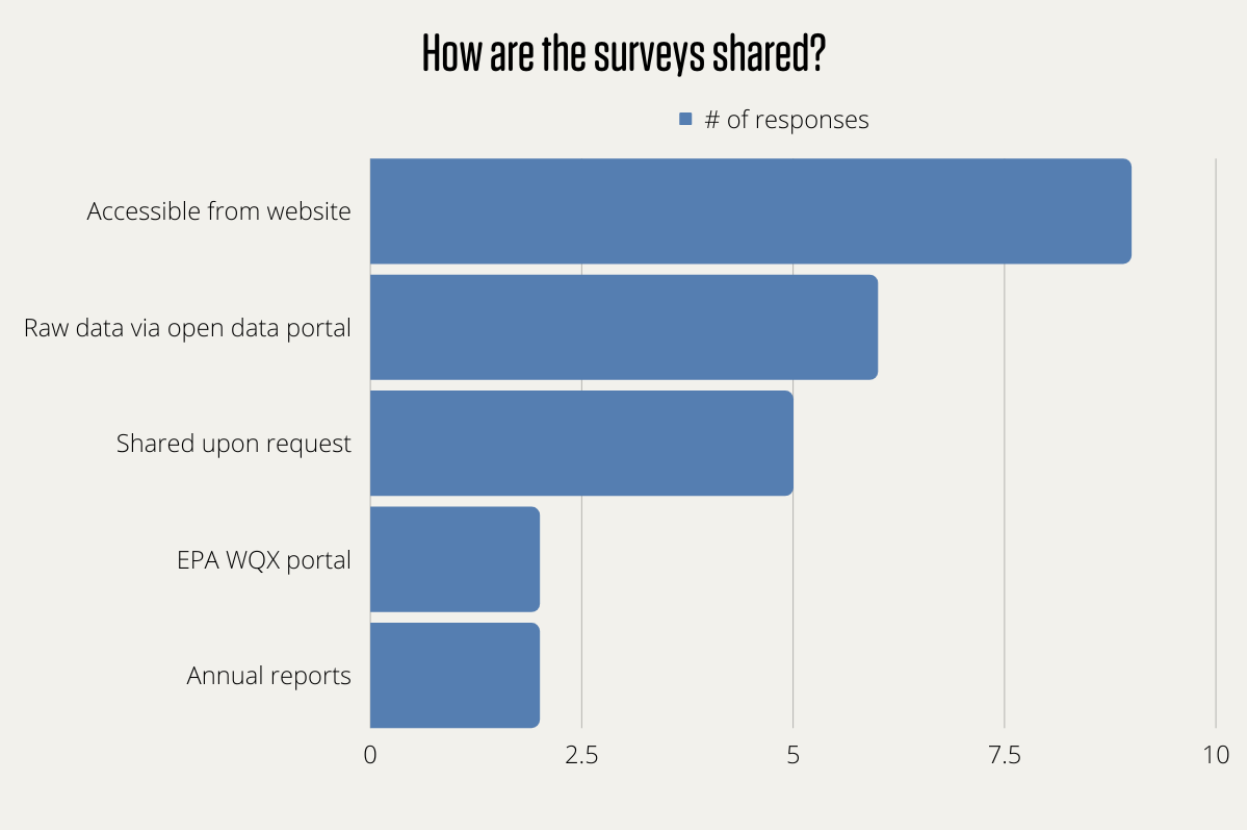

Figure 8. Row chart with the responses to the question about how beach environmental survey data are shared.

3.7 COVID challenges

The questionnaire responses indicated that 22 of 34 (65 percent) beach monitoring programs around the Great Lakes were adversely impacted by the COVID-19 pandemic. This adverse impact occurred across programs in Canada (64 percent), the United States (60 percent), and tribes (100 percent). The most common adverse impact response was that staff capacity was reduced. Five (23 percent) of those adversely impacted programs explicitly indicated that frequency of water sampling was reduced, while two programs (9 percent) indicated that lab capacity to perform water quality assays was reduced. Resources for many beach monitoring programs in public health units were already stretched before the COVID-19 pandemic.

4.0 Discussion and Conclusions

BSS/EHSS surveys are an important first step in identifying fecal pollution sources, assessing health risks and developing a risk management plan for protecting public health at beaches (Health Canada 2012; USEPA 2021). Health Canada guidelines indicate an EHSS should be conducted on an annual basis, just before the start of the swimming season. Some agencies do their annual survey after the end of the swimming season. The survey should be led by the authority with the best day-to-day knowledge of the beach and done with broad collaboration and communication with other sectors, government agencies, and stakeholders.

Overall, most jurisdictions and beach monitoring groups responding to the questionnaires conducted annual and routine BSS/EHSS. However, at least 26 percent of respondents stated they did not regularly perform annual BSS/EHSS, indicating that it is still common that this activity is not applied across the Great Lakes basin. Given sufficient staff and resources, the questionnaire responses, along with the successful case-studies outlined in section 3.4, indicate that enhancing the prevalence of BSS/EHSS would benefit the Great Lakes beaches. As outlined in this white paper and elsewhere, annual BSS/EHSS surveys at beaches are widely recommended as an important means to protect public health (Health Canada 2012; USEPA 2021). The HPAB has recommended the prevalence of these surveys as an indicator of the knowledge of pollution sources, adherence to best practices, and the "swimmability" of Great Lakes beaches (HPAB 2014).

Many of the questionnaire respondents indicated that they used the results of BSS/EHSS to investigate sources of fecal pollution at beaches. However, only 29 percent of beach monitoring programs indicated they knew all the fecal pollution sources impacting their beaches. In addition, despite this lack of knowledge of fecal pollution sources, relatively few programs indicated they had followed up on sanitary surveys to conduct expanded *E. coli* surveillance or microbial source tracking studies. Relatively less follow up in Canada might be related to the lack of regulatory requirements for source tracking equivalent to the Total Maximum Daily Load approach under the US Clean Water Act (Edge and Schaefer, 2006). The importance of BSS/EHSS, expanded *E. coli* surveillance and microbial source tracking for knowing your fecal pollution sources is widely recognized as an important part of assessing and managing health risks at beaches (Great Lakes and St. Lawrence Collaborative 2020; Health Canada 2012; USEPA, 2005, 2012; World Health Organization 1999).

More than one half of beach monitoring programs around the Great Lakes identified Canada geese (85 percent), gulls (74 percent), stormwater runoff (74 percent), and runoff from parking lots (59 percent) as sources of fecal pollution and potential health threats at beaches. These results are consistent with numerous beach studies around the Great Lakes reporting on the adverse impacts of bird fecal droppings (Edge and Hill, 2007; Nevers et al. 2014), stormwater runoff (Sauer et al. 2011; Staley et al. 2016), and parking lot runoff (Edge et al. 2018; McLellan and Salmore, 2003). While untreated human sewage is widely regarded to present the highest threat to human health, bird and other animal fecal droppings can also present human health risks (Brown et al. 2017). Sewage was identified as a potential health threat by 44 percent of beach monitoring programs, and it should be recognized that septic systems (Verhougstraete et al.

2015) and stormwater outfalls (Edge et al. 2021; Sercu et al. 2011) can often be under-recognized sources of human fecal wastes.

Algal blooms were reported as a potential health hazard by 58 percent of beach monitoring programs around the Great Lakes. Despite this widespread concern about algal blooms, very few beach monitoring programs indicated they had followed up on BSS/EHSS with studies to detect harmful algae or cyanobacteria. There is a growing need for more rapid test methods for assessing health risks associated with algal blooms. The forthcoming HPAB plan for a Great Lakes Microbial Source Water Quality Assessment will be seeking to evaluate molecular methods for more rapidly and comprehensively characterizing the potential health risks associated with algal blooms.

Dangerous currents were identified as a potential health threat by 32 percent of beach monitoring programs around the Great Lakes. There is growing concern about drownings in recreational water settings around the Great Lakes, and associated safety assessments should be part of BSS/EHSS assessments.

The use of BSS/EHSS to develop and execute a mitigation plan should be followed with impact measuring activities to follow the impacts to communities' quality of life and economy. Impact assessments for these activities could also serve to make the case to secure further funding and devote additional efforts to beach remediation. The case-studies identified in this white paper describe remediation success stories that provided qualitative and quantitative information to demonstrate improved beach water quality and beneficial economic impacts on local economies. For example, Bluffer's Park Beach, once one of Toronto's worst beaches, is now posted with swimming advisories less than 20 percent of each bathing season, and it was awarded the Foundation for Environmental Education's Blue Flag accreditation in 2011. To qualify for a Blue Flag, beaches must meet a series of stringent criteria in several categories, and accreditation is renewed on an annual basis.[1] Also, remedial actions at North Beach in Racine, Wisconsin have increased public use (120,000-plus visits annually) and expanded the role of the beachfront in the local economy. Remedial actions have also turned Samuel Myers Park WI into the number two birding hotspot in Racine County, with 38 new species observed since restoration began.

Remedial actions described by questionnaire respondents were consistent with growing reports of the benefits from some of these approaches at Great Lakes beaches. Waterfowl control efforts have been documented to lead to improved water quality at a number of Great Lakes beaches (Converse et al. 2012; Jordan et al. 2019). Sand grooming (Kinzelman et al. 2004) and landscaping to prevent surface water runoff into beach waters (Edge et al. 2018) have also been successful in improving beach water quality conditions. Cases of remediation successes need to be better documented, compiled and communicated. BSS/EHSS can be extremely valuable tools for documenting and evaluating the success of beach remediation actions.

The problem of getting timely access to water quality data is widely recognized (World Wildlife Fund Canada 2020). Researchers, governments, and practitioners are increasingly calling for more nontraditional data sources in water quality monitoring, such as data collected by community scientists. This is also true for beach data, where some analyses have found that

[1] More information about the global Blue Flag program is accessible at: blueflag.global.

community scientists can provide unbiased data as accurate as professional researchers (Gunn 2021; Pucino et al. 2021; Whitelaw et al. 2003) Further research has found that the data and information generated by community-based water monitoring programs may be unique resources that are, still relatively untapped (Albus et al. 2020). A recent report published by the International Institute for International Development on behalf of Canada's national Community Based Water Monitoring Collaborative was developed to underscore the value of and support a business case for community-based water monitoring in Canada (Gunn 2021). The report shows community science and public participation in environmental monitoring is a cost-effective way for Canadian and Indigenous communities to assert their interests and make the most informed decisions about their water resources. San Llorente Capdevila et al. (2020) conducted a broad literature review of community science projects focused on water quality monitoring. The most successful endeavors were marked by "engaged and knowledgeable participants who have enough resources to make meaningful contributions." The supporting institutions—including government agencies, nonprofits, or advocacy organizations—are also essential.

Our survey received only a limited response from Indigenous communities around the Great Lakes. Three Tribes responded from the United States, and no First Nations responded from Canada. This highlighted a limitation of our survey methodology for reaching out on the use of sanitary surveys beyond the Great Lakes Beach Association and public health units in Canada and the United States. The Great Lakes Beach Association has grown to be a very valuable public forum for information sharing and communicating knowledge for protecting public health at Great Lakes beaches. There are few other avenues to widely communicate with beach and recreational water programs, and associated public health units, around the Great Lakes transboundary area. Further efforts are needed to include Indigenous perspectives in future beach-related survey methods. While Ontario has a general responsibility to Indigenous peoples living off reserve, the health impacts of recreational water quality on First Nations people is part of the federal responsibility to protect the health of First Nations living on reserve. Programs and services to this end are delivered by Health Canada's First Nations and Inuit Health Branch. As in other provinces, Health Canada's First Nations and Inuit Health Branch is responsible for delivering health services to Indigenous reserves in Ontario. However, First Nations' Chief and Councils decide if there is interest or a need for recreational water quality monitoring at an on-reserve beach, and the nations in certain cases use their own on-reserve drinking water labs to test recreational water for indicator bacteria with samples sent to provincial labs for processing in other instances (Health Canada 2017; Parent-Doliner 2017). This may be particularly relevant for perspectives on the use of sanitary survey approaches for assessing recreational waters. Indigenous perspectives were recently shared at a workshop for a parallel HPAB project (Great Lakes Large Basin Microbial Water Study) indicating the need for a more holistic approach to assess waters for more diverse recreational purposes, for ceremony and traditional responsibilities to the land and water, and to extend beyond commonly restricted designations of beach and recreational water areas.

Unsurprisingly, the survey results indicated the disruptive events from the COVID-19 pandemic placed further pressure on strained beach managing capacity. Aligning community priorities with the official duties of beach managers and environmental health departments provides a useful supplementation to limited resources. Improved data sharing also would improve stakeholder engagement as well as expanding shared resources. These are needed to ensure there are sufficient staff, lab capacity and resiliency to maintain annual and routine BSS/EHSS surveys

through diverse public health pressures that can be anticipated in the future. The capacity to continue to perform, and to expand BSS/EHSS will be an essential part of transitioning Great Lakes beach programs from the current pollution response approach to a pollution prevention approach for protecting public health.

4.1 Recommendations, conclusions and priorities

This work demonstrates the importance of BSS/EHSS in supporting beach restoration and public health alerts, as well as to inform the protection of overall human health in the Great Lakes. We present here the recommendations arising from this work, as well as a summary of conclusions and priorities for the following key areas.

Recommendations

1. **For the next iteration of recreational water quality guidance, or by 2026, provinces, states and other agencies should explicitly provide comprehensive BSS/EHSS survey forms/checklists to public health units, health departments and appropriate tribal and First Nation agencies for implementation by beach managers.**

   This includes clear guidance on the survey collection methodology. Guidance should also clearly emphasize the importance of conducting annual and routine BSS/EHSSs at all beaches, particularly for those that have repeated beach postings or attract large numbers of people, and before doing additional water surveillance or beach remediation projects. Further, digital survey collection and data management and sharing options should be provided.

2. **Reliable and long-term funding is needed to advance BSS/EHSS follow-up studies and mitigation actions. Local, state/provincial, Canadian and US federal governments and other agencies should consider dedicating discretionary funds in two key areas for 2025-2030 to advance mitigation efforts to reduce beach closures and improve beach access and water quality under the Great Lakes Water Quality Agreement.**

   a) Identify or create targeted funding sources to follow up on BSS/EHSS outcomes and investigate potential health threats such as fecal pollution source tracking or algal blooms.

   b) Identify or create targeted funding sources to follow up on outcomes from BSS/EHSSs and health threat investigations, for completing beach remedial actions necessary to move from pollution response to a pollution prevention approach for protecting public health.

Conclusions and priorities

In addition to these recommendations there are also conclusions that can be drawn from the survey results, and we also suggest the following priorities for consideration.

Prevalence of BSS/EHSS

The work group concludes that beach management programs should have sustainable resources from state and provincial sources (financial and trained staff) to complete annual and routine BSS/EHSSs at beaches, including through periods with other public health sector pressures (e.g., pandemics, emergencies). A priority to support the prevalence of BSS/EHSS would be to establish inventories to guide budget projections so that increased costs and other constraints do not erode these resources.

BSS/EHSS identification of threats

Annual and routine BSS/EHSSs should be completed, and guidance provided before beach management programs initiate potential health threat follow-up studies such as expanded *E. coli* surveillance, microbial source tracking studies or investigations of the occurrence of harmful algal blooms or waterborne pathogens.

BSS/EHSS guidance for remedial actions

State and Provincial agencies should ensure that annual and routine BSS/EHSSs have been completed and provide guidance before beach management programs initiate remedial actions to address water quality and health threat problems.

Indigenous ways of knowing

Beach management programs should engage with First Nations and Tribes to expand ways of knowing, and also to better understand recreational water quality monitoring on reserves in Ontario and in the Great Lake states. Consultation with First Nations and Tribes will expand the capabilities for conducting BSS/EHSSs, and can work to include traditional ecological knowledge, and First Nation and Tribal knowledge holders.

Community science and data sharing

Beach management programs should engage with growing community science capacity to expand the capabilities for conducting BSS/EHSSs, communicate experiences through the GLBA, and make BSS/EHSS data accessible to the public. Establish and maintain annual community science training programs wherever possible.

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