Maine Healthy Beaches 2017
EPA Report
July 2018

I. Program Accomplishments

Maine Healthy Beaches (MHB) is managed by the Maine Department of Environmental Protection (ME DEP) and coordinated by the University of Maine Cooperative Extension (UMaine Extension). In 2017, this team worked with 28 local management entities to conduct routine monitoring, assessment, and public notification of water quality conditions for 60 beach management areas spanning Kittery to Mount Desert Island. MHB staff continued to build local capacity for well-informed beach management decisions and to address pollution issues when they arose during the beach season.

The MHB program accomplished the following in 2017:

- Processed 1296 enterococci samples at 109 routine and enhanced monitoring locations.
- Recruited and trained new beach managers and approximately 200 local staff and volunteers to collect water samples, conducted 29 technical trainings for over 140 local staff and volunteers, and facilitated 71 planning/problem-solving meetings (156 participants).
- Implemented precautionary rainfall advisories at 5 beaches impacted by non-point source pollution.
- Analyzed 140 samples for optical brightener levels to target human-sourced fecal contamination at 34 enhanced monitoring locations.
- Implemented objectives of the updated MHB Quality Assurance Project Plan (2016-2021) approved by ME DEP and EPA.
- Worked with the MHB program Technical Advisory Committee to implement Maine's EPA approved (2016) beach action value (BAV) monitoring protocol.
- Supported enhanced monitoring and pollution remediation efforts for: Rockport Harbor, Crescent Beach State Park, the Willard Beach storm drainage network, Goosefare Brook watershed, Kennebunk River, Ogunquit River watershed, and the Cape Neddick River watershed.
- Continued an applied research partnership with the University of New Hampshire (UNH) to test for human and non-human DNA markers utilizing microbial source tracking (MST) techniques.
- Continued updates to the MHB Risk Assessment Matrix (RAM), an evaluation of water quality trends and potential sources of fecal bacteria impacting coastal beaches.
- Used an extensive data analysis of 10 years of data (2006-2015) in conjunction with updated RAMs to update the program's classification/tiered monitoring plan, prioritizing resources to better assess pollution issues at beaches identified as "high-risk".
- Collaborated with students and faculty on the New England Sustainability Consortium (NEST) project focused on safe beaches and shellfish growing areas.
- Transformed data to action items and served on several working groups for improving water quality and ecosystem health.
- Provided expertise and advised towns/groups interested in monitoring freshwater recreation areas as well other areas along the coast.
- Presented 13 times for local, regional, and national audiences including the

Maine Sustainability and Water Conference and the Maine Beaches Conference.

II. Program Deliverables/Appendices

Appendix A *MHB 2017 Budget Summary*

Appendix B *MHB 2017 Beach Mgt. Area Classification/Tiered Monitoring Plan*

Appendix C *MHB Boating Brochure: Healthy Boating Equals Healthy Beaches. Maine Healthy Beaches, University of Maine Cooperative Extension and Maine Sea Grant.*

Appendix D *Maine Healthy Beaches Pet Waste Brochures (Saco, Old Orchard Beach, Ogunquit, Portland). Maine Healthy Beaches, University of Maine Cooperative Extension.*

Appendix E *MHB 2017 Notification Activity*

Appendix F *Excerpts from MHB Data Analysis (2006-2015). Maine Healthy Beaches, University of Maine Cooperative Extension/Walker Environmental LLC.*

Appendix G *DeFranco, E. December 2017. Best Practices for Healthy Beaches and Watersheds in Maine-Potential Bioremediation Strategies for Improving Water Quality, Orono, ME, University of Maine.*

Appendix H *Maine Healthy Beaches Public Notification Signage-Version 1 & 2. University of Maine Cooperative Extension, University of Maine School of Economics, and Maine Sea Grant.*

Appendix I *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in Goosefare Brook, Maine, 2012-2017. Maine Healthy Beaches, University of Maine Cooperative Extension.*

Appendix J *Sims, M. and K. Kaczor. April 2017. 2016 Goosefare Brook MST Summary and Next Steps. Waldoboro, ME. Maine Healthy Beaches Program, University of Maine Cooperative Extension.*

Appendix K *Maine Healthy Beaches Program: Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in the Willard Beach Watershed, South Portland, Maine, 2012-2017. Maine Healthy Beaches, University of Maine Cooperative Extension.*

Appendix L *Taylor, A. and Farrell A. December 2017. Jordan River Monitoring Report 2017, Bar Harbor, ME: Community Environmental Health Laboratory at the MDI Biological Laboratory.*

III. Budget Information

Program Activities

There are more than 29 miles of public access beaches along Maine's coast.

The US EPA sponsored, MHB program 2017 budget (Appendix A) supported all routine monitoring, assessment, notification, education/outreach, and enhanced monitoring and source-tracking efforts including:

- UMaine Extension staff salaries and a portion of two DEP staff salaries. This team of personnel provided extensive support to 28 local management entities (towns, state parks, a national park, and private beach associations) including program coordination, quality-assured protocols and structure, field/lab trainings, technical assistance, volunteer recruitment, education/outreach, etc.
- Partially supported DEP data specialist providing data management services, transferred MHB data to DEP's Environmental and Geographic Analysis Database (EGAD) system, managed the submission of MHB data into the US EPA databases (STORET and PRAWN), and fulfilled data requests as needed.

- Planning and problem-solving meetings with diverse partners including local beach managers, conservation commissions, consultants, researchers, etc.
- Field monitoring supplies, equipment, volunteer training packets, and quality-assurance including annual field, database, and observational trainings for nearly 200 citizen volunteers and local staff.
- Laboratory equipment, supplies, labor, sample transport (courier), training, and quality assurance support for four laboratories processing enterococci samples for 60 beach management areas spanning a large geographic area (approximately 200 mi.).
- Enhanced monitoring and pollution identification efforts as well as numerous planning and problem-solving meetings with diverse partners.
- Education and outreach efforts including delivering presentations to local, regional and national audiences, development and distribution of numerous publications, etc.
- A contract with Relyon Media to host the MHB database and public interface, as well as consultant services.
- Direct and indirect expenses including travel, telephone, computer services, postage, office support and supplies, photocopying, etc.

Volunteer Contribution

MHB program participation is voluntary and towns/parks designate local beach managers and field monitors to collect samples. Beach managers are typically town administrators, health nurses, fire chiefs, state park managers, and others who participate as an add-on to full-time jobs and schedules. The time devoted to MHB tasks varies and is difficult to quantify. Towns and state parks utilize citizen volunteers or devote paid staff time to sample collection, transport, and data entry. Each of the local staff/volunteer monitors attend a 2-hour pre-season field training and contribute an average of three hours weekly to sampling during the monitoring season. A conservative estimate of the total volunteer monitor contribution to the MHB program was approximately 8,000 hours ($22/hour) for a total of $176,000 in 2017.

IV. Performance Criteria

In 2017, the MHB program continued to provide a unified structure and quality-assured tools to implement an adaptive monitoring regime, assess the risk of pollution, notify the public of water quality conditions, and promote best practices on the beach and surrounding drainage areas. MHB's QAPP (updated in 2016) is peer-reviewed and has been used as a model for water quality initiates outside of the program. In 2017 MHB staff also provided ongoing training and technical support on a daily basis including responding real-time to water quality data, assessing pollution/risk of illness, and notifying the public of conditions on coastal beaches.

Monitoring

The MHB program is voluntary and monitoring coastal water quality for swimming and other water contact is the responsibility of local jurisdictions and is not mandated by state law. US EPA funding supports monitoring of moderate to high use beaches with adequate public access. Maine law allows public use of private beaches for "fishing, fowling and navigation" only. Participating beaches must have a management entity capable of meeting objectives and requirements outlined in the MHB program QAPP and MHB Program Town/Park Agreement. New beaches will be recruited over time as resources and funding allow and/or circumstances change eligibility for program participation.

In 2017, MHB staff successfully worked with 28 diverse local management entities to conduct routine monitoring for 60 beach management areas (Appendix B), 45 were classified as "Tier-1," 15 were classified as "Tier-2" (reduced monitoring effort), and "Tier-3" beaches were not monitored (i.e. did not participate in the program). Through the 2016 BAV selection process, Maine's participating beaches were evaluated and reclassified if necessary in order to reallocate resources to support increased monitoring efforts for beaches categorized as "high-risk". For beaches considered "low-risk", reclassification resulted in a reduced monitoring frequency, typically to a bi-weekly or monthly routine.

The monitoring season lasted approximately three months, extending from Memorial Day through the week of Labor Day. Approximately 1296 samples were collected at 109 routine and enhanced monitoring locations spanning Kittery to MDI. Monitoring sites for each beach were based on where people swim, at freshwater inputs (rivers, streams, storm drains), and near other high-risk features, wildlife areas, etc. Samples were collected in two to three feet of water at six to eight inches below the surface. For areas experiencing chronic bacterial pollution, additional monitoring sites were added in suspect areas to help determine contributing pollution sources and/or the worst-case scenario for water quality.

Parameters included: enterococci bacteria, air and water temperature, salinity, tidal stage, rainfall, and additional weather/field conditions that may affect beach water quality. Monitoring sites were resampled as soon as possible following an exceedance and the monitoring frequency increased until results were within acceptable limits. Samples were transported to the laboratory (three regional, one local) for analysis within six hours of collection. The majority of samples were processed by Nelson Analytical Laboratory and transported via a courier service. Samples were analyzed using the IDEXX Enterolert ® Most Probable Number enumeration method. All samples and parameters were collected and analyzed according to the US EPA-approved QAPP.

Assessment

In addition to routine beach monitoring, MHB staff evaluated the risk of pollution and potential/actual sources via a Risk Assessment Matrix, and in some cases, through GIS mapping and analysis, enhanced monitoring, and other pollution source-tracking efforts. MHB staff continued updates the RAM for each BMA in 2017, and these preliminary assessments of shoreline characteristics, non-point and point sources of pollution (on and offshore) and water quality, inform local beach management decisions. This risk-based ranking system also guides the program's beach classification and monitoring regime, as well as determines the need for more in-depth monitoring and sanitary surveys. The RAMs also fed into the process to select the most appropriate beach action value for Maine, and guided our efforts to update our pollution source files including the MHB Beach Inventory.

In an effort to assess water quality and pollution sources in 2017, the program supported enhanced monitoring and source-tracking efforts for: Rockport Harbor, Crescent Beach State Park, the Willard Beach storm drainage network, Goosefare Brook watershed, Kennebunk River, Ogunquit River watershed, and the Cape Neddick River watershed (see Section VI Collaborative Efforts).

Notification

In 2017, beach monitoring results were recorded in the MHB program internal database that automatically updated the program website www.MaineHealthyBeaches.org. Based on US EPA

Guidance Criteria and adopted by Maine, the safety limit was 104 enterococci per 100 ml of sample water. Once a decision was made to post the beach, the information was also publically accessible via the website and signage at beach access points. When results exceeded the safety limit and/or a beach status change occurred, an automatic email alert was sent to local beach managers, MHB staff, and partners. In some cases, towns provided supplemental information by providing educational signage (e.g. risk following rainfall, stagnant tide pools), content on local websites, Facebook pages, and hotlines. All beaches attributes, monitoring, and notification data was transferred to DEP's data management system for final submission into EPA's databases. The MHB program continued to make local beach information (site locations, monitoring and notification data, contact information, etc.) more easily accessible to the public via ArcGIS online.

Beach postings fall under local jurisdiction and are not mandated by state law. The program made recommendations to local beach managers based on the best and most current information available. In some cases, local managers waited for resample results before posting. Typically, this was for "low-risk" beaches and the decision was based on the results of neighboring sites, the magnitude of bacteria results, similarity of environmental conditions between sample collection day and results, historical water quality, risk of pollution, known pollution events, etc. Additionally, precautionary rainfall advisories (PRAs) (based on local precipitation levels rather than elevated bacteria) were issued in 2017. In an effort to expedite information transfer, an extensive Communication Plan of local beach managers and field monitors was updated for re-sampling efforts and beach status notification in 2017. Following each exceedance, MHB staff contacted local jurisdictions to ensure that program protocols were followed in a timely manner according to the QAPP, and on a daily basis, MHB staff quality-checked the database for accurate entry of field, laboratory, and notification data.

Additionally, MHB staff responded to numerous data and information requests from program participants, state agency partners, non-profits, researchers, students, etc. The MHB program routine and enhanced monitoring data was used by partners to inform ongoing efforts to address impaired water quality including funding proposals to support pollution source identification and elimination projects, biophysical and social science research, as well as watershed management, stormwater management, and comprehensive and water resource protection plans.

Education and Outreach

In 2017, MHB staff brought new beach managers up to speed with the program and notification protocols as needed and routinely shared research findings, program updates, etc. with local staff and volunteers. Additional support was provided as needed regarding local implementation of the program, issues of concern, etc. MHB staff also delivered 13 presentations and interviews to local, regional, and national audiences (over 700 participants), and staff participated in newspaper, television, and radio interviews reaching diverse audiences in 2017. MHB staff also provided extensive support to communities and organizations tackling bacterial pollution issues within and outside of Maine. This included outreach events, training materials, information on best practices, technical reports, and other efforts to raise public awareness and build local capacity to improve and protect water quality (see Section VI). For example, in 2017 MHB staff updated the program's boating brochure detailing best practices for boaters and available pump out locations (Appendix C) as well as pet waste education brochures for Portland, Saco, Ogunquit, and OOB to support local efforts to promote responsible pet stewardship and improved water quality (Appendix D).

V. Data Summaries

- 1296 enterococci samples (including field/lab duplicates) were processed at 82 routine beach monitoring sites and at 27 sites either located in close proximity to managed beach areas or in enhanced monitoring locations to help pinpoint pollution sources.
- 100% of Tier 1 beaches were monitored.
- 2.7% of routine beach samples exceeded the safety limit of 104 MPN/100mls of sample water.
- 47 beach action days were reported including 23 actions at 16 beach management areas. 12 of the reported days were "precautionary rainfall advisories," based on local precipitation levels rather than recorded bacteria levels (Appendix E).
- 99.2% of total beach days (defined as beach season length x beach management areas) were free of beach advisories or closures.

Exceedances

The safety limit exceedance rate in 2017 (2.7%) was the lowest observed in the program's history. Inter-annual variability of the percent exceedances is due to multiple factors including but not limited to: precipitation levels, beach and watershed characteristics (e.g. impervious surfaces, pollution sources), sample collection day/time, the number of monitoring sites and beach management areas, etc. Overall, the beach season was dry with the lowest precipitation levels recorded for the past six years; the average rainfall observed (7.29 inches) was less than 2016 (9.14 inches) and 2015 (12.00 inches)[1]. The majority of beaches with the greatest exceedance rates in 2016 were those with freshwater inputs that likely transport pollution from upland areas during all weather conditions, but especially when it rains.

Table 1. The percent of samples that exceeded the safety limit for each year spanning 2005-2017. Numbers do not reflect enhanced monitoring and field/lab duplicate data.

Year	# Samples	# Exceedances	% Exceedances
2005	1584	196	12.4%
2006	1339	124	9.3%
2007	1359	103	7.6%
2008	1276	79	6.2%
2009	1466	159	10.8%
2010	1486	166	11.2%
2011	1310	115	8.8%
2012	1472	156	10.6%
2013	1340	176	13.1%
2014	1190	96	8.1%
2015	1256	108	8.6%
2016	1315	66	5.0%
2017	966	26	2.7%
Total	17359	1570	9.0%

In 2017, there were very few exceedances overall (26) and of those exceedances, over 65% were associated with antecedent (48 hrs. precipitation[2]) of 0.25 in. or more. The following monitoring

[1] Precipitation data source: NOAA NCDC.
[2] MHB volunteer reported precipitation.

sites exhibited a greater than 12.5% exceedance rate[3] and collectively accounted for 31% of the total exceedances recorded (Table 2). Non-point source pollution likely contributed to fecal indicator bacteria (FIB) loading at these locations as all sites are impacted by freshwater inputs (rivers, streams, storm drains).

Table 2. The four monitoring sites for which greater than 12.5% percent of samples exceeded the safety limit (104 MPN/100ml) in 2017.

Beach	# Samples	# Exceedances	% Exceedances
GOOSE ROCKS (GR-1)	15	2	13.3%
GOOSE ROCKS (GR-5)	15	2	13.3%
LINCOLNVILLE BEACH (LIN-3)	15	2	13.3%
GOOSE ROCKS (GR-2)	16	2	12.5%

A key finding in the 2016 beach action value selection process was that beaches with the greatest number of data points between 70 and 104 MPN are also typically beaches considered "higher-risk" due to non-point and point sources of pollution (Appendix F). This finding influenced the decision to incorporate a conservative "warning limit" of 70 MPN as a trigger for a retest when possible, increasing the monitoring frequency at these beaches to better track contamination events. Using the 70 MPN/100ml warning limit, the following monitoring sites exhibited a greater than 15.4% exceedance rate and collectively accounted for 53% of the total exceedances observed (Table 3.).

Table 3. The 8 monitoring sites for which greater than 15.4% percent of samples exceeded the warning limit (70 MPN/100ml) in 2017.

Beach	# Samples	# Exceedances	% Exceedances
CAPE NEDDICK BEACH (YK-2)	14	4	28.6%
GOOSE ROCKS (GR-1)	15	4	26.7%
GOOSE ROCKS (GR-2)	16	4	25.0%
YORK HARBOR BEACH (YK-20)	13	3	23.1%
GOOSE ROCKS (GR-5)	15	3	20.0%
LINCOLNVILLE BEACH (LIN-3)	15	3	20.0%
MOTHERS BEACH (KBK-4)	26	4	15.4%
CRESCENT BEACH (CBSP-03)	13	2	15.4%

Beach Action Days

Based on the US EPA PRAWN calculation of a beach action day (BAD) (any part of 24 hours is counted as an entire action day), the number of beach action days in 2017 (47) was less than half of the number of days reported in 2016 (123) and substantially less than those for 2015 (248).[4] There were zero beach closures in 2017. Precautionary rainfall advisories (PRAs), accounted for 12 beach action days, 25.5% of the total recorded action days (47), and 30% of the total number of advisories (PRA=7, Contamination=16). The number of BMAs with action days was also less in 2017 (16) compared to 2016 (35) with just 5 BMAs posted under PRAs during the 2017 season. Of those 5

[3] Only those sites with greater than 10 monitoring dates included.

[4] Total BADs include both advisory types (Contamination and Precautionary Rainfall).

beaches, 4 were posted just one time following moderate to heavy rainfall with an average duration of 1.7 days. This decrease in beach advisories and total BADs is likely due to less precipitation overall as historical MHB program data indicates a greater number of bacteria exceedances and total BADs for seasons with greater total rainfall accumulations.

Of the 16 beaches with BADs in 2017, 15 also experienced BADs in 2016, and overall, these beaches were posted less or equally as frequently as they were in 2016. Six beach management areas (Goose Rocks, Lincolnville, York Harbor, Mothers, Goodies, Broad Cove Reserve) collectively accounted for 62% of the reported beach action days in 2017 (Table 4.). Of the enterococcus samples exceeding the safety limit at these locations[5], 64% occurred where antecedent (48 hrs.) precipitation was≥ 0.5 inches.[6]

Table 4. The six BMAs representing those accounting for 8% or more of the total % BADs for the 2017 season (PRA=Precautionary Rainfall Advisory; Contam.=Contamination Advisory).

Beach	# BADs	# Contam.	# PRAs	% Total BADs
GOOSE ROCKS	6	6	0	12.8%
LINCOLNVILLE BEACH	6	6	0	12.8%
YORK HARBOR	5	5	0	10.6%
MOTHERS	4	4	0	8.5%
GOODIES	4	0	4	8.5%
BROAD COVE RESERVE	4	0	4	8.5%

Depending on the timing of results and the availability of monitors/laboratories, resampling did not always occur the same day results were available. Also, beach managers sometimes kept an advisory in place until the next routine monitoring day indicated acceptable enterococci levels. There were also some "running" advisories where PRAs blended with contamination advisories and vice versa. PRAs often preceded contamination advisories and once bacteria results were available, PRAs were lifted and contamination advisories were put in place until routine results indicated safe levels. These factors, as well as the practice of counting any part of one day as an action day, inflated the duration and number of beach action days in 2017.

VI. Collaborative Efforts

Maine's coastal tourism and recreation industry contributes billions of dollars annually to Maine's economy. Clean coastal waters are a major priority. Results from a 2015 survey of Maine residents and visitors revealed reducing coastal pollution as the first of 13 possible priority actions, and clean waters and sandy beaches were the two most important factors when planning visits to coastal areas. However, the majority of Maine's beaches are impacted by freshwater inputs that transport pollutants from upland areas. Sources are typically difficult to find, often requiring intensive investigations beyond the immediate shoreline. Once sources are verified, solutions are often complex and expensive.

The MHB program plays a critical role in keeping coastal waters healthy. Since 2003, the program has provided extensive support to communities experiencing bacterial pollution issues with a focus on sharing resources and solving problems. Some examples include: circulation

[5] No exceedances were observed at Goodies Beach and Broad Cove Reserve.

[6] MHB volunteer reported precipitation.

studies, sanitary surveys, GIS mapping/analysis, stakeholder workshops, outreach campaigns, applying pollution source tracking tools like optical brighteners and DNA markers, etc. This work has built the foundation for historical and current local actions to identify, remove, and prevent pollution sources. For example, this work includes surveys of the shoreline and watershed, investigations of and improvements to wastewater/stormwater infrastructure, septic/cesspool removal, boat pump out installation, beach and watershed management plans, protective ordinances, local monitoring efforts and outreach campaigns, etc.

Working groups and applied research partnerships

In 2017, MHB staff actively participated in numerous working groups, as well as applied research partnerships that have been instrumental in improving decision-making, addressing pollution issues, reaching diverse audiences, and supporting student advancement in Maine and beyond. For example, MHB staff sought feedback from local participants and the public, as well as support from members of its Technical Advisory Committee, to help inform the BAV implementation plan for 2017. In 2016, diverse experts considered the state of the science in epidemiology and microbiology, as well as other factors like the high frequency of false positive postings, economic impact, feasibility and retaining program participants, etc. A subcommittee formed to focus on the recommendations and feedback received, as well as the analysis of 10 years of MHB program data and other factors. In 2017, the program began implementing measures outlined in the EPA approved BAV justification. MHB staff will continue to seek the expertise of its advisory committee, the research community, and other partners in establishing important program policies as well as addressing challenges.

Coastal beaches are complex systems and the regrowth and persistence of Enterococci in sand, seaweed and sediments confounds our understanding of recorded bacteria levels, especially because these "naturalized" contributions have not been linked to human illness. However, studies in Maine and elsewhere have indicated extremely elevated bacteria levels in seaweed that has been cast and warmed on the beach, as well as in neighboring beach water that has rinsed previously stranded algal mats. In response to concerns, MHB staff continued to consult experts in 2017 to guide information shared with beach managers, the public, press, etc. MHB staff also worked with local and state agency partners to inform strategies that would allow communities to better and more quickly respond to episodic events that pose safety and other concerns. More research is needed to understand any health risks posed by fecal indicator bacteria (FIB) levels generated from seaweed that's been "seeded" with fecal material from birds, pets, stormwater, etc. The MHB program will continue to consider FIB levels sourced from seaweed as a potential health risk until further research and guidance develops.

Additionally, UMaine staff continued active membership on the Marine Extension Team (MET), a collaboration of Maine Sea Grant and UMaine Extension, and also served on the Goosefare Brook, GFB Restoration and Outreach Committees, Casco Bay Working Group, Ogunquit River Watershed Restoration Committee, Maine Beaches Conference Steering Committee, Kennebunk River 319 planning committee, and Coastal Watersheds Working Group. MHB staff also continued collaboration with researchers working on the New England Sustainability Consortium (NEST) project focused on safe beaches and shellfish beds. MHB staff support included advising students and faculty and presenting at the Maine Sustainability and Water Conference and Maine Beaches Conference. In 2017, the NEST project's findings helped MHB understand the potential bioremediation strategies for improving water quality in Maine's watersheds coastal beaches (Appendix G) as well as the interests/needs of Maine beach users. Additionally, their work informed program priorities including the need for more visual signage. As a result, MHB worked extensively

with NEST researchers to create updates to MHB's public notification signage at major access points. The first revision involved minor updates to the existing sign, and the second incorporated a more visual version which included stakeholder feedback throughout the design process (Appendix H). These updated signs will be implemented for the 2018 beaches season. As part of MHB's ongoing efforts to improve the program and its effectiveness, MHB staff will continue to seek opportunities for collaboration in 2018.

Enhanced monitoring

The MHB program has supported enhanced monitoring of multiple parameters (toolbox approach) targeting human sourced fecal contamination. Typically, as the number of parameters that exceed a threshold (or detectable) limit increases, so does the confidence that human sources are impacting water quality. The focus areas have changed over time with the primary targets being freshwater inputs to the shoreline. However, program data and support (historical and current) has raised awareness regarding water quality issues and has helped make addressing them a priority. Although limited resources and staff has reduced the number of toolbox parameters monitored for the past several years, MHB staff continued an applied research partnership with researchers at UNH in 2017 to incorporate microbial source tracking (MST) tools into ongoing pollution source identification and remediation efforts.

Beyond routine beach monitoring, 136 samples were analyzed for Enterococci (ENT) at 27 additional monitoring locations in 2017. Samples were collected upland in freshwater inputs to the beach on designated dates throughout the season or were collected on a routine basis in "high-risk" areas such as the mouths of rivers and streams, storm drains, stagnant tide pools, etc. MHB also supported assessment of intermittent, suspected sources such as seepages and runoff typically associated with heavy rainfall. Additionally, MHB staff analyzed 168 samples for optical brightener (OB) levels at 34 enhanced monitoring locations in 2017. Optical brighteners are commonly used in commercial/retail products and are typically flushed down the drain. Therefore, when optical brightener concentrations are coupled with elevated fecal bacteria levels, it can be indicative of human-sourced fecal contamination.

Kittery

The MHB program has supported enhanced monitoring, assessment of bacteria levels in sand and seaweed, and other local initiatives to improve water quality. Kittery's commitment to clean water extends beyond coastal beaches. It is a designated "MS4" community, has successfully partnered with local groups, and has hired consultants, to help address the health of Kittery's water resources. This commitment is demonstrated through Kittery's hiring and retaining a Shoreland Resource Officer/Stormwater Coordinator, developing and implementing a stormwater management plan, surveying properties for malfunctioning septic systems, conducting investigations of sewer and stormwater infrastructure, etc. Over the past few years, this work has led to the removal of dozens of grey and black water discharges negatively impacting water quality.

In 2017, Kittery continued its commitment to public health and clean water by completing work on a 319 Phase IV implementation grant (award $59,050) funded by US EPA and administered by DEP to restore Spruce Creek, including installing bacteria filtration cartridges in targeted catch basins, a biofiltration system on a commercial property, a rain garden on a residential property, and targeted outreach in the community on pet waste and septic system maintenance. The town was awarded a Phase V 319 grant (award $36,543) funded by US EPA to focus on agricultural BMPs at commercial and residential farms in the Spruce Creek watershed and the installation of pet waste

bag dispensers and outreach materials.

Kittery continued enhanced monitoring and pollution source tracking efforts including smoke testing sewer lines, improvements and maintenance to sewer and stormwater infrastructure, and conducting stormwater educational outreach events. As part of the York County MS4 Stormwater Working Group, Kittery contracted with consultants to ensure MS4 priorities were met. In 2018, Kittery plans to reintroduce a septic pump-out ordinance that will require pump out of priority properties every three years, and will continue enhanced monitoring and source tracking, infrastructure improvements, and stormwater outreach. Kittery will also finalize and adopt updates to the town's Comprehensive Plan to include land use growth management strategies, planning for climate change impacts, marine resources management, and priorities for clean water in 2018.

York

The MHB program has supported multi-year enhanced monitoring studies, microbial source tracking, GIS watershed risk analysis, stakeholder workshops and more to supplement York's actions to address impaired water quality. Like Kittery, York is a designated "MS4" community, has hired and retained a Stormwater Manager/Shoreland Resource Officer, partnered with local groups, and held numerous outreach events to augment efforts to address the health of its water resources.

In 2017, York began implementing objectives of their 319-compliant Phase I implementation grant for the Cape Neddick River Watershed including intensified bacteria monitoring efforts as well as targeted education and outreach initiatives. Additionally, the town used a site-specific, weather-based model developed for York's beaches to inform precautionary rainfall advisories. York continued contracting with consultants as part of the York County MS4 Stormwater Working Group to ensure MS4 priorities were met and hired a consultant to map the town's entire stormwater infrastructure, including direction of flow. The town made improvements to sewer and stormwater infrastructure as well as routine and ongoing maintenance consisting of catch basin and sewer line cleaning and street sweeping. York conducted stormwater outreach initiatives including a Lawns to Lobsters Program providing yardscaping information to residents, municipal outreach, and contributions with other MS4 working groups to air "Ducky Ads." In 2018, York will reintroduce a septic ordinance requiring septic inspections at the time of property transfers. In response to a UNH study that indicated extremely elevated bacteria levels in cast seaweed and neighboring beach water, York will implement the latest technology in beach cleaning systems in 2018 that exposes the sand to UV radiation facilitating bacteria die-off.

Ogunquit River Watershed (Ogunquit, Wells)

In an effort to improve water quality in the Ogunquit River and understand the fate and transport of pollutants, the MHB program has supported a circulation study and multi-year enhanced monitoring and pollution source identification efforts. Ogunquit's commitment to water quality expands beyond the coastal zone to include protective ordinances in upland areas. In addition to retaining a Beaches Coordinator in 2017, Ogunquit continued implementation of Phase II of its 319 Ogunquit River Watershed implementation grant (award $69,340) including the installation of pet waste signage in targeted neighborhoods throughout the town and outreach initiatives educating tourists and residents regarding the proper disposal of pet waste (Appendix D). This work also included other targeted public outreach events, stormwater BMP installations, bacteria monitoring, and an intercept survey to gauge the public's awareness and understanding of the project. MHB continued to serve on the Ogunquit River Watershed Restoration committee in 2017. The Ogunquit Conservation Commission also conducted additional education/outreach activities

focused on the quality and preservation of water resources including pesticide awareness via a weekly blog.

Wells
Beyond routine beach monitoring, the MHB program has supported the analysis of samples collected intermittently to assess bacteria levels in sand, seaweed and stormwater impacting Wells beaches. The program will continue to support enhanced monitoring in the Webhanett River impacting water quality on Wells Harbor Beach in 2018.

Kennebunk/Kennebunkport
The MHB program has supported multi-year enhanced monitoring and pollution source identification efforts including monitoring of multiple water quality parameters, in-depth data analysis, a circulation study, sanitary surveys, GIS watershed risk analysis, stakeholder workshops and more to support improving water quality in the adjacent rivers that impact neighboring beaches in Kennebunk and Kennebunkport.

In 2017, the frequency of routine testing on Kennebunk's beaches continued at twice per week or more depending on the number of resamples and local volunteers continued enhanced monitoring efforts in the Kennebunk River. Kennebunkport's health nurse conducted education/outreach initiatives regarding the MHB program, including promoting best practices at the beach and larger watershed areas. The town also provided timely notification of water quality conditions on the community website and via the public health office's outgoing message. The town also installed a sewer extension providing 15 hookup opportunities to homes previously serviced by septic systems. Kennebunkport's Sandy Pines Campground, located in close proximity to Goose Rocks Beach, replaced 16 subsurface wastewater disposal systems linked to bathhouses and individual sites within the campground.

In 2018, Kennebunkport will increase the routine testing frequency at the town's beaches to twice per week. Additionally, because routine monitoring at Goose Rocks beach has revealed consistently elevated fecal bacteria concentrations, MHB staff worked with the town to design an intensified pollution source monitoring plan targeting the surrounding watershed to be conducted in 2018. Kennebunkport will also hire a summer intern to assist with septic surveys, education/outreach initiatives, and enhanced monitoring efforts in 2018.

Goosefare Brook Watershed (Saco and Old Orchard Beach)
Goosefare Brook (GFB) forms the border between the towns of Saco to the south and Old Orchard Beach (OOB) to the north, both designated as "MS4" communities. The MHB program has supported enhanced monitoring and pollution source tracking efforts, held stakeholder workshops, and more to address impaired water quality in GFB. In 2017, MHB staff continued to serve on the Goosefare Brook Restoration and Outreach committees, provided GIS support, helped organize outreach events, delivered presentations, and conducted enhanced source tracking monitoring in priority areas (Appendix I). MHB staff also continued an applied research partnership with researchers at the University of New Hampshire to incorporate MST techniques into ongoing pollution identification efforts.

Multi-year source tracking efforts led to the identification of two priority "hot-spot" regions with the potential for human-sourced fecal contamination, both located within the New Salt Road Tributary (NSRT) drainage. These regions are in densely developed portions of Ocean Park with one located at the mouth of GFB where the main stem and the NSRT drainage empty onto nearby

swimming beaches and the other located upland in the outlet of the NSRT from the Jordan Marsh. Recent monitoring efforts (2016-17) focused on these priority areas and in 2017, included 7 routine events from June-October at 5 priority sites and four additional suspect sites monitored less frequently. Parameters included enterococci (ENT), optical brighteners (OB), and microbial source tracking (MST) DNA analyses. ENT values ranged from <10 to 6,870 MPN/100mls with a combined geometric mean[7] of 772 MPN for all sites and OB values ranged from 33 to 157 µg/l with a combined mean of 94 µg/l for all sites[8]. DNA results demonstrate the presence of consistent human sources at the mouth of GFB with a seasonal increase in signal strength during the peak summer months (2016 & 2017). For both seasons, human source detection in the Jordan Marsh hot-spot was sporadic with human sources detected just a few times per season. For areas with persistent human sources, the signal strength (qPCR) was used to further bracket suspected source(s). To assess other sources potentially contributing to elevated fecal contamination, DNA tests specific to dogs, birds, and ruminants (2016 only) were also conducted. Results and recommendations were shared with OOB to assist with prioritization of ongoing resource management and remediation efforts (Appendix J).

In response, Saco and OOB continued collaborating to restore water quality in the GFB by implementing objectives of their Watershed Based Management Plan utilizing 319 Phase I Implementation grant funds from ME DEP in 2017. The focus of this work included stormwater retrofits, erosion/buffer control projects, and education/outreach initiatives. Outreach projects included a stream clean up event, buffer plantings with local schools, and hosting an April Stools Day event to educate the public regarding proper pet waste disposal (Appendix D). The town of OOB and the local Conservation Commission also partnered with local schools to perform storm drain stenciling and additional community outreach events. The efforts by students at one of those schools (Loranger Memorial School) as citizen scientists and educators of their community earned them a 2017 Teddy Roosevelt Maine Conservation Award.

Both communities continue to investigate the integrity of and make improvements to sewer/stormwater infrastructure, remediating any potential sources of illicit discharge. Saco utilized grant funding from the Maine DEP to perform necessary culvert upgrades within the GFB watershed. OOB Public Works worked with MHB staff to choose priority areas for investigations and continued investigative studies including camera work to ensure the integrity of sanitary infrastructure (Appendix J). The town continued using an in-house GIS program to better track and access inspection and cleaning records. Additionally, both communities continued to post supplemental signage at the mouth of the GFB in 2017, alerting the public of the potential risk of water contact at this location. The City of Saco and OOB Conservation Commission funded DNA analyses through an applied research partnership with MHB and UNH researchers. This work was conducted to augment ongoing bacteria monitoring to identify and remediate potential sources of illicit discharge within the storm and sewer networks within the GFB watershed.

In 2018, both communities will continue collaborating on 319 grant objectives to implement stormwater retrofits, erosion/buffer control projects, and education/outreach initiatives. As part of these efforts, OOB plans to develop a fill ordinance conferring greater protections to water quality within the GFB. Saco and OOB will continue enhanced monitoring and pollution source tracking

[7] US Environmental Protection Agency (EPA) recommend single sample maximum value for enterococci in marine waters is 104 (MPN/100 ml) and 61 (MPN/100 ml) for fresh water sites. EPA recommended geometric mean values are 35 (MPN/100 ml) and 33 (MPN/100 ml) respectively.

[8] MHB typically considers 100 µg/l as a lower threshold for OB results with the potential for human wastewater contamination.

efforts, as well as improvements to and maintenance of sewer and stormwater infrastructure. OOB Public Works will continue to work with MHB staff to document sewer and stormwater camera work, utilizing a GIS program to streamline and prioritize efforts, and will conduct follow-up investigations of suspect properties identified through 2015 smoke testing. The MHB program will continue its partnership with UNH researchers to identify sources of fecal contamination in priority areas utilizing MST methods in conjunction with bacteria and optical brightener monitoring. MHB staff will also serve on the Restoration and Outreach committees created to help inform future 319 grant funded efforts.

Willard Beach, South Portland

In an effort to address Willard Beach water quality, the MHB program supported multi-year enhanced monitoring, a shoreline/watershed survey, and stakeholder meetings. Of particular concern are the six stormwater drainage pipes discharging directly to the beach, draining stormwater from ~ 1 km^2 of residential and commercially developed areas. In 2017, the City posted rainfall advisories in support of public health due to the potential for pollution and the primary beach users being young children. The MHB program continued to support enhanced monitoring (Appendix K) in 2017 utilizing the pollution source tracking toolbox approach incorporating the collection of multiple parameters in an effort to pinpoint human sources. Parameters used to date include ENT bacteria, OBs, pharmaceutical and personal care products, canine detection, nutrients, and MST.

For 2017, 24 paired ENT and OB samples were analyzed at 7 sites including seven subsurface sites, and one beach site (Wil-02). Since enhanced monitoring began, over 200 ENT and OB samples have been analyzed at 15 sites (13 subsurface sites as well as site AB-01 and the routine monitoring site on Willard Beach (Wil-02)). Combined (2012-2017) ENT mean results for each site[9] ranged from 28-590 MPN/100ml and OB results from 10-115µg/l. All monitoring locations except DM0507 exceeded the EPA-recommended ENT geometric mean safety limit of 35 MPN/ml for marine waters while one site (CB1599) exhibited an OB mean concentration above 100µg/l.[10] Mean OB values were relatively low (less than 40 µg/l) for approximately half of sites routinely monitored, suggesting non-human sources (wildlife, pets) are likely the principal contributors to stormwater bacterial pollution at these locations. Human sources cannot be ruled out as at least 4 mean OB site values and two single sample values exceeded the threshold.

Canine source tracking efforts (2014 & 2016) focused in the sub-catchment draining to stormwater outfall WB-17 on Willard Beach and included enterococci sample collection (2014 only) in tandem with two sewage sniffing canines, a technique used to ensure even very low levels of human contamination are detected. Widespread detection of human-sourced bacteria by both canines suggests contamination in the separated stormwater system may be originating from nearby leaking sewer pipes, particularly those co-located with storm drains. In 2015-2016, the City expanded the pollution toolbox to include limited monitoring of surfactants, chlorine, and ammonia (2016 only) and MST testing (2016). Nutrient results revealed no concentrations above EPA established thresholds. MST samples were collected at two sites within the WB-17 sub-catchment and results indicated the presence of mammal sourced DNA in both structures tested (CB3294 & DM1045) and human DNA at within CB3294, suggesting human sources may be contributing to bacterial pollution at that location. The city plans to resume surfactant, chlorine, ammonia, and MST testing in conjunction with paired bacteria and OB monitoring in 2018.

[9] Only sites with five samples or greater included in ENT geomean and OB mean data summary comparisons. Sites monitored over multiple seasons were combined to obtain overall geomean ENT and mean OB values.

[10] Value MHB considers as a lower threshold for OB results with the potential for human wastewater contamination.

Using these toolbox parameters as well as dye testing and CCTV efforts, the City successfully identified and remediated an inadvertent cross connection between a private residence's internal plumbing and the City's stormwater system in 2017. In 2018, the City of South Portland will complete a review of City's TV inspection records to identify laterals into the Willard stormwater system and plans to follow up with dye tests to confirm no cross connections. Continued monitoring and education/outreach is needed to better understand and address the source(s) of bacteria impacting water quality on Willard Beach.

In 2017, the City continued implementing a pet waste and water quality campaign including collaboration with local partners to host the annual April Stools Day event, performed maintenance and improvements to sewer and stormwater infrastructure, and implemented an ordinance established in 2017 to reduce the use of synthetic pesticides in the City. The MHB program will continue supporting enhanced monitoring efforts within the storm drain system as well as South Portland's efforts to promote responsible pet ownership in 2018.

Crescent Beach State Park

In 2017, 9 ENT samples were analyzed at two sites in a neighboring marsh with results ranging from <10 to 109 MPN/100ml (marsh-east geometric mean 24 MPN/100ml and marsh-west average 10 MPN/100ml). Both marsh and beach sites were infrequently elevated in 2017, indicating the marsh discharge may only impact beach water quality after heavy rainfall as elevated counts have been observed historically associated with moderate to heavy precipitation. More information is needed to better understand any impacts these "naturalized" Enterococci have on recorded bacteria levels as well as human health.

Rockland

In 2017, Rockland began planning a stormwater and sewer separation project as well as upgrades to their waste water treatment plant to be funded by a 10.4 million dollar bond passed in 2016. Additionally, the City received a grant from the Maine DEP (award $42,209) to perform necessary culvert upgrades. Rockland also continued investigations, maintenance, and improvements to sewer/stormwater infrastructure and continued implementing a pet waste and water quality campaign. In 2018, Rockland will continue investigations and improvements to sewer and stormwater infrastructure, including the initial work on their stormwater/sewer separation and treatment plant upgrade projects. The City will also continue efforts to promote their pet waste and water quality campaign,

Rockport

The MHB program has supported Rockport's efforts to address pollution issues on Goodie's Beach, throughout the adjacent Harbor, associated tributaries, and the Pascal Ave. storm drainage network. In 2017, Rockport continued to post precautionary rainfall advisories in support of public health at a conservative threshold of 0.25 inches, particularly because small children primarily use the beach. The town also continued pollution source tracking efforts throughout the harbor and surrounding watershed including enhanced monitoring of multiple parameters, and also conducted education/outreach efforts including Best Management Practices for Watershed residents. As part of this work, Rockport removed and old clay wastewater system "lagoon" in the Rockport Harbor watershed that had surface malfunction/discharge that drained into a "farm pond" that was impacting a consistently problematic monitoring site located in the Winter Street ditch. For 2018, Rockport will continue enhanced monitoring and pollution source tracking efforts, implementing precautionary rainfall advisories, and conduct additional education/outreach campaigns.

Camden
The MHB program has supported local efforts to improve water quality on Laite Beach, in the adjacent harbor, associated tributaries, and storm drainage network. This work has included enhanced monitoring, Boater's Education Campaign, and bringing in outside expertize and funding. In 2017, Camden conducted enhanced monitoring of multiple parameters and pollution source tracking efforts and investigations of and improvements to storm and sewer infrastructure including in-home inspections properties in Camden resulting in the identification of 94 illicit inflow sources to the sewer system. Smoke and dye testing efforts identified two additional illicit connections (storm water catch basins tied to the sewer system). Camden continued door to door surveys of buildings in town that had not been inspected for illicit connections as well as the televising of priority sewer and stormwater infrastructure, following-up on suspected inflows when necessary. These inspections will continue until all buildings in town have been surveyed.

Additionally, the Conservation Commission was awarded a Maine Outdoor Heritage Foundation grant to address ongoing pollution in Camden Harbor (Award $5,000) which was matched by contributions from the Wastewater Department as well as additional donations. As a result, the Conservation Commission hired an intern who was instrumental in the completion of the door to door inspections. This intern also worked with the Conservation Commission to conduct education and outreach initiatives including a stormwater education campaign involving storm drain stenciling (125 drains) in partnership with a local middle school. Local articles and ordinances were also generated raising awareness of harbor pollution and best practices including reminders regarding the free boat pump-out service and the education regarding not feeding waterfowl.

In 2018, Camden will continue to inspect buildings in town that have not been inspected and follow-up/eliminate the 94 illicit inflows identified using CCTV inspection equipment and testing to verify cleanliness/corrective actions. The Conservation Commission and Wastewater Department plan to hire two more summer interns in 2018 to complete door to door surveys within the town. The Commission also plans to continue the storm drain stencil work.

Lincolnville
The MHB program has supported Lincolnville's efforts to address pollution issues at its coastal beaches, recreation areas, and freshwater resources. This work has included enhanced monitoring, sanitary surveys, beach clean-ups, and more to improve water quality. As a result, the town has worked with property owners to remediate over a dozen sources and has conducted feasibility studies, enacted legislation, and continues to hire contractors to pursue funding sources to improve and expand wastewater infrastructure. As part of ongoing efforts to improve water quality and infrastructure, Lincolnville used grant funds acquired from Maine DEP, the Nature Conservancy, Trout Unlimited, and town funds to upgrade a culvert to aid fish passage at the Coleman Pond outlet. Lincolnville voters approved $19,000 per year for 10 years to help fund capital improvement upgrades to Lincolnville Sewer District's wastewater treatment facility, collection system, and pump station at Lincolnville Beach. The town will use loans and grants secured to upgrade the Lincolnville Sewer District (approximately $3,325,000) in 2018.

Bar Harbor, Mt. Desert and Acadia
The MHB program has supported local water quality initiatives on Mount Desert Island including enhanced monitoring, surveys, special projects, stakeholder workshops, and more. In 2017, the Community Environmental Health Laboratory at the MDI Biological Laboratory examined multiple

water quality parameters in the Jordan River Watershed located in Frenchman Bay (Appendix L), including bacteria, optical brighteners, and salinity. Efforts were conducted to supplement work by the Department of Marine Resources to monitor declining water quality in the River. They also worked with Wild Acadia to identify potential pollution sources contributing to elevated bacteria levels in the Cromwell Brook watershed located in Bar Harbor and Acadia National Park. The MHB program supported Acadia National Park in its efforts to assess water quality on Sand Beach by supporting the analysis of 12 samples collected at a site capturing marsh/stream runoff behind the public beach area. Results ranged from <10 to 30 MPN/100mls of sample water with a geometric mean of 9 MPN/100ml. In 2018, Bar Harbor plans to install a boat sewage pump out station at the town pier.

The MHB program would like to thank EPA for their continued support for this project.