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Maine Healthy Beaches Program 2016 Annual Report to U.S. EPA

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Maine Healthy Beaches 2016
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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 2016, 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 and to address pollution issues when they arose during the beach season.

The MHB program accomplished the following in 2016:

- Processed 1660 enterococci samples at 112 routine and enhanced monitoring locations.
- Recruited and trained 11 new beach managers and approximately 200 local staff and volunteers to collect water samples, conducted 36 technical trainings for over 130 local staff and volunteers, and facilitated 21 planning/problem-solving meetings (158 participants).
- Implemented precautionary rainfall advisories at 23 beaches impacted by non-point source pollution.
- Analyzed 97 samples for optical brightener levels to target human-sourced fecal contamination at 19 enhanced monitoring locations.
- Updated the MHB Quality Assurance Project Plan (2016-2021) approved by ME DEP and EPA.
- Worked with the MHB program Technical Advisory Committee to determine an appropriate beach action value; submitted a justification that was approved by EPA.
- 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 Wells Harbor (Webhannet River).
- Developed a new 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.
- Updated the MHB Risk Assessment Matrix (RAM), an evaluation of water quality trends and potential sources of fecal bacteria impacting coastal beaches.
- Conducted an extensive data analysis of 10 years of data (2006-2015) and worked with a consultant on the development of a data exploration portal to share with local beach managers and partners.
- 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 17 times for local, regional, and national audiences including the Maine Legislative Coastal Caucus, the Maine Sustainability and Water Conference, the Penobscot Watershed Conference and to a national audience of 250 people at the US EPA National Beaches Conference in New Orleans, LA.

II. Program Deliverables/Appendices

Appendix A *MHB 2016 Budget Summary*
Appendix B *MHB 2016 Beach Mgt. Area Classification/Tiered Monitoring Plan*
Appendix C *MHB Risk Assessment Matrix*
Appendix D *MHB Waterfowl Feeding Flyer, Maine Healthy Beaches, University of Maine Cooperative Extension.*
Appendix E *MHB 2016 Notification Activity*
Appendix F *Maine Healthy Beaches Data Exploration Report, Walker Environmental Research, LLC.*
Appendix G *Maine Healthy Beaches Program Survey Response Report, University of Maine School of Economics.*
Appendix H *Ogunquit Pet Waste Brochure, Ogunquit Conservation Commission.*
Appendix I *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in Goosefare Brook, Maine, 2012-2016. Maine Healthy Beaches, University of Maine Cooperative Extension.*
Appendix J *Maine Healthy Beaches Program: Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in the Willard Beach Watershed, South Portland, Maine, 2012-2016. Maine Healthy Beaches, University of Maine Cooperative Extension.*
Appendix K *Gartley and Dorsky. November 2016. Town of Rockport-Goodies Beach Feasibility Study. Camden ME: Gartley and Dorsky Engineering and Surveying.*
Appendix L *Maine Healthy Beaches Public Outreach Pilot Survey Report. Community Environmental Health Laboratory at the MDI Biological Laboratory.*
Appendix M *MDI Pet Waste Brochure, 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 2016 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 29 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, MHB program Technical Advisory Committee, 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 2016.

IV. Performance Criteria

In 2016, 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.

Quality Assurance and Quality Control

In 2016, the MHB program successfully submitted an updated Quality Assurance Project Plan (QAPP)[1] for years 2016-2021 that was approved by ME DEP and EPA. This work included review and updates of all program components and included new standard operating procedures (SOPs) for data management to further streamline data quality control and data processing. The updated QAPP was peer-reviewed and has been used as a model for water quality initiates outside of the program. 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

[1] For more information on quality control objectives, requirements, actions, etc. please see the MHB QAPP.

The MHB program is a 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 2016, MHB staff successfully worked with 28 diverse local management entities to conduct routine monitoring for 60 beach management areas (Appendix B), 55 were classified as "Tier-1," five were classified as "Tier-2" (reduced monitoring effort), and "Tier-3" beaches were not monitored (i.e. did not participate in the program). The monitoring season lasted approximately three months, extending from Memorial Day through the week of Labor Day. Approximately 1660 samples were collected at 112 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 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 (RAM - Appendix C), and in some cases, through GIS mapping and analysis, enhanced monitoring, and other pollution source-tracking efforts. MHB staff updated the RAM in 2016, 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.

With partners, MHB staff also conducted an extensive data analysis of 10 years of data (2006-2015), including development of a data exploration portal shared with local beach managers, partners and the public (see Section V. Data Summaries). This work augmented management decisions and informed MHB's 2017 Tiered Monitoring Plan. Additionally, 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 Wells Harbor (Webhannet River) in 2016 (see Section VI Collaborative Efforts).

Notification

In 2016, 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 2016. 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 2016. 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 2016, MHB staff brought 11 new beach managers up to speed with the program, 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 17 presentations and interviews to local, regional, and national audiences (over 600 participants), and staff participated in newspaper, television, and radio interviews reaching diverse audiences in 2016. 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, MHB staff created a waterfowl feeding flyer (Appendix D) in 2016 to support Camden and other communities as they work to tackle the issue of bird waste.

V. Data Summaries

- 1660 enterococci samples (including field/lab duplicates) were processed at 83 routine beach monitoring sites and at 29 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.
- 5.0% of routine beach samples exceeded the safetylimit of 104 MPN/100mls of sample water.
- 123 beach action days were reported including 77 actions at 35 beach management areas. 53 of the reported days were "precautionary rainfall advisories," based on local precipitation levels rather than recorded bacteria levels (Appendix E).
- 97.9% 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 2016 (5%) 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 five years; the average rainfall observed (9.14 inches) was less than 2015 (12.00 inches) and 2014 (15.71 inches)[2]. 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 2005-2016. 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%
Total	16397	1544	9.4%

[2] Precipitation data source: NOAA NCDC.

In 2016, the following monitoring sites exhibited a greater than 12.5% exceedance rate and collectively accounted for 33.3% of the total exceedances recorded:

Table 2. The eight monitoring sites for which greater than 12.5% percent of samples exceeded the safety limit in 2016.

Beach	# Samples	# Exceedances	% Exceedances
GOOSE ROCKS (GR-1)	19	4	21.1%
CAPE NEDDICK BEACH (YK-2)	16	3	18.8%
OOB-OCEAN PARK	17	3	17.6%
CRESCENT BEACH (K-2)	15	2	13.3%
SCARBOROUGH BEACH (SBSP-1)	15	2	13.3%
GOOCHS BEACH (KBK-1)	32	4	12.5%
LAUDHOLM BEACH (LDHLM-2)	16	2	12.5%
YORK HARBOR BEACH (YK-20)	16	2	12.5%

Non-point source pollution likely contributed to fecal indicator bacteria (FIB) loading at these locations with six of the eight sites impacted by freshwater inputs (rivers, streams, storm drains). Of the enterococci samples that exceeded the safety limit at these eight locations, 59% occurred when antecedent (48 hrs.) precipitation was observed.[3] In particular, exceedances observed at two beaches (OOB-Ocean Park-, Scarborough Beach) were associated with antecedent (48 hrs.) precipitation 100% of the time (Table 2).

Beach Action Days

Based on the US EPA PRAWN calculation of a beach action day (any part of 24 hours is counted as an entire action day), the number of beach action days in 2016 (123) was less than half of the number of days reported in 2015 (248) and substantially less than those for 2014 (229).[4] There were zero beach closures in 2016. Precautionary rainfall advisories (PRAs), accounted for 53 beach action days, 43% of the total recorded action days (123), and over half of the total number of advisories (PRA=41, Contamination=36). This percentage of PRAs to total advisories closely mirrored that observed in 2015 (2016=43%; 2015=42%). Most beaches were posted under a PRA only once or twice during the season following flood conditions. Although PRAs accounted for more advisories overall, they were on average shorter in duration (1.29 days) than contamination advisories (1.94 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.

While the number of total BADs decreased by half, the number of beach management areas with action days for the 2015 and 2016 seasons were very similar (2016-35 BMAs, 2015-37 BMAs). Of the 35 beaches with BADs in 2016, 27 also experienced BADs in 2015, but these beaches were posted less frequently in 2016. Five beach management areas (Goodies, Goose Rocks, Willard, Seal

[3] Precipitation levels of 0.1 in or greater. Recorded by MHB volunteers.
[4] Total BADs include both advisory types (Contamination and Precautionary Rainfall).

Harbor, Sandy) collectively accounted for 40% of the reported beach action days in 2016. Of the enterococcus samples exceeding the safety limit at these five locations, 43.8% occurred where antecedent (48 hrs.) precipitation was >0.5 inches and 50.0% occurred on days where antecedent precipitation was >0.25 inches.[5]

Table 3. The five BMAs representing those accounting for 5% or more of the total % BADs for the 2016 season (PRA=Precautionary Rainfall Advisory; Contam.=Contamination Advisory).

Beach	# BADs	# PRAs	% PRAs	# Contam.	% Contam.
GOODIES BEACH	17	14	82.4%	3	17.6%
GOOSE ROCKS	9	3	33.3%	6	66.7%
WILLARD BEACH	9	4	44.4%	5	55.6%
SEAL HARBOR	7	2	28.6%	5	71.4%
SANDY BEACH	7	3	42.9%	4	57.1%

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 EPA's blanket status of any part of one day is considered an action day, inflated the duration and number of beach action days in 2016.

Data Exploration

As part of the process to select the most appropriate beach action value (BAV) for Maine, a Technical Advisory Subcommittee conducted extensive data analysis of 10 years of data (2006-2015). This work was also incorporated into the program's classification/tiered monitoring plan. A key finding was that beaches with the greatest number of data points between 70 and 104 MPN are also beaches considered "higher-risk" due to non-point and point sources of pollution. This influenced the decision to incorporate the conservative 70 MPN as a "warning limit" and trigger for a retest when possible. Other useful pieces of information gained included the percentage of exceedances for each beach, how often resamples are clean, etc. With partners, an extensive report (Appendix F) and a data exploration portal (http://walkerenvres.com/shiny/maine-healthy-beaches/) were created and shared with local beach managers, partners and the public.

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. Maine residents and visitors surveyed ranked 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 (Appendix G). 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.

[5] Recorded by NOAA NCDC.

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 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 2016, 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 its Technical Advisory Committee, to help determine what BAV to implement in 2017. 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 2016, the program's BAV justification was submitted to EPA and approved. 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's been cast and warmed on the beach, as well as in neighboring beach water that's rinsed previously stranded algal mats. In response to concerns, MHB staff continued to convene a working group of experts in 2016 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) Watershed Management Steering Committee, GFB Stream Monitoring and Assessment Committee, GFB Restoration Committee, Casco Bay Working Group, Ogunquit River Watershed Restoration Committee, Ogunquit River Coastal Community Grant Advisory Committee, Maine Beaches Conference Steering 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. In 2016, the NEST project's findings helped MHB understand the interests/needs of Maine beach users, as well as inform program priorities including the need for more visual signage. As part of MHB's ongoing efforts to improve the program and its effectiveness, MHB staff will continue to seek opportunities for collaboration in 2017.

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 forged a new applied research partnership with researchers at UNH in 2016 to incorporate microbial source tracking (MST) tools into ongoing pollution source identification and remediation efforts.

Beyond routine beach monitoring, 201 samples were analyzed for Enterococci (ENT) at 29 additional monitoring locations in 2016. 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 97 samples for optical brightener (OB) levels at 19 enhanced monitoring locations in 2016. 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 and 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 2016, Kittery continued its commitment to public health and clean water by posting precautionary rainfall advisories to inform the public of the potential risk associated with heavy rainfall. Additionally, Kittery began work on a $59,050 grant awarded by ME DEP to implement Phase IV of its Watershed Management Plan including the installation of stormwater retrofits on three roadways and parking lots as part of a Green Streets initiative. This work also included providing technical assistance to residential homeowners on two properties in the Spruce Creek watershed to implement stormwater BMPs. Kittery continued enhanced monitoring and pollution source tracking efforts including smoke testing sewer lines, improvements to sewer and stormwater

infrastructure, and stormwater educational outreach events. Monitoring efforts targeting Spruce Creek included bacteria and DNA analyses of all tributaries, continued collection of baseline data from the main stem of Spruce Creek using a data sonde and bacteria grab samples, and follow-up investigations to and mapping of identified hot spots.

Kittery also continued educating residents regarding stormwater impacts by conducting storm drain stenciling with local middle school science students and updating the town's stormwater website to include more information for residents and businesses. As part of the York County MS4 Stormwater Working Group, Kittery contracted with consultants to ensure MS4 priorities were met including the expansion of the town's septic system database to include the remaining systems in the Urbanized Area. In 2017, 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.

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 more to augment the town's efforts to address the health of its water resources.

In 2016, the town used a site-specific, weather-based model developed for York's beaches to inform precautionary rainfall advisories. Additionally, York developed a 319-compliant Watershed Management Plan that was approved by ME DEP in 2016 ($30,676). The town was also awarded a $95,000 grant to perform culvert upgrades and continued contracting with consultants as part of the York County MS4 Stormwater Working Group to ensure MS4 priorities were met. York made other improvements to stormwater infrastructure including the installation of catch basin filters along Shore Road and conducted stormwater outreach initiatives including the promotion of its Lawns to Lobsters Program providing yardscaping information to residents. In 2017, York will reintroduce a septic ordinance requiring septic inspections at the time of property transfers, and hire consultants to completely map all stormwater infrastructure including the direction of flow. 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 2017 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. MHB continued to serve on the Ogunquit River Watershed Restoration and the Ogunquit River Coastal Community Grant Advisory Committees in 2016. 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 2016, Ogunquit completed implementation of Phase I of its 319 Ogunquit River Watershed Management Plan (award $92,050) including several BMP installations (LID and stormwater) on public and private properties, illicit discharge investigations, and outreach initiatives. Additionally, efforts began on a 319-funded Phase II implementation grant ($69,340).

Ogunquit also continued to identify, monitor, and manage sources of fecal contamination in the

Ogunquit River Watershed through Coastal Community Planning Grant ($28,599) funding in partnership with the town of Wells. As a part this work, the Ogunquit Sewer District performed monitoring and sewer/stormwater inspections for identified "hot-spots." Additionally, a septic system database for the Ogunquit River Watershed was developed including properties in surrounding communities (Wells, York, South Berwick). Water quality monitoring was expanded to identify and further hone in on suspect areas across seasons, capturing dry and wet weather events, and incorporating DNA analyses to identify specific sources of fecal contamination. Ogunquit also conducted education/outreach activities focused on the quality and preservation of water resources including pesticide awareness and a pet waste and a water quality campaign educating tourists and residents regarding proper disposal of pet waste (Appendix H).

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. In 2016, the program continued to support enhanced monitoring in the Webhanett River impacting water quality on Wells Harbor Beach. As part of this effort, 30 samples were collected at two locations. Enterococci values ranged from <10 MPN to 288 MPN/100mls with seasonal geometric mean values of 12 MPN (site W-12) and 11 MPN (W-13).

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 2016, MHB staff worked with the Kennebunk Conservation Commission as well as the Kennebunk River Committee to share data and recommendations regarding improving water quality in the river. Also, the frequency of routine testing on Kennebunk's beaches continued at twice per week or more depending on the number of resamples.

Additionally, MHB staff worked with Kennebunkport's Goose Rocks Beach Committee regarding concerns related to a new campground development in the watershed. Kennebunkport also implemented precautionary rainfall advisories, and Kennebunkport's health nurse conducted education/outreach about 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.

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 2016, MHB staff continued to serve on the Goosefare Brook Watershed Management Plan Steering and Stream Monitoring and Assessment Committees, provided GIS support as well as conducted monitoring in priority areas (Appendix I). MHB staff also developed 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. 2016 monitoring efforts focused on these priority areas and included 8 events from May-October at three routine priority sites. Additionally, six suspect sites were incorporated into the adaptive monitoring plan. Parameters included enterococci (ENT), optical brighteners (OB), and DNA analysis. ENT values ranged from 31 to 10,462 MPN/100mls with a combined geometric mean[6] of 1,021 MPN for all sites and OB values ranged from 50 to 144 µg/l with a combined mean of 95 µg/l for all sites[7]. DNA results revealed the presence of consistent human sources at the mouth of GFB with a seasonal increase in signal strength during the peak summer season. Human source detection in the Jordan Marsh region was sporadic with human sources detected just a few times throughout the season. For areas with persistent human sources, the signal strength informed efforts to move upland and further bracket the suspected source(s). To assess other sources potentially contributing to elevated fecal contamination, DNA tests specific to dogs, birds, and ruminants were also conducted. These results were shared with OOB to assist with prioritization of ongoing source remediation efforts.

In response, Saco and OOB continued collaborating to restore water quality in the GFB by securing an additional 319 Phase I Implementation grant from ME DEP in 2016. Both communities continue to investigate the integrity of and make improvements to sewer/stormwater infrastructure, remediating any potential sources of illicit discharge. Saco amended their Zoning Ordinance with regards to stormwater management, increasing requirements for water quality treatment for new and redevelopment projects. The City also received a grant from ME DEP to perform culvert upgrades. 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. The town purchased a new program to better track and access future inspection information moving forward. Additionally, both communities continued to post supplemental signage at the mouth of the GFB in 2016, alerting the public of the potential risk of water contact at this location.

In 2017, both communities will continue collaborating on 319 grant objectives to implement stormwater retrofits, erosion/buffer control projects, and education/outreach initiatives. Enhanced monitoring and pollution source tracking efforts, as well as improvements to sewer/stormwater infrastructure will be conducted. OOB Public Works will continue to work with MHB staff to document sewer and stormwater camera work, incorporating the new GIS program to streamline and prioritize efforts and will continue follow-up investigations of suspect properties identified through smoke testing. The OOB Conservation Commission and the City of Saco will fund additional DNA analysis in partnership with the MHB program and UNH researchers to identify sources of fecal contamination in priority areas. MHB staff will also serve on the Restoration and Outreach committees created to help inform future 319 grant funded efforts.

Willard Beach, South Portland

[6] 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.

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

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 2016, the City consistently 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 J) in 2016 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 2016, 45 ENT samples and 44 OB samples were analyzed at 10 sites including eight subsurface sites, and two beach sites (Wil-02 & AB01). Since enhanced monitoring began, 183 ENT and 181 OB samples have been analyzed at 15 sites (14 subsurface sites as well as the routine monitoring site on Willard Beach (Wil-02)). Combined (2012-2016) ENT mean results for each site[8] ranged from 29-552 MPN/100ml and OB results from 12-115µg/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.[9] Overall, mean OB values were relatively low (less than 40 µg/l) for the majority of sites 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 two mean OB site values (CB1599, DM0423) and one single sample value (DM0424) 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 indicate the presence of mammal sourced DNA in both structures tested (CB3294 & DM1045) and human DNA at site CB3294, suggesting human sources may be contributing to bacterial pollution at that location. Continued monitoring and education/outreach is needed to better understand and address the source(s) of bacteria impacting water quality on Willard Beach.

Additionally, 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 approved an ordinance to reduce the use of synthetic pesticides in the City in 2016. In 2017, 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.

Crescent Beach State Park

[8] 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.

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

In 2016, 20 ENT samples were analyzed at two sites in a neighboring marsh with results ranging from <20 to 3654 MPN/100ml from marsh-east (geometric mean 177 MPN/100ml) and results ranging from <10 to 2382 from marsh-west (geometric mean 110 MPN/100ml). Although the marsh sites were frequently elevated, the beach sites were only impacted 1 time, indicating the marsh discharge may only impact beach water quality after heavy rainfall. More information is needed to better understand any impacts these "naturalized" Enterococci have on recorded bacteria levels as well as human health.

Rockland

In 2016, Rockland passed a 10.4 million dollar bond for storm water separation and upgrades to waste water treatment. The City also continued investigations and improvements to sewer/stormwater infrastructure including relining sewer lines to promote integrity. Additionally, Rockland implemented a pet waste and water quality campaign, and installed over 20 pet waste bag distribution stations. The community is also involved in replenishing the stations and policing the area for nonconformance.

Rockport

The MHB program has supported Rockport in its efforts to address pollution issues on Goodie's Beach, throughout the adjacent Harbor, associated tributaries, and the Pascal Ave. storm drainage network. In 2016, Rockport continued to consistently post precautionary rainfall advisories in support of public health at a conservative threshold of 0.25 inches, particularly since primarily small children 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. Based on previous pharmaceutical survey results, Rockport inspected 10 home-to-sewer connections with no issues found. Rockport also implemented a Coastal Community Planning grant in 2016 ($11,236), which is a GIS-based project called A Watershed Approach to Managing Land-Use Impacts to Coastal Waters. Additionally, MHB staff supported a town funded feasibility study of on-site treatment of storm runoff affecting Goodie's Beach (Appendix K). For 2017, 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 2016, 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 of 164 properties in the Bayview pump station sewer system area resulting in the identification of 24 illicit connections to the sewer system (sump pumps). Smoke and dye testing efforts identified two additional illicit connections (storm water catch basins tied to the sewer system). Through continued stormwater testing, a crushed sewer pipe on Mechanic Street leaking into a storm water ditch and the downstream river was identified and repaired. Follow-up bacteria testing verified the pollution was eliminated. The town also discovered and corrected an illicit grey water discharge, four-inch pipe connections in the storm drains were investigated with subsequent dye testing to verify no issues, and the High Street sewer system was replaced. Camden will continue televising priority sewer and stormwater until all 17 miles of pipe have been inspected. Additionally, the Conservation Commission passed an ordinance prohibiting the feeding of wild

animals (except songbirds), applied for a Maine Outdoor Heritage Foundation grant to address ongoing pollution in Camden Harbor (Award request=$34,807), and conducted a stormwater education campaign including storm drain stenciling and the generation of local articles and ordinances raising awareness of harbor pollution and best practices.

In 2017, Camden will follow-up/eliminate the 23 illicit connections identified (21 sump pumps, two catch basins) and propose plans for addressing residents that did not make survey appointments in 2016. The town will also follow up on suspected inflows discovered through sewer and stormwater inspections with CCTV inspection equipment and conduct stormwater testing to verify cleanliness/corrective actions. The town will also follow up on a "hot-spot" along High Street to verify the source of bacterial contamination and will continue door to door surveys of the Rawson Ave. pump station area.

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 improve wastewater infrastructure, Lincolnville acquired a $95,000 grant from Maine DEP for culvert upgrades, and will also use loans and grants secured in 2016 to upgrade the Lincolnville Sewer District (approximately $3,350,000) in 2017. Additionally, the MHB program assisted the town with assessing water quality at the Ducktrap River Recreation Area. This included analyzing 15 samples for Enterococci over the course of the monitoring season. Results ranged from <10 MPN to 1081 MPN/100mls of sample water with a geometric mean of 46 MPN/100 ml.

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 2016, Mt. Desert began implementing precautionary rainfall advisories in support of public health at Seal Harbor Beach. Additionally, the Community Environmental Health Laboratory at the MDI Biological Laboratory conducted a Public Outreach Survey (Appendix L) and Flyer (Appendix M) focused on pet waste and awareness of the MHB program. They also continued their partnership with the NEST project by examining multiple water quality parameters in the Cromwell Brook watershed located in Bar Harbor and Acadia National Park. Data collected through prior NEST collaborations to conduct enhanced rainfall monitoring of six watersheds on MDI was used by MHB to augment precautionary rainfall advisories in 2016. The MHB program also supported Acadia National Park in its efforts to assess water quality on Sand Beach by supporting the analysis of 15 samples collected at a site capturing marsh/stream runoff behind the public beach area. Results ranged from <10 to 621 MPN/100mls of sample water with a geometric mean of 16 MPN/100ml.

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