Maine Healthy Beaches
2013 Report to US EPA
April 1 2014

I. Program Accomplishments

There are more than 29 miles of public access beaches stretching along Maine's coast. Maine Healthy Beaches (MHB) is managed by the Maine Department of Environmental Protection (DEP) and coordinated by the University of Maine Cooperative Extension (UMaine Extension). This team worked with 28 local management entities to conduct routine monitoring, assessment and public notification of water quality conditions for 55 beach management areas spanning Kittery to Mount Desert Island.

MHB accomplished the following in 2013:

- Processed over 2156 Enterococci samples at 148 routine and enhanced monitoring locations.

- Delivered 36 technical trainings (field, database, laboratory) for 159 local staff and volunteers.

- Investigated Enterococci's relationship to local precipitation levels at targeted beaches; worked with local beach managers to implement precautionary rainfall advisories at 6 beaches impacted by non-point source pollution.

- In an effort to target human-sourced fecal contamination, nearly 455 samples were analyzed for optical brightener levels at over 58 enhanced monitoring locations.

- Supported enhanced monitoring and source-tracking efforts for: the Lincolnville Beach storm drainage network, Rockport Harbor watershed, Willard Beach storm drainage network, Spurwink River watershed, Goosefare Brook watershed, Ogunquit River watershed, and Wells Harbor (Webhannet River).

- In an effort to share resources and solve problems, staff planned and facilitated 38 meetings with partners (171 participants).

- Collaborated with local and state agency partners to conduct sanitary survey work in the Spurwink River Watershed including property surveys to determine the status of subsurface wastewater disposal (septic) systems.

- MHB data and support augmented local efforts to address pollution issues including protective ordinances, 319-Watershed Management, Comprehensive and Water Resource Protection Plans, etc.

II. Program Deliverables/Appendices

Appendix A *MHB 2013 Budget Summary*
Appendix B *MHB 2013 Beach Mgt. Area Classification/Tiered Monitoring Plan*
Appendix C *MHB 2013 Notification Activity*
Appendix D *Case Study: A preliminary examination of the effects of local precipitation on coastal beach water quality at targeted beaches in Maine*
Appendix E *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in Goosefare Brook, Maine, 2012-2013*
Appendix F *Risk Assessment Tables and Maps Depicting NRST Focus Areas, 2012 and 2013*
Appendix G *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in the Spurwink River, Maine, 2010-2013.*
Appendix H *Spurwink River Sanitary Survey: Maps of Priority Parcels, 2013.*
Appendix I *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in the Willard Beach Watershed, Maine, 2012-2013*

III. Budget Information[1]

Program Activities
The US EPA sponsored, MHB 2013 budget supported all monitoring, assessment and notification, education/outreach, enhanced monitoring and source-tracking efforts including:

- UMaine Extension staff salaries and a portion of the DEP staff's salaries. This team of personnel provides extensive support to 28 local management entities (towns, state parks, national park, and private beach associations) including program coordination, quality-assured protocols and structure, field/lab trainings, technical assistance, volunteer recruitment, education/outreach, etc.
- Partial support for a DEP data specialist to provide data management services, transfer MHB data to DEP's Environmental and Geographic Analysis Database (EGAD) system, manage the submission of MHB data into the US EPA databases (STORET and PRAWN), and fulfill data requests as needed.
- Pre-season regional beach manager meetings to: communicate program updates, revise Communication Plans, sign the MHB Agreement Form, address participants' needs, distribute materials, schedule field trainings, modify monitoring site locations, regional collaboration, etc.
- Field monitoring supplies, equipment, volunteer training packets, and quality-assurance including annual field, database, and observational trainings for over 180 citizen volunteers and local level staff.
- Laboratory equipment, supplies, labor, sample transport (courier), training, and QA/QC support for five Enterococci laboratories processing samples for 55 beach management areas spanning a large geographic area (approximately 200 mi.).

[1] See *MHB 2013 Budget Summary*, **Appendix A.**
[2] See **Section VII**.
[3] See *MHB 2013 Beach Mgt. Area Classification/Tiered Monitoring Plan*, **Appendix B.**
[4] Monitoring may be extended for targeted areas.
[5] For areas experiencing frequent bacterial pollution, the list of parameters is often increased as part of the pollution

- Enhanced monitoring and pollution identification efforts, as well as numerous planning and problem-solving meetings with diverse partners.[2]
- 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 participation is voluntary and towns/parks designate local beach managers and field monitors. Beach managers are typically town administrators, health nurses, fire chiefs, state park managers, etc. MHB tasks are an add-on to an already full schedule. The time devoted to these 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 over 180 local staff/volunteer monitors attended 2 hr. pre-season field training, and on average, contributed 3 hours weekly during the monitoring season. A conservative estimate of the total volunteer monitor contribution was approximately 7,964 hours ($20/hour) for a total of $159,280 in 2013.

IV. Performance Criteria

Beach Management Area Classification/Tiered Monitoring Plan[3]
MHB is a voluntary program and monitoring coastal water quality for swimming and other water contact usage 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 outlined in MHB protocols, the MHB Quality Assurance Project Plan (QAPP) and MHB Town/State Park Agreement. This includes a feasible plan for monitoring, assessment and timely public notification of water quality conditions. New beaches will be recruited over time as resources and funding allow and/or circumstances change eligibility for program participation.

MHB successfully worked with 28 diverse local management entities to conduct routine monitoring for 55 beach management areas. In 2013, 52 were classified as "Tier-1" and 3 classified as "Tier-2" with a reduced monitoring effort. "Tier-3" beaches did not participate in the program in 2013.

Beach Monitoring, Assessment, Notification, Education and Outreach
MHB provided a unified structure and quality-assured tools to implement an adaptive monitoring regime, assess the risk of pollution at each beach management area and notify the public of water quality conditions on Maine's coastal beaches.

[2] See **Section VII**.
[3] See *MHB 2013 Beach Mgt. Area Classification/Tiered Monitoring Plan*, **Appendix B.**

Monitoring

The monitoring season lasted approximately three months, extending from Memorial Day through Labor Day.[4] In partnership with MHB staff, local management entities selected monitoring sites for each beach based on where people swim, at freshwater inputs (rivers, streams, storm drains), and near other high-risk features including sewage treatment plant outfalls, wildlife areas, etc. Samples were collected in 2-3 feet of water at 6-8 inches below the surface. For areas experiencing chronic bacterial pollution, additional monitoring sites were added throughout the watershed and/or wet weather monitoring was conducted to help determine pollution sources.

Parameters[5] monitored include: Enterococci bacteria, air and water temperature, salinity, tidal stage, rainfall, and additional weather/field conditions that may affect beach water quality. Based on US EPA Guidance Criteria and adopted by ME DEP, the safety threshold is 104 Enterococci per 100 ml of sample water.

Approximately 2156 samples were collected at 148 routine and enhanced monitoring locations spanning Kittery to MDI. Samples are transported to the laboratory (3 regional, 1 local) for analysis within 6 hours of collection. The majority of samples are processed by Nelson Analytical Laboratory and transported via a courier service. Samples are analyzed using the IDEXX Enterolert ® Most Probable Number enumeration method. Beach sites are resampled as soon as possible following an exceedance. All samples and parameters are collected and analyzed according to US EPA-approved quality-assured protocols outlined in the MHB QAPP.

Assessment

Beyond routine beach monitoring, MHB 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, sanitary surveys and other pollution source-tracking efforts.[6]

MHB routinely assists local beach managers in completing or updating Risk Assessment Matrices, preliminary assessments of shoreline characteristics, activities (on and offshore) and water quality. MHB used this risk-based ranking system to inform the classification and monitoring regime for each beach management area, as well as to determine the need for an in-depth sanitary survey of the shoreline, freshwater inputs, and the surrounding watershed areas.

In an effort to assess water quality and pollution sources, MHB supported enhanced monitoring and source-tracking efforts for: the Lincolnville Beach storm drainage network, Rockport Harbor watershed, Willard Beach storm drainage network, Spurwink River watershed, Goosefare Brook watershed, Ogunquit River watershed, and Wells Harbor (Webhannet River) in 2013.

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[4] Monitoring may be extended for targeted areas.

[5] For areas experiencing frequent bacterial pollution, the list of parameters is often increased as part of the pollution source-tracking toolbox.

[6] This includes but is not limited to sanitary surveys of properties with subsurface wastewater disposal (septic, cesspool) systems and Illicit Discharge Detection and Elimination studies of sewer and stormwater infrastructure, See **Section VII**.

Notification

Once available, all beach monitoring results and beach postings were recorded in the MHB internal database that automatically updated the public interface viewable at www.MaineHealthyBeaches.org. An automatic email alert was generated for results ≥104 MPN per 100 ml of sample water and sent to local beach managers, MHB staff, and state agency partners.

The decision to post an advisory[7] was made by local beach managers and based on the results of neighboring beach 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. MHB provided recommendations and each decision to post the beach was made on a case-by-case basis. In addition to the website, beach status was posted at major beach access points. A few towns supported and maintained local signage, links from their individual websites, Facebook pages and hotlines. MHB co-developed local level signage to alert the public about potential high-risk areas such as stagnant tide pools and fresh water inputs with impaired water quality.

Monitoring sites were resampled as soon as possible following an exceedances and the monitoring frequency increased until results were within acceptable limits. However, resampling was contingent on the time of results and availability of monitors and laboratories, resampling did not always occur the same day results were available. This lag-time increased the duration of beach action days.

In some cases, beach managers waited for resample results before posting an advisory for areas with historically good water quality and a low risk of pollution. For areas with a history of poor water quality and a high risk of pollution, beaches were typically posted immediately upon receiving results. In 2013, 6 beaches issued "precautionary rainfall advisories[8]" based on local precipitation levels. In some cases, beach managers kept the advisory in place until the next routine monitoring day indicated acceptable Enterococci levels.

In 2013, an extensive Communication Plan of local beach managers and field monitors was updated for re-sampling efforts and beach status notification. MHB staff brought new beach managers up to speed with the program and notification protocols as needed. Following each exceedance, MHB staff contacted local jurisdictions to ensure that MHB protocols were followed in a timely manner according to the MHB QAPP. On a daily basis, MHB staff quality-checked the database for accurate entry of field, laboratory and notification data. MHB also provided ongoing database technical support.

All beaches attributes, monitoring, and notification data was transferred to DEP's EGAD system for final submission into US EPA's STORET and PRAWN databases. MHB continued to make

[7] Closures are rare and occur only when beaches experience chronic high bacteria levels or known safety or public health threats, and in municipalities where closing ordinances are in place.

[8] In most cases, precautionary advisories were triggered by > 1 inch of rainfall within 24 hours and typically lifted 24 hours after the rainfall ceased (or two full tide cycles).

local beach information (site locations, monitoring and notification data, contact information, etc.) more easily accessible to the public via a Google Earth Project launched in 2010. MHB responded to numerous data and information requests from NRDC, program participants, state agency partners, non-profits, etc. MHB 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, as well as watershed management, stormwater management, comprehensive and water resource protection plans.

Education and Outreach[9]

Bacterial pollution on beaches and shellfish growing areas threatens public health, the environment, and local economies. In response, MHB developed the *Municipal Guide to Clean Water: Conducting Sanitary Surveys to Improve Coastal Water Quality*[10] to assist communities, resource managers, non-profits, etc. in addressing bacterial pollution issues. Since 2010, it has been distributed to over 50 Maine communities, 8 state/federal agency partners, and 14 states (AL, CA, CT, FL, MA, MD, NH, NY, OH, RI, SC, VA, VT and WA). This resource was also available to download on the following websites: Maine Healthy Beaches, Maine Sea Grant, Great Lakes Working Research Group, Surfrider's Research Page and Blue Water Task Force Blog, and the Maine State Codes Enforcement Officers Resource page. Focused on addressing an important coastal issue, the Resource Guide was recognized as an outstanding outreach achievement by the Northeast Sea Grant Consortium in 2013.

MHB delivered 9 presentations to local and regional audiences (approximately 250 people), and MHB staff participated in newspaper, television, and radio interviews reaching diverse audiences nationwide. Staff also served on the steering committee, chaired a session and presented at the 2013 Maine Beaches Conference. MHB resources including training materials, program information, public reports, and other materials promoting best practices at the beach and throughout the watershed were also distributed statewide in 2013.

V. Flagship Beach Status

The two "flagship" beaches, Ferry Beach State Park and Wells Beach, continued to uphold all policies and guidelines set forth by MHB. In 2013, Ferry Beach had 2 exceedances (rate 11.8%) with 100% of those exceedances preceded by rainfall in the last 48hrs. In 2007, Wells Beach was divided into 3 separate management areas (Casino Square, Wells Beach and Wells Harbor). In 2013, Casino Square had 7 exceedances (rate 19.4%; rainfall preceded 85.7%) Wells Beach had 6 exceedances (rate 10.2%; rainfall preceded 100%) and Wells Harbor had 10 exceedances (rate 47.6%, rainfall preceded 100%).

VI. Data Summaries

[9] See **Section VII**

[10] http://www.seagrant.umaine.edu/extension/municipal-guide-to-clean-water

- 2156[11] Enterococci samples were processed at 87 routine beach monitoring sites as well as 61 sites that included routine sites located in close proximity to managed beach areas and enhanced monitoring locations to help pinpoint pollution sources.
- 100% of Tier 1 beaches were monitored.
- 13.1% of routine beach samples exceeded the safety threshold of 104 MPN/100mls of sample water. Of those exceedances, 84.7 % were preceded by rainfall.
- 275 beach action days were reported including 83 actions at 27 beach management areas. 18 actions totaling 61 days of the reported days were "precautionary rainfall advisories," based on local precipitation levels rather than recorded bacteria levels.[12]
- 95.2 % of total beach days[13] were free of beach advisories or closures.

Table 1. The percent of samples that exceeded the safety limit of 104 MPN Enterococci per 100ml of sample water for each year spanning 2005-2013. 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%
Total	12632	1274	10.1%

Inter-annual variability of the percent exceedances may be due to multiple factors including but not limited to: precipitation levels, beach and watershed characteristics (e.g. impervious surfaces, pollution sources), the number of monitoring sites and beach management areas, etc. Moreover, the Gulf of Maine is becoming wetter, fresher and warmer on average.[14] Freshwater runoff entering coastal beaches via rivers, streams and stormdrains transfers pollutants from upland areas to the surf zone. Nearly 85 % of recorded exceedances were preceded by rainfall in 2013.

Based on the US EPA PRAWN calculation of a beach action day (any part of 24 hours which affects public use of the beach is counted as an entire action day), the number of beach action days in 2013 (275) was greater than the number of days reported in 2012 (194) and 2011 (112). The number of BMAs with action days was less in 2013 (27) compared to 2012 (42).

The amount of rainfall observed (22.34 inches on average) during the 2013-monitoring season closely mirrored levels recorded during the 2012 (21.96 inches) and was nearly double the levels

[11] This number includes 20% field and laboratory duplicates
[12] See *MHB 2013 Notification Summary*, **Appendix C.**
[13] Defined as beach season length x beach management areas; (104 days x 55 BMAs) = 5720 total beach days
[14] Balch *et.al.* 2012.

for the 2011 (13.45 inches) season. Four beach management areas (Goodies, OOB Ocean Park, East End, and Goose Rocks) accounted for 40.7% of the reported beach action days in 2013. Non-point source pollution is likely contributing to bacteria load at these locations. Contributing factors include but are not limited to a high % impervious cover, adjacent urbanized areas, and freshwater inputs (storm drains, streams, rivers) that empty directly onto the beach. Of the beach actions occurring at these four locations, 64.7% had >0.25 inches antecedent (48 hrs.) precipitation.

In addition to record rainfall levels, the increase in beach action days in 2013 is likely linked to "precautionary rainfall advisories," the lag-time in obtaining bacteria results and the way beach action days are defined. Precautionary advisories accounted for 61 beach action days and 22.2 % of the total recorded action days. For the 2013 beach season, these areas were plagued with "running" advisories where precautionary measures blended with advisories based on bacteria results and vice versa. Additionally, depending on the time of results and the availability of monitors and laboratories, resampling did not always occur the same day that results were available. In some cases, beach managers kept an advisory in place until the next routine monitoring day indicated acceptable Enterococci levels. Moreover, any part of one day is considered an action day and this does not account for beaches that were re-opened earlier in the day. These and other factors increased the number of total advisory days in 2014.

In 2013, MHB investigated Enterococci's relationship to local precipitation levels at all routinely monitored beaches.[15] This work supports informed beach management decisions including precautionary rainfall advisories at "high-risk" beaches impacted by rivers, streams and storm drains. However, the information provided by this study is limited, as it was not designed specifically to target first flush conditions, the typical worst-case scenario for water quality. Plus, it did not track events over time to determine if and how quickly the events flush out of the system, and how long it takes for rainfall within the larger drainage basin to impact beach water quality.[16] For example, the routine beach sample could have been taken at any point in the wet weather event. Additionally, the reporting of local rainfall levels may have also impacted the results of this study.

VII. Collaborative Efforts to Address Bacterial Pollution[17]

Unsafe fecal bacteria levels degrade ecosystems, threatening public health and local economies largely dependent on tourism. Tourist spending is York County alone is anticipated to be over 500 million annually.[18] The majority of Maine's beaches are impacted by freshwater inputs (rivers, streams, storm drains) that transport pollutants from upland areas. Sources are typically difficult to find, often requiring intensive investigations beyond the immediate shoreline.

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[15] See *Case Study: A preliminary examination of the effects of local precipitation on coastal beach water quality at targeted beaches in Maine,* **Appendix D.**

[16] Maine Geological Study studies have determined that local circulation patterns may not allow the system to flush out quickly. It's also possible for bacteria levels leaving a source (river mouth) to be transported offshore during an ebbing tide, reside offshore in refrigerated state, and then travel back to the beach on the next flood tide. Moreover, it can take up to several days for rainfall within the larger watershed area to impact beaches downstream.

[17] Contact MHB for more information, technical reports, etc.

[18] Levert, Michael and David Douglas 2009. "Valuing Maine Beaches" Maine State Planning Office Presentation at the Maine Beaches Conference. In general, Maine is lacking reliable economic and beach usage data.

Once sources are verified, solutions are often complex and expensive. Subsurface wastewater disposal systems located in historically tidal wetland areas have a great potential to impact nearby water bodies. For many areas, wastewater disposal options are limited. Pollution sources are removed, yet new ones emerge. Sewer lines degrade over time and cross-connections to the storm water systems are far too common. Overall, there's a need for constant monitoring, maintenance, and expansion of sewer infrastructure. Most of Maine's population is located within coastal watersheds and over-development and impervious surfaces compound the issues. The Gulf of Maine is also changing with demonstrated increases in precipitation and river discharges lending to decreased salinity, increased water temperature, and an influx of dissolved nutrients.[19]

Addressing bacterial pollution requires collaboration at all levels. MHB has brought together local, state and federal partners in a collaborative process focused on sharing resources and solving problems. Since 2003, MHB has provided extensive support to communities experiencing chronic issues. Some examples of this support include:

- Circulation studies to determine the fate and transport of pollutants
- In-depth data analysis to explore Enterococci's relationship to multiple parameters
- Enhanced Enterococci and Optical Brightener monitoring
- Microbial Source Tracking
- Monitoring of pharmaceuticals and personal care products
- Assessing Enterococci levels in beach sand and seaweed wracks
- Geographical Information Systems Watershed Risk Analysis
- Facilitation of logistical and problem-solving meetings
- Stakeholder workshops and presentations to share data and strategies to improve water quality
- Property surveys to determine the status of subsurface wastewater disposal systems
- Identification of priority areas needing Illicit Discharge Detection and Elimination Studies of sewer and stormwater infrastructure
- Technical support and expertise from program staff, academic and agency partners
- Obtaining supplemental funding: supporting local initiates to acquire extramural funds
- Education and outreach campaigns promoting best practices

This work has led to important local actions to identify, remove, and prevent pollution sources. Some examples include efforts to:

- Implement precautionary rainfall advisories
- Survey properties to identify malfunctioning subsurface wastewater disposal systems
- Obtain funding for underserved populations needing septic system repairs or replacement
- Detect faulty sewer lines and illicit cross-connections
- Upgrade sewer and stormwater infrastructure

[19] Balch, W.M. et al. 2012. "Step-changes in the physical, chemical and biological characteristics of the Gulf of Maine, as documented by the GNATS time series." *Marine Ecology Progress Series*.

- Install boat sewage pump stations
- Establish local water quality protection ordinances
- Improve municipal records pertaining to wastewater disposal and stormwater
- Develop 319-funding proposals and Watershed Management Plans
- Inform Stormwater Management, Comprehensive and Water Resource Protection Plans and other efforts to restore ecosystem function
- Implement local water quality outreach campaigns
- Apply innovative source tracking tools (e.g. canine detection services)
- Create, fund or retain jobs (shoreland resource officers, environmental consultants)
- Train and educate local codes enforcement officers, resource managers, and students

Pollution Source Tracking Toolbox[20]

Since 2003, MHB 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. Although intensified monitoring has discontinued in some areas, the historical data has informed continuing efforts to address impaired water quality (e.g. watershed management plans, sanitary surveys, etc.). MHB data and support has raised awareness about water quality issues and has helped make addressing them a priority.

Enhanced Enterococci Monitoring

Beyond routine beach monitoring, 548 samples were analyzed at 61enhanced monitoring locations in 2013. Samples were collected upland in freshwater inputs to the beach on designated dates throughout the season to capture the impact of ebbing tidal conditions. Other sites were located in "high-risk" areas such as the mouths of rivers and streams, storm drains, stagnant tide pools, etc. and were collected on a weekly basis alongside routine beach sites. MHB also supported assessment of intermittent, suspected sources such as seepages and runoff typically associated with heavy rainfall.

Optical Brighteners

Optical brighteners are commonly used in commercial/retail products such as clothing detergents, dishwashing agents, and personal care products to brighten the whiteness of materials. These products are typically flushed down the drain and therefore, when optical brightener concentrations are coupled with elevated fecal bacteria levels, this can be indicative of human-sourced fecal contamination.

In 2013, MHB analyzed nearly 455 samples for optical brightener levels at 58 enhanced monitoring locations. MHB also analyzed samples for local and state partners to support their continuing efforts to identify sources of bacterial pollution. Typically, levels above 100 µg/l are considered a "red-flag" for human impacts.[21] However, humic substances (tannins and other dissolved organic compounds) can cause interference and result in elevated readings. Therefore, results were compared to the average reading for all sites at that particular location. Assessing

[20] Only Rockport received US EPA support for pharmaceutical and personal care product analysis in 2013.
[21] This level relates to the calibration of the MHB Turner Designs 10AU Fluorometer.

how results deviate from the overall mean can help tease out a meaningful signal from the background "noise."

A robust sample size is also valuable when determining the relationship between Enterococci and optical brightener levels, and often multiple seasons' worth of data is needed to understand the relationship. It is also important to collect samples at locations as close to the source as possible as distance and dilution (due to tides and mixing) can lead to lower concentrations. Moreover, pollution sources (e.g. malfunctioning septic systems) contributing to impaired surf zone water quality are often sourced from upland areas and are not typically located directly on the beach.

Kittery

MHB has supported enhanced monitoring, assessment of bacteria levels in sand and seaweed and other local initiatives to improve water quality.[22] Kittery's commitment to clean water extends beyond coastal beaches. It is a designated "MS4"community and has successfully partnered with local groups to address the health of Kittery's water resources. The town hired a Shoreland and Environmental Resource Officer in 2011 and has hired engineers and consultants to assist with their efforts to improve water quality in priority areas. This includes acquiring 319 watershed management funds from the Maine (DEP), surveying properties for malfunctioning septic systems, Illicit Discharge Detection and Elimination (IDDE) studies of sewer and stormwater infrastructure, stormwater mapping projects, implementing Low Impact Development and Best Management Practices, stormwater education events, etc. This work has led to the removal of dozens of grey and black water discharges over the past two years.

In 2012, algal growth was surfacing on beach face in the western cove of Fort Foster's Horn Point and this was the initial tell tale that an abandoned outhouse and leach field was impacting[23] the upland marsh area and associated beach seepage. With the help of local volunteers and the shoreland resource officer, MHB conducted intensified monitoring of the surf-zone, beach seepage and sand, and the marsh area behind the beach. MHB co-developed local signage with the town to alert the public to the possible risk of sand contact[24] for this section of beach. The shoreland resource officer also completed an upland survey to rule out other sources and held public events at Fort Foster to raise awareness of local water pollution issues. Additionally, Kittery hired Canine Detection Services to "sniff out" and verify the suspected human contribution at Horn Point and eventually removed the contaminants from the marsh.

In 2013, the town installed a "beaver deceiver" and upgraded the culvert in an effort to improve tidal flushing of the marsh. Kittery brought back the canines to verify the contamination was removed in 2012. Kittery also continued sanitary surveys and IDDE work throughout the town including smoke testing approximately 6,000 feet of sewer lines. Kittery plans to establish a local septic pump-out ordinance, requiring pump-out of priority properties every 5 years. The town will continue outreach events, pollution source tracking efforts, and make incremental improvements to storm and sewer infrastructure.

Town are required to develop and implement a stormwater management program

[23] Wildlife such and beavers and waterfowl were also likely contributing to bacterial water quality of the marsh..

[24] An additional site (K-6, western cove) was added to the routine beach monitoring efforts the in 2012 and since then results have been consistently acceptable except for a 8-21-12 reading of 120 MPN/100mls.

York
Since 2007, MHB has supported multi-year enhanced monitoring studies, Microbial Source Tracking, GIS Watershed Risk Analysis, Stakeholder Workshops and more to augment York's actions to address impaired water quality. In 2008, York hired a Shoreland Resource Officer that partnered with MHB and local volunteers to continue enhanced monitoring and source tracking efforts in the Cape Neddick River (CNR) Watershed. This work has expanded beyond the CNR as York was designated as an "MS4" community in 2012. The town also contracted with engineers and consultants to address stormwater issues including submitting a 319-watershed management proposal for the CNR. The town has also created a protective local ordinance requiring routine pump out of septic systems in priority areas and has adopted water resource protection measures into its Comprehensive Plan. In 2013, the town inspected and dye tested 7 properties within the CNR watershed and continued working on the 319-proposal. The town plans to continue its source tracking and watershed management efforts as well as hiring a consultant to conduct an intensified rainfall study of York's beaches in 2014.

Ogunquit River Watershed (Ogunquit, Wells)
Since 2005, MHB has supported multi-year enhanced monitoring and pollution source identification efforts including monitoring of multiple 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 Ogunquit River.

With the assistance of the Ogunquit Conservation Commission (OCC), Ogunquit has amended the Zoning Ordinance to expand the "Shore Land Zone" to include additional water bodies, a 75-ft. setback requirement along each new stream, and additional Resource Protection District areas within the town. Another amendment mandates that residential septic systems within the "Shore Land Zone" be pumped out every 3 years and systems outside of this area, every 5 years. The OCC was also awarded a $10,000 grant from the Maine Coastal Program to conduct a storm water mapping and drainage study. Additionally, Ogunquit installed a Bio Skirt /Snout in a storm drain designed to capture solids before they reach the river/ocean and installed 3 waterless urinals at public restrooms that have shown a significant reduction in the use of water.

All of the above actions helped Ogunquit secure a $30,000 grant from the Gulf of Maine Council to study the effects of sea level on the town's short and long term planning as well as their waste treatment facility. The Ogunquit Sewer District has also conducted IDDE studies and the town has made improvements to sewer and stormwater infrastructure. The conservation commission has launched education/outreach campaigns promoting best practices. Additionally, 56+ acres of green space and wetlands was donated to the Great Works Regional Land Trust to help protect the Ogunquit River Watershed and Ogunquit Beach. The town also hired consultants to continue enhanced monitoring and source tracking efforts including Canine Detection services to "sniff-out" human sources in 2012.

In 2013, Ogunquit contracted with consultants to repeat the canine detection strategy, develop a Watershed Committee, conduct further drainage mapping and source tracking in priority sub-

watershed areas, and develop a 319-watershed management proposal. The town was awarded the funds and MHB plans to continue supporting Ogunquit and partners as they continue to address water quality issues in the Ogunquit River watershed. Ogunquit will reintroduce a referendum banning the use of pesticides on all Ogunquit properties as well as a protective amendment to upgrade segments of the Leavitt Stream not currently protected for stream setbacks, and plans to hire a local beach coordinator in 2014.

Wells
Beyond routine beach monitoring, MHB has supported analysis of samples collected intermittently to assess bacteria levels in sand, seaweed and stormwater impacting Wells beaches. In 2013, MHB supported enhanced monitoring in the Webhanett River impacting water quality on Wells Harbor Beach. As part of this effort, 37 samples were collected at 8 locations during the beach season. Enterococci values ranged from 5 MPN to 6867 MPN/100mls with a combined geometric mean of 55.7 MPN for all sites. MHB plans to continue support for additional monitoring in 2014.

Kennebunk River (Kennebunk, Kennebunkport, Arundel, Lyman)
Since 2005, MHB has supported multi-year enhanced monitoring and pollution source identification efforts including monitoring of multiple 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 Kennebunk River.[25] As a result, Kennebunk conducted additional sanitary surveys and eliminated 3 illicit discharges along the Kennebunk River including a "straight-pipe" and a system that services multiple units. Kennebunk also routinely cleaned stormwater catch basins and has implemented a seaweed management plan to help improve water quality of Gooch's Beach. Additionally, the towns within the watershed have been active in the Kennebunk River Action Committee that has worked diligently to improve water quality and promote best practices including developing septic socials, Boater's Education Campaigns, and installing a boat pump out station in the river.

Kennebunkport
Beyond the work in the Kennebunk River, MHB has supported multi-year enhanced monitoring studies, circulation studies, in-depth data analysis, sanitary survey work, Stakeholder Workshops, education/outreach efforts, and more to support improved water quality on Goose Rocks Beach. The town contracted with Environmental consultants for source-tracking efforts and has taken extra steps to provide public access to local water quality conditions via the town's website, telephone announcements, supplemental signage, more frequent beach monitoring, precautionary rainfall advisories, etc.

Biddeford
In 2005 and 2006, MHB supported enhanced monitoring, sanitary survey work to identify malfunctioning septic systems, and compiled a sanitary shoreline/watershed report for all of Biddeford's beaches. This work led to the identification and removal of illicit discharges on Basket Island and improved water quality on neighboring Hills Beach.

[25] The Kennebunk River significantly impacts water quality on Kennebunk's Gooch's Beach and less so on Kennebunkport's Colony Beach.

Goosefare Brook Watershed (Saco and Old Orchard Beach)[26]

The Goosefare Brook forms the border between the towns of Saco to the south and Old Orchard Beach (OOB) to the north and both are designated "MS4" communities. Since 2010, MHB has supported enhanced monitoring and pollution source tracking efforts, held Stakeholder Workshops, and more to address impaired water quality in the Saco and Old Orchard Beach tributaries feeding the brook. In 2011 and 2012, US EPA expanded the pollution source tracking toolbox to include analysis of pharmaceutical and personal care products. The town also contracted with Canine Detection services to "sniff out" human sources in 2012. Over the past two years, MHB efforts have focused primarily on Old Orchard's New Salt Rd. Tributary (NRST) while 2012 DEP efforts focused on the tributaries feeding the SACO branch.

In 2013, MHB supported 170 Enterococci and 140 optical brightener samples at 17 sites stratified throughout the NSRT watershed. Enterococci values ranged from 5 MPN to 9999 MPN/100mls with a combined geometric mean of 157 MPN for all sites, and the optical brightener values ranged from 0 to 155 µg/l with a combined mean of 89 µg/l for all sites in the NSRT. Results were analyzed to determine how each site deviated from the NSRT-wide Enterococci geometric mean and the mean optical brightener value. Nine sites located primarily within the GFB-01 and GFB-05 series exhibited positive deviations from the Enterococci geometric mean and 7 sites (largely within the GFB-05 series only) demonstrated positive deviations from the optical brightener mean. The pollution source-tracking tools applied in the NRST were combined into a risk factor matrix, highlighting priority areas needing further investigation.[27]

Saco and Old Orchard have conducted property surveys to identify malfunctioning septic systems as well as IDDE studies of sewer and stormwater infrastructure. This has led to removal of numerous grey and black water discharges throughout the watershed as well as upgrades and expansion of sewer and stormwater infrastructure. Both towns posted supplemental signage at the mouth of the brook alerting the public of the potential risk of water contact in the mouth. Additionally, Saco and Old Orchard Beach worked together to submit a 319-watershed management proposal in 2013. The funding was awarded, a steering committee will be formed, information will be compiled on the condition of the watershed, stormwater retrofitting projects and watershed restoration planning will be launched, a suite of watershed health characteristics will be monitored and public outreach and involvement will be emphasized in 2014. MHB will continue to support these and other important actions to address the health of Goosefare Brook.

Spurwink River Watershed (Scarborough, Cape Elizabeth, South Portland)[28]

Since 2010,[29] MHB has supported enhanced Enterococci and optical brightener monitoring in the Spurwink River impacting Higgins Beach water quality. MHB also brought together diverse

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[26] See *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in Goosefare Brook, Maine, 2012-2013*, **Appendix E**.

[27] See *Risk Assessment Tables and Maps Depicting NRST Focus Areas, 2012 and 2013*, **Appendix F.**

[28] See, *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in the Spurwink River, Maine, 2010-2013***, Appendix G** .

[29] MHB continued to support monitoring in the mouth of the river on a weekly basis, but did not conduct enhanced monitoring in upland areas in 2011.

partners to share data and remediation strategies in 2012. In 2013, MHB partnered with Sprague Corporation to gain access to additional monitoring sites that included a windshield survey and site walk of potential monitoring locations on the western bank of the river.

MHB analyzed 122 Enterococci samples and 123 optical brightener samples at 14 sites throughout the watershed in 2013. Enterococci values ranged from 10 MPN to >24,196 MPN/100mls of sample water and optical brightener levels ranged from 6.62 to 220 µg/l. Due to the small sample size, data was combined for all sites and a Pearson's Product Moment analysis indicated a significant but very weak between Enterococci and optical brighteners (R^2=0.1750, p<0.0000). Results were analyzed to determine how each site deviated from the NSRT-wide Enterococci geometric mean and the mean optical brightener value. Six sites demonstrated a positive deviation from the Enterococci geometric mean and six sites exhibited a positive deviation from the optical brightener mean. Although there was no strong significant relationship between Enterococci and optical brightener levels, 3 primary areas in the Spurwink exhibited elevated mean concentrations of both parameters and those exhibiting positive deviations from both Enterococci and optical brightener means are of particular concern for potential human-sourced fecal contamination.

MHB also developed a sanitary survey work plan[30] and worked with agency partners to update records and conduct a sanitary survey of priority properties with subsurface wastewater disposal (septic) systems. This work highlighted on malfunctioning septic system in a location potentially impacting the river. This malfunction was followed up by the town of Scarborough and remediated. Due to impaired water quality in the Spurwink River and its impact on Higgins Beach, the local beach manager continued to implement precautionary rainfall advisories in 2013.

Willard Beach, South Portland[31]

Since South Portland joined the program in 2003, MHB has supported efforts to address water quality on Willard Beach. This includes multi-year enhanced monitoring of the storm drainage network, a shoreline/watershed survey, stakeholder meetings, etc. Of particular concern are the 6 stormwater drainage pipes discharging directly to the beach, draining stormwater from ~ 1 km^2 of residential and commercially developed areas. As a part of this effort, 29 Enterococci samples and 28 optical brightener samples were analyzed at 7 sites located within the stormwater system in 2013

In 2012 and 2013, MHB partnered with South Portland Water Resource Protection to monitoring Enterococci and optical brightener levels at sites within the storm drainage network. Monitoring in 2012 targeted wet weather events throughout September and October to ensure presence of adequate water, and samples for 2013 were collected bi-monthly from June through early September. In 2013, Enterococci mean[32] results ranged from 42-4344 MPN/100ml and from 6-98 µg/l for optical brighteners. A Pearson's Product Moment correlation combining data from all

[30] See *Spurwink River Sanitary Survey: Maps of Priority Parcels, 2013,* **Appendix H**

[31] See *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in the Willard Beach Watershed, Maine, 2012-2013,* **Appendix I**

[32] The sample size was insufficient to calculate a geometric mean

sites from 2012-2013 revealed a significant but weak relationship (R^2=0.3684, p< 0.0000) between Enterococci and optical brightener concentrations.

While comparison of Enterococci and optical brightener mean values suggests that non-point sources (wildlife, pets) associated with stormwater are likely the principal contributor to bacterial pollution at 7 of the 8 sites monitored (2012 & 2013), point sources cannot be ruled out due to the significant (yet weak) correlation between Enterococci and optical brighteners. A more robust data set is needed to better understand the source(s) of bacteria impacting water quality on Willard Beach. In 2014, MHB will partner with South Portland Water Resource Protection to conduct additional monitoring and to launch a pet waste and water quality campaign within the watershed.

Portland
Since 2002, MHB has supported a sanitary/watershed survey, optical brightener analysis, enhanced rainfall monitoring, and Boater's Education materials for East End Beach. In 2013, the local beach manager continued to post precautionary rainfall advisories when local precipitation levels were > 1 inch within 24hrs.

Popham Beach State Park
MHB has supported ongoing efforts to assess water quality in the Morse river mouth as well as stagnant tide pools that form on the beach on a weekly basis during the beach season.

Rockport
Since 2010, MHB has supported Rockport in its efforts to address pollution issues on Goodies Beach, throughout the adjacent Harbor, associated tributaries, and the Pasqual Ave. storm drainage network. In 2013, MHB focused on the stormwater discharge that empties adjacent to the public swimming beach. As a part of this effort, Enterococci and optical brightener levels were analyzed for 11 samples at 2 monitoring sites that receive water from the upland Pascal Ave. storm drainage network. Enterococci results at PA-01[33] ranged from 10 MPN to 1850 MPN/100mls of sample water with a geometric mean of 194 MPN. Optical brightener results ranged from 92.7-154 µg/l and with a mean of 125 µg/l. A Pearson's Product Moment analysis combining data from 2010-2013 indicated no significant relationship between Enterococci and optical brighteners (R^2=0.0187, p=0.7061). However, results should be interpreted with caution due to the small sample size and high variability of the data.

Enterococci results for site PA-02[34] ranged from 20 MPN to 24,190 MPN per 100 ml of sample water with a geometric mean value of 630 MPN and optical brightener results ranged from 38 - 182 with a mean of 121 µg/l. Elevated levels of Enterococci and optical brightener levels at PA-02 suggests the likelihood of human-sourced fecal contamination impacting water quality; however, a Pearson's Product Moment analysis indicated no significant relationship between the two parameters at this location (R^2=0.1273, p=0.1917), however the high variability of Enterococci values may have confounded this relationship. Additionally, US EPA supported analysis of 7 Pharmaceutical and Personal Care Products (PPCPs) at 2 locations in 2012 and at

[33] The site captures stormwater leaving a pipe emptying to the shoreline in the edge of Goodies Beach
[34] This site is located upland of PA-01 before the water enters the pipe beneath the boat house

11 sites in 2013. Bacteria, optical brightener and PPCPs results from 2012 and 2013 indicate the likelihood of human-sourced fecal contamination in the Pascal Ave. drainage network.

Since 2010, Rockport has investigated the integrity of sewer and stormwater infrastructure, surveyed 54 residences in the Goodies beach drainage basin, hired seasonal staff to collect samples, installed a boat sewage pump-out station, implemented precautionary rainfall advisories, and completed a Water Resource Survey. Rockport plans to continue enhanced monitoring and pollution source tracking efforts, develop a Watershed Export Model, increase the number of dog waste stations, stencil storm drains and other efforts to promote best practices at the beach, in the harbor, and upland drainage areas in 2014. MHB will continue to support efforts to better understand the sources of fecal contamination contributing to water quality at Goodies Beach.

Camden
Since 2008, MHB has supported local efforts to improve water quality at improve water quality on Laite Beach, in the adjacent harbor, associated tributaries and storm drainage network. In 2010, MHB obtained supplemental funding from US EPA to develop a Boater's Education Campaign and conduct enhanced monitoring throughout the harbor and watershed areas. MHB facilitated inter-department and inter-agency cooperation in support of expanded monitoring, sanitary surveys and IDDE studies of priority areas. In 2012, MHB partnered with Camden to obtain supplemental funding from the Maine Coastal Program to continue this work as well as follow through on key recommendations from prior studies. Since 2010, 3 cross connections and one broken sewer line have been remediated and Rock Brook was removed from the state's list of impaired waters. The town has also contracted with consultants to delineate watershed characteristics as well as to update the town's GIS database regarding sewer and stormwater infrastructure, and septic system parcels.

Lincolnville
Since 2004, MHB has supported Lincolnville in its efforts to address pollution issues at Lincolnville Beach and the Ducktrap River Recreation Area. 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 10 sources and has conducted feasibility studies, enacted legislation, and continues to hire contractors to pursue funding sources to improve and expand wastewater infrastructure.

In 2013, MHB focused on two storm drainage pipes emptying into Frohock Brook, ocean-side of the US Rt. 1. Bridge. As a part of this effort, 11 samples were analyzed for Enterococci and optical brightener concentrations at 2 monitoring sites (SDN and SDS) and Enterococci results ranged from 10 MPN to 5794 MPN/100 ml while optical brightener results ranged from 26-181 µg/l. Combining 2010-2013 data, the enterococci geometric mean value for site SDN (receives water from the storm drainage network along US Rt. 1 north of the bridge) was 1496 MPN/100ml [35] and the optical brightener mean 139 µg/l. Site SDS (receives water from the south) had an Enterococci geometric mean of 331 and an optical brightener mean of 78 µg/l. The coupled elevated levels of both parameters at site SDN may be indicative of human-sourced fecal

[35] The US EPA recommended geometric mean value for at least 5 samples collected within a 30-day period is 35 MPN for marine water and 33 MPN for freshwater.

pollution; however, the samples size at both locations was insufficient to draw robust conclusions. Potential sources impacting these sites are malfunctioning septic systems, wildlife, and illicit connections to the storm drainage network along US Rt. 1 and Rt. 173.

The Ducktrap River Recreation Area is a valued resource by the community and is accessed for a wide range of recreational activities.[36] MHB analyzed 15 samples for Enterococci levels over the course of the 2013 monitoring season. Results ranged from 10 MPN to 3076 MPN/100mls of sample water with a geometric mean of 169 MPN/100 ml. Potential sources include malfunctioning septic systems, wildlife and domestic animal waste.

Mount Desert and Bar Harbor

Since 2003, MHB has supported local water quality initiatives on Mount Desert Island including enhanced monitoring, surveys, special projects, Stakeholder Workshops, and more. This included enhanced Enterococci monitoring (2003-2005) of Stanley Brook (impacting Seal Harbor Beach) as well as monitoring of a suite of watershed parameters and a watershed survey of the watershed in 2005. In 2009, MHB supported a study of bacteria levels and UV light penetration on Seal Harbor Beach as well as a study of cruise ship impacts on Bar Harbor's town beach and adjacent harbor water quality in 2011. The towns have made improvements to sewer infrastructure, and Bar Harbor included a water resource protection chapter in its Open Space Plan. Bar Harbor will also hire consultants to further investigate the impact commercial cruise ships on harbor water quality. MHB will support this study and other local initiatives to improve water quality in 2014.

Applied Research Partnerships

MHB has partnered on studies pertaining to acoustic doppler profiling (circulation), microbial source tracking, assessment of microbial communities in sand and sediment, sustainability science, etc. In 2013, MHB provided guidance to the project: "Strengthening the scientific basis for decision-making: Advancing sustainability science and knowledge-action capacities in coupled coastal systems" focused on coastal beaches and shellfish growing areas in Maine and New Hampshire. MHB also partnered with the Marine Extension Team, a collaboration of Maine Sea Grant and UMaine Cooperative Extension, providing educational and applied research programs in coastal community development, ecosystem health, fisheries, aquaculture, and tourism. Researchers have been instrumental in relaying important details to local partners in support of informed beach management decisions and remediation efforts at MHB Stakeholder Workshops, Maine Beaches Conferences, Maine Water Conferences and beyond. MHB will continue its collaborative approach to addressing impaired water quality in 2014.

[36] Due to chronic bacteria issues and the lack of swimming, services, parking, lifeguards, etc., this recreation area located at the mouth of the river was re-classified as a Tier 3 beach in 2010. Lincolnville does not promote the area for swimming area and a permanent advisory sign is posted at this location.