Maine Healthy Beaches
2014 Report to US EPA
April 1, 2015

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 60 beach management areas spanning Kittery to Mount Desert Island.

MHB accomplished the following in 2014:

- Processed 1882 enterococci samples at 134 routine and enhanced monitoring locations.
- Delivered 38 technical trainings (field, database, laboratory) for 189 local staff and volunteers.
- Worked with local beach managers to implement precautionary rainfall advisories at 20 beaches impacted by non-point source pollution.
- In an effort to target human-sourced fecal contamination, 208 samples were analyzed for optical brightener levels at 23 enhanced monitoring locations.
- Supported enhanced monitoring and source-tracking efforts for: Bar Harbor, Rockport Harbor, Rockland Harbor, the Willard Beach storm drainage network, Goosefare Brook watershed, Ogunquit River watershed, and Wells Harbor (Webhannet River).
- Planned and facilitated 35 collaborative and/or problem-solving meetings with diverse partners (153 participants).
- Delivered presentations to local, state, and national audiences (e.g. US EPA National Sanitary Survey Webinar; Maine's Sustainability and Water Conference).
- Collaborated with faculty and students from Maine and New Hampshire on the New England Sustainability Consortium (NEST) project focused on safe beaches and shellfish growing areas.
- MHB data and support augmented local efforts to address pollution issues including protective ordinances, developing and enacting watershed management plans, intensified monitoring, etc.

II. Program Deliverables/Appendices

Appendix A *MHB 2014 Budget Summary*
Appendix B *MHB 2014 Beach Mgt. Area Classification/Tiered Monitoring Plan*
Appendix C *MHB 2014 Notification Activity*
Appendix D *An examination of the effects of local precipitation on coastal beach water quality 2008-2014*
Appendix E *Brochure: What to Do with Doo: clean up after your pets and do your part to keep our water resources healthy*
Appendix F *Summary Report of Enhanced Monitoring and Pollution Source Tracking Efforts in Goosefare Brook, Maine, 2012-2014*
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Appendix I *Bar Harbor Cruise Ship Monitoring Report 2014*

III. Budget Information[1]

Program Activities

The US EPA sponsored, MHB 2014 budget supported all monitoring, assessment and notification, education/outreach, enhanced monitoring and source-tracking efforts including:

- UMaine Extension staff salaries and a portion of a DEP staff salary. This team of personnel provided 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 that provided 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.
- 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, perform regional collaboration, 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 QA/QC 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.

[1] Appendix A

- 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 local staff/volunteer monitors attended a 2 hr. pre-season field training and contributed an average of 3 hours weekly during the monitoring season. A conservative estimate of the total volunteer monitor contribution was approximately 8,000 hours ($20/hour) for a total of $160,000 in 2014.

IV. Performance Criteria

Beach Management Area Classification/Tiered Monitoring Plan[2]
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. In 2014, MHB successfully worked with 28 diverse local management entities to conduct routine monitoring for 60 beach management areas, 57 were classified as "Tier-1," 3 were classified as "Tier-2" (reduced monitoring effort), and "Tier-3" beaches were not monitored (i.e. did not participate in the program).

Monitoring
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. The monitoring season lasted approximately three months, extending from Memorial Day through the week of Labor Day. 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 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 in suspect areas to help determine contributing pollution sources and/or the worst-case scenario for water quality.

Parameters monitored included: enterococci bacteria, air and water temperature, salinity, tidal stage, rainfall, and additional weather/field conditions that may affect beach water quality. Based

[2] Appendix B

on US EPA Guidance Criteria and adopted by Maine, the safety threshold was 104 enterococci per 100 ml of sample water in 2014. Monitoring sites were resampled as soon as possible following an exceedance 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; therefore resampling did not always occur the same day results were available.

Approximately 1882 samples were collected at 134 routine and enhanced monitoring locations spanning Kittery to MDI. Samples were transported to the laboratory (3 regional, 1 local) for analysis within 6 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. Beach sites were resampled as soon as possible following an exceedance. All samples and parameters were 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, and other pollution source-tracking efforts. 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 in 2014, MHB supported enhanced monitoring and source-tracking efforts for: Bar Harbor, Rockport Harbor, Rockland Harbor, the Willard Beach storm drainage network, Goosefare Brook watershed, Ogunquit River watershed, and Wells Harbor (Webhannet River).

Notification

Beach monitoring results were recorded in the MHB internal database that automatically updated the program website www.MaineHealthyBeaches.org. Once a decision was made to post the beach, the information was also publically accessible via the website and signage at major 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 state agency 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 EGAD system for final submission into US EPA's STORET and PRAWN databases. MHB continued to make local beach information (site locations, monitoring and notification data, contact information, etc.) more easily accessible to the public via ArcGIS online.

MHB also worked to build local capacity to make well-informed beach management decisions as well as address pollution issues when they arose. 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, 20 beaches issued precautionary rainfall advisories (based on local precipitation levels rather than elevated bacteria) in 2014. Several beaches were consistently posted following heavy rainfall, while other beaches were posted under a precautionary advisory only once or twice during the season following flood conditions. Whether the beach was posted following elevated bacteria levels or heavy rainfall, in some cases beach managers kept the advisory in place until the next routine monitoring day indicated acceptable enterococci levels. The lag time in obtaining results, the availability of monitors, and the posting of precautionary rainfall advisories increased the number and duration of beach action days in 2014.

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 2014. 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. Additionally, MHB responded to numerous data and information requests from NRDC, program participants, state agency partners, non-profits, researchers, students, 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, biophysical and social science research, as well as watershed management, stormwater management, and comprehensive and water resource protection plans.

Education and Outreach

MHB delivered 10 presentations to local, regional, and national audiences (over 400 participants), and staff participated in newspaper, television, and radio interviews reaching diverse audiences in 2014. MHB also broadly distributed resources including training materials, program information, public reports, and other materials promoting best practices at the beach and throughout the watershed. Additionally, communities and organizations tackling bacterial pollution on beaches and shellfish growing areas continued to use the *Municipal Guide to Clean Water: Conducting Sanitary Surveys to Improve Coastal Water Quality* in 2014. 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.

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 2014, Ferry Beach had zero exceedances and Wells Beach (divided into 3 separate management areas) had zero exceedances for Casino Square, 4 exceedances (rate 8.7%; rainfall preceded 25%) for Wells Beach, and 4 exceedances (rate 23.5%; rainfall preceded 50%) for Wells Harbor.

VI. Data Summaries

- 1182 enterococci samples (including field/lab duplicates) were processed at 86 beach monitoring sites, and at 48 sites either located in close proximity to managed beaches or in upland areas to help pinpoint pollution sources.
- 100% of Tier 1 beaches were monitored.
- 8.1% of routine beach samples exceeded the safety threshold of 104 MPN/100mls of sample water.
- 229 beach action days were reported including 98 actions at 34 beach management areas.[3] Of the reported days, 125 were precautionary rainfall advisories based on local precipitation levels rather than recorded bacteria levels.
- 95.8% of total beach days (defined as beach season length x beach management areas) were free of beach advisories or closures.

Table 1. The percent of routine beach samples that exceeded the safety limit of 104 MPN enterococci per 100ml of sample water for each year spanning 2005-2014.

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%
Total	13822	1370	9.9%

The program-wide exceedance rate in 2014 was less than 2013 and 2012. 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), sample collection day/time, the number of monitoring sites and beach management areas, etc. For example, the average amount of rainfall observed (15.71 inches) during the 2014 monitoring season was less than 2013 (17.20 inches) and 2012 (16.54 inches) seasons. However, 2013 monitoring captured more rain events compared to 2014 due to the timing of these events and their alignment with routine monitoring days.[4]

In 2014, the following beaches exhibited a greater than 20% exceedance rate and collectively accounted for 30% of the total exceedances recorded program-wide: Laite Beach (Camden), Goodies Beach (Rockport), Little Beach (Ogunquit), Wells Harbor (Wells), Willard Beach (S. Portland), Ferry Beach (Scarborough) and Riverside Beach (Ogunquit). Non-point source pollution is likely contributed to increased bacteria loads at these locations. All 7 beaches are impacted by freshwater inputs (rivers, streams, storm drains) and other potential contributing factors include

[3] Appendix C
[4] Rainfall levels recorded by NOAA NCDC

boats, wildlife, malfunctioning septic systems, leaky sewer lines, etc. Of the enterococci samples that exceeded the safety threshold at these 7 locations, 20.7 % occurred where antecedent (48 hrs.) precipitation was >1.0 inches, 31.0 % occurred where antecedent (48 hrs.) precipitation was >0.5 inches and 34.5% occurred on days where antecedent precipitation was >0.25 inches.

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 2014 (229) was less than the number of days reported in 2013 (275) and greater than those reported in 2012 (194). There were zero beach closures in 2014. Additionally, the number of BMAs with action days was greater in 2014 (34) compared to 2013 (27). This increase is likely due to precautionary rainfall advisories, which accounted for 125 beach action days and 54.6% of the total recorded action days. Four beach management areas (Laite, Willard, Goodies, and East End) accounted for 25.8% of the reported beach action days in 2014. Of the enterococci samples that exceeded the safety threshold at these four locations, 28.6 % occurred where antecedent (48 hrs.) precipitation was >1.0 inches, 47.6% occurred where antecedent (48 hrs.) precipitation was >0.5 inches, and 52.4% occurred on days where antecedent precipitation was >0.25 inches.

Depending on the timing of results and the availability of monitors and laboratories, resampling did not always occur the same day that results were available. Beach managers sometimes kept an advisory in place until the next routine monitoring day indicated acceptable enterococci levels. Over half of the advisory days in 2014 were precautionary measures based on local rainfall levels. In some cases, beaches experienced "running" advisories where precautionary postings blended with advisories based on bacteria results and vice versa. Additionally, US EPA considers any part of one day an action day, and this blanket status does not consider that some beaches were opened most of the day. These and other factors likely increased the number and duration of total advisory days in 2014.

VII. Collaborative Efforts to Protect Public Health and Ecosystem Integrity

Unsafe fecal bacteria levels degrade ecosystems and threaten public health and coastal economies that are largely based on tourism. 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. Once sources are verified, solutions are often complex and expensive. Subsurface wastewater disposal systems located in historically tidal wetland areas have the potential to greatly 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 system 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.[5]

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

[5] 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.

experiencing bacterial pollution 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 including identifying priority areas needing further investigations of sewer/stormwater infrastructure and the status of subsurface wastewater disposal (septic/cesspool) systems
- Facilitation of logistical and problem-solving meetings
- Stakeholder workshops and presentations to share data and strategies to improve water quality
- 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 (e.g. boat pump outs, pet waste)

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 wastewater repairs or replacement
- Detect faulty sewer lines and illicit cross-connections between storm and sewer infrastructure
- Upgrade sewer and stormwater infrastructure (replace asbestos and clay pipes with PVC)
- Install boat sewage pump stations
- Establish local water quality protection ordinances
- Improve municipal records pertaining to wastewater disposal and stormwater
- Develop 319-funding proposals, Watershed Management Plans, 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 and Environmental Resource Officers, environmental consultants)
- Train and educate local codes enforcement officers, resource managers, and students

Applied Research Partnerships

These partnerships have been instrumental in improving decision-making, addressing pollution issues, relaying information to diverse audiences, and supporting student advancement in Maine and beyond. In 2014, MHB continued collaboration with biophysical and social science researchers on the New England Sustainability Consortium (NEST) project "Strengthening the scientific basis for decision-making: Advancing sustainability science and knowledge-action capacities in coupled

coastal systems." This project, focused on safe beaches and shellfish growing areas, is managed by the EPSCoR programs at UMaine and UNH in partnership with College of the Atlantic, University of New England, University of Southern Maine, Great Bay Community College, Plymouth State University, and Keene State College. MHB support included multiple interviews, meetings, delivering a seminar to students and faculty, acting as co-chair, moderator and presenter at the NEST session at the Maine Sustainability and Water Conference, supporting intensified rainfall monitoring on Mount Desert Island, etc.

MHB also worked with the Gulf of Maine Research Institute's Ocean Data Products Team to test and evaluate an enterococcus predictive model developed by the University of South Carolina and modified to be used in Maine as a real-time decision support tool. The model integrated and processed the beach monitoring data with precipitation and other data (temp, salinity, currents) from ocean buoys. The goal was to create a unique predictive model specific to the individual data sources for each particular beach. Due to lack of timing and funds, the data holes were not filled in 2014 and the model was not re-calibrated to improve the predictive capacity.

Additionally, MHB staff participated in the NOAA Citizen Science Working Group, National Sea Grant Pharmaceutical and Personal Care Products Working Group, and the Marine Extension Team (MET). The MET represents 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. As a part of the MET, MHB staff attended monthly meetings, engaged in professional development, reviewed Maine Sea Grant research and grant proposals, served on the Maine Beaches Conference Steering Committee, etc. As part of MHB's ongoing efforts to augment decision making and remediation efforts, MHB will continue to seek opportunities for innovation through collaboration in 2015.

Pollution Source Tracking Toolbox

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. Due to limited resources and staff, the number of toolbox parameters monitored was reduced in 2014 compared to previous years. However, MHB data and support (historical and current) has raised awareness regarding water quality issues and has helped make addressing them a priority.

Beyond routine beach monitoring, 453 samples were analyzed for enterococci at 48 additional monitoring locations in 2014. 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 analyzed 208 samples for optical brightener levels at 23 enhanced monitoring locations in 2014. 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.

Rainfall

Maine has experienced and will continue to be challenged by more frequent and intense wet weather events.[6] Given the amount of rainfall and the prevalence of freshwater inputs to the shoreline, MHB continued to investigate enterococci's relationship to local precipitation levels at all routinely monitored beaches in 2014.[7] Overall, This work supported 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. This analysis is also limited in its ability to track events over time to determine the duration of contamination events as well as how long it takes for rainfall within the larger drainage basin to impact beach water quality. For example, the routine beach samples associated with rainfall could have been taken at any point in the wet-weather event. Additionally, inconsistent reporting of local rainfall levels may have also impacted the results of this study. MHB will continue to build the dataset and investigate the relationship between enterococci and rainfall levels in 2015.

Pet Waste and Water Quality

In 2014, MHB developed the brochure, *What to Do with Doo: clean up after your pets and do your part to keep our water resources healthy*,[8] to assist communities in promoting responsible pet waste management. This resource was modified to be locally relevant including incorporating site-specific photos, characteristics, etc. MHB staff worked with the following entities to cater the brochure to meet local-level needs: the Community Environmental Health Laboratory (Bar Harbor), the City of Rockland, the Higgins Beach Association, and the City of South Portland.

Kittery

MHB 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 and Environmental Resource Officer, developing and implementing a stormwater management plan, surveying properties for malfunctioning septic systems, conducting investigations of sewer and stormwater infrastructure, etc. This work has led to the removal of dozens of grey and black water discharges negatively impacting water quality.

With the assistance of diverse partners, MHB supported efforts to track down and remove sources of fecal pollution impacting the western cove of Fort Foster. This included intensified monitoring of the surf-zone, beach seepage and sand, and the marsh area behind the beach.
MHB also co-developed local signage to alert the public to the possible risk of sand contact for this section of the park. As a result, the town conducted a sanitary survey, held public education/outreach events, hired Canine Detection Services to "sniff out" and verify the suspected human contribution, removed an abandoned outhouse pit and brought the canines back to verify the source was removed. Additionally, the town installed a "beaver deceiver" and upgraded a culvert to improve tidal flushing of the marsh.

[6] Fernandez et. al. 2015. Maine's Climate Future: 2015 Update. Orono, ME: University of Maine 24 pp.
[7] Appendix D
[8] Appendix E

In 2014, Kittery continued its commitment to public health and clean water by posting precautionary rainfall advisories and by taking several actions to identify, remove, and prevent bacterial pollution. Kittery hired consultants to augment their efforts to protect and improve the quality of water resources. In addition to intensified bacteria monitoring, employing the canines, and smoke/dye/camera testing of sewer lines of priority areas, Kittery conducted a sonde study and monitored for nutrients and solids in Spruce Creek as well as completed a watershed investigation of Fort Foster. The town also made improvements to sewer and stormwater infrastructure and created a septic system database. Additionally, green infrastructure projects were installed and water quality education/outreach events were held. These events included Septic Socials, presentations to the Town Council and the Planning Board, a YardScaping workshop, a public event with Canine Detection Services, distributing septic system flyers, press releases and more. In 2015, Kittery will continue enhanced monitoring, improvements to sewer and stormwater infrastructure, expand the septic system database, deliver educational outreach events, and also plans to establish a local septic pump-out ordinance requiring the pump-out of priority properties every 3 years.

York

In an effort to improve water quality on York's beaches, MHB 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 Shoreland and Environmental Resource Officer, partnered with local groups, and has hired consultants to augment the town's efforts to address the health of its water resources. Examples of this work include enforcing a local ordinance requiring routine pump out of septic systems in priority areas of the Cape Neddick River, adopting water resource protection measures into its Comprehensive Plan, inspection and remediation of malfunctioning septic systems, and continued efforts to obtain 319 Watershed Management funds.

In 2014, York hired a consultant to conduct an intensified rainfall study of it coastal beaches to better understand the bacteria-rainfall relationship including how much local rainfall will likely trigger an exceedance and as well as the duration of contamination events. This work will help inform local decision-making regarding beach advisories in 2015. Additionally, York proposed a septic ordinance that would require septic inspections at the time of property transfers. Unfortunately, this measure did not pass in 2014. In 2015, York will continue pollution source tracking and watershed management efforts including enhanced monitoring of enterococci and optical brighteners at Long Sands and Short Sands beaches, as well as extending the rainfall project to include microbial source tracking to pinpoint human sources. York will also implement a septic system-mapping project; upgrade two pump stations, and conduct an inflow and infiltration study focusing on areas impacting Long Sands Beach. Additionally, York will install catch basin filters and continue improvements to sewer and stormwater infrastructure.

Ogunquit River Watershed (Ogunquit, Wells)

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. Ogunquit's commitment to water quality expands beyond the coastal zone to include protective ordinances in upland areas. For example, with the assistance of the Ogunquit Conservation Commission (OCC), Ogunquit amended the Zoning Ordinance to expand the "Shore Land Zone." This includes 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 also obtained funding to conduct a storm water mapping and drainage study and has launched education/outreach campaigns promoting best practices throughout the watershed. 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 has also conducted investigations of and improvements to sewer and stormwater infrastructure. 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. Additionally, Ogunquit obtained funding to study the effects of sea level on the town's short and long term planning as well as their waste treatment facility. The town also hired consultants to continue enhanced monitoring and source tracking efforts including Canine Detection services to "sniff- out" human sources, as well as obtain 319 funds to develop and implement a Watershed Management Plan. In 2014, MHB served on the Watershed Committee and the town employed enhanced monitoring, Canine Detection, smoke, dye, and DNA testing to target human-sourced fecal pollution. Additionally, Ogunquit surveyed watershed residents and passed an amendment to the Stream Protection District Ordinance that upgraded segments and allows protection for all of Leavitt Stream. The town also passed a referendum banning the use of pesticides on all town properties and hired a Deputy Beach Manager to enhance Ogunquit's local routine beach monitoring and notification program. In 2015, Ogunquit plans to hire a Natural Resource Officer, will continue educational outreach initiatives, and continue the 319 grant supported Ogunquit River Watershed restoration efforts.

Wells

Beyond routine beach monitoring, MHB has supported the analysis of samples collected intermittently to assess bacteria levels in sand, seaweed and stormwater impacting Wells beaches. In 2014, MHB supported enhanced monitoring in the Webhanett River impacting water quality on Wells Harbor Beach. As part of this effort, 29 samples were collected at 2 locations. Enterococci values ranged from <10 MPN to 556 MPN/100mls with a seasonal geometric mean values of 23 MPN (site W-12) and 40 MPN (W-13). MHB plans to continue supporting the town's efforts to assess water quality in the river in 2015.

Kennebunk River (Kennebunk, Kennebunkport, Arundel, Lyman)

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. 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.

In 2014, MHB supported enhanced monitoring targeting rainfall events including the analysis of 14 samples collected at 3 beach locations to help assess the linkage between bacteria and rainfall

on Gooch's Beach. This work captured two events, one in June and the second in August. Pre-rain results on Gooch's beach for June were low (<10 MPN) for site KBK-1 and results obtained over a 4 hour duration were also low with only one sample exceeding the safety limit (range 20-108 MPN). However, the second site (KBK-2) had low pre-rain results (61 MPN), but continued to escalate over the course of 4 hours (range 122- >24, 200 MPN). Pre-rain results were not obtained for the August event, but results for both sites were elevated following > 5 inches of rainfall recorded with 48hrs. Results for site KBK-1 were 8,162 MPN and 15,530 MPN for KBK-2 on August 14th and 4,884 MPN (KBK-1) and 2,427 MPN (KBK-2) on August 15th. Samples were also collected on Mother's beach during the August event resulting in 4,106 MPN on August 14th and 84 MPN on August 15th. These preliminary results indicate rainfall can negatively impact water quality on Kennebunk's beaches.

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 consultants to implement pollution source-tracking and has taken extra steps to provide public notification of local water quality conditions via the town's website, telephone announcements, supplemental signage, more frequent beach monitoring, precautionary rainfall advisories, etc. In 2014, Kennebunkport continued to post precautionary rainfall advisories on its beaches when local rainfall levels were great than 1 inch within 24hrs.

Goosefare Brook Watershed (Saco and Old Orchard Beach)[9]

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. MHB has supported enhanced monitoring and pollution source tracking efforts, held Stakeholder Workshops, and more to address impaired water quality in the Saco and OOB tributaries feeding the brook. Initially, MHB efforts focused on the entire watershed but recently, MHB has focused primarily on Old Orchard's New Salt Rd. Tributary (NSRT). With EPA support, the pollution source tracking toolbox was expanded to include the analysis of pharmaceutical and personal care products and nutrients, and the Ocean Park Conservation Society contracted with Canine Detection services to "sniff out" human sources in 2012. Combining the results of multiple source tracking approaches was useful in generating a risk factor matrix to highlight priority areas needing further investigation. As a result, Saco and Old Orchard have conducted property surveys to identify malfunctioning septic systems as well as investigations 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.

In 2014, MHB supported 180 enterococci samples at 17 sites and 149 optical brightener samples at 16 sites stratified throughout the NSRT watershed. Enterococci values ranged from <10 to 6,490 MPN/100mls with a combined geometric mean of 275 MPN for all sites. Optical brightener values ranged from 34 to 163µg/l with a combined mean of 92 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. Seven sites located within the GFB-01 and GFB-05 series exhibited positive deviations from the enterococci geometric mean and 6 sites (largely within the GFB-05 series only) demonstrated positive deviations from the optical

[9] Appendix F

brightener mean. A potentially useful approach to identifying "hot-spots" of contamination is by examining how levels for each site deviate from the mean of all sites. In areas like the NSRT where all sites have elevated bacteria levels and OB results are likely impacted by humic interference, examining deviations from the mean may help pull a meaningful signal from the variability as well as help identify the most problematic sites within the system. Additionally, sites with positive deviations for both enterococci and OB levels are likely impacted by human sources

Additionally, Saco and Old Orchard Beach continued to work together on a Watershed Management Plan in 2014. In addition to enhanced monitoring and GIS support, MHB continued to serve on the Watershed Steering Committee. As a part of this work, a suite of watershed health characteristics were monitored and data was collected by a diverse group of partners including the Maine DEP, York County Soil and Water Conservation District (YCSWCD), MHB, and environmental consultants. Parameters collected included: enterococci, optical brighteners, aquatic fauna, dissolved oxygen, temperature, and conductivity. Maine DEP also conducted a sonde study, watershed and stormwater mapping and biological monitoring (rock bags).

In 2014, Saco conducted enhanced monitoring, investigated the integrity of and made improvement to sewer and storm water infrastructure. This work included televising over 68,000 linear feet of sewer and storm drain infrastructure, cleaning178 catch basins and over 10,000 linear feet of sewer lines (town-wide), completing a comprehensive flow analysis within Bear Brook watershed sanitary sewer system, replacing manholes and sewer laterals as well as separating a drain line from the sanitary system. Saco also delivered education events for school-aged children and adults through public tours of the Water Resource Recovery facility, educating residents about water-conservation and pathways through sewer and stormwater infrastructure.

OOB also continued investigations to ensure the integrity of septic systems, sewer and stormwater infrastructure in 2014.[10] This worked included dye and camera testing to ensure the integrity of over 13,500 feet of sewer lines. Additionally, 68 homes were dye tested with no malfunctions detected. At least 75 catch basins were cleaned and the town hired a contractor to replace 8ft of frozen sewer lines. OOB also completed multiple drainage projects (replacing over 2,500 ft. of sewer lines) within the watershed including the installation of new manholes, sewer, drain lines, tie-ins, and the repair of 2 sets of leeching pipes at dead end roads along the beach.

Additionally, both towns continued to post supplemental signage at the mouth of the Goosefare brook in 2014, alerting the public of the potential risk of water contact at this location. In 2015, Saco will use the results of the comprehensive flow analysis within the Bear Brook Watershed sewer system to formulate a priority list of areas needing further investigation. Additionally, as part of the 319 supported GFB Watershed Management Plan, stormwater-retrofitting projects and watershed restoration planning will be launched, additional watershed health data will be collected, and public outreach and involvement will be emphasized.

Spurwink River Watershed (Scarborough, Cape Elizabeth, South Portland)

MHB has supported enhanced monitoring, sanitary survey work and brought together diverse partners to share data and remediation strategies to address water quality in the Spurwink River that empties onto Higgins Beach. As a result, the town remediated a malfunctioning septic system in

[10] Appendix G

2013 and hired a Beach Monitoring Coordinator dedicated to coordinating beach monitoring efforts and educational outreach initiatives in 2014. Additionally, the Higgins Beach Association continued to post precautionary rainfall advisories in 2014. In 2015, Scarborough plans to renew bacteria source tracking work initiated by MHB in the Spurwink River Watershed to improve the overall water quality at Higgins Beach.

Willard Beach, South Portland[11]

In an effort to address Willard Beach water quality, MHB supported multi-year enhanced monitoring, 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, 25 enterococci and optical brightener samples were analyzed at 7 sites located within the stormwater system in 2014. Enterococci mean results ranged from 38-1523 MPN/100ml and from 5.8-122 µg/l for optical brighteners. A Pearson's Product Moment correlation combining data for all sites from 2012-2014 revealed a significant moderate relationship (R^2=0.5256, 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 8 of the 10 sites monitored (2012-2014), point sources cannot be ruled out due to the significant moderate 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.

As a result of MHB supported enterococci and optical brightener monitoring, South Portland employed Environmental Canine Services to "sniff- out" human sources and the City conducted dye testing and camera work of priority areas, resulting in the identification and removal of an illicit cross connection between sewer and stormwater infrastructure in 2014. In addition, the town conducted stormwater education/outreach, launched a pet waste and water quality campaign, continued upgrades to sewer and stormwater infrastructure, and consistently posted precautionary rainfall advisories at the beach. MHB will continue supporting enhanced monitoring efforts within the storm drain system as well as South Portland's efforts to promote responsible pet ownership in 2015.

Portland

MHB has supported a sanitary/watershed survey, optical brightener analysis, enhanced rainfall monitoring, and Boater's Education materials for East End Beach. In 2014, 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 water quality assessment and special signage relating to stagnant tide pools forming on the beach on a weekly basis during the monitoring season. In 2014, MHB supported 12 additional samples collected from tide pools and results ranged from <10 MPN to 246 MPN with a seasonal geometric mean of 12 MPN/100 mls of sample water.

Rockport

[11] Appendix H

MHB has supported Rockport in its efforts to address pollution issues on Goodies Beach, throughout the adjacent Harbor, associated tributaries, and the Pascal Ave. storm drainage network. With the help of EPA and the Rockport Conservation Commission, the pollution source tracking toolbox was expanded beyond enterococci and optical brighteners to include the analysis of Pharmaceutical and Personal Care Products (PPCPs) in 2012 and 2013. In 2014, MHB continued focusing on the stormwater discharge emptying adjacent to the public swimming beach. As a part of this work, 8 enterococci samples were analyzed at 2 monitoring sites that receive water from the upland Pascal Ave. storm drainage network. Enterococci results at PA-01 ranged from <10 MPN to 6131 MPN with a seasonal geometric mean of 122 MPN. Enterococci results for PA-02 ranged from 119 MPN to 132 with a geomean of 125 MPN.

In response, Rockport 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. In 2014, Rockport continued enhanced monitoring efforts in the harbor and surrounding watershed and hired a consultant to analyze mtDNA samples on storm flow from 3 culverts that drain to Goodie's Beach (positive canine presence). Additionally, Rockport conducted home plumbing inspections of 39 properties to ensure home wastewater plumbing met code requirements (no issues were found). The town continued sewer and stormwater infrastructure investigations (smoke/dye/camera work) to ensure the integrity of approximately 2,900 feet of gravity sewer line (no issues were found). In an effort to further identify human sources of fecal pollution, Rockport conducted a PPCP survey of 39 households. Out of the 36 responses, only one indicated PPCP usage of interest that aligned with recorded PPCP results.

Additionally, Rockport increased the number of dog waste stations in the village and around the harbor, provided information to registered dog owners concerning Goodie's Beach bacteria issues and best practices, and stenciled select catch basins to educate the public regarding storm flow to the beach and the harbor. The beach manager also continued to consistently post precautionary rainfall advisories for > .25 inches of rainfall in 24hrs. In 2015, Rockport will inspect additional home-sewer connections, evaluate the feasibility of on-site treatment of storm runoff affecting Goodie's Beach water quality, and begin developing a watershed nutrient export model.

Lincolnville

In an effort to improve the quality of Lincolnville's water resources, MHB has supported Lincolnville's efforts to address pollution issues at Lincolnville Beach, Frohock Brook, the Ducktrap River Recreation Area and Norton's Pond. 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. In an effort to assess water quality in Frohock Brook adjacent to Lincolnville Beach, 14 samples were analyzed for enterococci levels during the summer of 2014. Results ranged from <10 to 546 MPN/100mls of sample water with a geometric mean of 36 MPN/100 ml. Additionally, MHB supported water quality assessment of the Ducktrap River Recreation Area, a valued resource by the community. In 2014, MHB analyzed 14 samples for enterococci over the course of the monitoring season. Results ranged from <10 MPN to 677 MPN/100mls of sample water with a geometric mean of 44 MPN/100 ml.

Bar Harbor, Mt. Desert and Acadia

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 of Stanley Brook (impacting Seal Harbor Beach) as well as monitoring of a suite of watershed parameters and a watershed survey of the watershed. MHB has also supported a study investigating 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. As a result, the towns have made improvements to sewer infrastructure and Bar Harbor included a water resource protection chapter in its Open Space Plan.

In 2014, Bar Harbor hired consultants to further investigate the impact of cruise ships on harbor water quality.[12] As a part of this work, MHB supported the analysis of 33 samples for enterococci levels at 3 sites. Results ranged from <10 to 3255 MPN. The town supported analyses of additional parameters including phytoplankton communities, biological oxygen demand, dissolved oxygen, metals, nutrients, nitrogen, salinity, transparency/turbidity, and chlorine. Results from this study indicated that the overall water quality in the harbor is good, yet future work should also investigate the impact of other commercial vessels (e.g. fishing) and land-based sources contributing to contaminated runoff.

Additionally, MHB supported Acadia in its efforts to assess water quality on Sand Beach by supporting the analysis of 18 samples collected at a site capturing marsh/stream runoff behind the public beach area. Results ranged from <10 to 1785 MPN/100mls of sample water with a geometric mean of 31 MPN/100ml. MHB also supported the analysis of 24 samples at 6 locations targeting wet weather events to assist the NEST project's efforts to better understand the relationship between rainfall and bacteria levels impacting beaches and shellfish growing areas. Results ranged from <10 to 7555 MPN. In 2015, Bar Harbor will install a boat pump out station and plans to continue working with consultants to assess the impact of cruise ships and commercial vessels on harbor water quality.

[12] Appendix I