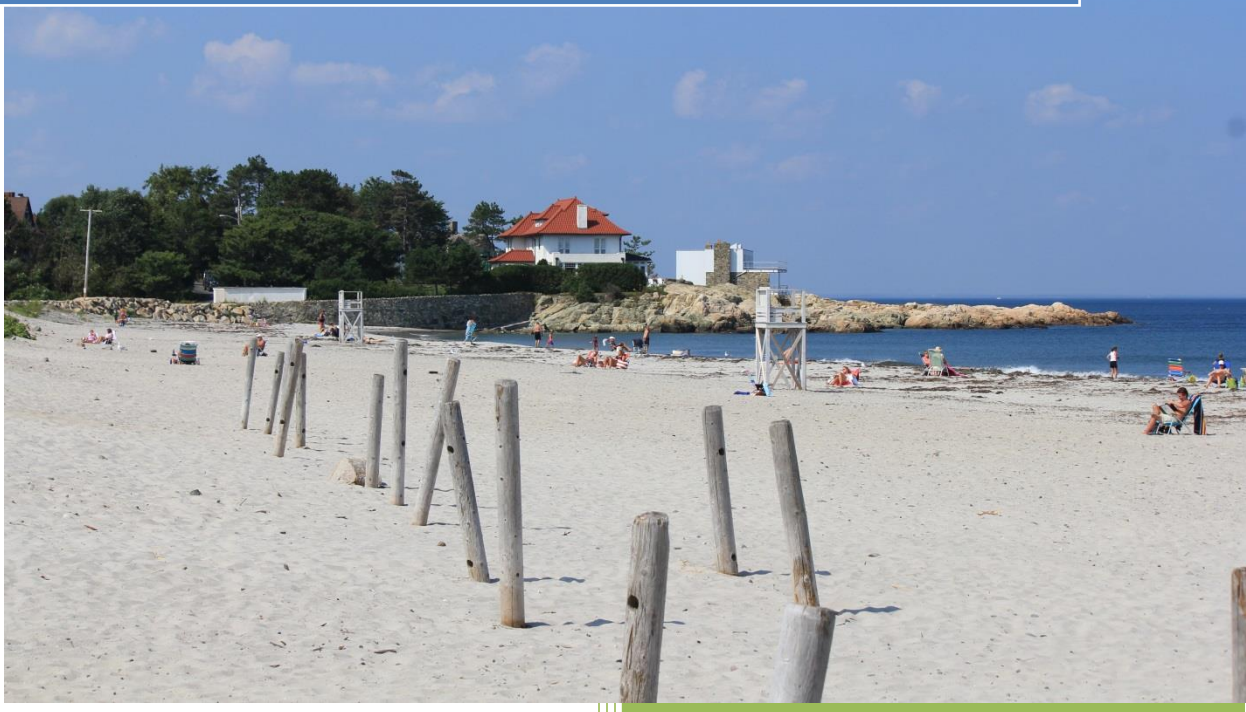
2019

Massachusetts Beach Testing Results: Annual Report



Sandy Beach, Cohasset, MA

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Executive Summary

Swimming is one of the most popular recreational activities in Massachusetts (EOEEA, 2017), with over 111 million individual trips to coastal beaches annually (EOEEA, 2007). Each year, the Massachusetts Department of Public Health, (DPH), Bureau of Environmental Health's Environmental Toxicology Program collects beach water quality data from local health departments and the Massachusetts Department of Conservation and Recreation. This report provides a description and summary of that information.

- **Water quality:** In 2019, a total of 15,599 water samples were collected from 586 marine and 575 freshwater beach sampling locations. These locations represent 530 marine and 533 freshwater beaches statewide, with 100% of marine and 98% of freshwater beach communities reporting water quality information to DPH. Approximately 6.1% and 3.3% of samples exceeded the Massachusetts bacterial water quality standards for marine and freshwater beaches, respectively. The overall low exceedance rates indicate that Massachusetts beaches generally have high water quality. Elevated bacteria accounted for 73% of beach posting days for poor water quality; additional reasons for notifications included: cyanobacterial harmful algae blooms, rainfall (typically associated with elevated bacteria), and other hazards (e.g., combined sewer overflow, missed sample).

- **Field data:** In 2019, a majority (98%) of water samples submitted to DPH had accompanying field data. Recent rainfall and pollution sources at sampling sites were identified as two important factors that contributed to elevated bacteria levels at recreational waterbodies. As in previous years, the number of exceedances dropped exponentially as days since rainfall increased. Pollution sources, particularly the presence of larger numbers of birds at marine and freshwater beaches, were associated with higher levels of bacteria.

- **Public notification:** DPH's marine beaches website (http://ma.healthinspections.us/public_21/) provides near real-time information on bacteria levels at public marine beaches during the beach season, as well as information on historical bacteria levels. In 2019, approximately 17,013 users visited the website with peak usage occurring during the month of July. Individuals are also notified of unsafe conditions at beaches by physical signage that beach operators are required to post. In 2019, 99% of marine and 76% of freshwater beaches were in compliance with the public notification requirements.

Introduction

Health risks to swimmers associated with poor water quality have been documented in numerous studies (Marion et al., 2010; Wade et al., 2003). Beachgoers may be exposed to pathogens through recreational activities in and around polluted waterbodies (Hlavsa et al., 2015). In the United States, most swimming-associated illnesses are caused by a variety of pathogens associated with fecal contamination (Cabelli et al., 1982; USEPA, 2012). Fecal matter can enter beach water in a variety of ways: sewage treatment system failures, combined sewer overflows, discharge of sewage by boats, re-suspension of sediments, and rainfall with resulting surface runoff (Galfi et al., 2016; Rodrigues et al., 2016).

To minimize swimming-associated illness and injury and to notify the public about the quality of beach water, DPH regulations require regular water quality monitoring and public notification of unsafe conditions. All public and semi-public bathing beaches in Massachusetts are monitored for fecal indicator bacteria (FIB), and on occasion, harmful algae. Monitoring occurs during the beach season which generally begins when the school year finishes in mid-June and ends during the weekend of Labor Day.

DPH adopted the U.S. Environmental Protection Agency (USEPA) criteria for enterococci and *E. coli* in marine- and fresh-waters in 2001. These criteria consist of both a single sample and geometric mean (geomean) value reported as colony forming units per 100 milliliters of water (CFU/100 mL) (see Table 1). When beach water exceeds these water quality standards, DPH requires that the beach be posted with a notice alerting the public to the possible risk of swimming.

At a majority of beaches in Massachusetts, water quality is considered to be unacceptable when two samples collected on consecutive days exceed the water quality standards. This approach is consistent with DPH regulations, and has helped to minimize the impact of beach closures on vulnerable socio-economic populations, whose local beach may be the only accessible means of recreation during the summer.

Some of the highest use beaches operated by the state are in the urban areas of Boston, Lynn, Quincy, and Revere. Beaches with a history of multi-day elevated bacteria levels are still required to post after a single exceedance. Posting is also required when the geomean of the five most recent samples exceeds the geomean standard.

Beach Type	Indicator	Single Sample	Geomean
Marine	Enterococci	>104	>35
Freshwater	Enterococci	>61	>33
	E. coli	>235	>126

Table 1. DPH recreational water quality criteria (CFU/100 mL)

In addition to water samples, field data such as days since rainfall and potential pollution sources are required to be recorded at the time of sample collection. Field data help facilitate the interpretation of bacteria data and can improve the understanding of water quality at the local and state level.

Pomps Pond, Andover, MA

Water Quality

Marine beach exceedances During the 2019 beach season, 8,043 samples were collected and analyzed from 586 marine sampling locations in the 60 communities with marine beaches. Of these 586 locations, 203 (35%) had at least one bacterial exceedance. A total of 488 out of the 8,043 samples exceeded the 104 CFU/100 mL standard bringing the percentage of exceedances for marine waters to 6.1%, which is greater than the average historical exceedance rate of 4.9% (Figure 1).

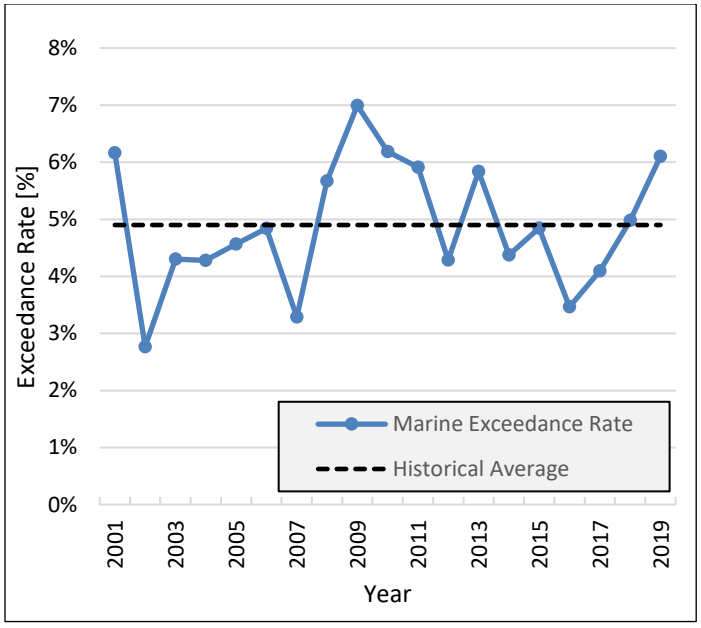

Figure 1. Marine beach exceedance rate (2001 – 2019)

Freshwater beach exceedances During the 2019 beach season, 7,531 samples from 575 freshwater sampling locations were collected and analyzed for the approved fecal indicator bacteria. Most freshwater beaches (89%) used *E. coli*. Among the 575 freshwater locations, 112 (20%) in the 179 communities reporting beach data had at least one bacterial exceedance. A total of 245 out of 7,531 samples exceeded the standard bringing the percentage of freshwater exceedances to 3.3%, which is lower than the average historical exceedance rate of 3.9% (Figure 2).

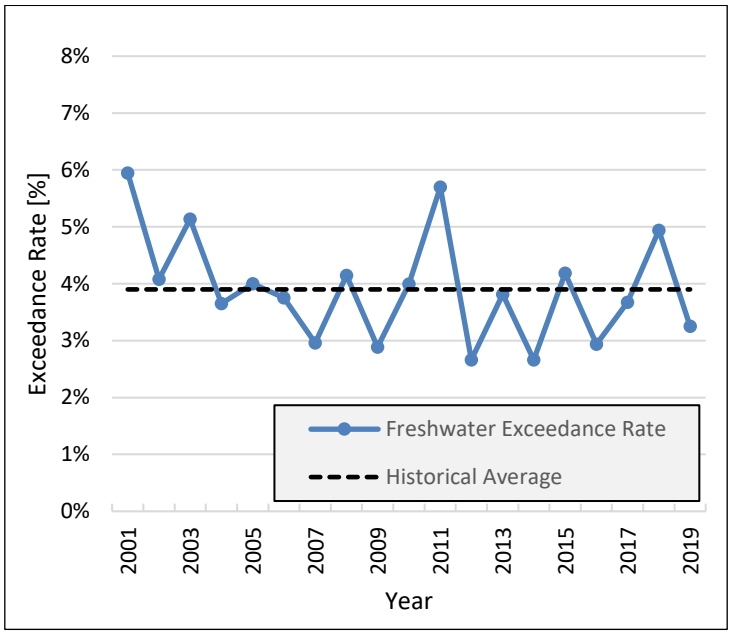

Figure 2. Freshwater beach exceedance rate (2001 – 2019)

Posting beaches In 2019, beaches were posted for 2,236 days, advising individuals to not swim in the water. Figure 3 displays the causes of postings -- with the majority of posting days due to the exceedance or expected exceedance (e.g., rainfall) of a water quality standard. For marine beaches, there were 915 total posting days due to elevated bacteria (94%), rainfall (6%), or other reasons (e.g., combined sewer overflow, missed sample) (0.3%). For freshwater beaches, there were 1,321 posting days due to elevated bacteria (58%), cyanobacterial harmful algae blooms (38%), or other reasons (4%).

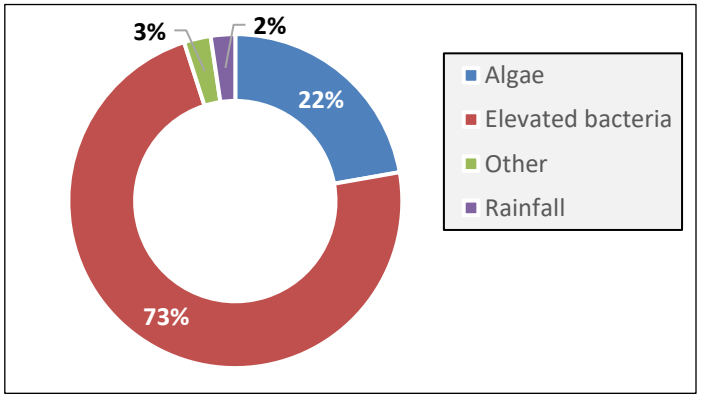

Figure 3. Posting details for marine and freshwater beaches in 2019

Environmental Justice Communities Beach access and water quality are particularly important in environmental justice (EJ) communities, as these communities are disproportionally affected by the increased presence of environmental hazards and poor health outcomes (DPH, 2017). For example, EJ communities have high population densities, low income, and high levels of non-vehicle ownership. This means that more individuals in these communities, compared to any other area in the state, will tend to frequent a local public beach for cooling off or enjoying summer recreation. As rainfall is a significant factor in flushing enteric bacteria into beach water (e.g., 64% of bacterial exceedances occur within 24 hours of a rain event), any increase in rain near a population dense EJ area will lead to an increase in exceedances.

Approximately half (55%) of beach locations in Massachusetts are located in a municipality that contains an EJ community. While the exceedance rate at freshwater beaches was similar between EJ and non-EJ communities, marine beaches in EJ communities had a higher exceedance rate than marine beaches in non-EJ communities (Figure 4).

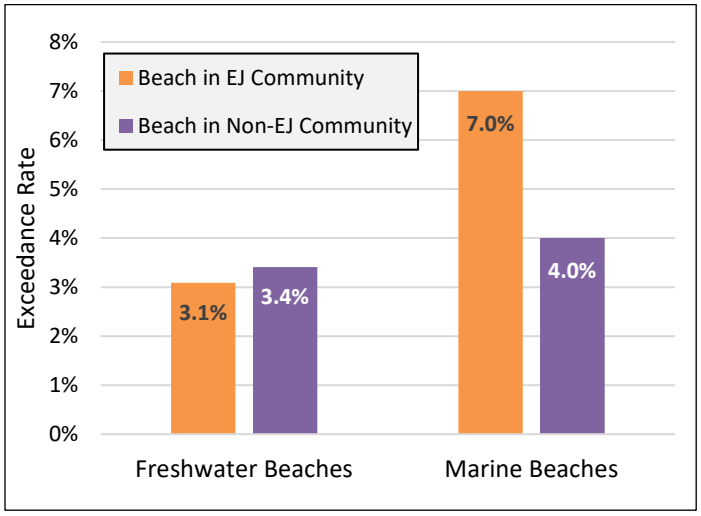

Figure 4. Exceedance rate at beaches located in an EJ community and beaches not located in an EJ community

Field Data

Potential pollution sources Information on potential sources of bacteria was not consistently reported in the past, and if it was, it was typically reported on a present/absent basis. Starting in 2017, beach operators were asked to report the number of swimmers, birds, and dogs present in the water when a sample was collected. Figure 5 shows the mean bacteria levels of samples at marine and freshwater beach locations in 2019 compared to the number of reported bathers, birds, and dogs. The data indicate that increases in bird populations during sampling were associated with increases in bacteria levels at marine and freshwater beaches. Increases in human and dog populations were also associated with higher bacterial levels at freshwater beaches, while their impact was less consistent at marine beaches. Note that results for enterococci at freshwater beaches were not evaluated due to the low number of samples.

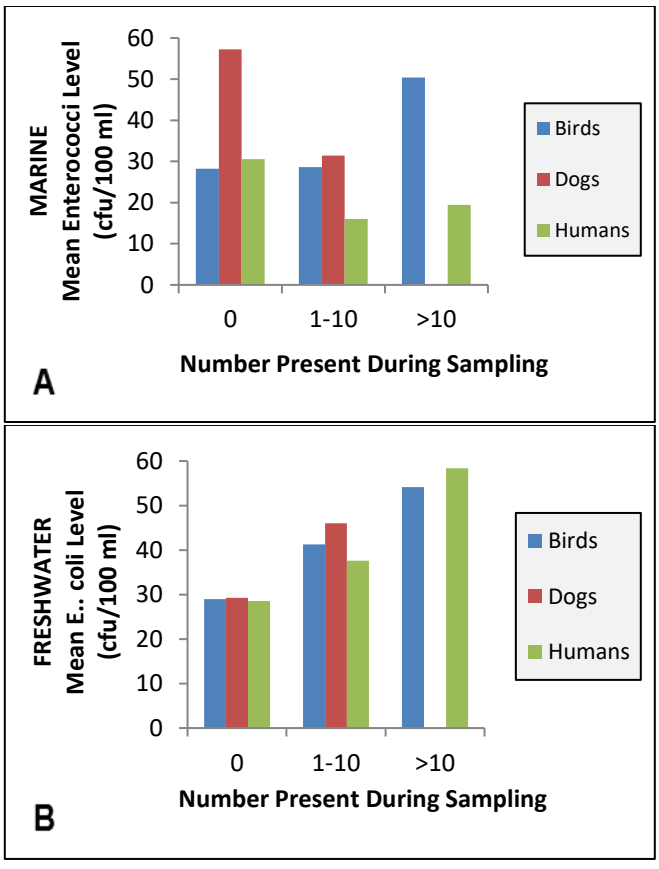

Figure 5. Mean bacteria levels and numbers of birds, dogs, and humans at marine (A) and freshwater (B) beaches

Rainfall Rainfall is recognized as one of the major drivers of bacterial exceedances in beach water (Harder-Lauridsen et al., 2013). An exponential drop in the number of exceedances occurs as the time between rainfall and sample collection increases (Figure 6). For marine beaches, 310 of 488 bacterial exceedances occurred within 24 hours after a rain event; at freshwater beaches, 98 of 245 exceedances were observed within 24 hours after a rain event.

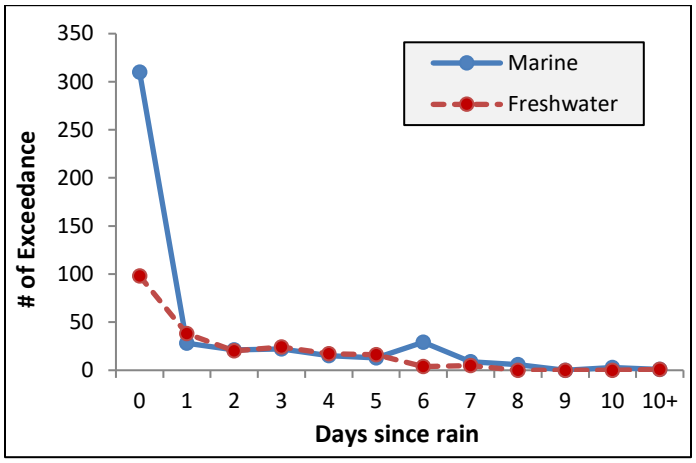

Figure 6. Relationship between the number of bacterial exceedances and days since rainfall in 2019

Historically, at both marine and freshwater beaches, exceedances generally rise and fall with rainfall amounts, with some exceptions. In 2019, this pattern was observed in both marine and freshwater results. This historical relationship between exceedances of water quality criteria at marine and freshwater beaches and the total amount of rainfall between June and August is shown in Figure 7. The rainfall data were obtained from the National Oceanic and Atmospheric Administration (NOAA, 2019). Data sets from two coastal communities, Boston and Chatham, were used to represent monthly rainfall amounts at marine beaches; for rainfall at freshwater beaches data sets from Amherst and Ashburnham, along with those from Boston and Chatham, were used to represent monthly rainfall across the state.

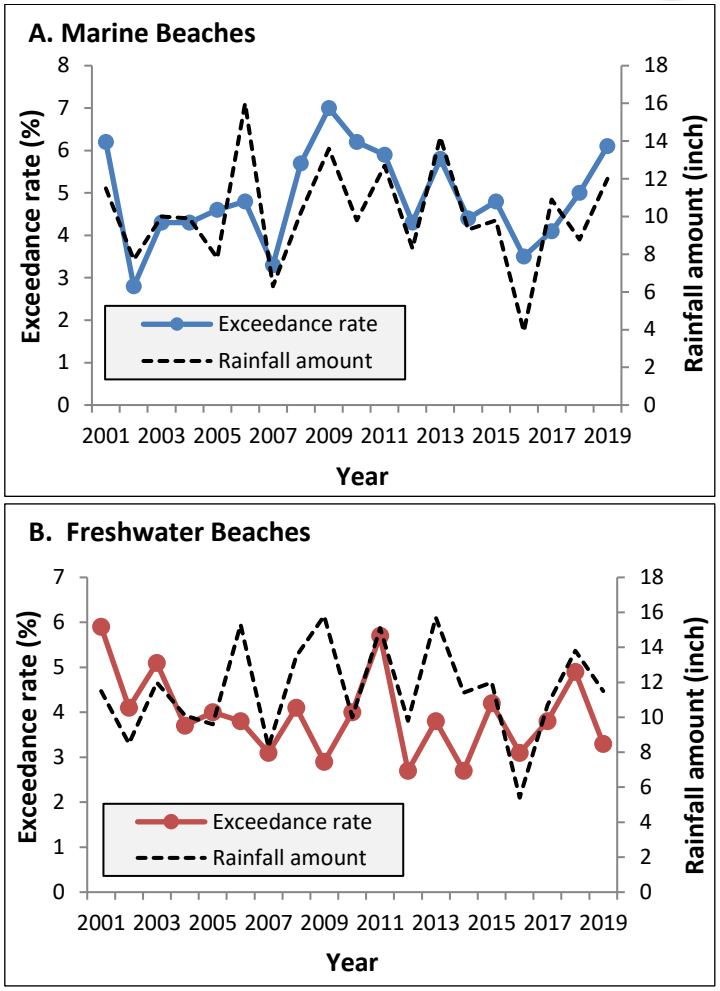

Figure 7. The historical relationship between rainfall amounts and exceedance rates at (A) marine and (B) freshwater beaches in Massachusetts from the 2001 to 2019 beach seasons

Public Notification

Beach website The DPH beach monitoring website (http://ma.healthinspections.us/public_21/) provides the public with up-to-date marine beach testing and posting information and presents the data in an easy-to-use format. In 2019, approximately 17,013 users visited the website during the beach season (this includes both new and returning users). An analysis of weekly usage data demonstrated an increase in the number of users as the beach season progressed (Figure 8) with a maximum number of users (n=2,856) occurring in week 9 toward the end of July. Website usage also peaked during the 4th of July week (n=2,695).

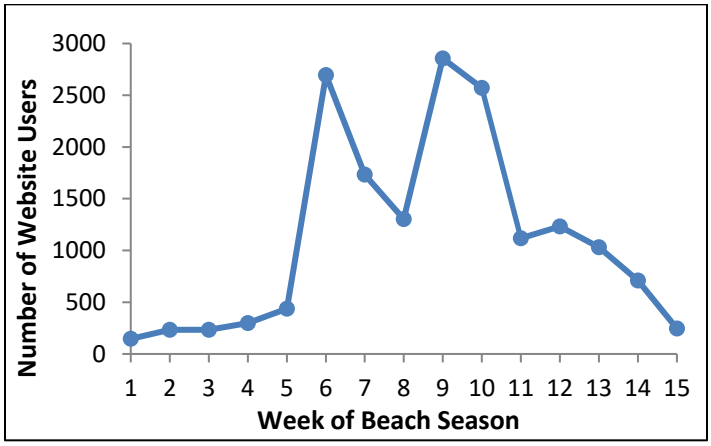

Figure 8. Number of DPH marine beach website users per week during the 2019 beach season

Beach postings When water quality standards are exceeded or other safety concerns exist, beach operators are required to post signage at the beach advising individuals of the hazard and recommending they stay out of the water. This is an essential part of the public notification system. Marine and freshwater beaches were posted properly 99% and 76% of the time, respectively.

Conclusions

In 2019, the exceedance rate at marine beaches was greater than the historical average, while at freshwater beaches the exceedance rate was slightly lower. Spikes in exceedances were often associated with significant rain events that occurred during the months of June and July throughout the state. However, given the number of beaches sampled in Massachusetts, the average historical exceedance rates of 5% or less indicate that the state has beaches with generally high water quality. Public notification of marine results and postings via DPH's marine beaches website continued to be a highly utilized means of communicating with the public.

Acknowledgements

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For more information, please visit:

DPH Beaches website: http://www.mass.gov/beaches

DPH Algae website: http://www.mass.gov/dph/algae

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