

BACTERIAL WATER MONITORING OF RECREATIONAL SWIM BEACHES
ACADIA NATIONAL PARK

Prepared By: Robert M. Breen
Acadia National Park
Bar Harbor, Maine 04609

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EXECUTIVE SUMMARY

In 1994 Acadia National Park (ANP) resource management staff conducted bacterial water sampling at several recreational swim beaches within the park. The purpose of the sampling was to provide information to park managers on the potential health risk to park visitors from water-borne pathogens. Freshwater swimming areas sampled included the ANP guarded beach at Echo Lake and at the unguarded beach at Lakewood. Sampling was also conducted in marine waters at the guarded swim beach at Sand Beach and in the brackish wading lagoon at the east end of Sand Beach. Sample analysis was performed by the Health and Environmental Testing Laboratory, Maine Department of Human Services (MDHS). Freshwater samples were analyzed for Escherichia coli, marine and estuarine waters for enterococci bacteria. Sampling was conducted weekly from mid-June to mid-September. ANP began sampling for bacterial contamination at several swim beaches on Mount Desert Island (MDI) in 1993 on a bi-weekly basis. The National Park Service (NPS) currently does not require monitoring for bacterial contamination at swim beaches, however several NPS areas e.g. Assateague Island National Seashore, Delaware Water Gap National Recreation Area, Glen Canyon National Recreation Area do have monitoring programs to determine bacterial water quality at public swim beaches. Bacterial levels at Echo Lake, Lakewood, and Sand Beach were well within MDHS and United States Environmental Protection Agency (EPA) guidelines throughout the sampling season. Bacteria densities at Sand Beach lagoon exceeded MDHS and EPA criteria for single samples on August 22, and September 6, but in both instances returned to acceptable levels the following week. Soaking rains of one inch or more occurred within 24 hours preceding the August 22 and September 6 sampling periods. Continued monitoring of bacterial densities at selected park beaches is recommended to provide a larger dataset to better understand the range of bacterial densities and long-term trends.

INTRODUCTION

Several studies at recreational swimming beaches have indicated that swimming-associated gastroenteritis is related to the quality of the bathing water and that the most appropriate bacterial indicators are the enterococcus group for marine and estuarine waters, and Escherichia coli for freshwater (Dufour, 1984; Van Orden, 1990; American Public Health Association, 1989). The EPA has established human health guidelines for E. coli and enterococci (United States Environmental Protection Agency, 1986). EPA guidelines are designed to reduce the risk, not completely eliminate the possibility of becoming ill. For example, it is estimated that marine waters just meeting the EPA standard of 35 enterococcus/100ml would result in 19 illnesses for every 1000 swimmers.

The state of Maine has adopted stricter standards (which have been approved by EPA) that are calculated to reduce risk to 5 illnesses per 1000 swimmers for marine waters (Class SB), and 0/1000 for freshwater lakes (McGovern, 1989).

In 1992 the Mount Desert Island League of Towns (LOT) conducted preliminary bacterial monitoring at three freshwater lakes (Echo Lake, Long Pond, Lakewood), testing for fecal coliform. Although those results indicated bacterial levels were within acceptable limits, there was a recommendation to more thoroughly monitor conditions over a longer season (Reeb, 1992).

Acadia National Park and the LOT cooperated in a water quality monitoring program for twelve lakes on Mount Desert Island in 1993 (NPS, 1994). As a part of that program the park conducted bacterial sampling at three freshwater swim beaches including the ANP guarded beach at Echo Lake, the swimming area at "Ponds End" on Long Pond (maintained by the town of Mount Desert), and at the unguarded ANP swim beach at Lakewood; and in marine waters at the ANP guarded beach at Sand Beach and in the brackish lagoon area at the east end of the beach (Fig. 1). Samples were taken approximately every two weeks and analyzed by A&L Laboratory, Inc. Auburn, Maine. Each water sample was analyzed for both E. coli, and enterococcus bacteria. Bacterial levels were within both DEP and EPA guidelines in 1993.

The 1993 program was considered to be a pilot program designed to provide a preliminary evaluation of bacterial conditions at public swimming areas for park and town managers. There is no record of previous systematic sampling of bacterial water quality at these public swim beaches. The 1993 sampling results indicated bacterial densities at all sample locations were high enough to warrant further evaluation.

MAINE/EPA GUIDANCE CRITERIA

Maine's Bacteria Standards for Water Contact Recreation and EPA's Ambient Water Quality Criteria For Bacteria are listed in Table 1. Multiple sample criteria are based on a statistically significant number of samples which is considered by EPA to be a minimum of 5 samples equally spaced over a 30 day period. The Maine Department of Human Services recommends a minimum of 12 weekly samples collected over a summer season. The long term geometric mean bacterial density is considered to be a more important indicator in determining health risk than is a single sample. The single sample guideline can be used to trigger repeat sampling or other management actions especially when routine monitoring is at longer intervals.

The state of Maine, through the Maine Water Pollution Law, has adopted more stringent standards than EPA for bacterial densities in Class GPA waters (Great Ponds and natural lakes less than 10

acres in size). Maine bacterial standards, which are approximately 4 times stricter than EPA guidelines, have been established to obtain a maximum risk level for contact recreation in Class GPA lakes and ponds equal (theoretically) to 0 per 1000 swimmers. Although the state bacterial water quality standard for *E. coli* is based on a targeted geometric mean of 29 per 100 ml, the standard is exceeded when the geometric mean of a given number of samples exceeds the threshold value for the upper 90 percent Confidence Limit.

Maine has three standards for the classification of estuarine and marine waters. The highest classification are Class SA waters. Class SA waters are "outstanding natural resources and ... should be preserved because of their ecological, social, scenic, economic or recreational importance." Class SA waters are to have a bacteria content "as naturally occurs" which recognizes that wildlife and other natural factors can influence bacterial densities. ANP's estuarine and marine waters are in this classification. Class SB waters, the next highest classification, are to have a bacteria content that does not exceed a geometric mean density for enterococcus bacteria of 8 per 100 ml, or an instantaneous level of 54 per 100 ml. For purposes of having a quantitative reference, the criteria for Class SB waters have been used to determine compliance with state standards.

TABLE 1. EPA AND MAINE BACTERIAL GUIDELINES

<u>EPA GUIDELINES:</u>	Geometric mean	single sample
<u>E. coli</u>	126	235
Enterococci (freshwater)	33	61
Enterococci (marine)	35	104
 <u>MAINE STANDARDS:</u>	 Geometric mean	 single sample
<u>E. coli</u>	29	194
Enterococci	8	54

State guidelines recommend closing a beach when the standard is exceeded, and reopening when subsequent testing indicates bacterial densities have returned to an acceptable level. However, the state has only implemented bacterial monitoring in a limited number of places, and acknowledges that local communities and other agencies (e.g. ANP) have the discretion to determine what actions are appropriate to protect public health at areas they manage (J. Sowles, Maine DEP, pers comm.).

It is important to note that determining the risk to human health based on a correlation between the incidence of illness in bathers

and the levels of a given bacterial indicator is not entirely straightforward. Many swimming related illnesses are caused by viruses or bacteria other than those used as indicators. In addition, much of the research concerning the incidence of illness related to water contact recreation in marine waters has been conducted in areas with water temperatures warmer than those found along coastal Maine in summer, where bathers usually stay in contact with the water for shorter periods of time. Further, there has been no evidence of significant water contact related illness reported by bathers/swimmers from beaches on MDI.

SAMPLING LOCATIONS

In 1994, bacterial monitoring was conducted at the following locations: the guarded beaches at Echo Lake, Sand Beach and the Sand Beach lagoon, and the unguarded beach at Lakewood (Fig. 1). Due to the withdrawal of support for islandwide water quality monitoring by the MDI League of Towns, Ponds End on Long Pond monitored in 1993 was not monitored in 1994.

SAMPLING METHODS

Bacterial monitoring was conducted weekly from June 20 to September 19. Sampling was usually done between 8am and noon on Monday or Tuesday by ANP resource management staff using containers provided by the MDHS Laboratory. Samples were collected by wading into the water approximately thigh deep and submerging the sample bottle about one foot below the surface. Care was taken to keep fingers from touching the lid or inside of the sample bottle thus avoiding contamination. The date, time of sampling, location, weather conditions and surface water temperature were recorded. In addition, rainfall data (taken from ANP National Atmospheric Deposition Program rain gage) for 24 and 72 hours prior to sampling were also recorded. All samples were mailed to the MDHS Laboratory the same day and analysis was performed within 30 hours of collection following EPA approved procedures (USEPA, 1986). Results of the laboratory analysis were usually obtained within 72 hours.

Due to concern by the Town of Mount Desert of possible bacterial contamination to the public swim beach at Seal Harbor from a beaver dam on Stanley Brook, sampling of water behind the dam and at the beach was conducted prior to and after removal of the dam on August 1. Also, three locations along Stanley Brook and at the stream outlet in Seal Harbor were sampled on September 19 to determine potential bacterial contamination from the Seal Harbor sewage treatment plant.

RESULTS

A total of 14 water samples were collected for bacterial analysis at each location (Table 2.). Echo Lake, Lakewood and Sand Beach

all remained within EPA and Maine Bacteria Standards throughout the summer. The highest single sample E. coli densities at Echo Lake and Lakewood were counts of 70 and 32 respectively. The highest single enterococci density at Sand Beach was a count of 10.

On August 22, Sand Beach Lagoon had a enterococci count of 160, which exceeded the Maine Bacteria Standard for a single sample of 54. Another sample collected on August 29 resulted in a E. coli count of 10, well within acceptable standards. Sand Beach lagoon also had a single E. coli count of 400 on September 6th. This sample exceeded the Maine Bacteria Standard for a single E. coli sample of 194. Sampling on September 12 resulted in a count of 8.

Because of the brackish water conditions at the lagoon sampling was alternated for both E. coli and enterococci to see if there was a difference between the two indicators in relation to their respective standards following a rain event. Each of the high bacteria sample events at the lagoon were preceded by soaking rains (approximately 1 inch) within 24 hours of sampling, and both of the indicators responded similarly (i.e. spiked to high densities then returned to acceptable levels).

Bacteria levels from the August 1 and September 19 sampling at Stanley Brook and Seal Harbor Beach were well below Maine Bacteria Standards for recreational swimming (Table 3.).

DISCUSSION AND RECOMMENDATIONS

The results of monitoring conducted in 1993 and 1994 indicate that bacterial levels at all ANP areas sampled were well within Maine Bacteria Standards and EPA guidelines, except for the two short-term exceedances at Sand Beach lagoon. The shallow and relatively warmer waters of the lagoon attract many visitors especially children who probably spend more time wading and playing there than in the colder waters at Sand Beach. Additional monitoring of the lagoon is needed to better understand the dynamics of bacterial fluctuations and the risk to human health.

Further, the proximity of individual beach areas to septic systems, camps and/or private residences, and the lack of toilet facilities (concern with increase in open disposal of human waste) near some beaches make it likely that bacterial pollution at these beach areas may become a problem in the future.

Additional sampling in the Seal Harbor/Stanley Brook area is needed to further clarify the potential for bacterial contamination to the stream and beach from the sewage treatment plant and residential development along the park boundary.

Interest has also been expressed by ANP staff to monitor other popular swimming areas in the park such as Ike's Point and the

ledges on Echo Lake, and the swimming area used by local residents on the Long Pond fire road near Southern Neck. An assessment should be made of these and other potential areas to determine the volume of human use and likelihood of bacterial contamination before expanding monitoring.

Another consideration for future monitoring would be to collect samples later in the day. Since the objective is to determine the highest potential risk to swimmers, sampling in early afternoon when temperatures and bathing activity are at their peak would provide the best indication of risk. Care must be taken however to assure samples can be mailed to the laboratory that day.

It is recommended that bacterial monitoring at popular swimming areas in ANP be continued to better determine fluctuations in bacterial densities and potential unhealthful conditions, and to track trends over time. Specific recommendations include: 1). using E. coli (freshwater) and enterococci (marine/estuarine waters) as bacterial indicators rather than total or fecal coliform; 2). sampling weekly over the swimming season (early June through mid September) which allows for the recommended minimum of 5 samples over thirty days and 12 samples over the season; 3). continuing to use the MDHS Laboratory for sample analysis (the state lab handles these types of analyses routinely and has high perceived credibility by the public); 4). developing appropriate management actions to be taken when bacterial levels at a given site reach an unacceptable level. A Standard Operating Procedure (SOP) for future monitoring and management actions should be prepared for approval by the Superintendent.

LITERATURE CITED

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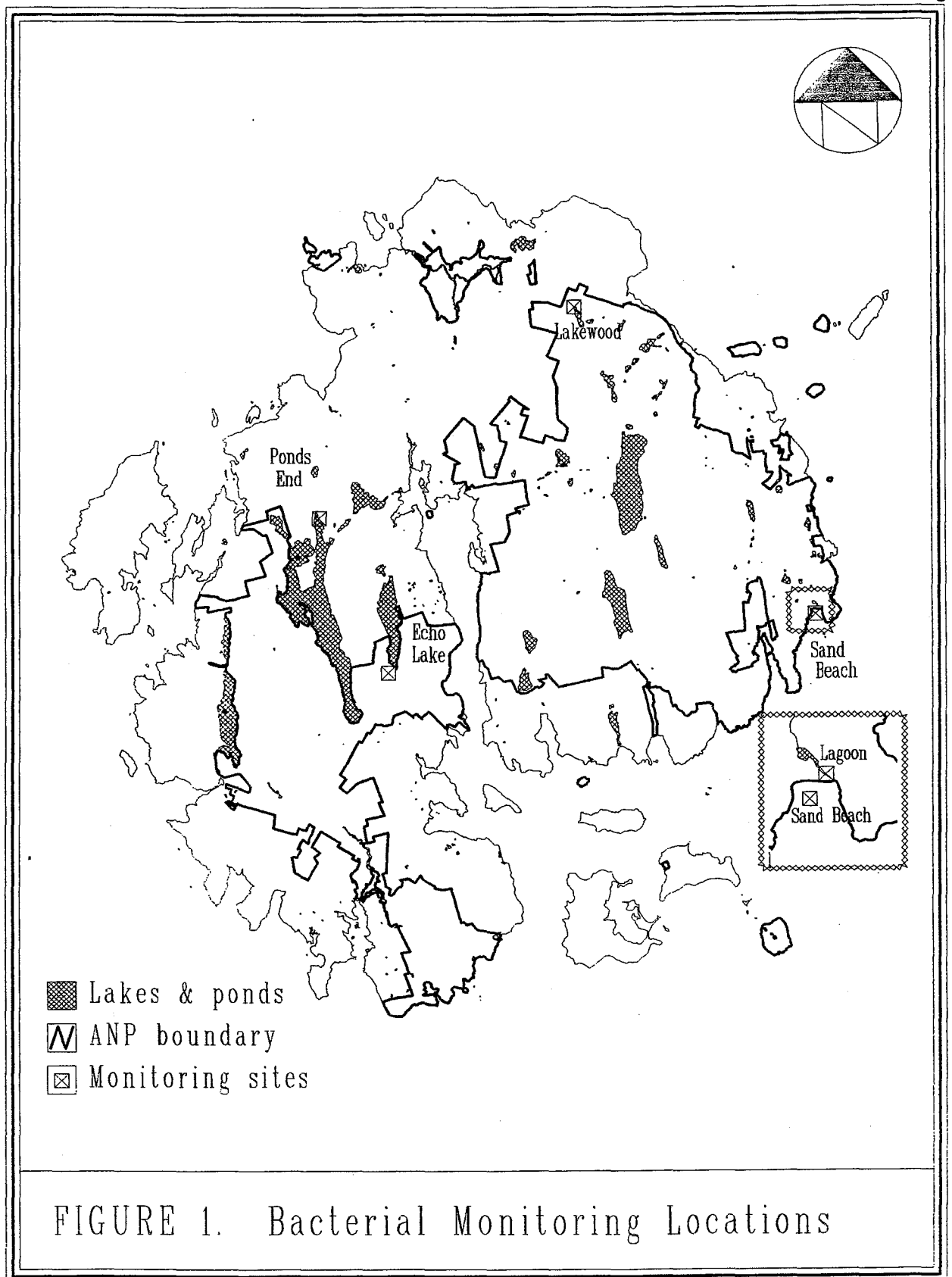


TABLE 2. Bacterial Densities at Acadia National Park, 1994
(units are # of colonies/100ml.)

Date	Freshwater (<u>E. coli</u>)		Marine (Enterococci)	
	Echo Lake	Lakewood	Sand Beach	Lagoon
6/20	2	0	2	8
6/27	0	0	0	4
7/5	0	0	0	0
7/11	28	6	0	14
7/18	0	4	0	0
7/25	10	0	2	2
8/1	30	0	0	4
8/8	70	0	6	0
8/16	4	0	0	8
8/22	4	20	8	160
8/29	16	0	0	10
9/6	2	32	10	400 (E.coli)
9/12	4	0	10	8 (E.coli)
9/9	0	2	0	0
Geo. mean	2.24	0.48	0.67	2.17*

* Geometric mean for 12 enterococci samples, excludes E. coli samples of 9/6 and 9/12.

TABLE 3. Bacterial Densities at Stanley Brook and Seal Harbor Beach
(units are # of colonies/100ml)

Date	Stanley Brook (<u>E. coli</u>)	Seal Harbor Beach (enterococci)
8/1	36 *	12 (9am) 0 (2pm)
9/19	60 * 0 ** 0 ***	2

* sampled below sewage treatment plant

** sampled below old fire station

*** sampled above old fire station