Prospect Park Biodiversity Project: A Microbiological Perspective

Natassa Gavalas and Andrew Cook

Introduction

Recreational use of water can substantially benefit the health and well-being of humans by providing an environment for pleasure, relaxation, and physical activities that may involve contact with water. If, however, recreational water is polluted, it may have adverse health effects related to physical, chemical and microbial hazards (*Water Safety Plan*). Therefore, water analysis constitutes a valuable tool for monitoring the quality and safety of recreational water. Recreational water analysis relies largely on ascertaining the presence or absence of certain organisms, termed indicator species; these indicators provide a metric with which to measure changes in water quality and conditions ("Microbial Fact Sheets").

Coliforms, bacteria residing in the intestines of humans, animals and birds, are some of the most commonly used indicators. *Escherichia coli* (*E. coli*) is a common species of fecal coliforms, widely used as an indicator to measure water quality. The presence of *E. coli* in recreational water, especially at elevated levels, has been proven to indicate fecal contamination ("Lakes and Reservoirs"). According to the U.S. Environmental Protection Agency's (EPA) established guidelines for recreational water quality, coliforms should not exceed 400 colony forming units (CFU)/100 mL for primary contact, 1000 CFU/100 mL for secondary contact (i.e. fishing, boating), and *E. coli* concentration should not exceed 126 CFU/100 mL per water sample (*Water Quality Standards*).

Coliforms exhibit traits common to pathogenic bacteria in humans: they possess a Gram-negative rod structure; they utilize either an aerobic or facultative-anaerobic respiration process; they are also generally non-endospore forming bacteria that ferment lactose to acid and CO_2 gas at 35° C (Cabral). Coliforms include both fecal coliform bacteria: bacteria that are found naturally in the intestines of warm-blooded animals and non-fecal coliform bacteria that can be found in plants, soil and in the aquatic environment (Farmer).

E. coli is a type of thermo-tolerant coliform bacteria that is prevalent in the feces of all warm-blooded mammals, including humans. It does not occur naturally in fresh water, vegetation, and soil, unlike total coliform bacteria which may live and reproduce in soil and water (Cabral). Hence, the presence of *E. coli* in water indicates that fecal contamination from humans or other warm-blooded animals has occurred. Furthermore, if levels of *E. coli* in recreational waters are found to be greater than guideline-stipulated levels, it is probable that disease- causing microorganisms are also present.

Prospect Park is a public park located in the New York City Borough of Brooklyn; it offers a scenic natural environment with spacious lawns, sports fields, forested areas, as well as Brooklyn's only lake. Prospect Park Lake is an artificially created lake that spans a 60-acre area along the park's southeast quadrant. The freshwater lake is fed by a natural stream with several surrounding ponds and provides a unique habitat for flora, fauna, and microorganisms. In addition to housing several species, Prospect Park Lake offers resting, feeding and breeding grounds for migratory birds (*Prospect Park Alliance*). The Prospect Park Biodiversity project of the New York City College of Technology, which aims to enhance students participation and learning in STEM through a civically- engaged framework, utilized the eco-complexity of Prospect Park Lake for an interdisciplinary study of biodiversity. The goal of the microbiological research was to perform a comprehensive water quality analysis of Prospect Park Lake. The water quality analysis attempts to determine the total number of bacteria and the fecal contamination by determining number of indicator coliforms, specifically *E. coli* and *Enterobacter* species.

Methods

Water samples were collected from five different sites in Prospect Park Lake according to accessibility determined by the Prospect Park Alliance. The samples were placed in 50 ml sterile tubes and stored in a cooler at 4°C, so as to prevent the growth of bacteria, and transported to the Microbiology Lab at the NYC College of Technology, where they were tested.

A ten-fold serial dilution of the water samples was performed in order to obtain an optimal number of bacterial colonies. From each dilution, 1 ml was plated on the surface of both nutrient agar and MacConkey agar. Nutrient agar is a complex medium generally used for the cultivation and isolation of colonies. MacConkey agar is a selective and differential medium used for detection of *E. coli*, a lactose fermenter that forms red/ pink colonies following incubation. The plates were incubated at 37°C for 48-72 hours, allowing the bacteria to grow and form visible colonies.

To determine the number of bacteria, the colony forming units (CFU) assay was used. The resulting colonies that formed during incubation were counted manually and recorded as the number of CFU per 100 ml of water. In addition, inoculation of Simmon Citrate agar from selected colonies on MacConkey agar was used to differentiate between *E. coli* and *Enterobacter spp*.

Results & Conclusions

The highest total number of bacteria and *E. coli* were found from site number three, whereas site number five showed the least amount for both total number of bacteria and number of coliforms. Although Prospect Park Lake has no direct agricultural drainage from livestock or crops, the park itself offers a variety of habitats that embrace numerous wildlife species. Thus, one can hypothesize that the potential sources of bacterial and fecal contamination besides humans and domestic animals are wildlife.

Among the birds found along the lake are members of the Anatidae family that includes ducks, geese, and swans. All of these species were observed in sites one, four and five. Wild birds are known to excrete large amounts of fecal indicator bacteria, which may harbor enteric pathogens. Several studies have indicated that the density of aquatic birds can affect bacteria counts, as birds can be a natural source of fecal coliform bacteria and specifically *E. coli* (Hoyer et al.). However, their contribution to water pollution is difficult to estimate, and therefore would require the performance of specific tests (Kirschner et al.).

Several freshwater turtles were seen at site three and may have largely contributed to the number of total bacteria and coliforms found at that site. According to Mitchell's study on enteric bacteria in natural pollution of freshwater turtles, there is a miniscule threat of wild-turtle-associated bacterial pathogenicity (Mitchell et al.). It should be noted that although the primary source of coliform bacteria—particularly *E. coli*—in natural waters is the feces of warm-blooded animals, it has been shown that coliforms inhabit the gastrointestinal tract of several species of cold-blooded freshwater turtles as well. Nevertheless, cold-blooded vertebrates are rarely considered a potential source of coliform bacteria in natural waters and there is a limited body of literature regarding the association of coliform with aquatic turtles (Harwood et al.).

Another factor contributing to the higher numbers of bacteria in site two and three is the observed stagnation of the water, which includes lack of current and aeration. The low number of total bacteria and coliforms at sites four and five may be attributed to water dynamics, underwater currents, as well as the actual topography of the location; both sites are located at the widest part of the lake.

Enterobacter spp—facultatively anaerobic Gram-negative bacilli—were present in all sites except sites three and four, as indicated by the color change observed in the utilization medium. The presence of *E.coli* in sites three and four was confirmed by the absence of growth and color change on the Simmon Citrate agar.

Our results indicate that the coliforms exceed the safety standards for secondary contact (1000 CFU/100ml) established by the U.S. Environmental Protection Agency (Lakes and Reservoirs). According to the World Health Organization (WHO), the contamination of recreational water with fecal material is a persistent threat to public health. However, based on the observations and data recorded, it appears that the areas in which the water quality exceeds significantly the EPA safety standards are the areas with the highest concentration of wildlife. Thus, it seems that the elevated coliforms are due to natural sources that inhabit Prospect Park Lake. Measurements of pollution must include the detection of fecal contamination from all warm-blooded animals, as this is the natural link to the occurrence of pathogenic microbes in polluted water (Cabral). Further research would be required in order to establish a definitive positive correlation between coliforms and wildlife in the specific areas sampled in this project. Moreover, the samples drawn from most expansive area of the lake, sites four and five, displayed lower coliform levels.

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Nominating faculty: Professor Liana Tsenova, Department of Biological Sciences, School of Arts & Sciences, New York City College of Technology, CUNY.

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