MONTCLAIR STATE UNIVERSITY

PASSAIC RIVER INSTITUTE

The College of Science and Mathematics

Citizen Science Pathogen Monitoring 2014

The Third River Pathogen Study

Friends of Bonsal Preserve
&
Montclair State University

February 18, 2015

FINAL REPORT NARRATIVE

Recipient Name: Friends of Bonsal Preserve and Montclair State University

Report Type: Final

Period Covered: April 1, 2014 to February 10, 2015

Award Amount: $24, 938.00

Award Match: $8,100.00

Project Narrative:

Born from community concern, the Friends of Bonsal Preserve, a local environmental stewardship group of the Alonso F. Bonsal Wildlife Preserve, partnered with Montclair state University and secured a citizen science pathogen monitoring grant from the New England Interstate Water Pollution Control Commission. The grant allowed for pathogen monitoring of the Third River, which runs through the Bonsal Preserve. This report presents the 'Citizen Science Pathogen Monitoring of the Third River' findings. The project was conducted with personnel from both the Friends of Bonsal Preserve and personnel from the Passaic River Institute at Montclair State University. The project studied the Third River during the Summer months from June to August 2014.

PROJECT GOALS:

1. Assessed water quality of the Third River, particularly pathogen indicators.
2. Based on project findings, worked with municipal governments, local Environmental Commissions, and NJDEP to develop a management plan in order to eliminate source(s) and improve the water quality.
3. Brought greater awareness of water quality issues to the residents of the communities along the Third River.
4. Encouraged greater public participation by making data from the study openly available. Community members had opportunities to be trained as the future "citizen scientists."
5. Created a set of benchmarks for future testing to study long-term trends, to measure effectiveness of efforts on pollution reduction, and to make data available to researchers.

PROJECT SUMMARY

Citizen science develops a collaborative relationship between scientists and volunteers who are engaged in their communities to expand the opportunity for scientific data collection, providing access to scientific information for community members. In 2014, a citizen science partnership was created that allowed the community group, Friends of Bonsal Preserve, to collaborate with Montclair State University, the NY-NJ Harbor Estuary Program, New England Interstate Water Pollution Control Commission, the NJ Department of Environmental Protection, and the US Environmental Protection Agency to monitor pathogen indicator levels at ten sites along the Third River, a tributary of Passaic River. The pathogen indicator, *Enterococcus*, was monitored five times per month over three months (June-August) in 2014 using the Fluorogenic Substrate Enterococcus Test (*Standard Methods for the Examination of Water and Wastewater*, 9230D), commonly known as IDEXX Enterolert©. A YSI field sonde was used to collect additional data concerning river conditions and possible sources of pollution. Field observations were also recorded. The results of this study indicated high levels of pathogens were found throughout the Third River, but particularly while passing the town of Nutley. Rain events were also found to dramatically increase *enterococcus* levels.

PROJECT PERSONNEL

Name	Title	Organizational Affiliation
Jonathan Grupper	Project Leader	Friends of Bonsal Preserve
Meiyin Wu	Project QA/QC Manager	Montclair State University
Myla Ramirez & Matt Newton	Data Entry, Field, & Laboratory Personnel	Montclair State University
Daniel Cruz, Elsa Latheef, Vera Lazar & Sanford Sorkin	Volunteer Field & Lab Personnel	Friends of Bonsal Preserve

COURSE OF ACTION

The Third River, located in northern New Jersey, is the third tributary into the Passaic River. It traverses through the counties of Essex and Passaic, and its headwaters are located at the Woodland Park Reservoir. Geographically, the Third River basin includes highly urbanized areas that consist of mostly residential areas. The main stem of the river borders many parks and preserves throughout its course. The Third River was studied during the summer months of June through August. Third River water samples were collected and analyzed five times each month; once a week and a fifth floating day that allowed for post-rain event collection when possible. Ten monitoring locations were chosen to provide a general representation of the river along its main stem (Figure 1 and Table 1). The study parameters included pathogen, water chemistry and

field observations to provide a concise finding of the water quality. The pathogen indicator, Enterococcus, was tested using Standard Method for the Examination of Water and Wastewater 9230D-commonly known as IDEXX Enterolert®. Water chemistry parameters included water temperature, pH, dissolved oxygen, salinity, conductivity, and specific conductance. Water chemistry parameters were measured using a Yellow Stone Instrument® (YSI) 556 MPS. Field observation parameters of precipitation, potential pollution sources, recreational activities, odor, cloud cover, and tidal stage were recorded using an observation sheet. Data analysis provided a representation of each month that was monitored. Monthly Enterococcus values were obtained by finding the geometric mean of the five weekly data records. The monthly water chemistry parameters were each obtained from the arithmetic average of its data records.

Table 1. Third River Monitoring Locations

Site Code	Town Code	Latitude	Longitude	Description
FBP-01	C1	40.87222	-74.1907	Notch Road, Clifton
FBP-02	M1	40.85065	-74.1895	Grove Street, Montclair
FBP-03	M2	40.85006	-74.18563	Bonsal Preserve upstream, Montclair
FBP-04	M3	40.84934	-74.18793	Bonsal Preserve downstream, Montclair
FBP-05	B1	40.82278	-74.18208	Clarks Pond Nature Preserve, Bloomfield
FBP-06	B2	40.81007	-74.1925	Brookside Park, Bloomfield
FBP-07	N1	40.81269	-74.16176	Booth Park, Nutley
FBP-08	N2	40.82617	-74.14187	Kingsland Park, Clifton/Nutley
FBP-09	C2	40.82866	-74.13361	Oak Street, Clifton
FBP-10	C3	40.82318	-74.13245	Riverwalk Way, Clifton

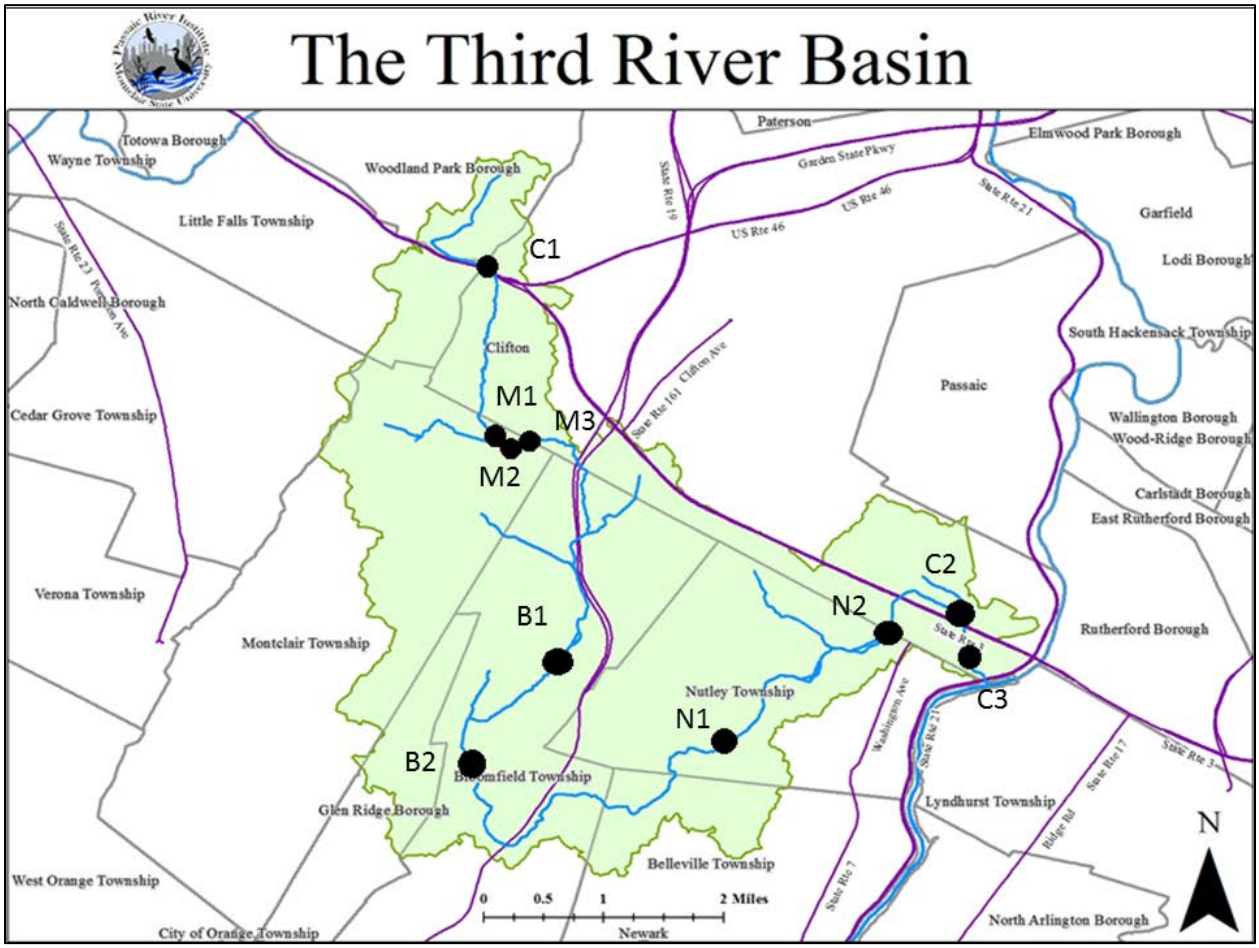

Figure 1. Ten monitoring locations are depicted along the main stem of the Third River.

QUALITY CONTROL MEASURES

For data quality assurance and quality control, appropriate field, lab, and data management measures were taken. Field monitoring location coordinates were routinely monitored to ensure identical sampling locations at each event. The YSI® 556 MPS field instrument measuring water chemistry parameters was calibrated at the beginning and end of each sampling event using manufacturer's instructions. The range and sensitivity of each YSI® 556 MPS parameter is listed below, along with the Garmin Montana 650T GPS sensitivity (Table 2). Duplicate YSI profile readings were taken during each sampling event to ensure the precision of data.

Table 2. Instrument Range and Sensitivity

Instrument	Range	Sensitivity
YSI 556 MPS		
Water temperature	-5 to 45°C ±0.15°C	0.1°C
Salinity	0 to 70 0/00 ± 0.1 0/00	0.01 0/00
Conductivity	0 to 200 mS/cm ± 0.001mS/cm	0.001 to 0.1 mS/cm
Dissolve Oxygen	0 to 50mg/L ± 0.2 mg/L	0.01 mg/L
pH	0 to 14 units ± 0.2 units	0.01 units
Garmin Montana 650T GPS		± 15 meters

For pathogen analysis, the Enterolert method is a designated standard method. All laboratory reagents and materials were used from the same lot and vendor for quality control purpose. A laboratory fortified blank sample was performed with each batch and evaluated against a certified recovery value. A positive sample was conducted simultaneously for quality control purpose. Regular field/lab data checks were performed to ensure monitoring according to the approved quality assurance project plan, measurements & calibrations performed correctly, data meets acceptance criteria, and holding times were met. Data sheets were reviewed by a second individual before electronic data transcription. A second review was conducted by a different individual to monitor for entry, transcription, or calculation errors. Proper data and documents were stored in physical and electronic forms. Any missing data were documented. All QA/QC procedures are documented and can be accessed through the NY-NJ Harbor Estuary Program website. (http://www.harborestuary.org/citizenscience-2014project.htm)

SUMMARY REVIEW

Water Temperature

Aquatic organisms are dependent on certain temperature ranges for optimal health. The water temperature may also play a role in the growth of pathogens. Temperature can affect many other parameters in the water, including the amount of dissolved oxygen available. The averages for each month were found to be generally within the same area, with only slight difference that were likely due to the temperature shift during the time of sampling (Figure 2). Monitoring sites were not plotted in order of sampling and did not generally increase in temperature corresponding to time of day.

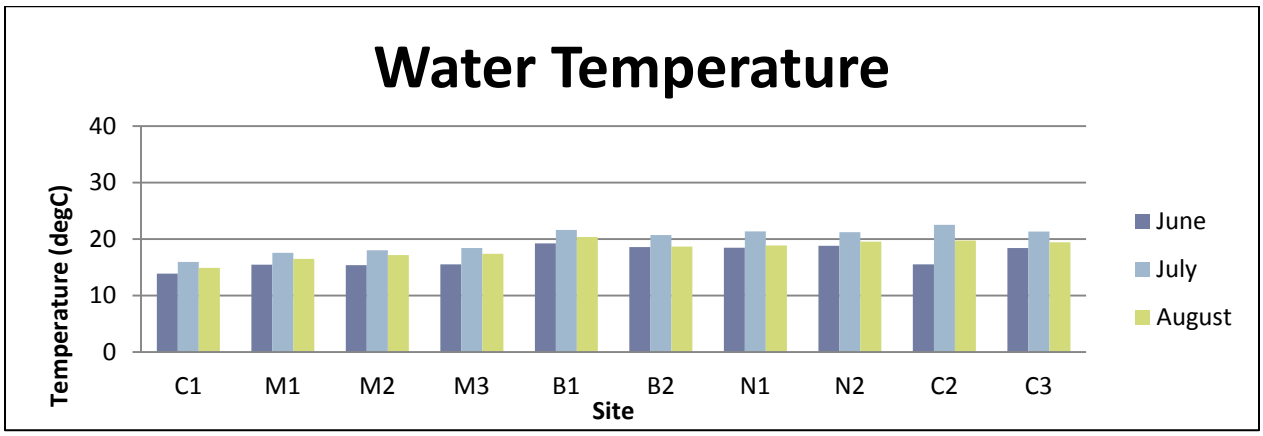

Figure 2. Mean Monthly Water Temperature at Ten Sampling Stations along the Third River in June, July and August 2014.

Dissolved Oxygen

Dissolved oxygen is a measure of the amount of oxygen dissolved in the water, which is essential for both plants and animals. Low level of oxygen in water may be harmful to fish and other aquatic organisms. Water receiving significant amounts of runoffs carrying solids, debris and organic materials might exhibit low dissolved oxygen level due to oxygen demands in the water. This situation can be alarming during hot summer months. The dissolved oxygen concentration during the study period ranged from 5mg/L to 10 mg/L above the 1986 U.S. EPA's Quality Criteria for Water allows a 7-day mean minimum of 4 mg/L of dissolved oxygen (Figure 3).

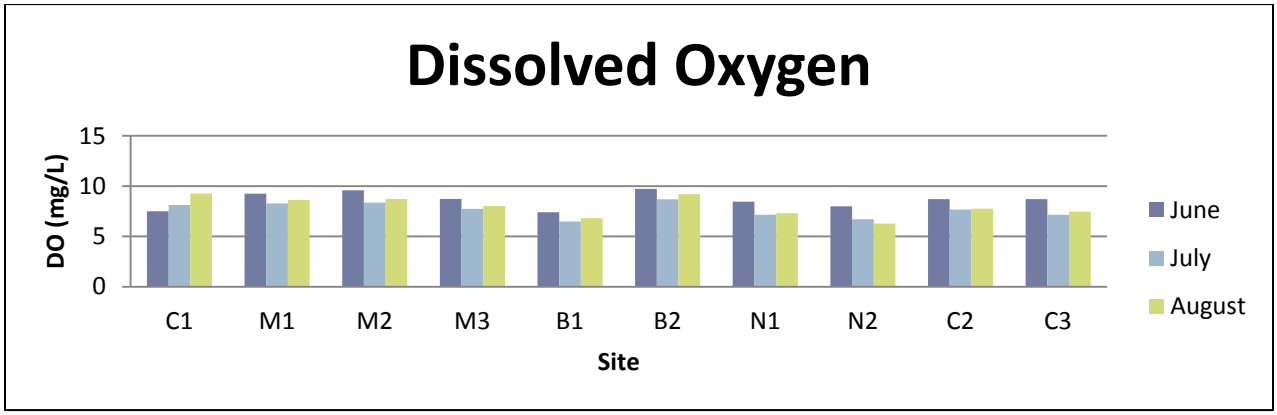

Figure 3. Mean Monthly Dissolved Oxygen Concentration at Ten Sampling Stations along the Third River in June, July and August 2014.

pH

The pH of the water contributes to corrosiveness and influences biological, chemical, and geological reaction rates in water. pH can be impacted by the quality of source water such as runoff and biological processes such as decomposition. Water has a natural pH of 7 and the pH averages for each month were found to be between 7.2 and 7.7 in the site locations (Figure 4). The results show that there were no extreme pH change through the time of the sampling period.

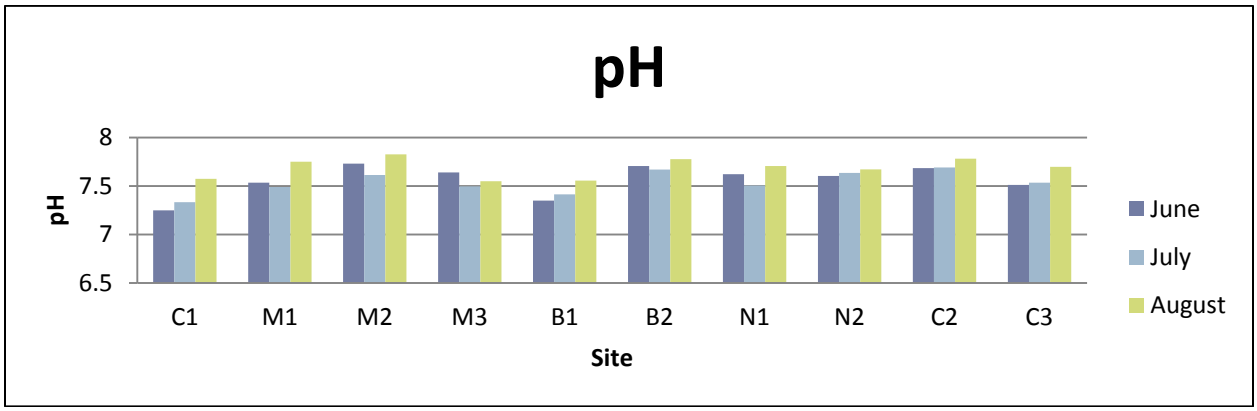

Figure 4. Mean Monthly pH Value at Ten Sampling Stations along the Third River in June, July and August 2014.

Conductivity and Salinity

Conductivity is a measure of the ability of water to conduct an electrical current. It is highly dependent on the amount of dissolved solids but can also be affected by stream discharges like sewage. The monthly conductivity averages were found to be within a range from 0.5-0.9 ms/cm (Figure 5).

Conductivity is highly dependent on dissolved solids, such as salt, and can be correlated to salinity when water is under tidal influence. From previous studies sampling the Third River, It was suspected that the lower two study sites (C2 and C3) might be under tidal influence. The results of the monthly salinity averages showed salinity readings gradually increasing towards the more upstream sites (Figure 6), consistent with the conductivity readings (Figure 5). The results of our study suggested that the lower two study sites were not under tidal influence at the time of sampling.

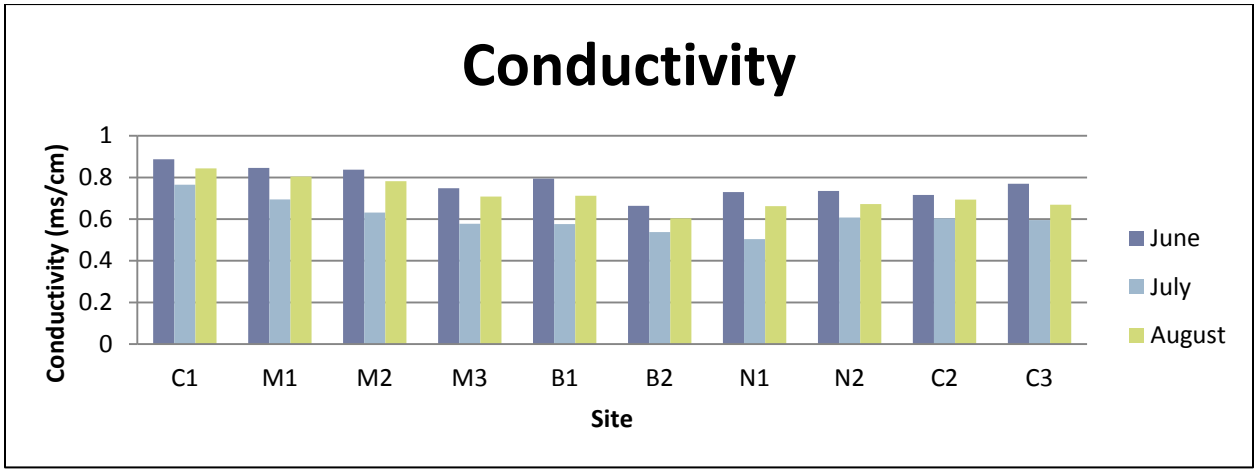

Figure 5. Mean Monthly Conductivity at Ten Sampling Stations along the Third River in June, July and August 2014.

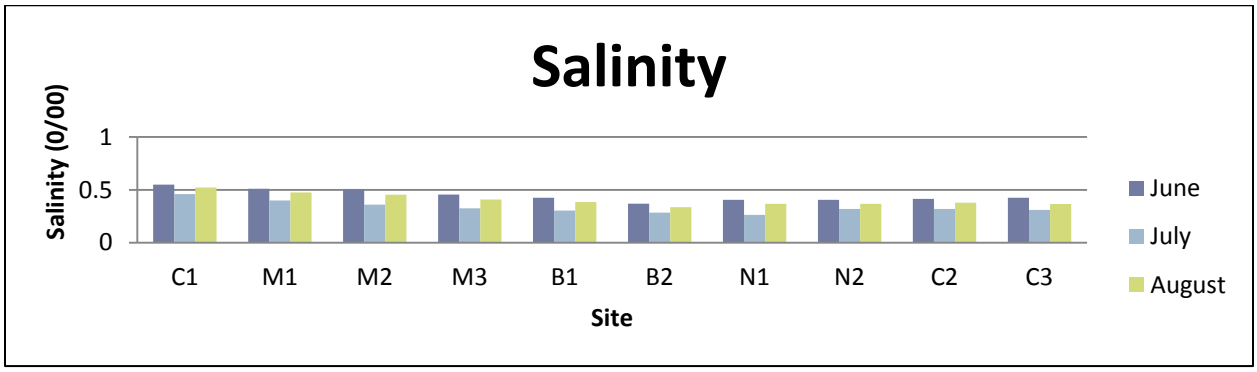

Figure 6. Mean Monthly Salinity at Ten Sampling Stations along the Third River in June, July and August 2014.

Enterococcus

Enterococcus (EN) serves as a pathogen indicator and is an indicator of fecal contamination. Enterococcus levels are categorized by the Water Quality Standards of 1986[11]. Low levels of enterococcus for primary contact is considered single sample maximum concentration (SSMC) to be less than 61 MPN/100mL with a geometric mean of 33 MPN/100 mL, moderate SSMC from 61 to 104 MPN/100mL, and high SSMC from105 to 500MPN/100mL. Enterococcus SSMC of 501 MPN/100mL and above are considered very high (Table 3). Although the Third River is not designated for primary contact use, the Friends of Bonsal community would ideally like the river to be clean enough for primary contact. The results indicate that all sites during the sampling period were not suitable for primary contact .

Table 3. Enterococcus Range of 1986 Water Quality Standards

Category	Range
Low	< 61 MPN/100 mL
Moderate	61 – 104 MPN/100 mL
High	105 – 500 MPN/100 mL
Very High	501 & > MPN/100 mL

In June, high levels of enterococcus were found at site N1 (Figure 8). Upstream of site N1, large groups of geese were seen and could be the cause of the high pathogen levels. Enterococcus levels in July presented very high levels of enterococcus at all study sites (Figure 9). July was found to have more frequent rain events as opposed to the June and August months, which might cause the higher pathogen levels. August enterococcus levels, in comparison to June and July, were lower; but all sites still exceeded the primary contact standards (Figure 10).

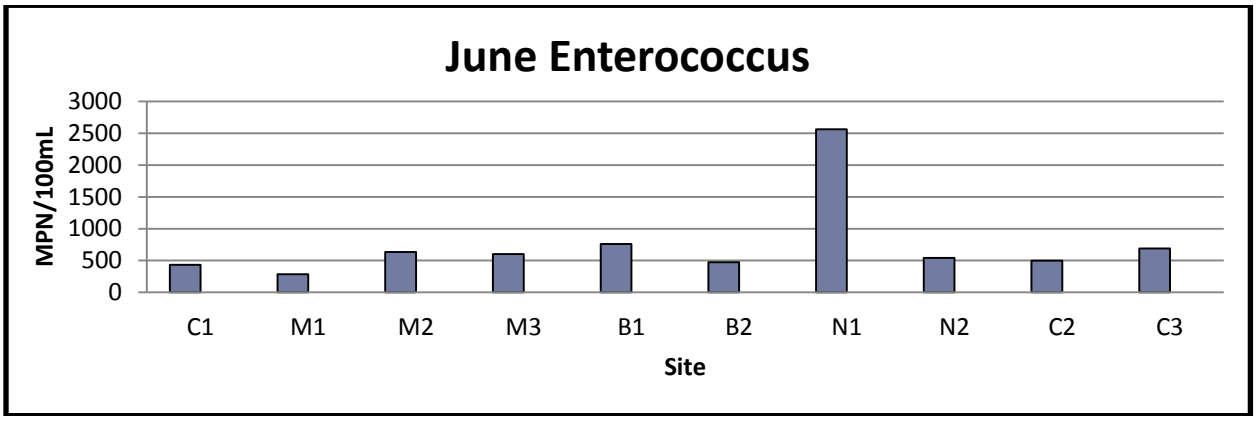

Figure 8. Geometric Means of Enterococcus at Ten Sampling Stations along the Third River in June 2014.

[1] US EPA Quality Criteria for Water 1986.

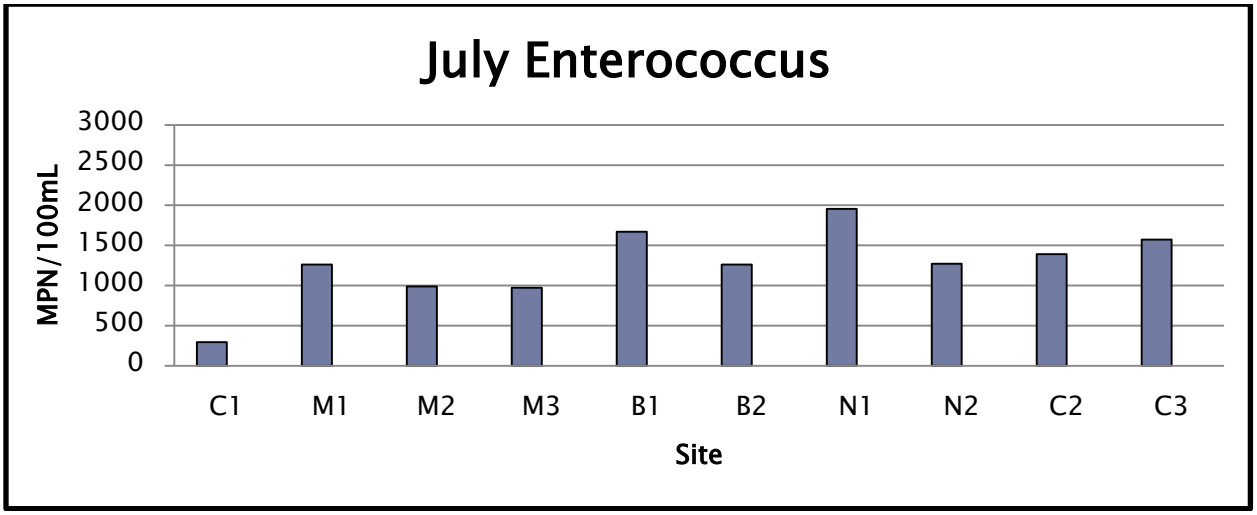

Figure 9. Geometric Means of Enterococcus at Ten Sampling Stations along the Third River in July 2014.

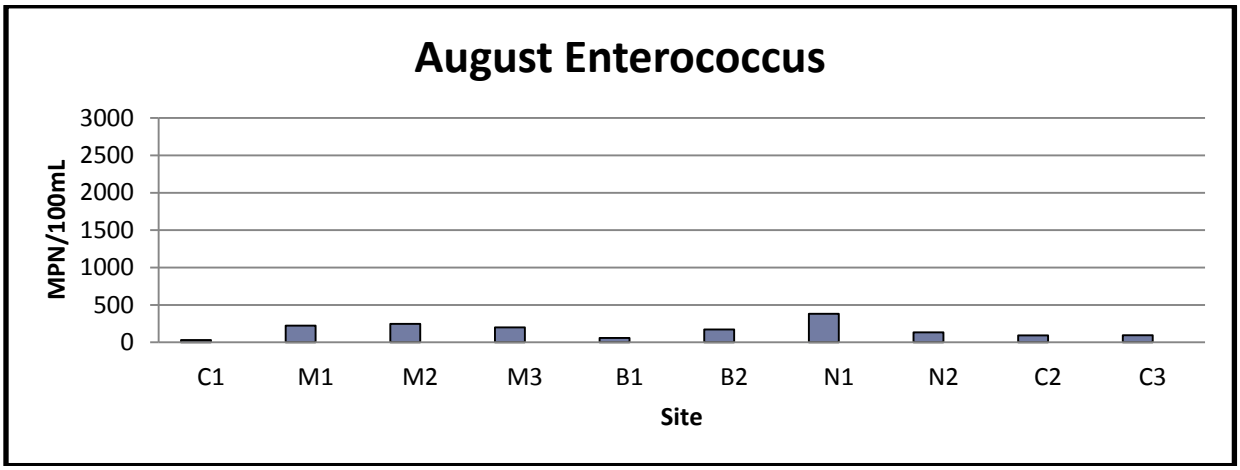

Figure 10. Geometric Means of Enterococcus at Ten Sampling Stations along the Third River in August 2014.

Effects of Rain on Enterococcus

A rain event was defined as a sampling event conducted within 48 hours of rain, independent of quantity of rain fall. Rain and the runoff were found to significantly affect enterococcus levels during the study.

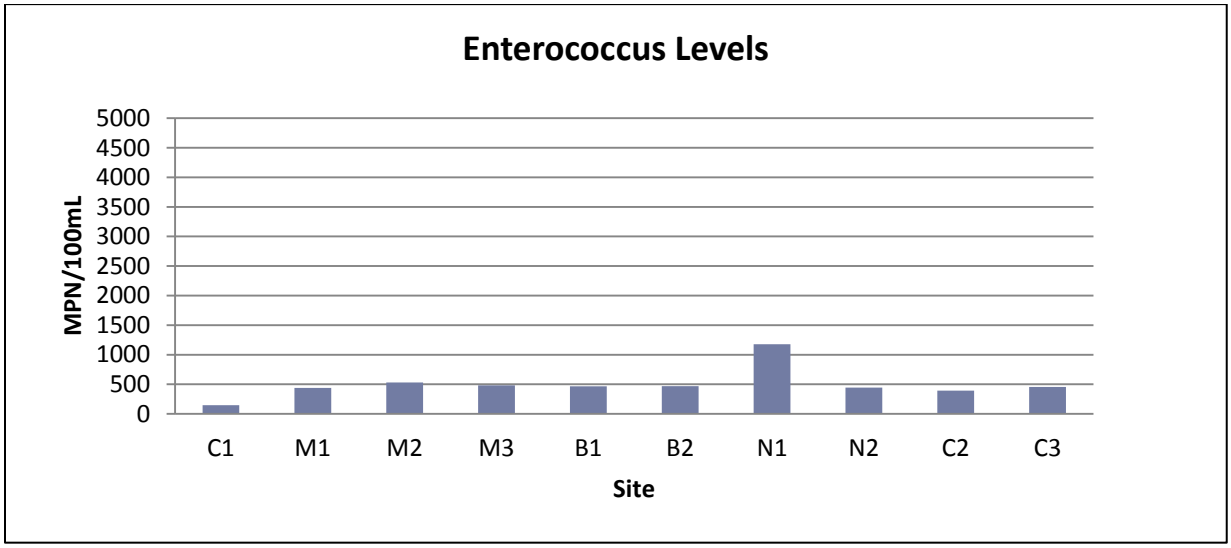

Figure 11. Geometric Means of Enterococcus at Ten Sampling Stations along the Third River in summer 2014.

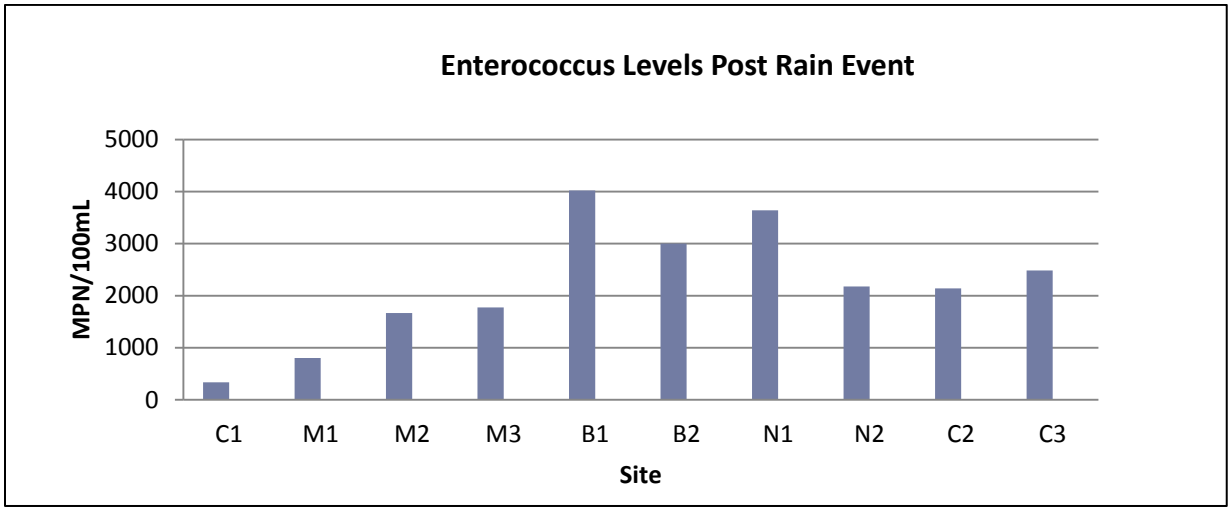

Figure 12. Geometric Mean of Enterococcus Sampled Within 48 Hours of a Rain Event at Ten Sampling Stations along the Third River in summer 2014.

Third River Basin Enterococcus Levels

Aggregate Summer enterococcus levels range from moderate to very high levels (Figure 13). The upstream site C1 was the only site considered moderate. Sites M2 and N1 had enterococcus levels considered very high, which could be contributed from the large population of geese in the area. Rain was a large factor in bacterial levels and all ten monitoring sites showed an increase in enterococcus levels when rain event data was isolated (Figure 14). Sites M1 through C3 showed very high enterococcus levels while the most upstream site C1 exhibited high levels.

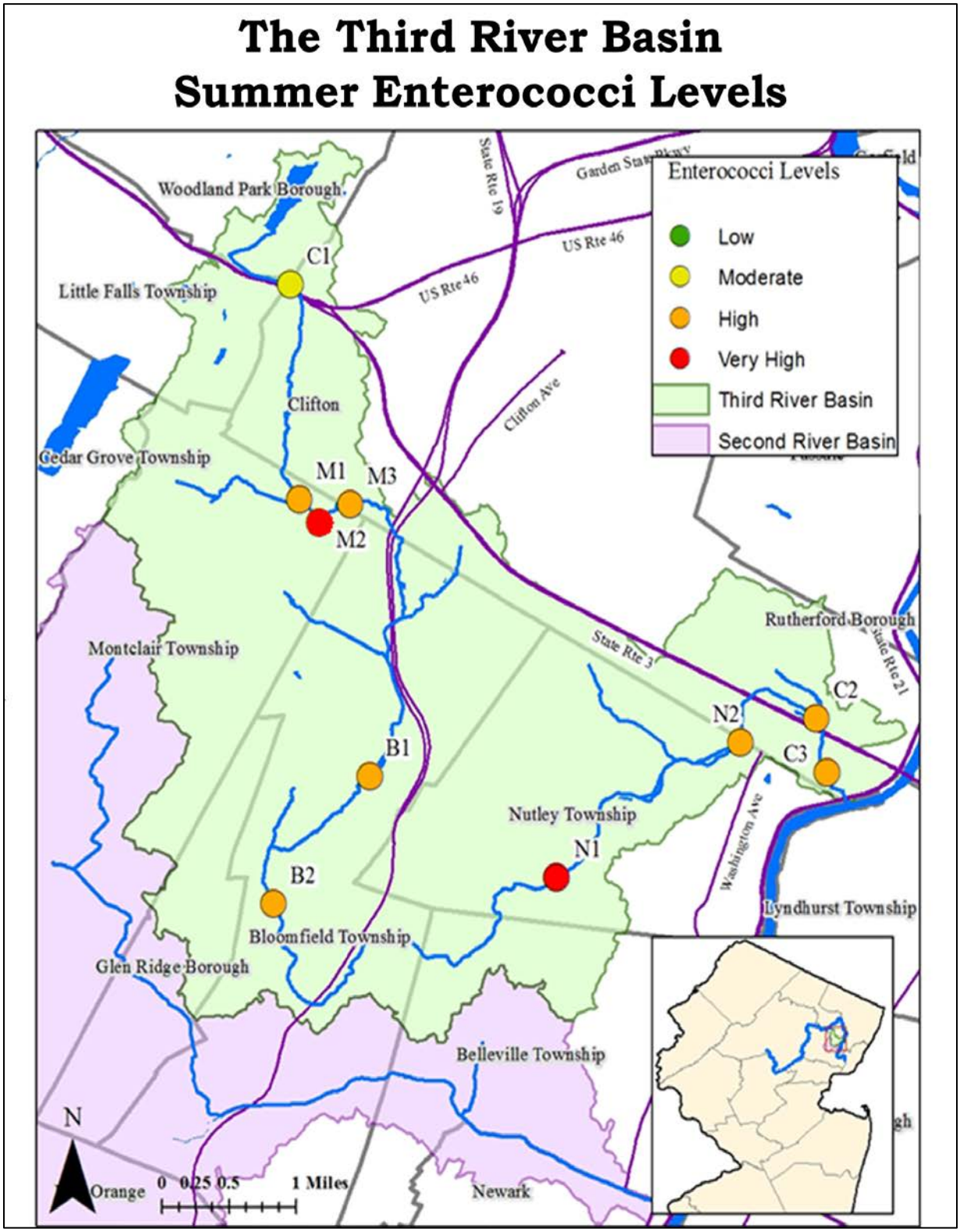

Figure 13. Enterococcus level categorization at ten sampling stations along the Third River in summer 2014 based on the 1986 Water Quality Standards

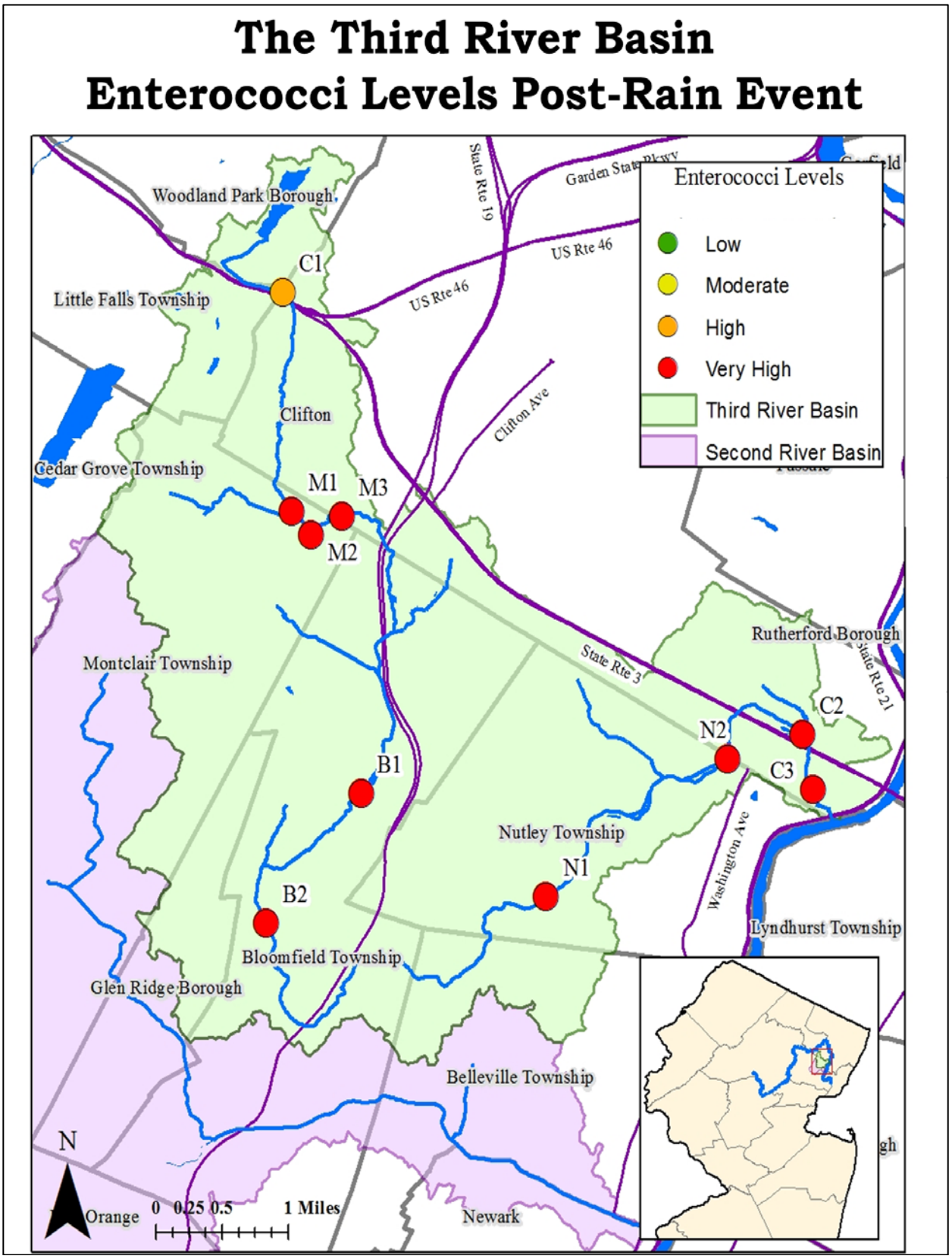

Figure 14. Post-rain Enterococcus level categorization at ten sampling stations along the Third River in summer 2014 based on the 1986 Water Quality Standards

ACCOMPLISHMENTS

The partnership created between the Friends of Bonsal Preserve and Montclair State University provided a unique relationship that benefited personnel from both groups. This relationship will serve as a foundation for future scientific, citizen science, and environmental education projects.

Project deliverables

Third River project data was uploaded to the EPA Water Quality Exchange (WQX) and Storage and Retrieval (STORET) Data Warehouse. All data, pictures, and QAPP can be accessed by the public.

The project findings were presented at a public event held at the Environmental Protection Agency building at Manhattan on November 21, 2014. The presentations were followed by a panel discussion on the future of citizen science in the region, with a focus on water quality. An additional information and discussion session of the project results was held on November 16, 2014 at Montclair State University campus. The goal of this data sharing and outreach event was to organize local communities and coordinate future monitoring efforts and potential management actions. The event was attended by 36 concerned individuals including residents, environmental community groups, and municipality representatives. The goal is for this working group to further discuss the results, which can generate applied improvements and future studies of the water quality of the Third River.

The results of this project was also presented at the Passaic River Symposium on October 9-10, 2014 at Montclair, NJ, and at the Metropolitan Association of College and University Biologists' annual meeting on November 1, 2014, at Molloy College in Long Island, NY.

PROJECT EVALUATION

Overall Evaluation

Citizen scientists completed the project and satisfied the designated project goals. Visibility of citizen science was raised within the local communities and trained citizen scientists generated high quality data that were shared with the public and the states' environmental departments through the Water Quality Exchange portal. By conducting water quality monitoring of the Third River, members of the local communities fostered stewardship by directly engaging in environmental data collection, analysis, and management.

To evaluate the project, data checks and assessments were conducted biweekly by citizen scientists and the project QA/QC manager. An on-site field inspection was conducted two weeks into the sampling season to ensure proper protocol by the field sampling teams. The EPA Region 2 lab and field staff conducted technical system assessments of the sample collection and use of YSI, as well as a laboratory assessment.

Data Use and Recommendations

Data generated to provide monthly averages and the geometric means of the respective parameters provided a snapshot of the water quality during the monitoring months of June-August. The enterococcus geometric means were used to produce the Third River Basin

Enterococcus Levels Maps (Figures 13 & 14) and used for project presentations. All data was uploaded to WQX/STORET and used to identify future water quality projects.

LIMITATIONS

Science and data communication between community members and scientists is a common issue. A clear explanation of environmental issues especially pertaining to microbiology and various contaminants was needed to provide a general foundation of project understanding. To accomplish this, Montclair State University held a series of training sessions on environmental safety, field safety, lab safety, and microbiology to provide volunteers and community members with background knowledge and laboratory techniques not limited to the project design. The training provided citizen scientists and volunteers with an understanding of project safety and environmental microbiology. This was continued through an open inquisitive environment where non-technical community volunteers were encouraged to frequently ask questions.

CONCLUSIONS AND RECOMMENDATIONS

The pathogen monitoring project provided water quality data for the Third River, where it was determined that the river is not suitable for primary recreation due to high levels of the pathogen indicator, enterococcus, present throughout the river. The source of contaminants is not known at this time but molecular techniques can be applied to identify host origins in the future.

PICTURES

The pictures below were taken by project staff during sampling events in summer 2014. Wildlife could be a possible source of bacterial contamination. In Figure 15, a flock of geese were seen at Kingsland Park in Nutley. Oil and grease were monitored at the most downstream site located on Riverwalk Way in Clifton (Figure 16). In August, algae spanned the width of the river at the Kingsland Park location in Nutley (Figure 17). As a result of the efforts of the citizen scientists, a large yellow drum was removed by the Passaic Valley Sewage Commission from the most upstream site in Clifton.

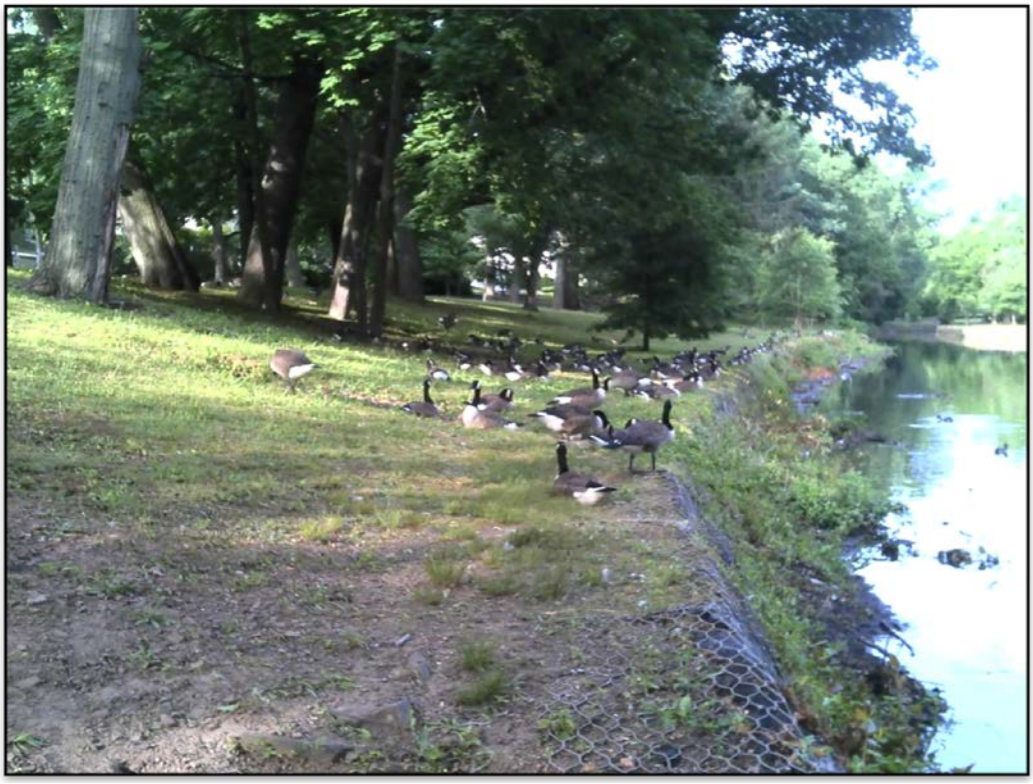

Figure 15. A flock of geese are found at site N2, Kingsland Park located in Nutley.

Figure 16. Oil and grease are found in the river by sampling location C3, located on Riverwalk Way in Clifton.

Figure 17. Algal growth is shown above in site N2, Kingsland Park in Nutley.

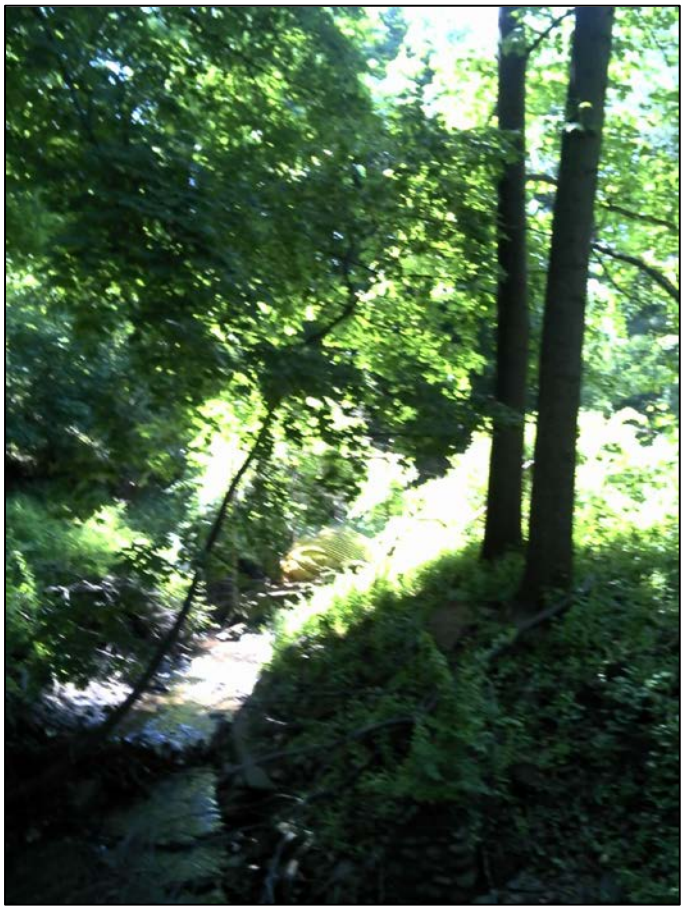

Figure 15. A large plastic drum was found at site C1 in Clifton. Passaic Valley Sewage Commission was contacted and the drum was removed.