



Stopping Trash Where It Starts

Bronx and Harlem River Watershed Case Study

**HUDSON
RIVER
FOUNDATION**

**NY/NJ
HARBOR
& ESTUARY
PROGRAM**

URBANWATERS
FEDERAL PARTNERSHIP
Restoring Urban Waters, Revitalizing Communities

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Table of Contents

Table of Contents.....	1
Acronym Key.....	2
Executive Summary.....	3
Project Synopsis.....	4
Tasks Completed.....	5
Task 1 – Partner identification, site selection and QAPP development.....	5
Task 2 –Field data collection.....	8
Task 3 – Analysis and reporting.....	8
Methodology.....	13
Quality Assurance Tasks Completed.....	13
Conclusions.....	14
References.....	15
Acknowledgements.....	16
Suggested Citation.....	16
Appendices.....	17
A. Quality Assurance Project Plan: Stopping Trash Where It Starts.....	17
B. Stopping Trash Where It Starts QC'd Data.....	17
C. Site Survey Photographs.....	17

Acronym Key

BxHUWP	Bronx & Harlem Urban Waters Federal Partnership
CSO	Combined Sewer System
GIS	Geographic Information System
HEP	New York-New Jersey Harbor & Estuary Program
MS4	Municipal Separate Storm Sewer System
NYCDEP	New York City Department of Environmental Protection
PRI	Passaic River Institute of Montclair State University
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance and Quality Control
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency

Executive Summary

The New York-New Jersey Harbor & Estuary Program (HEP), Bronx & Harlem Urban Waters Federal Partnership (BxHUWP), and Montclair State University's Passaic River Institute (PRI) worked with local partners to collect data from 20 locations in the Bronx and Harlem River Watersheds. Data collected included the types, potential sources, and the conditions leading to litter generation and dispersal to inform reduction strategies in the region. *Stopping Trash Where it Starts* initiative started in 2017 with 35 sites surveyed in the Passaic River Watershed. In 2018, HEP and PRI expanded the initiative in the Bronx and Harlem River Watershed by partnering with the Bronx River Alliance, the Bronx is Blooming, Van Cortlandt Park Alliance, and the Bronx Theatre High School.

The objectives of the survey include characterizing and identifying right-of-way litter focusing on floatables, or marine debris, entering local waterways and the local conditions contributing to debris dispersal. Characterizing the type of debris in the right-of-way enables water managers to target specific actions to reduce marine debris and stopping trash where it starts. The initiative works to:

- Better characterize local sources and types of floatable debris to the Harbor and Estuary;
- Utilize the data collected at each location to help identify the most effective source reduction actions, including voluntary source control, preventative and reactive policy options, and target public awareness and education campaigns; and
- Create opportunities to engage citizens and stewardship organizations in identifying sources of litter and showcasing this project to educate local businesses and residents about trash impacts and solutions to encourage responsible vendor and consumer behavior and stewardship.

Ultimately, this initiative provides data on the most prominent sources and types of litter to inform pollution prevention measures to reduce marine debris in the estuary. Knowing the composition of street trash at the municipality level, or even better at the block level, aids in suggesting the types of interventions needed and the locations with the greatest needs.

In the Bronx and Harlem River Watershed, a total of 17,843 items were collected, resulting in an average of 511 debris items per visit at an average weight of 4.7 kilograms and a volume of 51 liters. The litter surveys detailed in this report provide a snapshot of sources of floatable debris from the Bronx and Harlem River Watershed. These consist largely of cigarette butts and food/drink-related single-use, disposable plastics. This is a concerning problem across all sites surveyed from 2018 through 2019, especially within the Bronx. This finding is consistent with the HEP/PRI surveys in the Passaic River Watershed and a similar study conducted by NYC DEP elsewhere in New York City. It is recommended that right-of-way litter management strategies and efforts should primarily focus on managing cigarette butts and single-use, disposable plastics to reduce marine debris in the region.

In 2019, HEP extended the use of this protocol to further collect debris data in the Hackensack River Watershed. This work, supported by HEP staff and dedicated funding from United States Environmental Protection Agency (USEPA), will further enable HEP and its partners to progress towards our mutual goal of reducing floatable debris and improving the waters of the estuary.

Project Synopsis

New York and New Jersey have taken measures to address marine debris through the municipal separate sewer system (MS4) and combined sewer overflow (CSO) permits. Both states capture and remove marine debris through floating barriers, skimmer vessels, netting or screening facilities, as well as source control programs such as street sweeping and stewardship programs (i.e., adopt-a-catch-basin, adopt-a-beach or clean streets-clean beaches, etc.). According to the latest State of the Estuary Report, the largest skimming program, operated by United States Army Corps of Engineers (USACE), as well as the program run by the New York City Department of Environmental Protection (NYCDEP), data shows a downward trend in floatable debris collected since 2001 (Stinnette, et al, 2018). Although the downward trend may be attributed to the removal of heavier than normal debris, such as derelict piers, in the earlier days of the skimmer vessel program, there has also been an increase in stewardship efforts conducting shoreline cleanups. Both in New York and New Jersey, data collected by stewardship groups are also showing a statistically significant decline in debris on beaches indicating that there has been less litter on shorelines over time (Figure 1; Stinnette, et al, 2018).

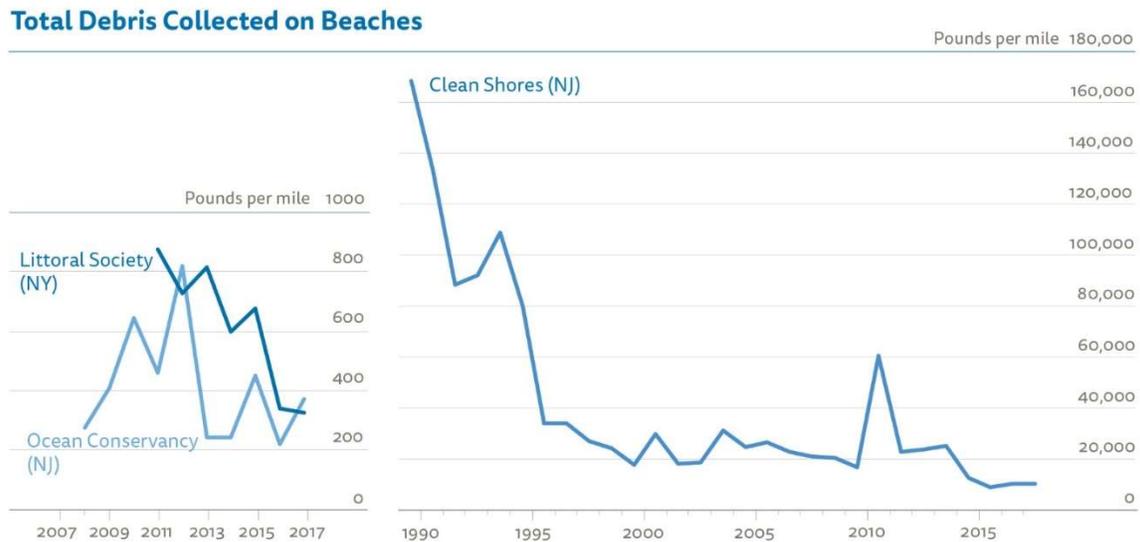


Figure 1. Total Debris Collected on Beaches in pounds per mile over time (Stinnette, et al, 2018)

However, these efforts solely address the issue of trash once it becomes marine debris. In 2014, an estimated total of \$59M was spent on marine debris waste management activities in the Hudson-Raritan Estuary (Kim, et al., 2015). While efforts to clean up floatable debris will continue to be necessary, pollution prevention strategies are more sustainable and a rational manner of tackling the issue.

In 2016, the USEPA Region 2 and the NYCDEP collaborated with Columbia University to design a street litter survey protocol to collect information about the type, quantity, and sources of street litter. The survey, developed with input from HEP, aimed to highlight the causes of floatable debris and provide an understanding to develop effective source reduction strategies (NYCDEP, 2016). The following year, HEP partnered with the Passaic River Institute (PRI) at Montclair University to initiate *Stopping Trash Where It Starts* to focus on developing a litter survey protocol. The protocol goal is to collect data on the type and material of floatable debris found in the right-of-way, or sidewalk, to inform pollution prevention strategies. The initiative was piloted in the Passaic River Watershed across six (6) municipalities and

helped to identify behaviors associated with litter debris (Da Silva, 2018). The lessons learned from the pilot were then applied to conduct the Bronx River and Harlem River Watershed study in 2018.

Led by HEP and PRI staff, with the assistance of the Bronx River Alliance, the Bronx is Blooming, Van Cortlandt Park Alliance, the Bronx Theatre High School, and the BxHUWP, a data collection protocol and datasheet was revised to improve the data collection process; a quality assurance and quality control (QA/QC) of volunteer-collected data was established, including the creation of a Quality Assurance Project Plan (QAPP); a training was delivered to the local organizations that would later lead the data collection; the data was analyzed for this report; and the final data was shared with the local community groups. Upon approval of the QAPP in October 2018, local community groups (Bronx River Alliance, the Bronx is Blooming, Van Cortlandt Park Alliance, and the Bronx Theatre High School) completed a training led by PRI and HEP in August 2018. Once the approved QAPP was received, the local community groups worked with volunteers to conduct 40 litter surveys along 20 sites during the months of October 2018 to October 2019 to collect the types, sources, and conditions leading to litter generation and dispersal in the Bronx and Harlem River watersheds.

Tasks Completed

Task 1 – Partner identification, site selection and QAPP development

A kick-off meeting organized by the BxHUWP Ambassador with a number of local community groups was held on June 1, 2018 to gauge interest in *Stopping Trash Where it Starts*. This initial call led to the identification of local partners interested in working with HEP and PRI and later identification of potential sites for the project. HEP and PRI completed the process of site selection using the established criteria available in QAPP (Appendix A) which included distance to the main stem of a river, impervious surface area, and other geographic information system (GIS) criteria. HEP and PRI further refined the data collection protocol and litter survey to improve the forms for field use.

The project team selected 20 sites throughout the Bronx and Harlem River Watersheds.. Of the 20 sites, five (5) were along the Harlem River, six (6) were along Tibbetts Brook (a tributary of the Harlem River), and nine (9) were along the Bronx River as shown in Figure 2.

The image shows the title and approval page of a Quality Assurance Project Plan (QAPP) for the project "Stopping Trash Where it Starts". The plan is effective as of August 15, 2018, and was prepared by the Hudson River Foundation/NY, NJ Harbor & Estuary Program (HEP). The page includes five approval signatures and dates:

Role	Signature	Date
HEP Project Manager	Rosana Da Silva	10/12/18
Montclair University/Passaic River Institute Project Manager	Melvin Wu	10/15/18
Montclair University Project QA Officer	Tsung-Ta Hsu	10/15/18
EPA QA Officer	Carol Lyles	10/16/18
EPA Project Officer	Richard Winfield	10/15/2018

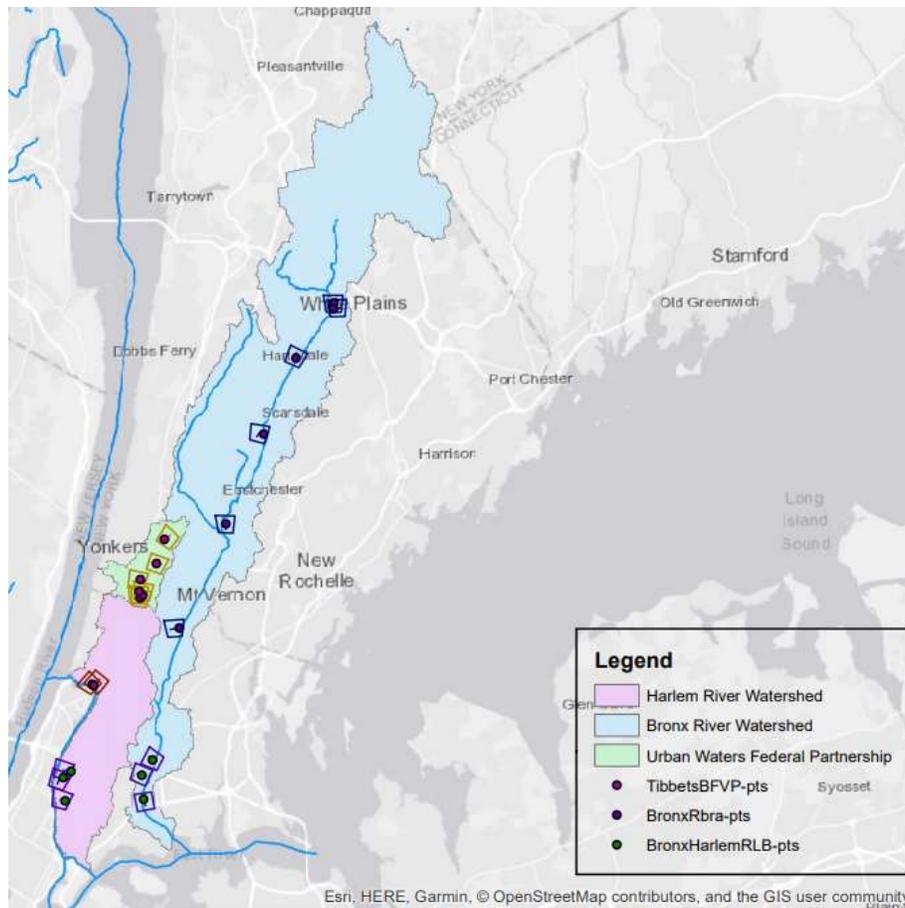


Figure 2. Bronx and Harlem River Litter Survey points (center of each 400-meter segment) and survey quadrant regions.

The Bronx River Alliance, the Bronx is Blooming, Van Cortlandt Park Alliance, and the Bronx Theatre High School all conducted scouting visits to propose sites to PRI. PRI then confirmed, rejected, or slightly modified sites following evaluation of access to the waterway, first-glance grade of littering, presence of a walkway for safety of the surveyors, and proximity to parking for loading operations. A total of 20 sites were selected and the survey responsibility varied per community partner and supervisor per Table 1. The Bronx River Alliance surveyed nine (9) sites all along the Bronx River; the Bronx is Blooming surveyed three (3) sites on the southern end of the Harlem River around the Highbridge neighborhood of the Bronx; the Bronx Theatre High School surveyed two (2) sites on the northern end of the Harlem River in the Marble Hill neighborhood of the Bronx; and the Van Cortlandt Park Alliance surveyed six (6) sites along Tibbetts Brook, which flows into the Harlem River, located in Yonkers (Table 1).

Table 1. Bronx and Harlem River Site Location and ID

Site ID	Neighborhood		Site Description	Lead Organization	Project Supervisor
BH_01	Marble Hill	Bronx	W 225th	Bronx Theatre High School	Danny Steiner
BH_02	Marble Hill	Bronx	Broadway	Bronx Theatre High School	Danny Steiner
BH_03	Lincoln Park	Yonkers	McClellan	Van Cortlandt Park Alliance	John Butler

BH_04	Lincoln Park	Yonkers	Tibbetts	Van Cortlandt Park Alliance	John Butler
BH_05	Lincoln Park	Yonkers	Midland	Van Cortlandt Park Alliance	John Butler
BH_06	Park Hill	Yonkers	Putman	Van Cortlandt Park Alliance	John Butler
BH_07	Park Hill	Yonkers	Wendover	Van Cortlandt Park Alliance	John Butler
BH_08	Dunwoodie	Yonkers	Cook	Van Cortlandt Park Alliance	John Butler
BH_09	West Farms	Bronx	E 180th	Bronx River Alliance	Michelle Luebke
BH_10	West Farms	Bronx	E 174th	Bronx River Alliance	Michelle Luebke
BH_12	Hunts Point	Bronx	Bronx	Bronx River Alliance	Michelle Luebke
BH_13	Highbridge	Bronx	Martin	Bronx is Blooming	Jose Rivera Jr
BH_14	Highbridge	Bronx	W 167th	Bronx is Blooming	Jose Rivera Jr
BH_15	Highbridge	Bronx	E 153rd	Bronx is Blooming	Jose Rivera Jr
BH_16		White Plains	Ferris	Bronx River Alliance	Michelle Luebke
BH_17		White Plains	Main	Bronx River Alliance	Michelle Luebke
BH_18	Scarsdale	Yonkers	Scarsdale	Bronx River Alliance	Michelle Luebke
BH_19	Hartsdale	Greenburgh	Hartsdale	Bronx River Alliance	Michelle Luebke
BH_23		Bronxville	Palmer	Bronx River Alliance	Michelle Luebke
BH_26	Woodlawn Heights	Yonkers	E 235th	Bronx River Alliance	Michelle Luebke

HEP and PRI led the development and submission of the QAPP. In preparation for the approval of the QAPP, PRI delivered a day training workshop on August 23, 2018 to all project supervisors and some staff members and volunteers who would later participate in the study. A total of 10 participants attended the training which included the survey protocols, familiarization of each field form, and a mock field survey to practice the protocol. The QAPP was approved by USEPA on October 16, 2018. Local partners were provided a final copy of the approved QAPP and were authorized to begin field work.



Local community groups and volunteers attend the litter survey protocol training at the Bronx River Alliance facility on August 23, 2018.

Task 2 –Field data collection

Each site was visited twice between October 30, 2018 and October 1, 2019 by a minimum team of two (2) representatives and volunteers from the Bronx is Blooming, Bronx River Alliance, Bronx Theatre High School, Van Cortlandt Park Alliance, Hudson River Foundation, and HEP. Over 600 volunteer hours were recorded for the length of the study during the 40 survey sites across the 20 sites.¹ Surveys were avoided during or within 48 hours of rain events, street sweeping, and garbage/recycling pick up schedules in each neighborhood or municipality of the site.

For each survey, a 400-meter segment on one side of the street and an estimated one (1) foot into the street or to the equivalent end of the nearest catch basin was considered within the study segment. Crosswalks were not included in the study nor were added as part of the 400-meter segment for safety. Debris was collected from the end of visible property lines or an estimated five (5) feet from the sidewalk to the curb and included the one (1) foot into the roadway. Trash found within the designated survey area was identified, sorted based on different categories and subcategories at an off-site location (e.g. food-related items, bags and plastic bottles, drink-related items, tobacco-related litter as indicated on the tally matrix), and quantified by number, volume and weight. The minimum debris size for the survey was 2.5 centimeters (the size of a cigarette butt). Large, bulk items and hazardous materials were not included in the survey, but noted on the tally form and/or photographs were used to document its presence (Appendix C). All collected debris was placed into a garbage bag labelled with the site identification number and date of the survey for off-site sorting and quantifying numbers, volume, and weight.

Project partners submitted their completed data sets, corresponding data sheets, and site photographs to PRI. PRI reviewed the data and performed the quality control of all the data which included materials, types, categories and noticeable brands, site characteristics such as presence/absence of trash and recycling bins, food-related businesses within the block, trash hot spots, and other variables of interest. The full list of types of data collected is available in Appendices of the QAPP (Appendix A) and the quality controlled data (Appendix B).

Task 3 – Analysis and reporting

During the quality control process, PRI identified two sites, BH_13 Martin and BH_15 E 153rd, which did not pass the assurance protocol listed in the QAPP and were therefore removed from the analysis. The total number of study sites were reduced from 20 to 18 sites and a total of 40 visits were reduced to 36



Van Cortlandt Park Alliance leads staff and volunteers to sort and quantify collected debris from a litter survey in Yonkers, NY.

Photo Credit: Van Cortlandt Park Alliance

¹ The true total of un-paid volunteer hours cannot be calculated due to inconsistencies in recordkeeping for this metric by all participating organizations.

visits for the final analysis. Among the 18 sites, 11 sites were located in Westchester County and seven (7) were in Bronx County. A total of 17,843 items were collected during the 36 surveys conducted in the study area (Figure 3), resulting in a total of weight of 83.8 kilograms and a total volume of 919 liters. On average, 511 items were documented during each visit with an average weight of 4.7 kilograms and an average volume of 51 liters. Of all the sites, site BH_09 in the Bronx was found to have the highest counts, weight, and volume among all the surveyed sites with 3,054 items, a weight of 13.4 kilograms, and a volume of 219.4 liters.

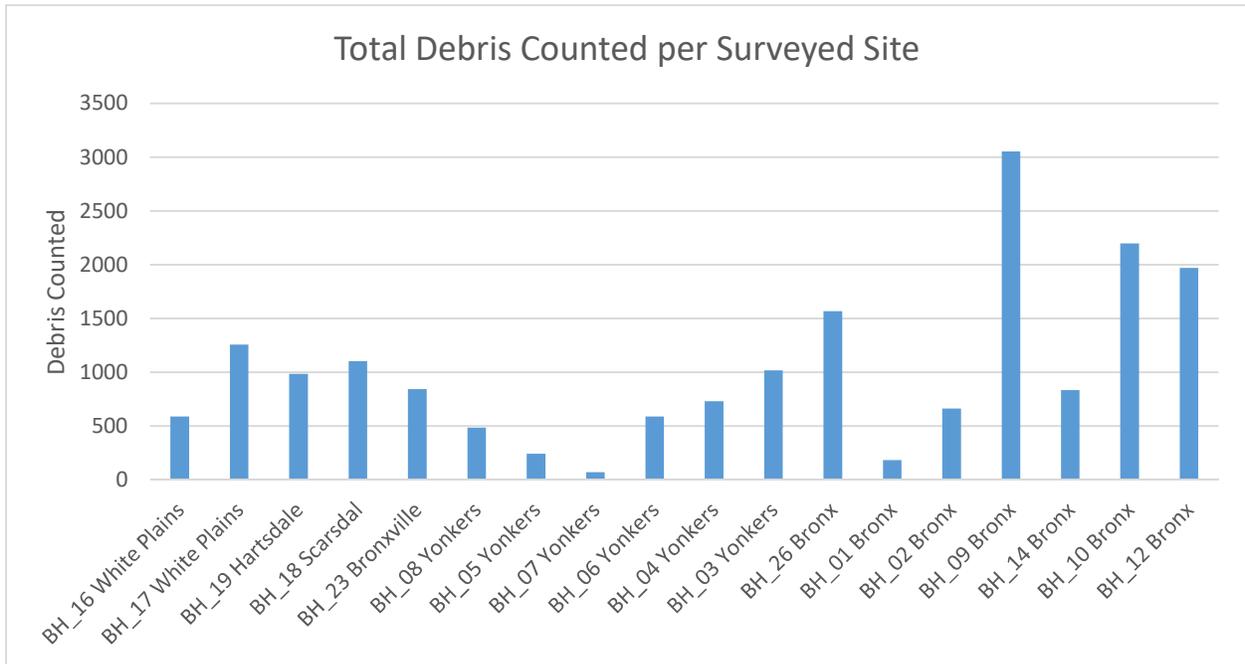


Figure 3: Total Debris Counted per Surveyed Site

In addition, correlations of foot and vehicle traffic against volume, weight, and counts of trash at each site were tested. The foot and vehicle traffic counts were obtained by tallying the number of people and vehicles that passed by the surveyor in at least two 10-minute periods. Correlation analysis of the three means of trash quantification revealed a less pronounced relationship with vehicle traffic (Figure 4) compared to foot traffic (Figure 5). These results suggest that foot traffic has a greater influence on the amount of trash on the street than the vehicle traffic.

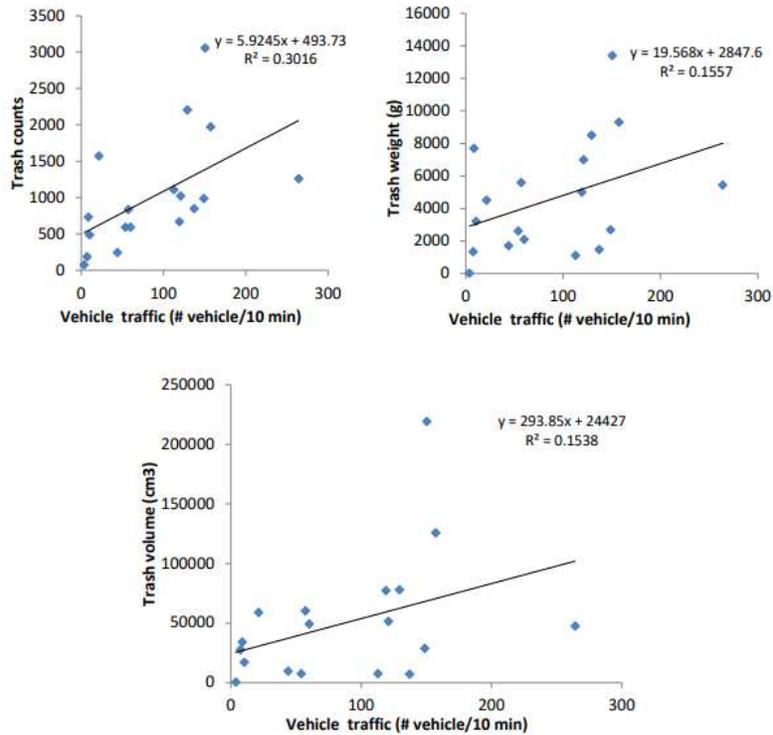


Figure 4: Correlations between vehicle traffic and trash counts ($R^2=0.3016$), trash volume ($R^2=0.1538$), and trash weight ($R^2=0.1557$).

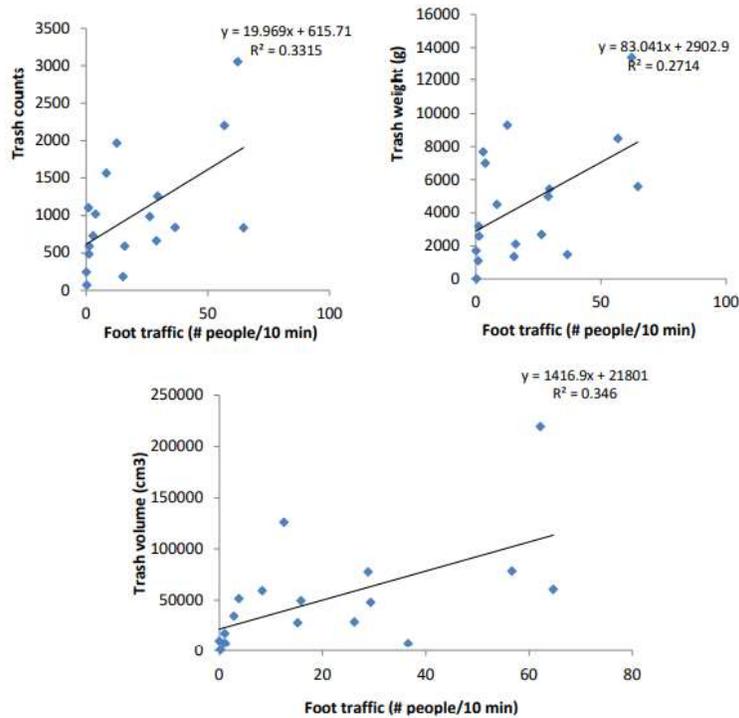


Figure 5: Correlations between foot traffic and trash counts ($R^2=0.3315$), trash volume ($R^2=0.346$), and trash weight ($R^2=0.2714$).

Floatable items, such as plastic/rubber, Styrofoam, and cigarette butts, accounted for 66.7% of the total number of items collected across the 36 surveys (Figure 6). The top three floatable categories were counted (Figure 7) and abundance of each floatable item was recorded. Of all 36 surveys, 58% of floatable debris was cigarette butts followed by 40% of plastic and rubber, and 2% of Styrofoam. Cigarette butts were found to be the most numerous among all items, representing 39.6% of all trash counts and 58% of all the floatable items documented.

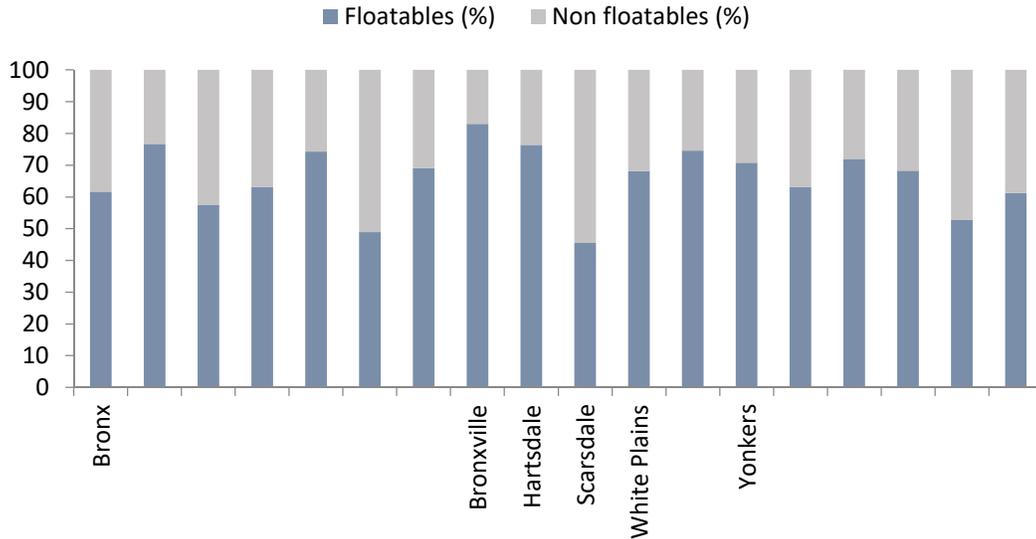


Figure 6. Relative abundance of floatable items (blue) vs. non floatable items (grey) documented at each site, arranged by municipalities.

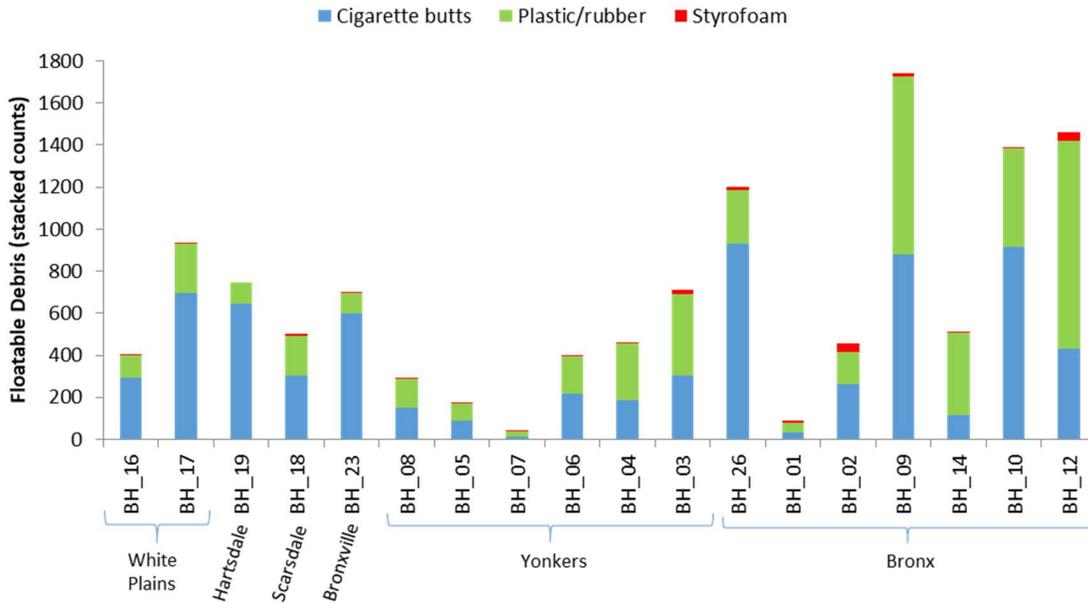


Figure 7. Counts of floatable trash in the top three floatable categories, cigarette butts (blue), plastic/rubber (green) and Styrofoam (red), documented at each study site.

On average, 23.6% of all items documented were found to be food and drink related. This is lower than the Passaic River Watershed, which had 32%, and national beach clean-up surveys that find single-use plastics and food-related wrapping making up one-third to two-thirds of all marine debris (Da Silva, 2018; USEPA, 2018). Across each of the 36 sites, food and drink related items ranged from 9% to 41.8% of the total relative abundance (Figure 8). Per site, an 800 by 800 meter squared quadrant which used the middle of the segment as the quadrant's midpoint identified a total of 351 food-related businesses. These included grocery or convenient stores, restaurants, fast food store/trucks/carts, coffee shops, delis, liquor stores, gas stations, bars or pubs, and other businesses where people may be leaving the business with consumer goods and potential trash.

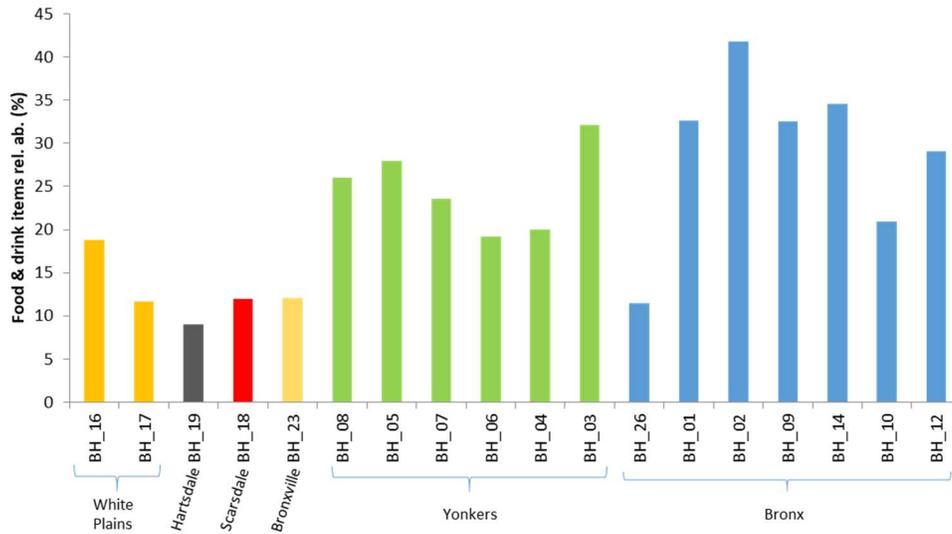


Figure 8. Percentages of food and drink items documented at study sites

Food and drink related businesses (all but restaurants) were found to correlate with all the food and drink related item counts documented during the survey ($R^2 = 0.3904$), indicating that food and drink related businesses have an influence on street trash (Figure 9).

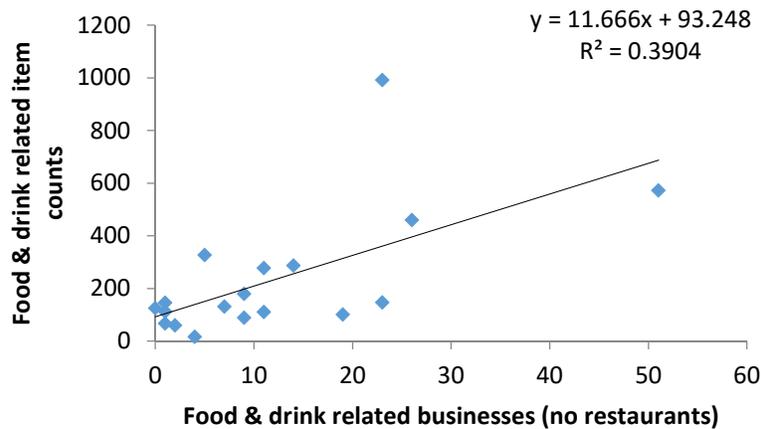


Figure 9. Correlation between the business activities selling food and drinks (all but restaurants) and the total numbers of food and drink items documented.

Methodology

All surveys were conducted using the same methodology indicated in the QAPP and recorded using the same datasheets to ensure a high degree of comparability between sites. Litter amount, type and site conditions were recorded using the datasheets found in the QAPP and were later submitted electronically to PRI using fillable excel spreadsheets provided by HEP. PRI's Project Quality Assurance (QA) Officer reviewed 10% of the data to verify completeness and reasonableness of the data entered into the datasheets by the community group supervisor and volunteers (Appendix B).

All survey days were avoided within 48 hours after street sweeping, trash collection schedules, and after a rain event. Each team consisted of a community group supervisor (who participated in the PRI training) and at least one additional individual, with a preference of three (3) individuals per team for safety reasons and an additional level of data verification. Teams were provided with clipboards, work gloves/latex gloves, safety vests, trash pickers, trash/recycling bags, and a site ID list which included street names and associated addresses delimiting the area to be surveyed and indicative coordinates.

A total of 20 sites were identified and surveyed twice to result in a total of 40 surveys led by a community group supervisor from the Bronx River Alliance, the Bronx is Blooming, Van Cortlandt Park Alliance, and the Bronx Theatre High School. The site name, ID, location and community group lead is listed in Table 1. Community groups conducted initial site visits to areas of interest where they had questions regarding debris distribution or had on-the-ground knowledge to areas impacted by debris. A total of 26 sites were initially identified and shared with HEP and PRI. The final list was narrowed down per protocols outlined in the QAPP by PRI to 20 selected sites. Sample photographs in Appendix C highlight the field work and conditions conducted during the surveys.

All survey locations consisted of a 400-meter stretch of the right-of-way (or sidewalk), one (1) foot into the street, and only on one side of the street. The starting point for the survey was recommended to be a particular cross-street or address identified on Google Maps. Consideration of flood areas, slope, surface runoff, impervious surfaces, and structures versus empty spaces or lots were also considered during the selection process. Litter surveys were conducted from October 30, 2018 through October 1, 2019, with no particular day of the week required. Trash was collected by the surveyors on site, but bulk items and hazardous materials were avoided and noted on the field form. For all site visits, a surveyor was responsible for annotating uncollected materials on site and tallying the collected items in an off-site location. A second surveyor was responsible to walk along the sidewalk to count vehicles and people passing in the designated study area for a total of 10 minutes. Collected items were then properly disposed of by the teams and the datasheets were submitted to PRI for analysis.

Quality Assurance Tasks Completed

For quality control measures, HEP and PRI primarily relied on the standardized methodology and protocols outlined in approved QAPP (Appendix A). HEP required community group supervisors and Montclair State University volunteers to participate in a training event. The community group supervisor was responsible for ensuring that the volunteers followed protocols on the day of the data collection and communicated with the QA manager. Lessons learned from the Passaic River Watershed to improve the QAPP were effective in the following:

- reducing inconsistencies between the number of trash bins and storm drains at the same site from the first and second survey visit;

- collecting debris materials and transporting it to an indoor facility where tallying and documentation;
- and clearly identifying the collection limits by improving the field site maps for the community group supervisor and volunteers.

HEP and PRI required a community group supervisor to be in attendance of all survey events to ensure protocols were followed. PRI, as the QA manager, extended communications to each community group supervisor to check in, and during calls the QA manager was able to address issues and concerns that were raised such as modifying the site limits due to safety concerns and clarifying the minimum size debris to be collected. As the QA manager received completed tally forms, clarifications were requested from the community group supervisor and/or volunteer and 10% of the data was reviewed to verify completeness and reliability of the data between physical data sheets and the entered digital spreadsheets. Request for responses did not always provide clarification and the QA manager thereby indicated when a failure in protocols was observed. This led to the removal of two sites, BH_13 Martin and BH_15 E 153rd, and the data collected was therefore removed from the analysis. The total number of study sites were reduced from 20 to 18 sites and a total of 40 visits were reduced to 36 visits for the final analysis. All data were recorded in the same datasheets as outlined in the QAPP for comparability analysis between sites.

A before and after photograph of each site was taken as part of the survey form protocol (additional photographs can be viewed in Appendix C). The community group supervisors that followed protocol by sorting trash off-site, took photographs of sorted trash by materials. The photographs provided a reference point for brand abundance, but not all volunteers conducted the survey in this manner. This created an inconsistency between sites and limited the identification of the most abundant brands in the survey.

Conclusions

The most effective way to prevent marine debris is to prevent waste, specifically single-use, disposable plastics such as bottles, bags, straws, stirrers, and food/drink-related wrapping (USEPA, 2018). The results of the Passaic River Watershed survey suggest trash reduction strategies should focus on pro-environmental behavior changes or actions targeting smokers (to reduce tobacco litter) and consumers or producers of food/drink-related litter (Cortes, Kim, Rubin, & Villela de Faria, 2016). Consistent with the Passaic River Watershed survey and a similar study in New York City, cigarette butts, as well as food and drink related items, were found to be the most numerous floatable debris found in the Bronx and Harlem River Watershed. This is a concerning problem across all sites surveyed in this study, especially along the sites in the Bronx. It is recommended that street trash or right-of-way litter management strategies and efforts should primarily focus towards the reduction of cigarette butts and food and drink related items.

Prior to the survey, NYCDEP established a *Don't Trash Our Waters* campaign which centered on specific neighborhoods where street litter is a persistent challenge, with a focus in the city's MS4 areas. In 2017 and 2019, the campaign was implemented in Coney Island to encourage local residents and businesses to play a role in keeping waterways trash-free by generating less trash (i.e., Zero Waste Pledge, The B.Y.O. Movement Pledge). This included making the connection between beaches and streets, provides opportunities for residents to adopt-a-basket (and notify sanitation team when bins are full), and organize clean ups (NYCDEP, 2016, 2018, 2019; NYC Sanitation, 2016). NYCDEP has also built litter control devices within sewer outfalls along the Bronx River that use hydraulic bar screens and nylon netting

systems to capture litter before it can become marine debris (NYCDEP, 2019). While some data is collected by NYCDEP, such as weight, they do not get into the specific breakdown of the type and material of the debris collected. In utilizing the specific data gathered as part of the *Stopping Trash Where it Starts*, as well as the similarly specific data collected by the Bronx River Alliance through *Project WASTE*, NYCDEP has an opportunity to design a campaign to target the most predominant source and types of marine debris in the Bronx and Harlem River watershed. Specially, a targeted campaign on cigarette butts and food/drink-related plastics in the Bronx would aid in the reduction of marine debris. A follow up survey could later be implemented at the same sites to determine the effectiveness of the campaign and further inform what additional waste management strategies are needed to reduce marine debris.

As suggested in the Passaic study, partnerships with local businesses and vendors can improve waste management strategies by placing trash bins and cigarette butt receptacles in specific areas where people either congregate or are likely to dispose of debris. For example, sites BH_09, BH_10, and BH_12 composition of cigarette butts and food/drink-related plastics were also the greatest areas with the most numerous amount of convenient stores (respectively, 14, 13, and 35 stores within each quadrant) where both materials (cigarettes and food/drink-related single use plastic) can be purchased. The initial study completed in New York City indicated that trash bins directly outside a place where litter is generated from does not capture all of the debris. By assessing the correlations of businesses and foot traffic, it is suggested that trash bins be available further away from these business to capture debris as the consumer is walking away from the place of purchased goods. For cigarette receptacles, it is suggested that they are placed in areas where people naturally congregate for a period of time, such as along business corridors (capturing employees taking cigarette breaks) and bus stops.

The results of this study further demonstrated that quantifying street litter using all three metrics (counts, weight, and volume) provides a clear picture for the purpose of prioritizing areas in need of cleaning and identifying locations that need a more effective waste management intervention. Past surveys often quantified street trash using count and ignored weight and volume. It is recommended that any future litter survey efforts should include all three metrics. Knowing the composition of street litter at the municipality level, or even better at the block level, will help in suggesting the type of intervention needed and the locations with the greatest needs. The study results suggest that the Bronx had the most street litter using all three metrics, counts, volume, and weight and further attention should be focused on implementing street trash or right-of-way reduction strategies in the Bronx.

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Appendices

A. Quality Assurance Project Plan: Stopping Trash Where It Starts

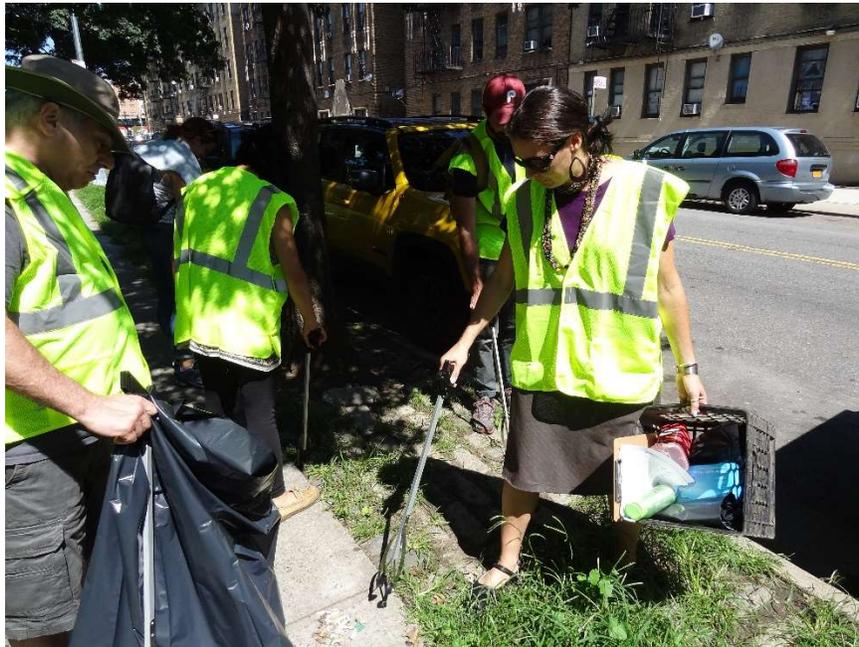
https://www.dropbox.com/s/vsa5pg3u7oocdm2/HRF%20QAPP-TFW_BronxHarlemRWatershed_FINAL.pdf?dl=0

B. Stopping Trash Where It Starts QC'd Data

https://www.dropbox.com/scl/fi/810ilsft5si3xrkwb1pt9/BronxHarlem_QC-dDate_Shareable.xlsx?dl=0&rlkey=9trssve64a555q51fpc9uvvy7

C. Site Survey Photographs

Local community groups and volunteers attend the litter survey protocol training at the Bronx River Alliance facility on August 23, 2018.





Bronx Theatre High School's site visits at BH_01 and BH_02 within the Bronx.





Bronx River Alliance site visit along BH_18 in Scarsdale.



Van Cortlandt Park Alliance site visits throughout Yonkers.

