Mississippi River Plastic Pollution Initiative

2021 SCIENCE REPORT

University of Georgia

Kathryn Youngblood, Sheridan Finder, Jenna Jambeck

Foreword

The Mississippi River is America's most essential inland waterway, providing hundreds of billions of gallons of water each day to key industries, as well as drinking water to 20 million people in 50 cities in 10 states. The river is rich in biodiversity, supporting a wide range of plant and animal species, but it also hosts a threatening foreign substance – plastic pollution.

Plastic litter that continuously enters the Mississippi River poses a large threat to environmental quality and ecosystem health, and these impacts extend far beyond the river valley. As the drainage system for 40% of the continental United States, plastic waste and other litter travels through storm drains and smaller waterways into the river and its tributaries, ultimately making its way to the Gulf of Mexico and into the ocean.

Approximately 11 million metric tons of plastic enters the oceans each year, so understanding the extent of the plastic pollution problem is key to devising effective solutions that will combat this crisis.

The United Nations Environment Programme North America Office, Mississippi River Cities and Towns Initiative, National Geographic Society and University of Georgia's Debris Tracker have come together through the Mississippi River Plastic Pollution Initiative to generate a first ever snapshot of plastic pollution along the River.

Using a 'citizen science' approach, this initiative facilitated and supported data collection along the lower, middle, and upper river. The aim was to understand the movement and accumulation of plastic pollution while painting as rich a picture as possible within a small amount of time of the extent, type, and brand of plastic litter along the river.

The intention is for the *Mississippi River Plastic Pollution Initiative 2021 Science Report* to generate information about plastic waste concentrations in specific areas, which all stakeholders – from policy makers, to businesses and citizens - can use to take action within their communities. We hope that this research will not only help cities and towns along the Mississippi, but also provide an example of what can be done collectively to address the plastic pollution crisis around the world.

Barbara Hendrie
Director, North America Office
United Nations Environment Programme

Dr. Jenna Jambeck
Distinguished Professor, Environmental Engineering
University of Georgia

Colin Wellenkamp
Executive Director
Mississippi River Cities and Towns Initiative

Valerie Craig
Vice President, Science & Innovation
National Geographic Society

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Contact:
Dr. Jenna Jambeck
jjambeck@uga.edu

Authors:
Kathryn Youngblood, Sheridan Finder, Jenna Jambeck

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Executive Summary

The United Nations Environment Programme (UNEP) North America Office, the Mississippi River Cities and Towns Initiative (MRCTI), the University of Georgia's Debris Tracker, National Geographic Society, and other local and national partners worked together on a pilot study for the Mississippi River Plastic Pollution Initiative to generate a first-ever snapshot of the state of plastic pollution along the Mississippi River. The data was generated through a 'citizen science' approach, enlisting the participation of hundreds of community volunteers covering targeted areas along the river to understand the movement and accumulation of plastic pollution. Debris Tracker, an open data citizen science movement and free mobile phone app, was used to collect the data. Three cities participated in the pilot study: Baton Rouge, Louisiana; St. Louis, Missouri; and St. Paul, Minnesota. The data gathered in the basin, along the river and in the pilot communities was examined to understand the state of plastic litter in these river cities. The goal was to generate as rich a picture as possible, within a dedicated timeframe, of the extent and type of litter that can make its way to the river.

The project consisted of the scientific strategy development, training and outreach, field data collection and data analysis and reporting. The community training and data collection occurred from March – April, 2021. The initiative was successful in engaging citizen scientists in the three pilot cities and beyond. Data collection along the river corridor, outside of the pilot cities, and continued tracking beyond the defined data collection dates of the initiative show that there is high interest and momentum to further expand data collection along the Mississippi River and in the Basin.

Over 94% of the 75,184 litter items documented in the river basin were located within 50km of the main stem of the Mississippi River, including 69,733 litter items logged on the Debris Tracker app and 5,451 items manually uploaded through the Debris Tracker website. Plastic was the top material found ranging from 74% to 81% of the count of items in the basin and in the cities. While there was some variation as noted in the report for particular differences in items found, the top ten items remained relatively consistent with cigarette butts, food wrappers, beverage bottles, hard/foam/film plastic fragments, plastic bags, aluminum cans, and paper being some of the most common items found. PPE, an emerging contaminant in the environment and waterways, was a consistent 1-2% of the items found (by count).

The pilot cities were each successful in collecting enough data to provide a snapshot of the litter in the city. The litter density calculated by the number of litter items over the area surveyed in (count/m^2) is similar for Baton Rouge and St. Louis, but appears relatively lower for St. Paul (Table ES-1). Further analysis of data and influencing factors could help to better evaluate both the similarities and the differences in the litter density data.

A small percent of the items logged (about 1.5%) had brands noted. The category of items with brand and most common packaging were noted for each city. St. Louis participants recorded the most brand data, followed by Baton Rouge, and then St. Paul.

Table 1: Pilot City Litter Summary Data

City	Items (Count)	Geofence	Transect Area	Overall Density
Baton Rouge, LA	9.546	30 x 33 km^2	13,800 m^2	0.61 items/m^2
St. Louis, MO	28,540	38 x 44 km^2	40,023 m^2	0.69 items/m^2
St. Paul, MN	12,997	21 x 34 km^2	43,179 m^2	0.28 items/m^2

Nearly 80% of the people who were logging litter data for this project also picked up the litter they were documenting. With a total of 75,184 items tracked in the basin, it is estimated that this data collection effort resulted in 60,150 litter items removed from the environment. Assuming an average mass of 5g (0.011lb) per litter item, this results in over a quarter ton (662lb or 300kg) of litter removed from the buffer area near the river during the project period.

After data collection was completed, feedback was solicited from the pilot cities, local organizations, and the core partner team. Components of the project that worked well and are recommended to be sustained or expanded are:

- Many participants collecting data reported they were collecting data along with others. This community-based aspect could be expanded in the messaging around the initiative, encouraging others to share data collection activities with their networks.
- Many users are tracking multiple times, which is an opportunity for individualized volunteer feedback and mobilization. A longer relationship of feedback to the user (e.g., seeing their data and totals) and input of data on their part, could foster extended engagement with the app.
- While the majority of users did choose to pick up the litter they logged, some did use the option to record data without cleaning up, making participation in the initiative more broadly accessible. The framing of data collection as a priority over cleanups, while a different paradigm than is typical for many cleanup groups, was key for the scientific success of the initiative.
- Using an open data and near real-time data collection tool like Debris Tracker had several benefits in that all of the data is freely accessible to anyone at any time, and the researchers could adjust their data collection activities to be complementary with the community-based efforts effectively and efficiently, in real-time.
- Cities and local partners want additional data collection in their communities to understand progress and effectiveness of efforts.

Project components to consider improving in future iterations are:

- Broader outreach, over a longer period of time, perhaps through community organizations not focused on cleanups, could expand the initiative's reach and in-person trainings, where possible, could help to get people tracking faster and more easily than virtual trainings.

- Incentives for data collection and/or stipends for organizations working with underserved communities, like environmental justice organizations could help reach new audiences.
- Further engagement with schools and universities could help with scientific, transect data collection for density analysis.
- The majority of the litter data was not tagged with a brand, speaking to the challenge of identifying upstream sources of common litter items such as cigarette butts, plastic bags and foam and plastic fragments and the time it takes to note this data beyond logging each litter item.
- Developing an automated or streamlined method of noting where data has been collected that can be easily communicated to the participants to satisfy the science requirement.
- While MRCTI is known to city officials, it is not widely known or recognizable as a brand amongst the general population, and thus clearer branding of the Mississippi River Plastic Pollution Initiative on the Debris Tracker app and in other outreach materials could serve to eliminate confusion.
- The timing of this project was shifted because of COVID-19. Further discussions on the time of year for sampling are important. In fall, the river is lower, so some debris may be more visible and accessible. The spring is often the time of community cleanup as the days become warmer, and the river height is good for observing floating debris.
- Organizations reported that training volunteers to collect data following the scientific protocols was challenging. Additional materials, such as training videos and engagement pamphlets made readily available to partner organizations, could remove some of the training burden on organizations. Additionally, a stipend could help offset organizational time and effort to engage new partners without resources to cover staff time to train and engage volunteers.

Essential to the success of this project is the participation by the pilot communities, especially the leadership and engagement of the Mayor and Mayor's offices. Results from this pilot initiative were presented to the Mayors and city officials, as well as city partners, in June 2021. Based upon the project partners and these discussions with the cities and local partners, the following opportunities for reducing plastic pollution in the Mississippi River were identified:

- Stormwater outfalls are moving waste from urban areas into waterways, lakes, and canals. Opportunities to intercept floatable debris exist at stormwater inlets and outfalls. From both mayoral teams and local partner organizations, there is high interest in interventions at stormwater drains and trash traps in waterways, such as canals.
- Recyclable materials like PET bottles and aluminum cans are high on the list of items found. These items are ending up in the environment rather than being recycled. Reverse vending, deposit schemes, or refill options are potential interventions. General doubts about the effectiveness of recycling programs from recent news might also be contributing to lack of participation in recycling.
- There are likely to be hyper-local neighborhood level discrepancies in litter densities, which may be driven by a lack of access to packaging types other than plastic and variability in city services. Community-based, neighborhood level engagement efforts could help generate context-specific solutions.
- Many of the commonly littered items – like cigarettes and food wrappers – are products people tend to consume on-the-go. Partners and mayoral teams feel there is a missing education component.
- Local governments face obstacles of time, resources, money, and prioritization. Many cities are engaged and ready to make change, but there is need for direction on next and the most effective steps. Developing action plans in each city with knowledge exchange between cities (e.g., facilitated by MRCTI) could be a key step.

- Engaging brands was an avenue that was mentioned by both local partners and mayoral teams to provide funding for local initiatives.

The next steps are to continue the dialogue in the cities, and between stakeholders, to take action in order to address plastic pollution in their community in order to protect their local environment, the Mississippi River and the global ocean beyond.

Introduction

Background

The Mississippi River flows over 2,000 miles from its headwaters in Minnesota to the Gulf of Mexico; the basin drains 40% of the United States and encompasses 32 states. It is one of our most essential inland waterways, supporting the livelihoods of people living along the river, and is home to diverse plant and animal species. The Mississippi River generates over $400 billion in revenue and supports over 1.5 million jobs.[1] The River is also impacted by our actions. Items that we use every day – like disposable coffee cups, water bottles, masks and plastic bags – can end up in the environment, and then be blown by wind or washed by rainfall into the river.

In September 2018, state legislators and mayors of cities and towns along the Mississippi River made a commitment to reduce plastic waste in the Mississippi River Valley. Under the leadership of the Mississippi River Cities and Towns Initiative (MRCTI), mayors invited public and private entities to reduce their plastic use or waste stream by 20% by 2020.

The United Nations Environment Programme (UNEP) North America Office, the Mississippi River Cities and Towns Initiative (MRCTI), the University of Georgia's Debris Tracker, National Geographic Society, and other partners worked together on a pilot study for the Mississippi River Plastic Pollution Initiative to generate a first-ever snapshot of the state of plastic pollution along the Mississippi River. The data was generated through a 'citizen science' approach, enlisting the participation of hundreds of community volunteers covering as large an area as possible along the river. Debris Tracker, an open data citizen science movement and free mobile phone app, was used to collect the data. Three cities participated in the pilot study: Baton Rouge, Louisiana; St. Louis, Missouri; and St. Paul, Minnesota. The data gathered in the basin, along the river and in the pilot communities was examined to understand the state of plastic litter in these river cities. The goal was to generate as rich a picture as possible, within a dedicated timeframe, of the extent and type of litter that can make its way to the river.

1. Data compiled by MRCTI

The Core Partners

MRCTI is a coalition of 101 mayors from across the Mississippi River Basin, which spans nearly a third of the country. The Mississippi River provides drinking water to more than 20 million people and 50 cities. More than 60 billion gallons of fresh water is withdrawn from the river daily. The River's resources support 1.5 million jobs and create $496.7 billion in annual revenue.

UNEP is the leading global environmental authority that sets the global environmental agenda, promotes the coherent implementation of the environmental dimension of sustainable development within the United Nations system, and serves as an authoritative advocate for the global environment. It provides leadership and encourages partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

The University of Georgia's Debris Tracker is a free mobile app designed to help community members make a difference by contributing data on plastic pollution. Developed in 2010 in partnership with the National Oceanographic and Atmospheric Administration (NOAA) and currently supported by Morgan Stanley, the Debris Tracker community is creating a bigger picture of marine debris and plastic pollution through collecting open data, generating scientific findings, informing policy, and inspiring upstream design. Every day, dedicated educational, non-profit, and scientific organizations and passionate citizen scientists from all around the world record data on inland and marine debris with the easy-to-use app, with over 4 million items logged to date.

The National Geographic Society, a global nonprofit organization, functioned as an organizing partner for this initiative. National Geographic Society uses the power of science, exploration, education and storytelling to illuminate and protect the wonder of our world.

Other Partners

Once the pilot cities were identified, local partners joined the initiative to identify areas of interest or concern for litter, organize cleanups that were happening during the project period, and to get training on how to collect data for this project. *1 Mississippi*, an organization supported by the Mississippi River Network (MRN) that encourages River Citizens through education, inspiration, and opportunities to embrace the Mississippi River, joined as an "umbrella" organization to connect all of the local partners in each city for a cohesive campaign along the Mississippi River. *1 Mississippi* launched a website for local partners to join together with each other and several webinar meetings were held (one overall meeting and one for each city) to engage and expand local partners. A list of city partners is included in Appendix A.

Methods

In order to get a "snapshot" of plastic pollution along the Mississippi River, the following methods were employed and are further described in this section.

1. Development of the scientific strategy and surveying plan
2. Training of community-based volunteers
3. Field work and data collection
4. Data Analysis

Development of Scientific Strategy and Plan

The planning portion of this project took place from September 2020 – February 2021. Planning involved meeting regularly with the core partners to discuss the goals of the project, identify the pilot cities, and connect with community partners to identify areas of interest or concern within the cities. A specific litter list (the MRCTI list in the Debris Tracker app) was developed collaboratively with partners during this portion of the project to be used by citizen science participants to collect data. The NOAA Marine Debris list, which is the default list in Debris Tracker, was modified based upon input from partners on common items found along the river. In addition, users had the opportunity to type in specific items under "Other" for each material category, as well as other items that did not fit into any category. The full MRCTI list of items is provided in Appendix B.

The largest deliverable of this planning period was the development of the science behind the field work and the development of the Debris Tracker Citizen Science Field Guide. The guide is a 13-page document that outlined the steps that community-members could take to join and participate in the initiative. The document contained step-by-step directions on how to contribute data to the project for 1) Litter on land, 2) Floating litter or Debris, and 3) Accumulation areas. These methods are further described here.

Debris Tracker was the data collection tool used in each of the methods outlined below. At the end of each tracking session was a survey to identify which method the user was employing and further information about land use and if the litter being logged was picked up or not. The survey contained the following questions:

1. What type of site were you sampling?
    - **a.** Litter on land
    - **b.** Floating debris in the river
    - **c.** Accumulation area
    - **d.** Other
2. Time spent tracking (minutes)
3. How many people helped collect your data?
4. Did you pick up the litter you tracked (yes/no)
5. Which of the following land uses most applies to the general surrounding area?
    - **a.** Residential (housing)
    - **b.** Commercial (developed buildings)
    - **c.** Mixed (housing and buildings)
    - **d.** Industrial (such as warehouses)
    - **e.** Green spaces (such as parks)
    - **f.** Other
6. If recording land-based debris, where was your survey transect located?
    - **a.** Along a sidewalk
    - **b.** In a gutter
    - **c.** Along a roadside
    - **d.** Other
7. Any interesting litter items to note?
8. Any other observations to share?

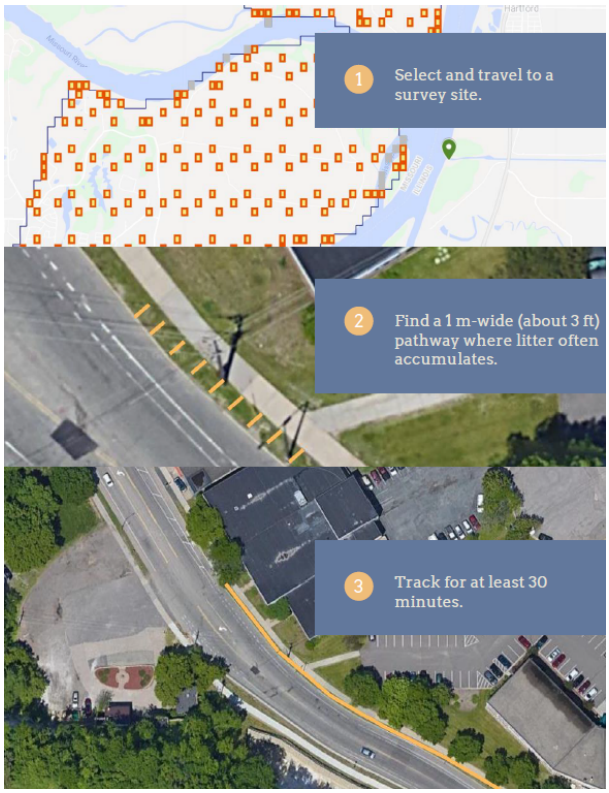
Litter on Land

Sampling areas in each pilot city were determined based on input from local partners and areas of interest in the community. To provide a comprehensive look at what items are ending up on the ground from societal activities close to the source and in order to capture active, upstream litter input, volunteers were asked to collect data in the identified urban areas (as opposed to just riverbanks).

Community members (citizen scientists) were asked to select a 200 x 200 m (or about 650 x 650 ft) square on the map provided (example shown in Figure 1). Once a community member arrived at their selected square, they were asked to determine a safe place to collect data along a roadside, sidewalk or other walkable area where litter often accumulates, e.g., a pathway on the side of a road, between a roadway and sidewalk or along a walkway in the park. If multiple pathways existed, the community members made the determination which to take. They were asked to follow the pathway generally; a pathway was not necessarily a straight line, i.e., if the path turns the person tracking should follow it.

The community member who was tracking was asked to visually estimate a 1m/approx. 3 ft width (about the length from the center of an adult's chest to the fingertips of an outstretched arm) covering the area where litter accumulates in the pathway. They were then asked to use Debris Tracker to walk for a minimum of 30 minutes and record all litter items in the 1 m wide pathway (transect). When possible, community members were asked to type the brand of each litter item in the description box in Debris Tracker.

Figure 1: Quick start steps for collecting data in a transect.



The goal of the yellow squares was to spread out the community members to collect data all around the cities in a variety of locations. Based upon previous work, the researchers determined that 300m of transect data in a 1km square was enough to characterize that area. Once adequate data was collected in the square, the square was marked dark blue on the manually updated, online sampling map. Community members were told that the blue squares indicated data collection was complete (which gave them a sense of accomplishment), and to collect data in other location squares that were still yellow.

Floating Litter and Debris

Floating litter observation points were designated and shown on the community maps for Baton Rouge, St. Louis, and St. Paul. Community members were asked to stand on the bank of the river in a safe location during the day (for optimal light and visibility) and observe the river for a minimum of 15 minutes. They were asked to use Debris Tracker to record all visible debris within about 100 m (or about 325 ft) during that time period. If there were floating items that

they could not identify, they were asked to log them as "other". They were also asked to not log natural floating debris, like sticks or logs. When filling out the submission survey, they were asked to note this effort as "Floating debris in the river" as the type of data collection.

Accumulation Areas

During the planning phase of the project, some organizations identified areas where litter accumulates and that needed to be cleaned up. Some organizations already had planned clean-up events, which ranged from locations in a park, along the riverbank, a canal or in a gutter.

Volunteers were given two options to collect data in this situation:

1. Log data as they cleaned: Tracking in pairs with one person logging items in Debris Tracker while the other partner cleans up. This generates the most accurate geospatial litter data.
2. Clean First, Log Later: If it was easier to pick up all the litter and then sort and count it, community members could do that. While this doesn't generate point-specific data on where litter is found, it can still be valuable in identifying broad patterns. There are two options for getting the data to the database in this case.

If the community member was in the same location where they collected the litter, they could sort the litter and log the data in the Debris Tracker app at the site.

If they were sorting in a different location than where they collected the litter (or if they needed to log it on their computer later), they could log in to their account on debristracker.org and select "Manually upload data." They could enter the quantity and type of items they have found (just like in the app) and then select the location where the data was collected on a map. Like data from the app, manually uploaded data is part of Debris Tracker's open database that is free and publicly accessible.

When filling out the submission survey, the community members were asked to note this effort as "Accumulation area" as the type of data collection. If a community member opportunistically came across an accumulation area in a transect or during tracking, they were asked to log it as an accumulation zone in Debris Tracker and estimate the area in the description box.

Training of Community-Based Volunteers

Training consisted of developing a video overview of the project and giving one targeted webinar to educators and four webinars to community groups and individuals. The education webinar was given February 25, 2021. The community webinars were given over four weeks in March. Each of the webinars included 20 minutes of training on how to use Debris Tracker and how to collect data for the initiative, followed by 40-45 minutes for further details on the development of the science, Q&A, and highlighting or hearing from members of the pilot cities and communities about local plastic pollution and environmental issues. All webinars were recorded and placed on the main project

webpage at UNEP for anyone interested in the project to access. The following webinars were given from February 25 – March 31, 2021:

- Educator Workshop – February 25, 2021
- Data Collection for Land-based Plastic Pollution – March 10, 2021
- The Debris Tracker and Local Initiatives – March 16, 2021
- Citizen Science and Environmental Justice – March 25, 2021
- Local Ecosystems and Plastic Pollution in Cities – March 31, 2021

Field Work and Data Collection

The primary field work of the initiative took place from April 1 – 25, 2021. This was the advertised time window for the project to the public and participating groups and partners. Public events to disseminate information about the project and to encourage data collection by the community were held in each city. The events were held on each Saturday during the window of field work and consisted of speeches by city representatives (often the mayor) and representatives from MRCTI, University of Georgia and sometimes other cities or partners. Each city event is described in more detail below.

Baton Rouge, Louisiana

This event occurred April 10, 2021 and was led by Mr. Mark Armstrong of the City of Baton Rouge. The event occurred on a barge on the river hosted by Shamrock Marine and included speeches by the following:

- City of Baton Rouge: Hon. Sharon Weston Broome, Mayor of Baton Rouge
- UGA: Prof. Jenna Jambeck (with Kathryn Youngblood in attendance)
- LSU: Prof. Mark Benfield
- Local press attended and notable stories included:
  - » The Advocate
  - » WBRZ TV

St. Louis, Missouri

This event occurred on April 17, 2021 and was led by Charlene Waggoner, PhD of the Greenway Network, Inc. in collaboration with Brian Waldrop of the Missouri Department of Conservation. The event occurred at the City's North Riverfront Park and included speeches by the following:

- City of St. Louis: Tom Nagel, Deputy Communications Director for Mayor Lyda Krewson presented a proclamation declaring the day "Mississippi River Plastic Pollution Initiative Launch Day"
- City of Kimmswick, MO: Hon. Phil Stang, Mayor of Kimmswick

- City of East St. Louis, IL: Hon. Mayor Robert Eastern III, Mayor of East St. Louis
- MRCTI: Mr. Colin Wellenkamp
- MRCTI: Ms. Jennifer Wendt
- UGA: Prof. Jenna Jambeck (with Sheridan Finder in attendance)
- Local press attended and notable stories included:
  - » US News
  - » KMOV TV
  - » FOX 2

St. Paul, Minnesota

This event was held April 24, 2021 and was led by Ms. Angie Tilges of Great River Passage. The event was hosted to highlight the St. Paul Citywide Spring Cleanup, but also mentioned St. Paul's participation as a pilot city in the initiative. It occurred at Harriett Park directly on the river in St. Paul and included speeches from the following:

- City of St. Paul: Russ Stark, Chief Resilience Officer
- City of St. Paul: Hon. Melvin Carter, Mayor of St. Paul
- Conservation Corps: Ms. May Yang-Lee
- MRCTI: Ms. Jennifer Wendt
- UGA: Prof. Jenna Jambeck
- Pioneer Press
- KSTP
- WCCO

In addition to the above events to encourage data collection in the community, UGA researchers traveled to each city to collect data to be complementary with the community-based work. Researchers could observe, in real time, where the community was collecting data and they could work to collect data where it was needed. Prof. Jenna Jambeck traveled to all three cities for the project and was in Baton Rouge April 7 – 11, St. Louis, April 15 – 18, and St. Paul April 21 – 25. Debris Tracker Citizen Science Director, Kathryn Youngblood was in Baton Rouge April 8 – 12 and St. Louis April 13 – 15. Graduate Research Assistant Sheridan Finder was in St. Louis from April 15 – 18. In Baton Rouge, Kathryn Youngblood visited a classroom and students along with a National Geographic Educator on April 12. In St. Louis, Jenna Jambeck and Sheridan Finder also visited a National Geographic Educator classroom in St. Louis on April 16. In Minnesota, Jenna Jambeck gave a seminar to the University of Minnesota on April 23. In addition to all of the community-based activities outlined in this report, GPS embedded bottle tags were launched by a collaboration of the researchers and community members in St. Louis and St. Paul (technical issues prevented launch in Baton Rouge, but that is expected in June 2021). These bottle tags were mentioned in the launch events and covered by the press. They have been sending data back to the researchers and their location and paths are posted on the Mississippi-specific Debris Tracker page. Besides the community collaborators involved, academic collaborators in each community include: Baton Rouge, LSU, Mark Benfield; St. Louis, SLU, Elizabeth Hasenmueller; St. Paul, UMN, Boya Xiong.

Data Analysis

Land-Based Litter

Data analysis was conducted with Geographic Information Systems (GIS) including using ArcMap to determine the quantity and the characteristics of litter collected in five areas that are nested within each other, starting with the largest area. Data was queried from the database in the five areas from both the MRCTI list and the NOAA list for a distinct time period. While the publicly specified time period of the project was April 1 – 25, community members began tracking right after trainings were completed in March. To take all associated data into account, the time period considered for all geofenced areas of this report is March 15 – April 25. In addition, while the MRCTI list was the targeted list for use for the project, the researchers were aware of various groups using the NOAA list as well, and since the list is similar to the MRCTI list, data in the areas of interest were pulled from each list. The areas identified to provide a snapshot of litter and plastic pollution along the Mississippi River were:

1. **The entire Mississippi River Basin —** To quantify and characterize the litter in the entire Mississippi River Basin, which drains 40% of the continental US. Since the press about the project was national, people may have tracked anywhere in the entire basin, so this area was considered first geospatially.
2. **Within 50 km of the river —** To quantify and characterize the litter closer to the river. This litter may be able to make its way to the river by getting blown or washed into the river or waterways that lead to the river.
3. **Baton Rouge, Louisiana —** To quantify and characterize the litter in a 30 x 33 km^2 geofence surrounding the city that encompassed the majority of areas that community members tracked. Also, to evaluate the number of transects that were completed in the gridded areas identified by the researchers.
4. **St. Louis, Missouri —** To quantify and characterize the litter in a 38 x 44 km^2 geofence surrounding the city that encompassed the majority of areas that community members tracked. Also, to evaluate the number of transects that were completed in the gridded areas identified by the researchers.
5. **St. Paul, Minnesota —** To quantify and characterize the litter in a 21 x 34 km^2 geofence surrounding the city that encompassed the majority of areas that community members tracked. Also, to evaluate the number of transects that were completed in the gridded areas identified by the researchers.

Floating Litter

Floating litter was compiled in terms of time spent by community members and items observed and logged into the app.

Accumulation Areas

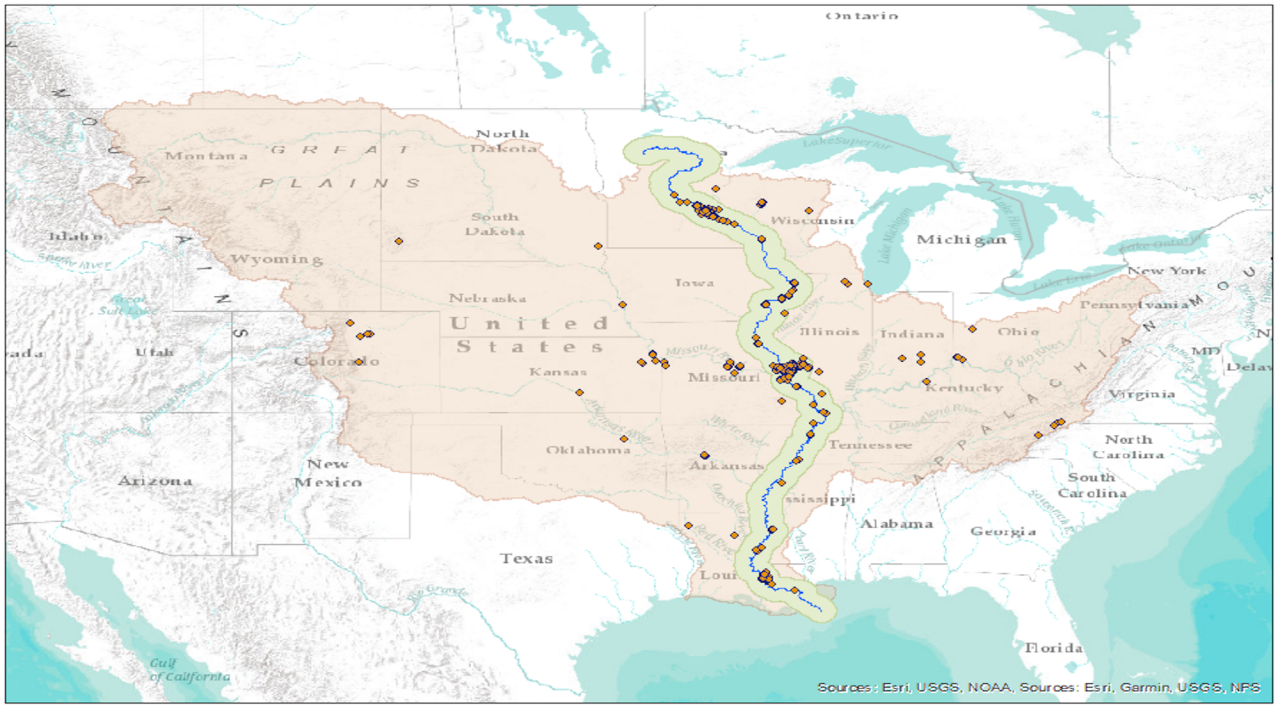
Accumulation areas were mapped and locations are shown in the results. These are areas where cleanups also took place which were noted and recorded in Debris Tracker by volunteers.

Results

Litter in the Mississsippi River Basin

The Mississippi River Basin encompasses 32 States and drains 40% of the continental United States (Figure 2). The total number of items tracked in the entire basin during the timeframe considered for this project (March 15 – April 25) was 75,184 items, including 69,733 items tracked on the Debris Tracker app and 5,451 items manually uploaded on the Debris Tracker website. The top material categories were plastic (74%), metal (8%), and paper (7%) (Figure 3). The top ten items found in the entire basin are shown in Figure 4, with cigarette butts leading the way, followed by food wrappers, beverage bottles and foam fragments.

Figure 2: Map of Debris Tracker Data along the Mississippi River



Data collected by community members in the Mississippi River Basin and within 50km of the main stem of the River

Figure 3: Material Categories (by percent) logged in the Mississippi River Basin

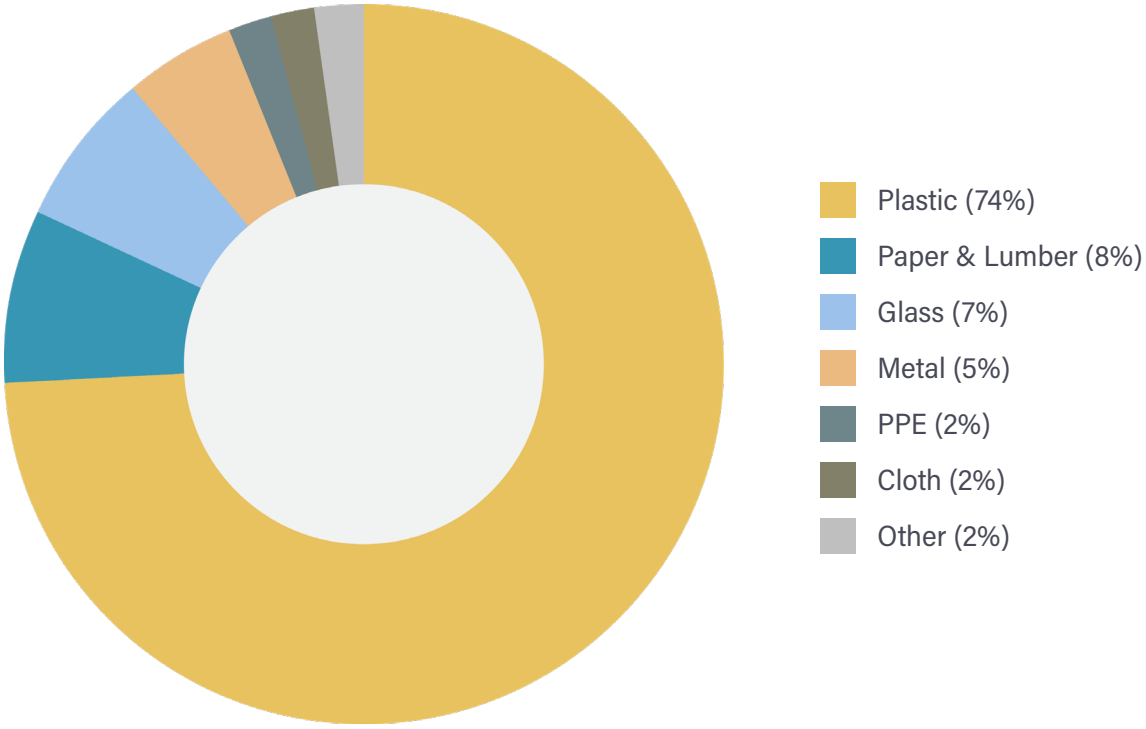
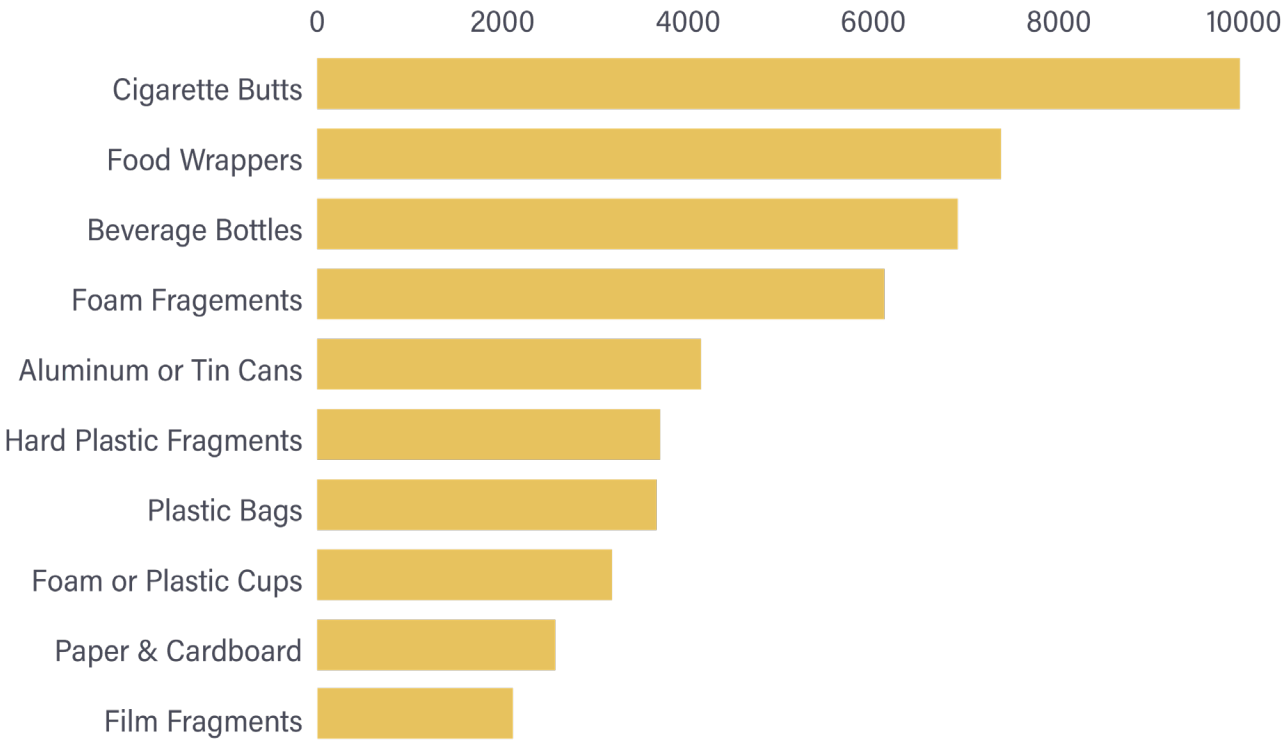


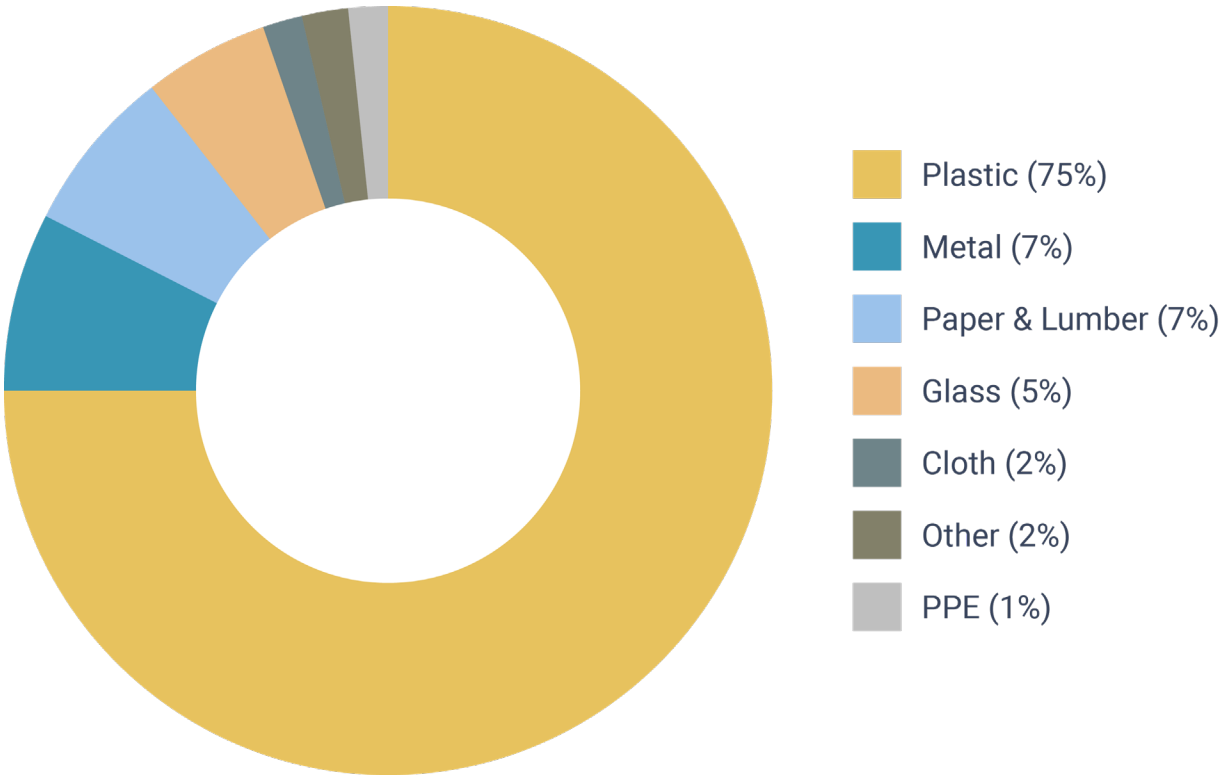
Figure 4: Top Ten Items (by count) logged in the Mississippi River Basin



Litter along the Mississippi River

The goal of this project was to increase our understanding of the state of plastic pollution along the Mississippi River, so data was compiled in the 50km buffer (as outlined in the Methods) along the main stem of the Mississippi River (shown in Figure 2). A total of 1,307 participants logged 64,936 litter items in 708 tracking sessions; an additional 5,451 items were manually uploaded through the Debris Tracker website, all within the 50 km buffer. In total, 70,387 items were logged within the buffer. 94% of items logged in the basin were logged within 50 km of the river. Because nearly all the data was collected near the river, the results are similar to, and drive the characteristics of the basin data previously presented. The largest material category logged was plastic (75%) followed by metal (7%) and paper (7%) (Figure 5). The states along the river with the most data collected were Missouri (36.1%), Minnesota (27%), Louisiana (17.2%), Illinois (14.1%), Tennessee (2.2%), Iowa (2.1%), Wisconsin (0.9%) and Mississippi (0.5%).

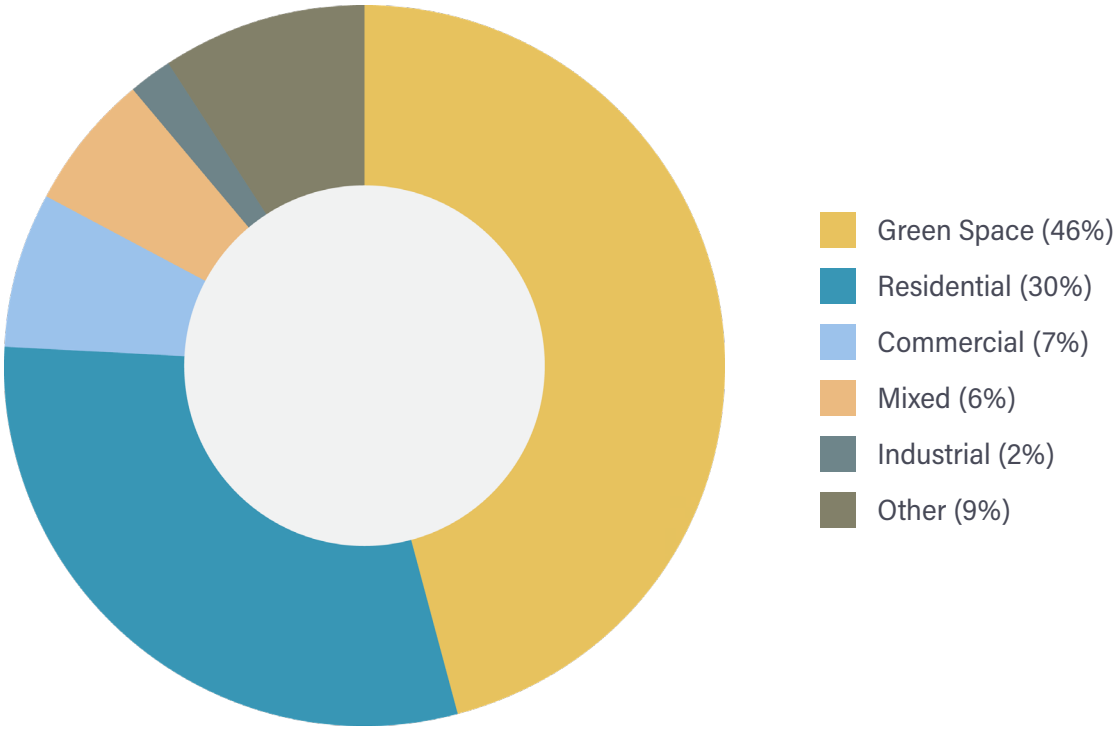
Figure 5: Material Categories (by percent) logged within 50 km of the of the Mississippi River



A survey was given at the end of each tracking session when participants were using the MRCTI list (see Methods section for details of the survey). While the survey was optional, there was outstanding participation; 88% of the people logging data with Debris Tracker also responded to the survey before submitting the data. Nearly 80% of the people who were logging litter data for this project also picked up the litter they were documenting. With a total of 75,184 items tracked in the basin, it is estimated that this data collection effort resulted in **60,150 litter items removed from the environment**. Assuming an average mass of 5g (0.011lb) per litter item, this results in over a quarter ton (662lb or 300 kg) of litter removed from the buffer area near the river during the project period.

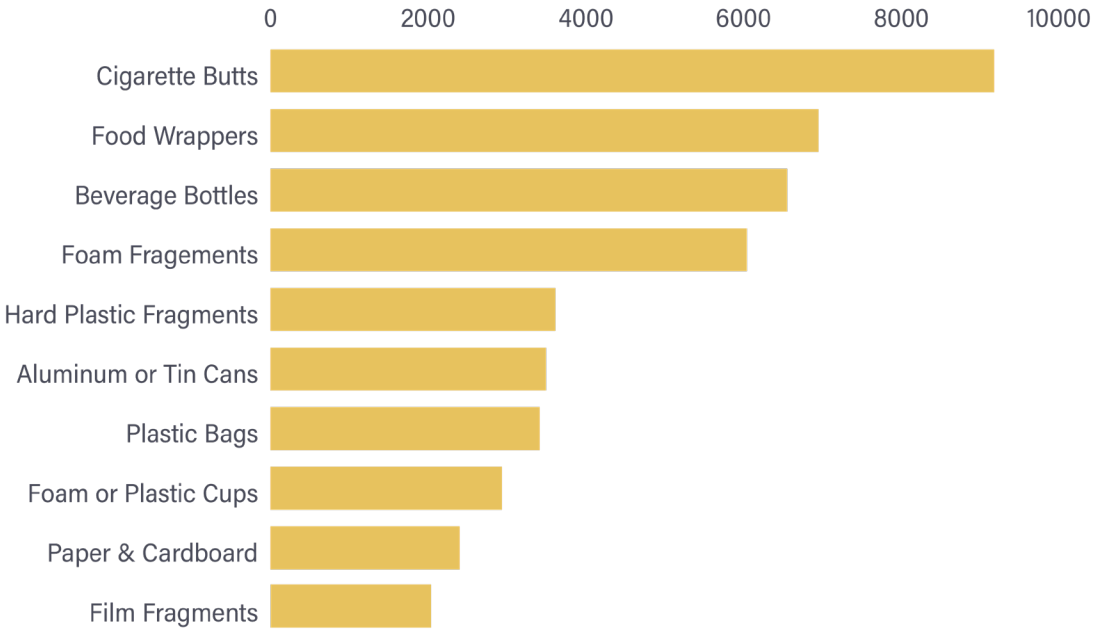
Within 50km of the river, the most common land use area where data was collected was green space (e.g., parks) (46%) followed by residential areas (30%) and to a lesser extent, commercial areas (7%) and mixed use areas (6%). The land use area with the least data collected is industrial areas (2%) (Figure 6). Land use is known to have impact on litter quantities and characteristics, so having a diverse set of them to represent the areas along the river is important. Determining the land use percentages within the buffer of the river could be a good next step in analysis. Future work could then examine land use for choosing areas to collect data; however, community members may not be as likely to collect data in industrial areas or may have difficulty with access. The influence of land use can be further explored in more in-depth data analysis as well as future work.

Figure 6: Land use areas where community members reported tracking litter along the Mississippi River (90% reporting)



The most common items found in the 50k buffer of the river for this project are cigarette butts, food wrappers, beverage bottles, foam fragments and hard plastic fragments (Figure 7). The top 10 items found also include plastic bags, aluminum cans and plastic or foam cups (Figure 7). Some of the interesting litter items noted by community members were a cash register drawer, a bathtub, boogie boards, doll heads, a refrigerator door, political campaign signs and a two-foot long large plastic owl.

Figure 7: Top Ten Items (by count) logged within 50 km of the Mississippi River Basin



Participants were also asked to enter brand information on litter items when possible. Participants may have chosen not to enter brand or may not have been able to discern brand information, so there is no brand ranking; however, common brands found in each city are listed to provide information on what company/industry stakeholders may be interested in discussions about the results. A total of 965 (1.5%) items had brand identified when they were logged on the app (note that submitting brand data was not available when using the manual data upload on the Debris Tracker website). Of that 965 items, a total of 322 unique brands were named. Brand information may help local and place-based discussions, so further information on brands is provided in each pilot city litter results section.

Litter in the Pilot Cities

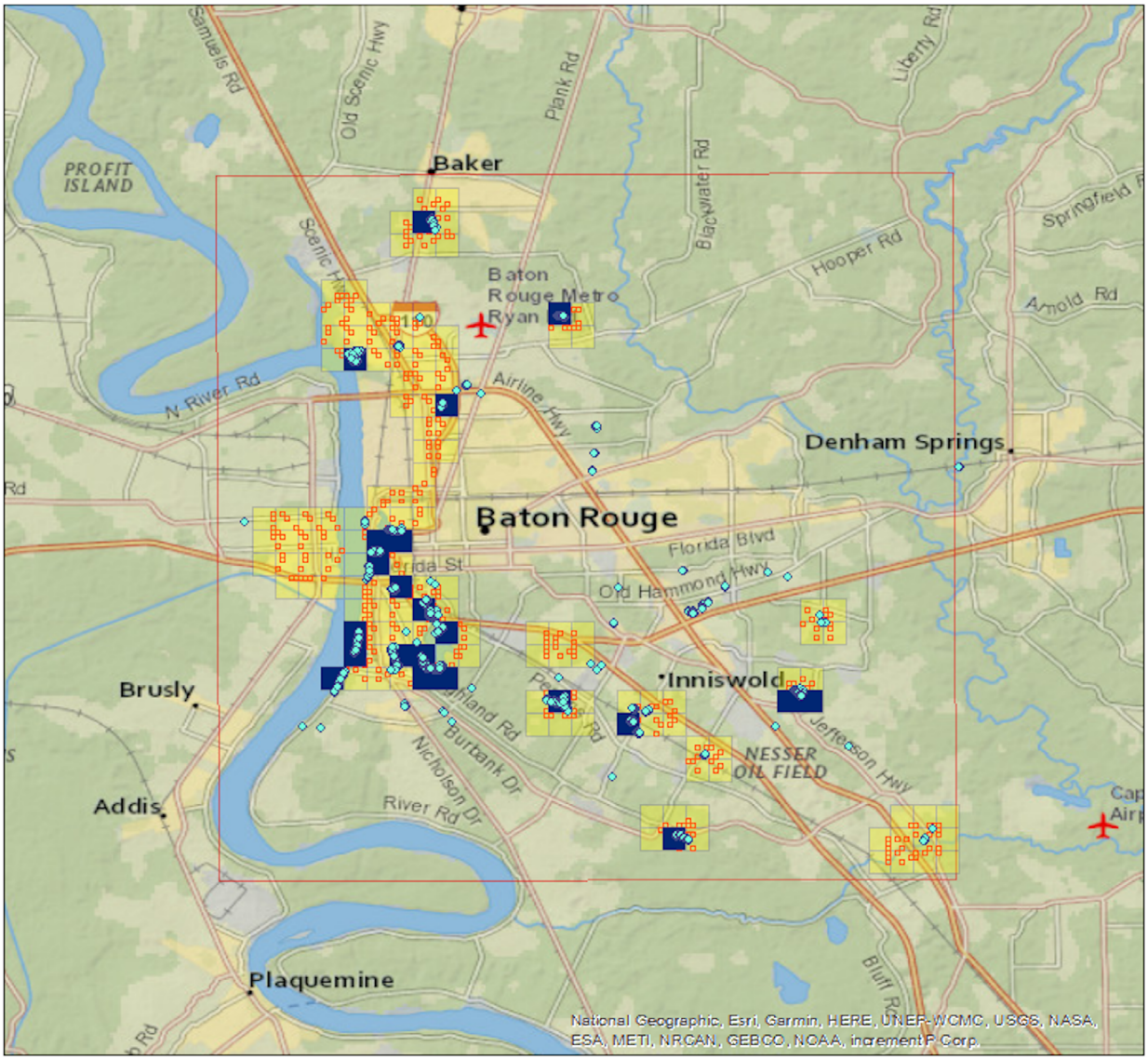
Three cities joined the Mississippi River Plastic Pollution Initiative during this pilot phase and represented the areas of the river near the source, in the middle and closest to the mouth. The cities of Baton Rouge, Louisiana, St. Louis, Missouri, and St. Paul, Minnesota agreed to participate in the initial stages of development of community-based data collection to represent a snapshot of plastic pollution along the Mississippi River. This section details the data collected on litter in each pilot city.

Baton Rouge

The geofenced area in Baton Rouge is 30 x 33 km^2 and encompassed 145 yellow 1km^2 squares for community members to start their tracking in 402 targeted locations (each 0.2 km^2). Community members went to 52 of the 145 targeted areas (36%) to collect data and 22 (15%) of the targeted areas met the benchmark of data collection for

density analysis (Figure 8). A total of 13,286 meters of 1m wide transects were completed in the targeted areas and an additional 514 meters was completed outside the targeted areas (but still inside the geofence) for a total of 13,800 m^2 of transects completed in Baton Rouge. A total of 8,388 items were logged into Debris Tracker in the transects conducted inside the geofence of Baton Rouge.

Figure 8: Geofenced area of Baton Rouge

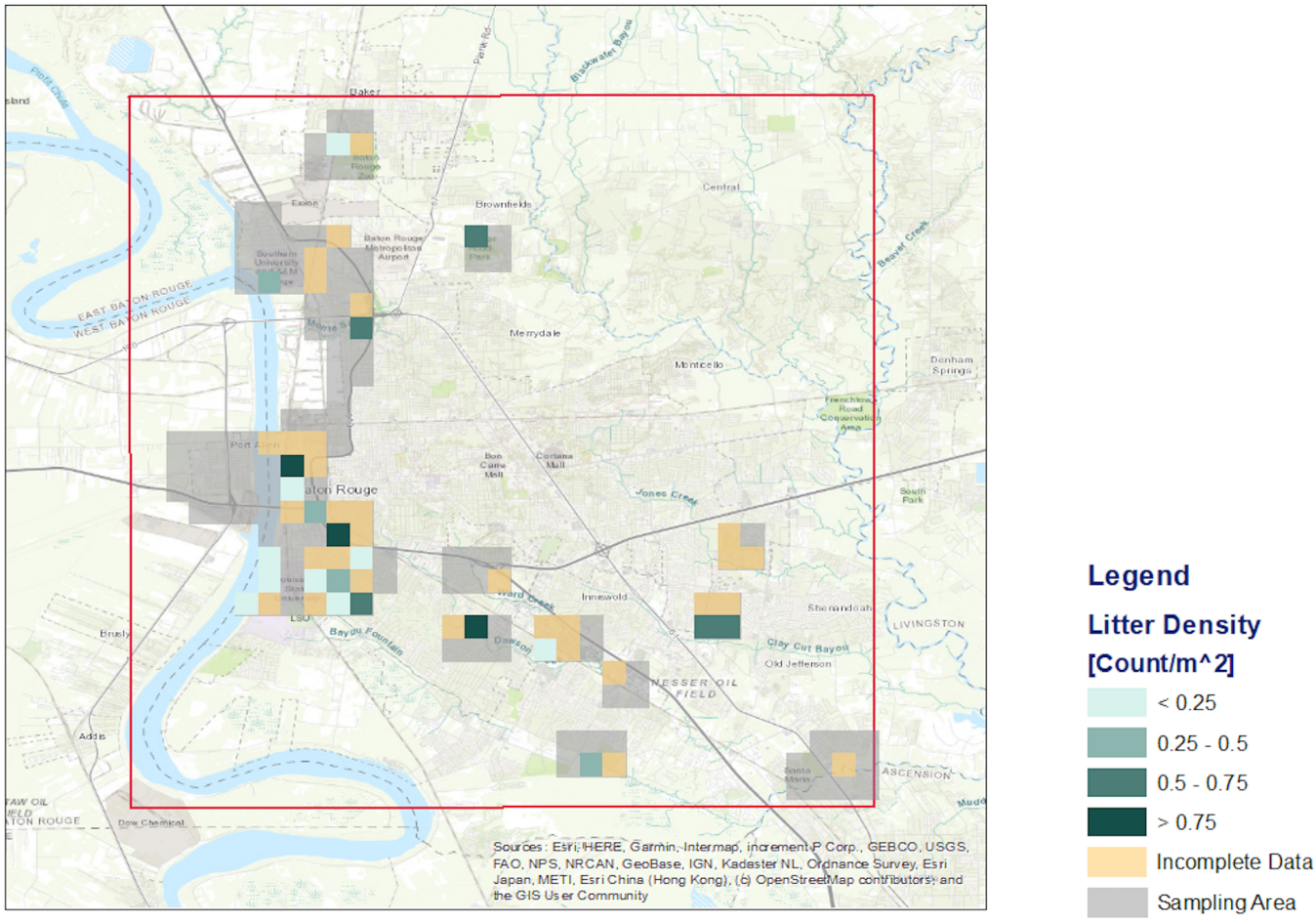


Note: the yellow squares indicate targeted areas for community-based tracking, the blue squares show where the benchmark of data was collected, and the light blue dots are items logged with the Debris Tracker app or manually uploaded on the Debris Tracker website.

Based upon the 13,800 m^2 of transects completed, the overall (average) litter density in Baton Rouge is 0.61 items/m^2. However, this litter density differed in various parts of the city that were sampled (Figure 9). An interactive online version of this map was supplied to the city to be able to explore litter densities across the city in differing neighborhoods. Further investigation of the data in terms of population count, land use and other potential influencing factors

may be necessary in order to fully evaluate the similarities or differences in the litter densities between neighborhoods and the cities. In addition to data collected with the app, 1,158 items were manually uploaded on the Debris Tracker website for a total 9,546 litter items recorded in Baton Rouge.

Figure 9: Litter Densities Across Baton Rouge in April 2021



The largest material category logged was plastic (82%) followed by metal (6%) and paper (5%) (Figure 10). The emerging contaminant of PPE was 1% of items logged. The top items logged in Baton Rouge were beverage bottles as the top item, followed by food wrappers, foam fragments, and foam or plastic cups . Many of the cups observed in the field were foam. Coming in third was foam fragments, which could be the result of foam cups and other items fragmenting in the environment. Cigarette butts were ranked 5th in the top items which differs from both the basin data, river data and the other two pilot cities' data. Notably, straws also ranked in the top 10 items in Baton Rouge (Figure 11).

Figure 10: Material Categories (by percent) logged within the geofence of Baton Rouge

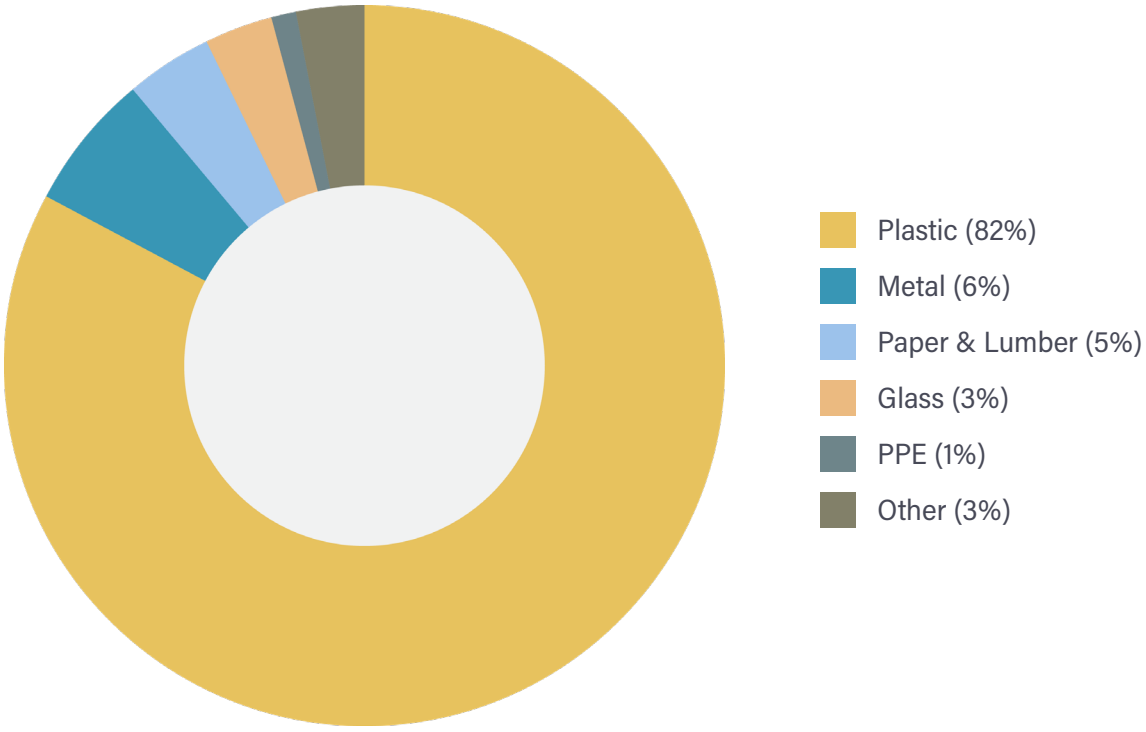
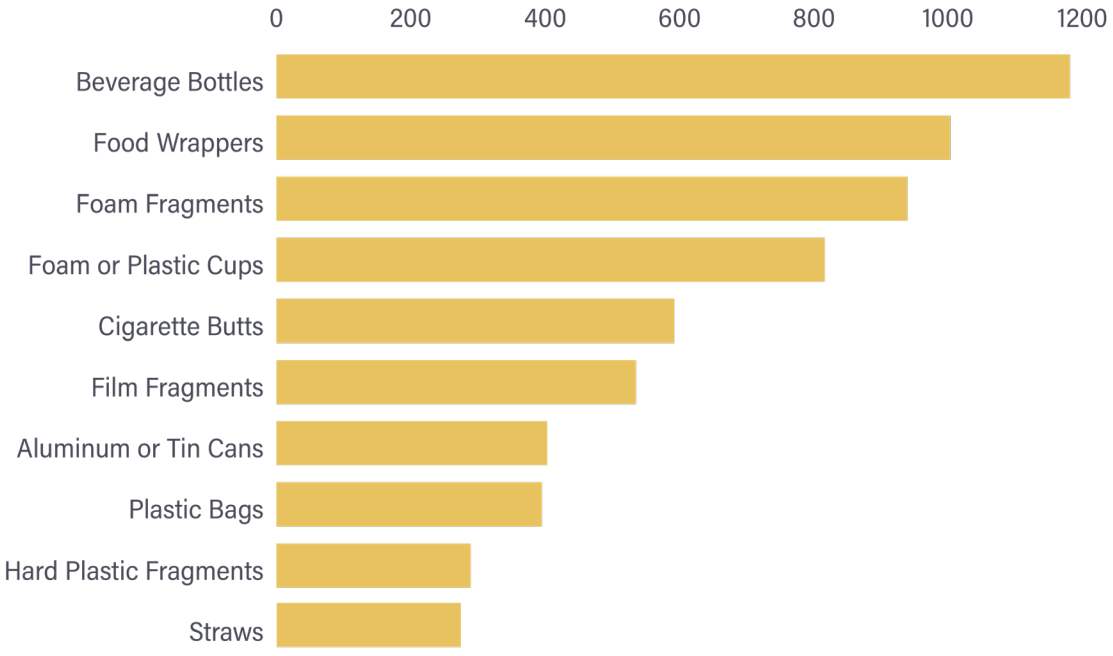


Figure 11: Top Ten Items (by count) logged within the geofence of Baton Rouge



Baton Rouge's geography contains numerous water bodies, both natural and engineered. The city is designed to drain quickly from regular precipitation and flooding events. The water system includes canals, lakes and bayous, which provide ample opportunity for transport of plastic from land to aquatic systems. While cigarette butts may simply be less than the top three larger items in Baton Rouge, there also is the possibility that they could be transported faster to water bodies while larger items stay on land longer (this may also be observed with fragments as well). During field data collection by the researchers, it was observed that even in areas where transects were not highly populated with people, there was still litter observed in nearby waterways or canals, likely transported by wind or water. There are three booms installed in canals in Baton Rouge, which serve to capture some floating debris (Figure 12). One of these booms was sampled by Prof. Mark Benfield and his students for this project. Further information on what was found there may shed light on the composition of litter found on land, as well as the movement of litter from land to water bodies in Baton Rouge. Other observations for Baton Rouge included litter in canals and waterways that appeared to be associated with stormwater outfalls, and while some debris was observed along the river banks, the river level was high during the data collection period, making litter deposition along the banks challenging to observe.

Figure 12: Example of storm drainage deposition of litter and canal with floating accumulation areas.

Of the 8,388 items logged with the Debris Tracker app in Baton Rouge, 129 (1.5%) entries noted brands with 80 unique brands mentioned. This is a very small quantity of brands identified, so caution should be taken when referring to this data; however, when examining the categories of items found, there are brands mentioned to start conversations about litter and plastic pollution (Table 1). Brand information was intended to be collected by LSU from the boom that was sampled during this same project period (but outside the scope of this report). The LSU data may provide more insight on brands for the City of Baton Rouge.

Table 2: Categories of items and brands noted by community members in Baton Rouge

Category	All Brands mentioned (in alpha order)
Alcohol (typically not plastic packaging)	Abita, Anheiser-Busch, Bud Ice, Bud Light, Budweiser, Corona, Makers's Mark, Michelob Ultra, Mike's Hard Lemonade, Miller Lite, Natural Light, Seagrams, Smirnoff, Taaka, T.W. Samuels
Beverage (often plastic packaging)	Apple & Eve, Aquafina, Bolthouse Farms, Capri-Sun, Coca-Cola, Dasani, Diet Coke, Dr. Pepper, Grower's pride (juice), Kleinpeter (dairy), Minute Maid, Mott's, Red Bull, Sprite
Candy/gum (nearly always plastic packaging)	Air Heads, Altoids (metal packaging), Butterfinger, Heath, Hi-Chew, Jolly Rancher, Juicy Fruit, M&M's, Milky Way, Nestle, Now and Later, Reese's, Snickers, Three Musketeers, Werther's Original, Wrigley's
Condiment (plastic)	Heinz, House Recipe
Fast food (usually paperboard except for wrap/cups — plastic lined paper or foam)	Cane's, Church's, McDonald's, Popeyes, Rally's, Sonic, Wendy's, Whataburger
Fast food (foam Cups)	Smoothie King, Thirst Buster
Fishing gear (usually metal or plastic)	Eagle Claw
Personal care (typically plastic)	Aleve, Band-Aid, Chapstick, Halls
PPE (plastic)	Heypex Global
Snack (almost always plastic)	Welch's, Fruit Roll-Up, Smuckers, Doritos, Tillamook, Hostess, Hungry Jack, Orville Redenbacher's, Dole
Tobacco (plastic)	Black and Mild, Kool, Swisher Sweets, White Owl
Unknown/Other	Firestone, Great Value, Lululemon, Xerox

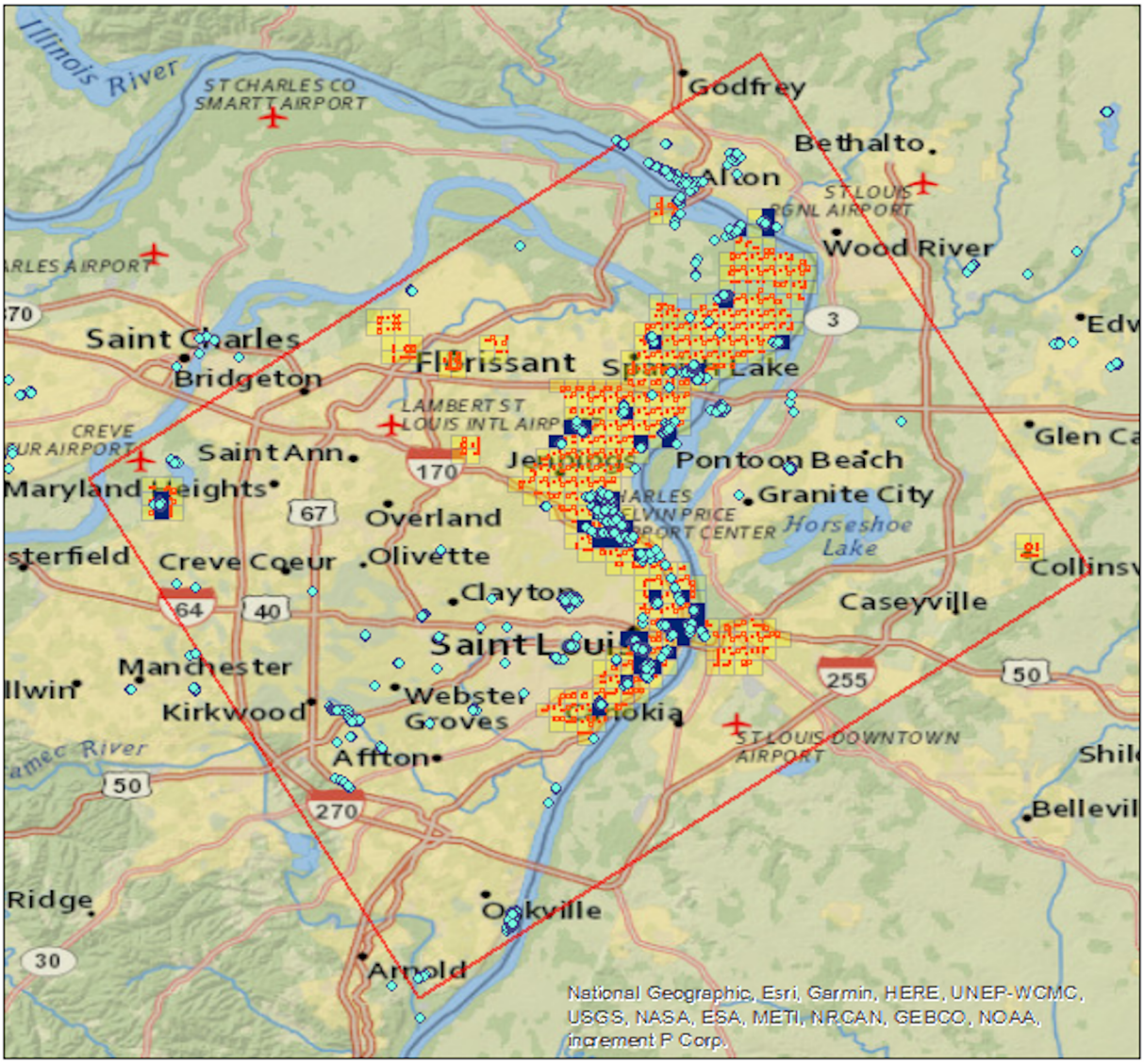
Figure 13: Example of litter along riverbank in Baton Rouge

Foam or plastic cups were the third top item found in the litter.

St. Louis

The geofenced area in St. Louis is 38 x 44 km^2 and encompassed 323 yellow squares for community members to start their tracking in 918 targeted locations (each 0.2 km^2). Community members went to 74 of the 323 yellow targeted areas (23%) to collect data and 43 (13%) of the targeted areas met the benchmark of data collection for density analysis (Figure 14). A total of 19,261 meters of 1m wide transects were completed in the targeted areas and an additional 20,762 meters was completed outside the targeted areas (but still inside the geofence), for a total of 40,023 m^2 of transects completed in St. Louis. A total of 27,658 items were logged into Debris Tracker in St. Louis.

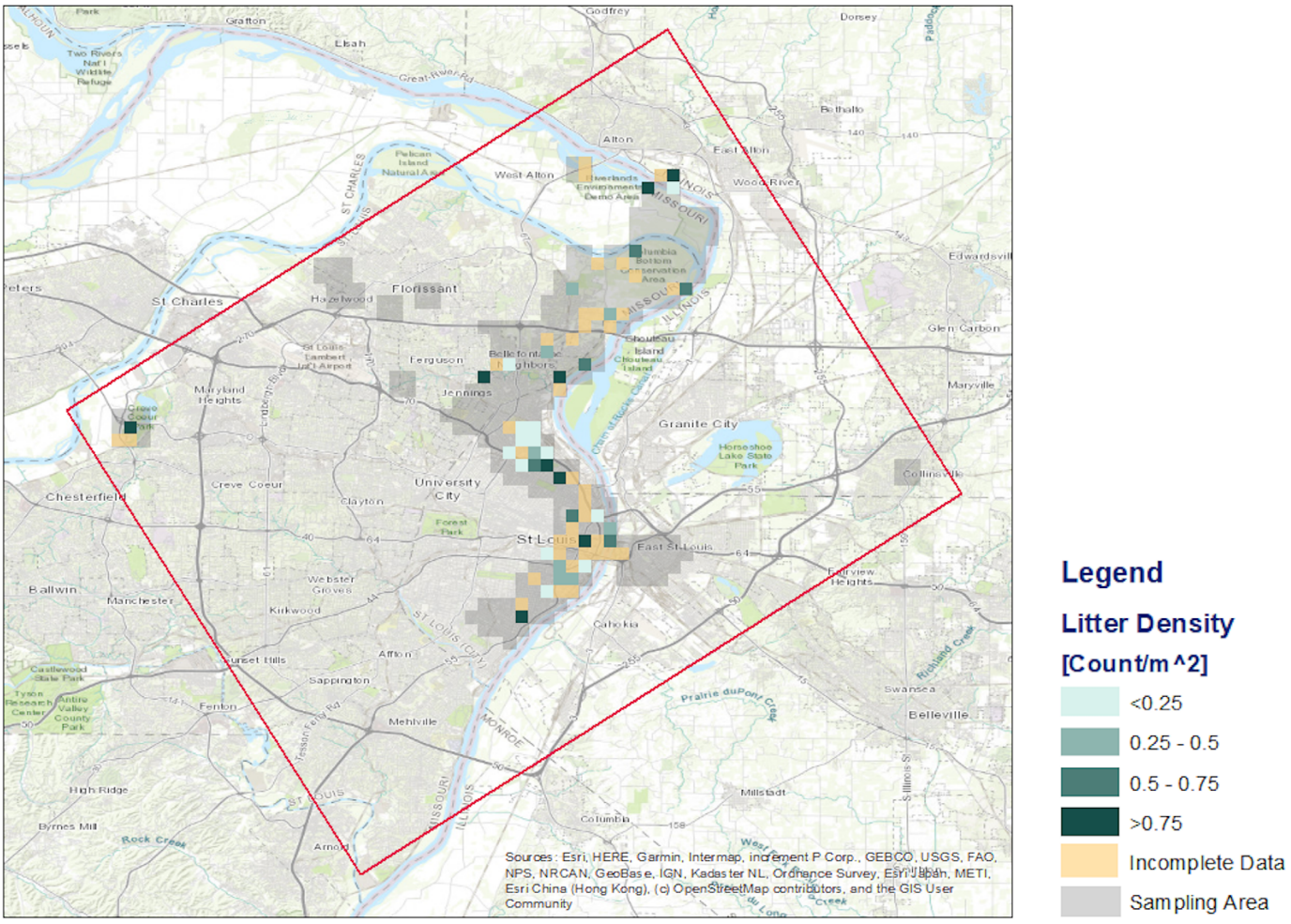
Figure 14: Geofenced area of St. Louis



Note: the yellow squares indicate targeted areas for community-based tracking, the blue squares where the benchmark of data was collected, and the light blue dots are items logged with Debris Tracker or manually uploaded through the Debris Tracker website.

Based upon the 40,023 m^2 of transects completed, the overall litter density in St. Louis is 0.69 items/m^2. This is slightly higher than, but relatively close to, the density reported in Baton Rouge (0.61 items/m^2). However, this litter density differed in various parts of the city that were sampled (Figure 15). An interactive online version of this map was supplied to the city to be able to explore litter densities across the city in differing neighborhoods. Further investigation of the data in terms of population count, land use and other potential influencing factors may be necessary in order to fully evaluate the similarities or differences in the litter densities between neighborhoods and the cities. In addition to data collected with the app, 882 items were manually uploaded to the Debris Tracker website, for a total of 28,540 litter items logged in St. Louis.

Figure 15: Litter Densities Across St. Louis in April 2021



The largest material category logged was plastic (74%) followed by paper (7%), glass (7%), and metal (7%) (Figure 16). The emerging contaminant of PPE was 2% of items logged.

Figure 16: Material Categories (by percent) logged within the geofence of St. Louis

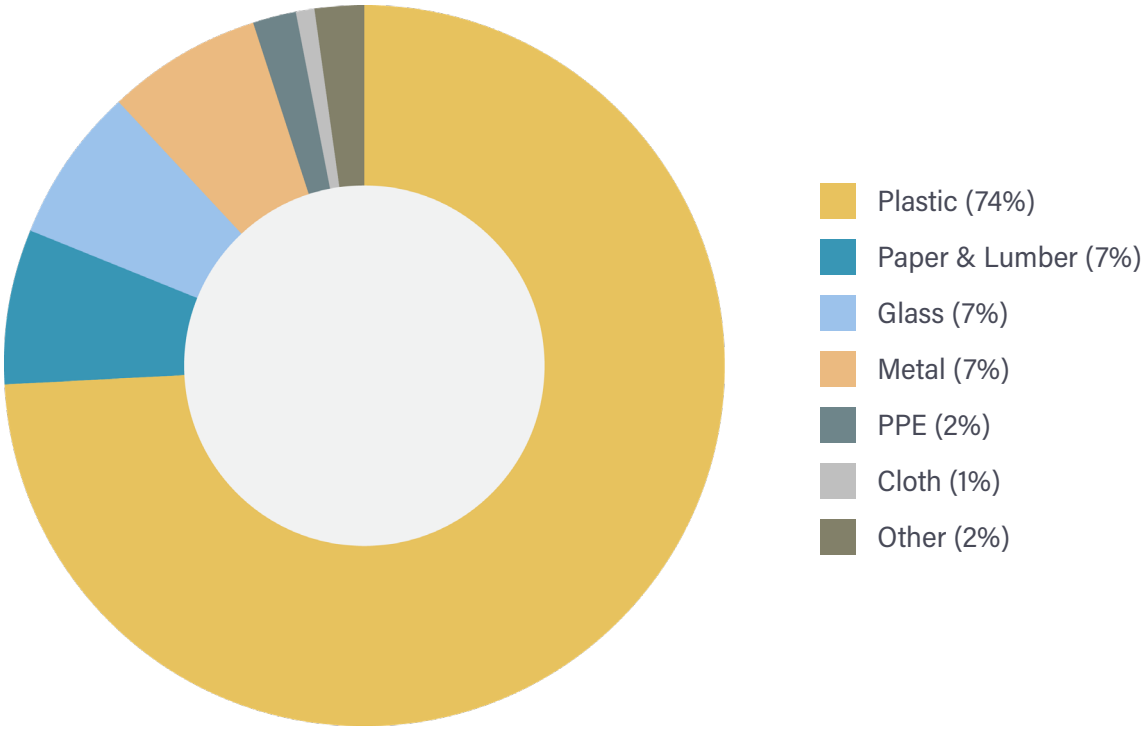
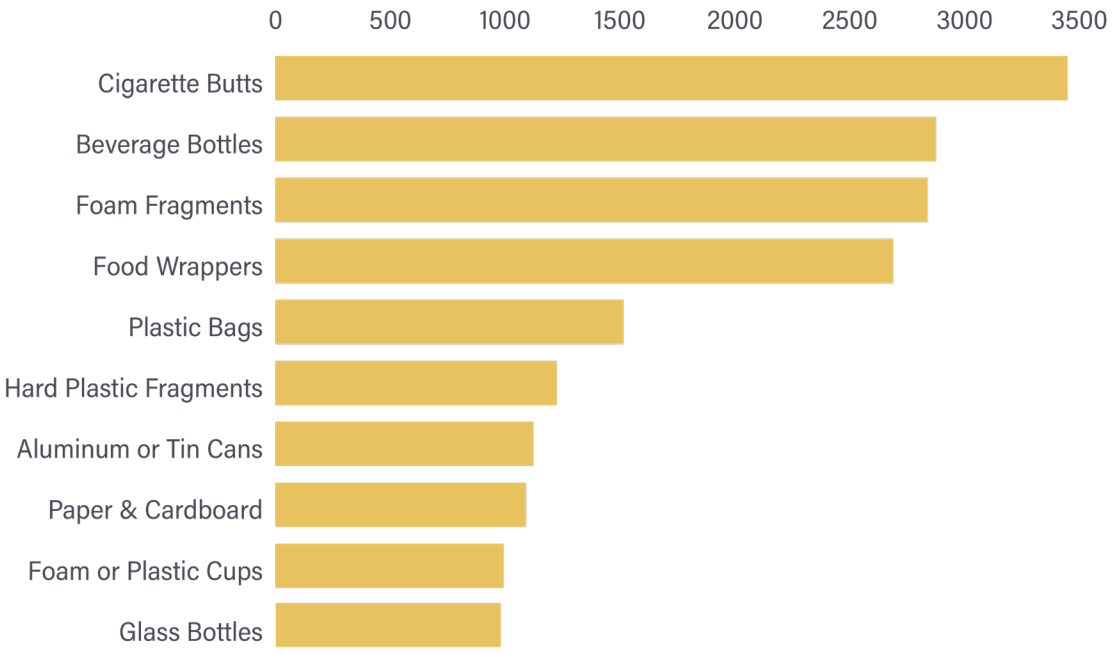


Figure 17: Top Ten Items (by count) logged within the geofence of St. Louis



The top items cigarette butts (#1) and beverage bottles (#2) were similar to the litter found within 50km of the river. For St. Louis, foam fragments (#3) and food wrappers (#4) were in slightly different positions for the 50km river data, but

both were still in the top five. The last item in the top five was plastic bags, a similar ranking position for this item as in St. Paul. The rest of the top ten was similar to the river and Baton Rouge, except St. Louis' top ten contained glass bottles and did not contain straws (Figure 17).

Of the 27,658 items logged with the Debris Tracker app in St. Louis, 411 (1.5%) entries noted brands with 195 unique brands mentioned. This is a small quantity of brands identified, so caution should be taken when referring to this data; however, when examining the categories of items found, there are brands mentioned to start conversations about litter and plastic pollution (Table 2).

Table 3: Categories of items and brands noted by community members in St. Louis

Category	All Brands mentioned (in alpha order)
Alcohol (typically not plastic packaging)	American honey, Bacardi, Bud, Bud Ice, Bud Light, Budweiser, Busch, Busch Light, Cayman jack, Coors, Coors Light, Corona, Crown Royal, Fireball, Heineken, Hennessy, Keystone, Maker's Mark, Michelob Ultra, Mike's, Milwaukee's Best, Modelo, New Amsterdam, O'Doul's, Seagrams, Smirnoff, Sutter Home, Tito's, Twisted Tea
Beverage (often plastic packaging)	5-hour Energy, 7Up, Aquafina, Arizona, Bai, Brisk, Bubly, Buzzwtr, Capri-Sun, Cherry Coke, Coca-Cola, Community Coffee, Dasani, Dean's, Dr. Pepper, Fanta, Gatorade, Gushers, Hi-C, Ice, Langers, Life Water, Minute Maid, Mott's, Mountain Dew, Mr. Pure, Neuro, Ocean Spray, Old Tyme, Pepsi, Powerade, Prairie Farms, PurAqua, Red Bull, Robinsons, Silver Falls, Snapple, Sprite, Suncup, Tropicana, Vess
Candy/gum (nearly always plastic packaging)	3 Musketeers, Airhead, Almond Joy, Big Red, Butterfinger, Dum-dums, Frooties, Haribo, Hershey's, Jolly Ranchers, Kit Kat, Lemonhead, M&M's, Mike and Ikes, Mounds, Mr. Goodbar, Nerds, Nestle, Original Gourmet, Pez, Reese's, Skittles, Snickers, Tootsie Roll, Trolli, Wrigley's
Fast food (usually paperboard except for wrap/cups — plastic lined paper or foam)	Burger King, Cane's, Chester's, Culver's, Dierbergs, Italia Pizza, Jack in the Box, KFC, McDonald's, Popeyes, Sonic, Steak n Shake, Subway, Taco Bell, Wendy's, White Castle
Fast food (foam Cups)	Hit-n-Run, Love's, On the Run, Polar Pop, Quik Trip, Starbucks
Personal care (typically plastic)	Band-Aid, Chapstick, EOS, Terra Green
Snack (almost always plastic)	Angonoa's, Austin, Bake crafters, Belvita, Blue Bunny, Cheetos, Cheez-it, Clif Bar, Doritos, Frito-Lay, Funyuns, Good Times, Hostess, Hot Pocket, Jack Links, Lays, Lion's Choice, Maruchan, Milano, Nabisco, Nice, Nutra-Grain, Nutter butter, Planter's, Pop-Tart, Pringles, Rice Crispies, Ruffles, Slim Jim, Zambos

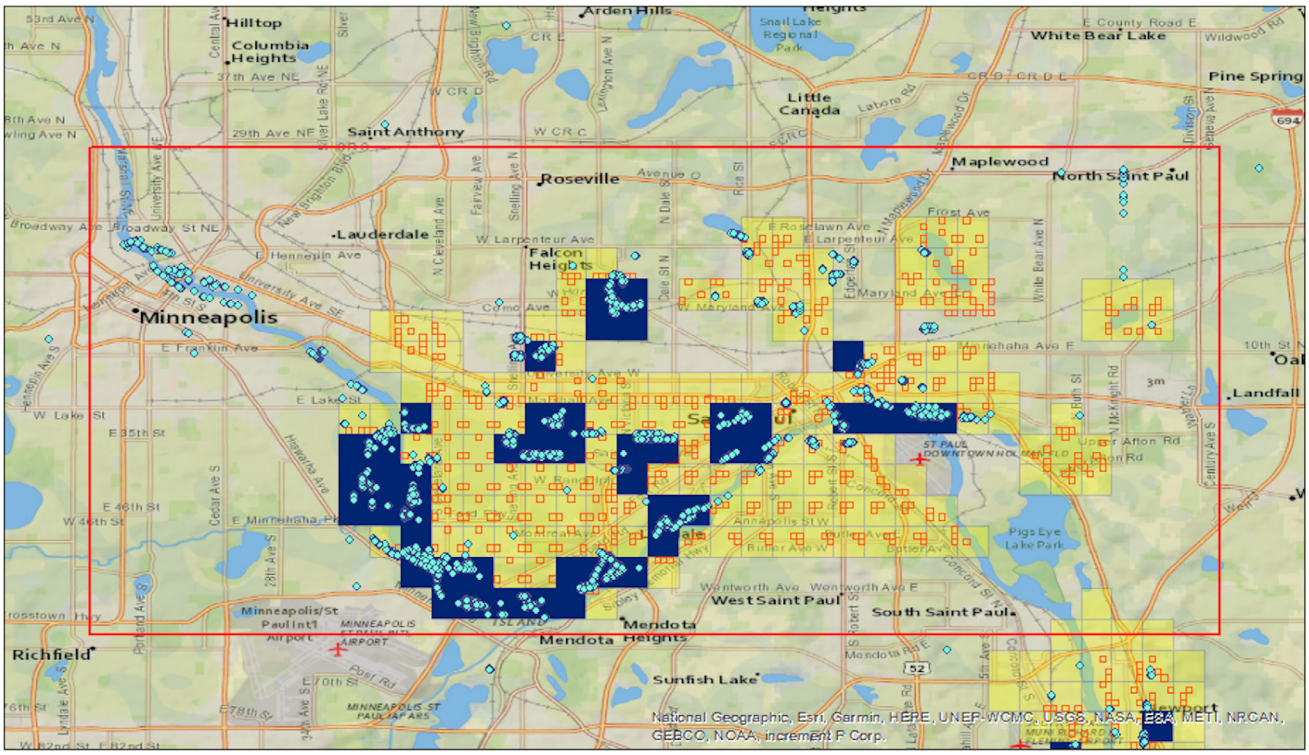
Category	All Brands mentioned (in alpha order)
Store (plastic bags, branded items, usually plastic)	Casey's, Save a Lot, Schnucks, Straub's, Wal-Mart
Tobacco (plastic)	Benson and Hedges, Black and Mild, Camel, Dutch, Grizzly, L&M, Marlboro, Newport, Romeo y Julieta, Salem, Skoal, Splitarillos, Swisher Sweets, White Owl
Toy (often plastic)	Disney,Hasbro, Hatchimal, Lego
Unknown/Other	Decade, Chef's Quality, Futsal, Great Value, J.B. HUNT, Kirkland, Lee's, Matador, Quickies, Sunbelt

Figure 18: **Example of cigarette and plastic fragment litter found in the parking lot at North Riverfront Park where the lunch event was held in St. Louis**

St. Paul

The geofenced area in St. Paul is 21 x 34 km^2 and encompassed 190 yellow squares for community members to start their tracking in 619 targeted locations (each 0.2km^2). Community members went to 95 of the 190 targeted areas (50%) to collect data and 46 (24%) of the targeted areas met the benchmark of data collection for density analysis (Figure 19). A total of 33,069 meters of 1m wide transects were completed in the targeted areas and an additional 10,110 meters was completed outside the targeted areas (but still inside the geofence), for a total of 43,179 m^2 of transects completed in St. Paul.

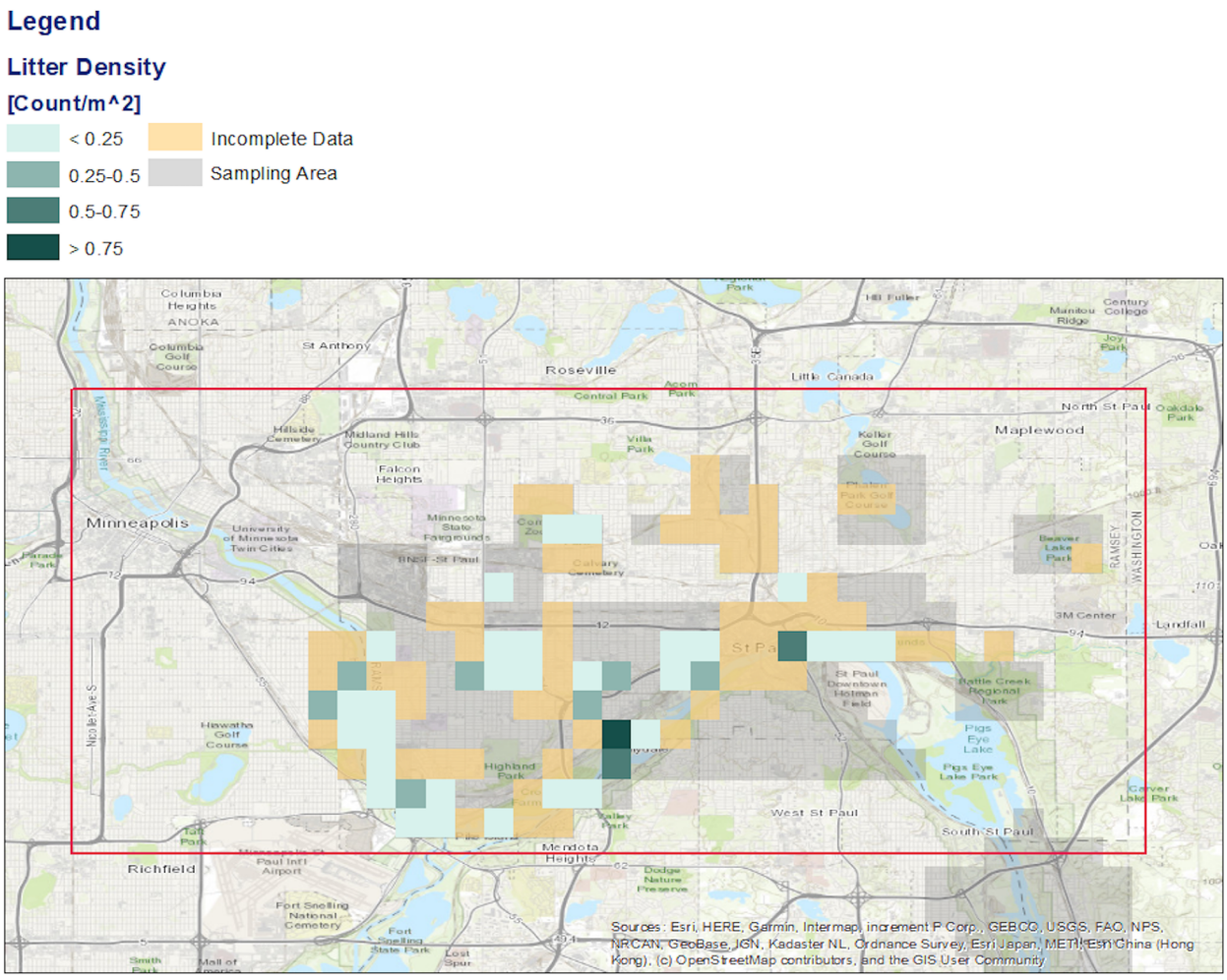
Figure 19: Geofenced area of St. Paul



Note: the yellow squares indicate targeted areas for community-based tracking, the blue squares where the benchmark of data was collected, and the light blue dots are items logged with the Debris Tracker app or manually uploaded on the Debris Tracker website.

A total of 12,298 items were logged into Debris Tracker in St. Paul. Based upon the 43,179 m^2 of transects completed, the overall litter density in St. Paul is 0.28 items/m^2. This value is less than both Baton Rouge (0.61 m^2) or St. Louis (0.69 m^2). However, this litter density differed in various parts of the city that were sampled (Figure 20). An interactive online version of this map was supplied to the city to be able to explore litter densities across the city in differing neighborhoods. Further investigation of the data in terms of population count, land use and other potential influencing factors may be necessary in order to fully evaluate the similarities or differences in the litter densities between neighborhoods and the cities. In addition to data collected with the app, 699 items were manually uploaded to the Debris Tracker website, for a total of 12,997 litter items logged in St. Paul.

Figure 20: Litter Densities Across St. Paul in April 2021



The largest material category logged was plastic (75%) followed by metal (7%) and paper (7%) (Figure 18). The emerging contaminant of PPE was 1% of items logged (Figure 21).

Figure 21: Material Categories (by percent) logged within the geofence of St. Paul

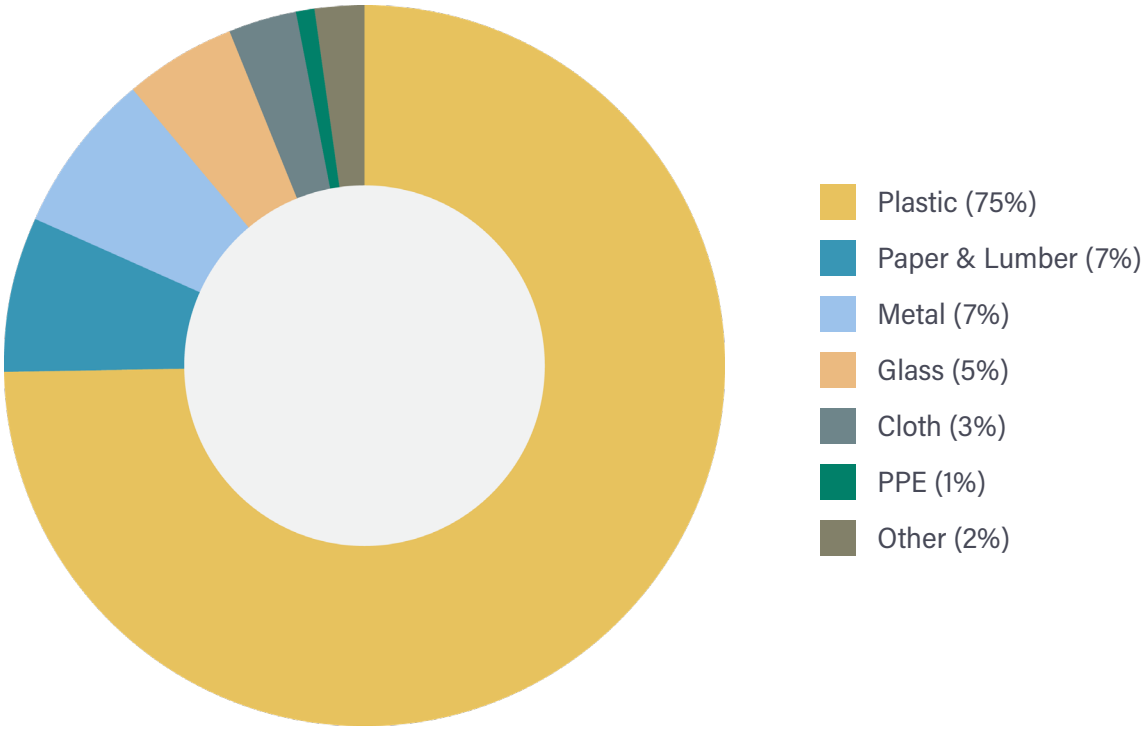
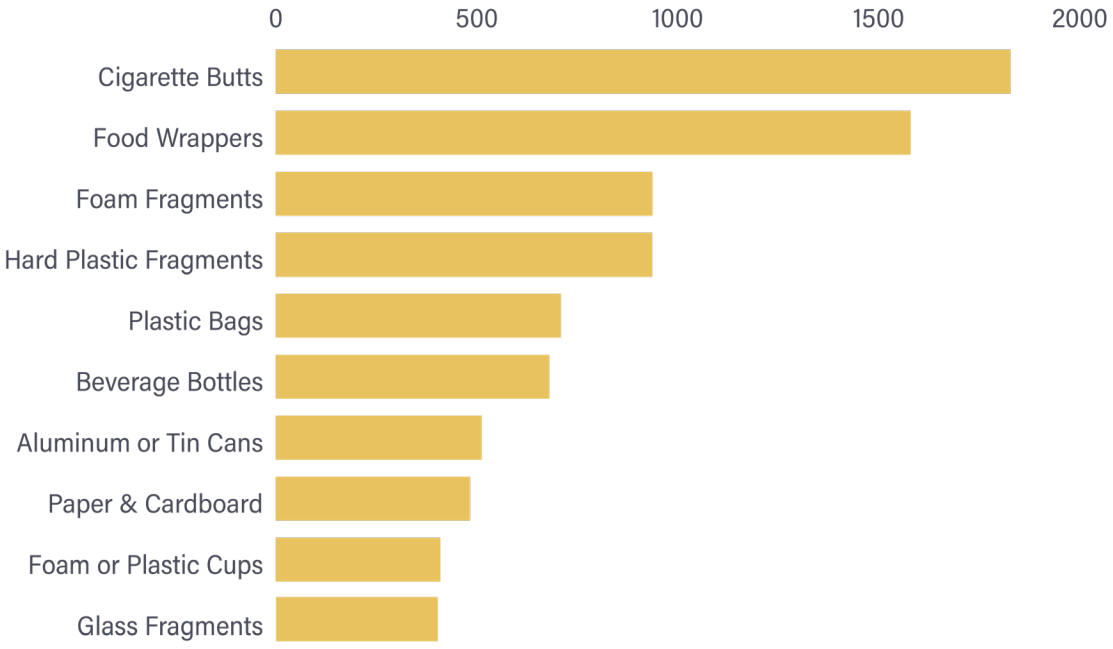


Figure 22: Top Ten Items (by count) logged within the geofence of St. Paul



Similar to the entire river at 50km and St. Louis, cigarette butts landed at the top of the list in St. Paul. Notably, beverage bottles were not in the top five items as they were in the other cities and along the entire river, and plastic bags

moved up into the top five items in St. Paul. The rest of the top ten were similar items, including food wrappers at the #2 spot and both foam and hard fragments in the list. Notably, film fragments were not in the top ten (but were for the river), although plastic bags were in the top five here. Film fragments were replaced by glass fragments in the top ten in St. Paul (Figure 22).

Of the 12,298 items logged with the Debris Tracker app in St. Paul, 12 (0.1%) entries noted brands with 9 unique brands mentioned. This is a very small quantity of brands identified, so caution should be taken when referring to this data; however, when examining the categories of items found, there are brands mentioned to start conversations about litter and plastic pollution (Table 3).

Table 4: Categories of items and brands noted by community members in St. Paul

Category	All Brands mentioned (in alpha order)
Alcohol (typically not plastic packaging)	Modelo
Beverage (often plastic packaging)	Aquafina, Mountain Dew
Candy/gum (nearly always plastic packaging)	Airhead, Reese's
Condiment (nearly always plastic)	Heinz
Fast food (usually paperboard except for wrap/cups — plastic lined paper or foam)	McDonald's, Taco Bell
Store (plastic bags, branded items, usually plastic)	Home Depot

Figure 23: The launch event coincided with the Citywide Spring Cleanup at Harriett Island Park, and a plastic water bottle found on the edge of the Mississippi River in MN.

Floating Litter

A total of 22 sessions were spent tracking floating debris by community members and researchers. A total of 74 people spent time logging floating debris for a total of 991 minutes (15.2 hours). While the minimum time requested was 15 minutes, the average time spent was 45 minutes. Interesting items noted included a yoga mat, a beachball, and a syringe, as well as a note of "overwhelming plastic bags" as described by one community member. This floating litter data collection was a preliminary test of this type of data collection for the river. The researchers note that it is more difficult to record floating debris because of variable weather conditions (windy/sunny glare, etc.), the large width of the river, and obstacles in front of the riverbank that may block the observer's view. Floating litter data is integrated into the material breakdown and top item counts for each pilot city in the sections above.

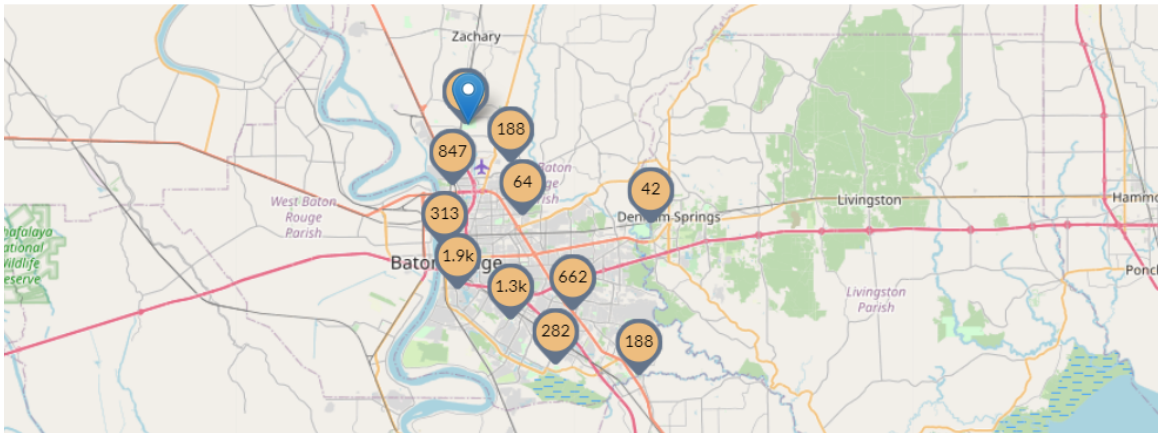
Figure 24: Floating beverage bottle logged by the researchers for this project

In total, there were 1,812 floating litter items logged as part of the initiative. 80% of the items logged were plastic, followed by 10% metal and 5% glass. Top items were foam fragments (383), plastic bags (281), plastic beverage bottles (217), foam or plastic cups (149), and aluminum or tin cans (123). Notably, some items which are very prevalent in land-based litter, such as cigarette butts, were not observed in floating litter due to buoyancy but are still likely to be entering the river system.

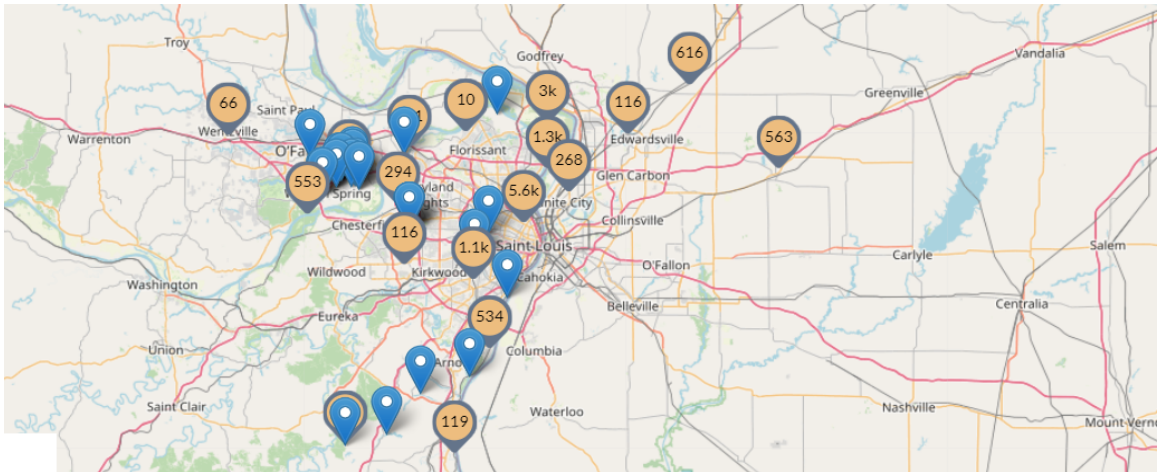
Accumulation Areas

Data was recorded with Debris Tracker for cleanups in community-identified accumulation areas in the three pilot cities. Most often, the logging of litter was done using the manual data upload portal on the Debris Tracker website because of the challenge of recording large numbers of items in the field. Manually uploaded data are noted in the maps below by the blue markers, while orange markers represent data uploaded through the Debris Tracker app (Figure 25). Data from accumulation sites was integrated into material breakdowns and top item counts for each pilot site, as shown in breakdowns above. Because of disparate surveying methodologies, accumulation data was not included to assess litter densities; only standardized transect data was included in this value.

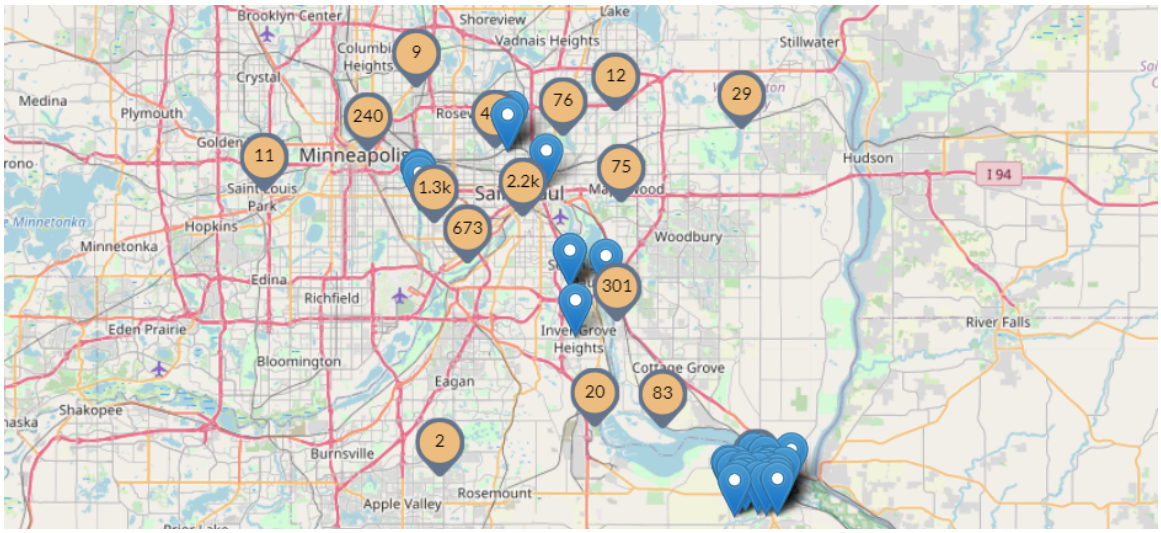
Figure 25 a-c: Accumulation Areas where cleanups occurred during the project period in Baton Rouge (a), St. Louis (b), and St. Paul (c)



(a) Baton Rouge



(b) St. Louis



(c) St. Paul

Figure 26: Cleanups of accumulation areas were conducted during this project and data often entered manually into Debris Tracker database

Of the 5,451 manually uploaded data points from accumulation sites, there was a similar material breakdown (78% plastic, 8% metal, and 4% paper) and similar top items (cigarette butts, foam fragments, beverage bottles, food wrappers, and aluminum or tin cans) as data collected in transects along the river, suggesting that litter collected in accumulation sites derives from the urban sources targeted by the transect surveying method.

Lessons Learned and Recommendations for the Initiative

Note: This section does not include actions to be taken by the cities. Potential opportunities for action and intervention were discussed by the cities, partners and stakeholders with the data from this report as a resource and presented in a separate section. This section contains recommendations on how to improve the science and data collection associated with this pilot project.

Overall, the initiative was successful in engaging citizen scientists in the three pilot cities and beyond. Data collection along the river corridor, outside of the pilot cities, and continued tracking beyond the defined data collection dates of the initiative shows that there is interest and momentum to expand data collection along the Mississippi River and in the Basin. After the initial data collection period, feedback was solicited from the pilot cities, local partners, and core partners through virtual meetings and an online survey. Based on this feedback, components of the project that worked well and are recommended to be sustained or expanded upon:

- Many participants collecting data reported they were collecting data along with others. This community-based aspect could be expanded upon in the messaging around the initiative, encouraging others to share data collection activities with their networks.
- Many users are tracking multiple times, which is an opportunity for individualized volunteer feedback and mobilization. A longer relationship of feedback to the user (e.g., seeing their data and totals) and input of data on their part could foster extended engagement with the app.
- While the majority of users did choose to pick up the litter they logged, some did use the option to record data without cleaning up, making participation in the initiative more broadly accessible. The framing of data collection as a priority over cleanups, while a different paradigm than is typical for many cleanup groups, was key for the scientific success of the initiative.
- Using an open data and near real-time data collection tool like Debris Tracker had several benefits in that all of the data is freely accessible to anyone at any time, and the researchers could adjust their data collection activities to be complementary with the community-based efforts effectively and efficiently, in real-time.
- Cities and local partners want additional data collection to understand progress and effectiveness of efforts.

Some lessons learned and recommendations to be considered in future iterations of the project are:

- Broader outreach, over a longer period of time, perhaps through community organizations not focused on cleanups, could expand the initiative's reach and in-person trainings, where possible, could help to get people tracking faster and more easily than virtual trainings.

- Incentives for data collection and/or stipends for organizations working with underserved communities like environmental justice organizations could help reach new audiences.
- Further engagement with schools and universities could help with scientific, transect data collection for density analysis.
- The majority of the litter data was not tagged with a brand, speaking to the challenge of identifying upstream sources of common litter items such as cigarette butts, plastic bags and foam and plastic fragments and the time it takes to note this data beyond logging each litter item,
- Developing an automated or streamlined method of noting where data has been collected to satisfy the science requirement and can be easily communicated to the participants.
- While MRCTI is known to city officials, it is not widely known or recognizable as a brand amongst the general population, and thus clearer branding of the Mississippi River Plastic Pollution Initiative on the Debris Tracker app and in other outreach materials could serve to eliminate confusion.
- The timing of this project was shifted because of COVID-19. Further discussions on the time of year for sampling are important. In fall, the river is lower, so some debris may be more visible and accessible. The spring is often the time of community cleanup as the days become warmer, and the river height is good for observing floating debris.
- Organizations reported that training volunteers to collect data following the scientific protocols was challenging. Additional materials, such as training videos and engagement pamphlets made readily available to partner organizations, could remove some of the training burden on organizations. Additionally, a stipend could help offset organizational time and effort to engage new partners without resources to cover staff time to train and engage volunteers.

City Opportunities

Results from this pilot initiative were presented to the Mayors and city officials, as well as city partners in June 2021. Based upon the project partners and these discussions with the cities and local partners, the following opportunities for reducing plastic pollution in the Mississippi River were identified:

- Stormwater outfalls are moving waste from urban areas into waterways, lakes, and canals. Opportunities to intercept floatable debris exist at stormwater inlets and outfalls. From both mayoral teams and local partner organizations, there is high interest in interventions at stormwater drains and trash traps in waterways, such as canals.
- Recyclable materials like PET bottles and aluminum cans are high on list of items found. These items are ending up in the environment rather than being recycled. Reverse vending, deposit schemes, or refill options are potential interventions. General doubts about the effectiveness of recycling programs from recent news might also be contributing to lack of participation in recycling.
- There are likely to be hyper-local neighborhood level discrepancies in litter densities, which may be driven by a lack of access to packaging types other than plastic and variability in city services. Community-based, neighborhood level engagement efforts could help generate context-specific solutions.
- Many of the commonly littered items – like cigarettes and food wrappers – are products people tend to consume on-the-go. Partners and mayoral teams feel there is a missing education component.
- Local governments face obstacles of time, resources, money, and prioritization. Many cities are engaged and ready to make change, but there is need for direction on next and the most effective steps. Developing action plans in each city with knowledge exchange between cities (e.g., facilitated by MRCTI) could be a key step.
- Engaging brands was an avenue that was mentioned by both local partners and mayoral teams to provide funding for local initiatives.

Appendices

Appendix A — Local Project Partner List

Baton Rouge, LA

City of Baton Rouge

Mississippi River Network

1 Mississippi

Rotary Club Baton Rouge

Mid City Redevelopment Alliance

Quapaw Canoe Company

LSU College of Coast and Environment

LSU College of Coast and Environment

Graduate Student Organization

LSU Campus Sustainability

LSU Geaux Green

Southern University 771 Alliance Sierra Club

Climate Reality

BREC

Louisiana Stormwater Coalition

Visit Baton Rouge

Keep Louisiana Beautiful

United Nations USA Baton Rouge

Louisiana Wildlife Federation

Healthy Gulf

Sierra Club Baton Rouge

Louisiana Earth Day

St. Lous, MO

City of St. Louis

Brightside St. Louis

Mississippi River Network

1 Mississippi

Rotary Club

Big Muddy Adventures

Missouri Stream Team

Stream Teams United

Missouri Department of Conservation

Madison County

Great Rivers Greenway

Gateway Arch National Park

League of Watershed Guardians

Saint Louis University WATER Institute

Missouri Confluence Waterkeepers

Living Lands and Waters

EarthWays Center of Missouri Botanical Garden

U.S. Green Building Council - Missouri Gateway Chapter

St. Louis Green Business Challenge

earthday 365

National Great Rivers Research and Education Center

St. Lous, MO cont.

Open Space Council

St. Louis County Department of Public Health

Washington University Office of Sustainability

River Des Peres Watershed Coalition

U.S. Army Corps of Engineers

City of St. Louis Board of Aldermen Christine Ingrassia

Missouri Environmental Education Association

Missouri Green Schools

River Cities Rotary

Jefferson County

Blue2Blue Conservation

US Coast Guard Auxiliary, 8 Western

Rivers District's Marine Safety

James River Basin Partnership

United Nations Association of Saint Louis

St. Louis Zoo

Greenway Network

Missouri River Relief

Sierra Club – Illinois Chapter Piasa Palisades

Watershed Cairns

St. Louis Aquarium Foundation

St. Paul, MN

City of St. Paul

Great River Passage

Mississippi River Network

1 Mississippi

St. Paul Sunrise Rotary Club

Rotary Club District 5960

Hastings Area Rotary Club

Friends of Mississippi

Mississippi Park Connection

Freshwater Society

United Nations Association of MN

Capitol Region Watershed District

Urban Roots MN

Lower Phalen Creek Project

Conservation Corps of Minnesota

Center for Global Environmental Education

Hamline University

Minnesota Valley National Wildlife Refuge

City of Newport

Friends of Pool 2

Other / All

Elkay

Rotary International

Mississippi River Network

1 Mississippi

Appendix B — MRCTI Debris Tracker List

Plastic
Food Wrappers
Beverage Bottles
Other Jugs or Containers
Bottle or Container Caps
Cigar Tips
Cigarette butts
Disposable cigarette lighters
Six-pack rings
Plastic Bags
Foam or Plastic Cups
Plastic lids
Plastic Utensils
Plastic take out containers
Foam take out containers
Straws
Balloons
Personal Care Products / Toiletries
Hard Plastic Fragments
Foam Fragments
Film Fragments
Fishing Gear
Tobacco Packaging
Needles or Syringes
Single-serve plastic liquor bottles
Plastic Balls or Toys
Other Plastic

Metal
Aluminum or Tin Cans
Aerosol cans
Metal Bottle Caps
Metal Fragments
Electronics
Household Appliances
Cylinders, Tanks, and Barrels
Other Metal

Glass
Glass Bottle
Glass Jars
Glass Fragments
Lightbulbs and Tubes
Other Glass

Rubber
Latex Balloons
Flip-flops
Rubber Gloves
Tires
Rubber Fragments
Other Rubber

Cloth
Clothing and Shoes
Fabric Pieces
Gloves (non-rubber)
Towels or rags
Rubber flip-flops
Mattresses
Carpet or Rugs
Other Cloth

Paper and Lumber
Paper Bags
Lumber/Building Materials
Food Wrappers (paper)
Paper and cardboard
Palletts
Stir sticks
Other Paper or Lumber

PPE
Masks
Disposable Gloves
Face shields / Goggles
Gowns
Empty bottles of hand sanitizer
Other PPE

Other Items
Other
Test Item

END OF DOCUMENT