Final Report

Environmental Enhancement Grant – WKC PRE- 020

Improving Human and Ecosystem Health through Microplastic Reduction

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WATERKEEPERS® CAROLINA

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Executive Summary

Waterkeepers Carolina was awarded a $188,800 grant to complete a collaborative project to assess the presence of micro and macro plastics in our surface waters statewide. Our main goal of this project is to better understand the degree to which microplastic pollution is impacting our streams, wildlife, and public health, and through strategic assessments of possible solutions, to reduce microplastic pollution.

Waterkeepers Carolina (WKC) is a network of fifteen waterkeepers across North Carolina. Collectively, we work as advocates on localized and statewide issues to protect and promote water quality in our surface waters.

As proposed in the grant application, all fifteen waterkeepers were able to collect 273 surface water samples to assess microplastic in 15 watersheds. This dataset is the first of its kind. Inorganic particles in each sample were analyzed in partnership with the Plastic Ocean Project. To support the analysis of a large number of samples, MountainTrue personnel, trained in microplastic identification, provided additional data to the project. Every surface water sample analyzed contained microplastic pollution, averaging 14 microplastics per 1 Liter of sample. Fibers were the most common type of microplastic found across all samples.

This project shed light on some of the difficulties collecting and processing microplastic samples, and we simplified our sample analysis to accommodate our project budget and deliverables. However, this more robust analysis of WKC collected samples is still ongoing and we have leaned on partners at Plastic Ocean Project and NC State University to continue to understand the fate and transport of microplastics in our waterways.

All fifteen Waterkeepers received and installed Trash Trouts, passive litter collection devices, in each of their watersheds. At the trap locations, Waterkeepers completed 150 cleanouts and audited 70,000 pieces of trash in collaboration with the Duke Law and Policy clinic. Styrofoam comprised the vast majority of the trash.

The program brought in 1163 volunteers contributing to roughly 2500 volunteer hours removing trash from our streams. This grant allowed our Waterkeeper programs to grow their litter prevention programs within our own organizations, adding 22 additional trash traps to our waterways outside of this grant funding. This growth in our individual litter prevention program allowed our NC Waterkeepers to leverage $254,600 in additional funding to support this work. Each trap is estimated to collect 1,000, 1,500 pounds of trash per year. The total impact, per year, of the 37 traps is the removal of 19 - 28 tons/year from North Carolina waterways.

The project's cost totaled $446,315.76 including $258,292 matching contributions that resulted in 58% match. Matching support for the project was provided by private foundations, donations, grants, Z. Smith Reynolds Foundation and Sound Rivers.

Project Summary

Waterkeepers Carolina, in partnership with UNC- Wilmington, Duke Law and Policy Clinic, and the Plastic Ocean Project assessed the presence of micro and macro plastics in our surface waters statewide. The results of this project is facilitating a better understanding of the degree to which microplastic pollution is impacting our streams, wildlife, and public health and through strategic assessments of possible solutions, to reduce microplastic pollution.

Waterkeepers Carolina members collected surface and sediment samples for analysis.WKC analyzed the data to compare variations in sites across the state, and create informational material with this data to engage the public on the presence, quantities, and sources of microplastics in our surface waters.

The second phase of the project was installation of 15 Trash Trouts, passive litter collection devices, across the state. Following installation of the litter collection devices, each Waterkeeper assembled teams of volunteers to empty, clean, and survey the litter collected in partnership with the Duke Law and Policy Clinic. The litter surveys categorized types and quantities of litter most commonly found in surface waters. This information will inform WKC next steps in advocating for the most effective solutions to preventing plastic pollution through policy and behavior changes.

Narrative of Work Completed

The completed project outputs include:

1. Identify 30 sampling locations and collect 360 surface and 360 sediment samples for the presence of microplastics **AMENDED**
2. Estimate of microplastic loading rates from stormwater or wastewater **AMENDED**
3. Characterize types of microplastic from surface and sediment samples **AMENDED**
4. Characterize amount of microplastics in urban vs rural landscapes **AMENDED**
5. Identify and install instream litter collection devices at 15 locations **COMPLETED**
6. Train 20 volunteers to deploy the litter traps, collect and survey macroplastics **GOAL EXCEEDED**
7. Complete macroplastic audits at each location **COMPLETED**
8. Complete final educational report of the findings **COMPLETED**

Below is a bulleted list of the work completed by this grant:

Objective 1: Determine microplastic presence, type and concentrations in water and sediment samples in 30 streams

- This objective was completed in part. A total of 273 samples were analyzed. All Riverkeepers collected and submitted surface water samples which were analyzed by the Plastic Ocean Project. That analysis showed us what types of plastics were present in our samples. We were

able to narrow our analysis of plastics into ten categories of microplastics: Acrylonitrile Copolymer, adhesives, bioplastics, miscellaneous plastics, PET, flame-resistant polymers, polyurethane, PVC/PVA, resins, and rubber. These categories were present in all samples collected but at varying levels. (Infographic Attached)

- Our simplified analysis conducted by MountainTrue allowed us to quantify the amount of microplastics present. As we discovered, this level of sample analysis is not certifiable because microplastics can often look like other natural debris and the manual counting of the particles under a microscope is prone to error. However, we can conclusively say that microplastics were present in every sample analyzed.

- Sediment samples were collected by each Waterkeeper, however lab analysis was too costly and tedious for our partners at UNCW. These soil samples were not processed, and there is currently no approved methodology for sampling microplastics in soils.

Objective 2: Estimate loading rates

- Because our microplastic sampling protocol changed due to cost and time constraints, we were not able to collect multiple samples from different locations to assess loading rates from urban or rural environments. However, we were able to partner with Dr. Barbara Doll and her team and NC State University to better understand the sources and transport of microplastics focused on the Neuse watershed.

> "The concentrations of microplastics were widely variable across season and flow conditions. The data were analyzed using streamflow, land cover and population variables to determine what factors may influence microplastic concentrations and to determine the relative contribution of plastic loading from different land uses throughout the Neuse River Basin. Microplastic concentrations ranged from 0.02 to 221 particles per cubic meter with the highest concentrations observed in the most developed catchments during stormflow conditions." (Doll, B., Fox, J., Putnam, G. 2023. NC Sea Grant. Engaging Partners to evaluate plastics loading to the Pamlico Sound from urban and rural lands via the Neuse River in North Carolina).[1]

Objective 3: Characterize and quantity the type of macro plastics most commonly found

- As of November 2023, Waterkeepers across North Carolina have installed 15 Trash Traps to clean up litter from waterways. Collectively, we've held over 150 Trash Trap clean outs and counted 62,911 pieces of litter.
- Of that litter, nearly three-fourths were styrofoam pieces. 48,236 pieces of styrofoam were removed from streams. For all but two of our locations, styrofoam far outpaced other types of

[1] chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ncseagrant.ncsu.edu/wp-content/uploads/2023/04/Plastics_Final_Report_2-1-23.pdf

macroplastic in our streams. Other categories of litter include hard plastics, plastic films, metal, glass, and other.

- In those other categories, we removed 797 plastic bags, 6,079 plastic bottles, 1076 food wrappers, 3242 cigarette butts, 533 drink cans, and 424 balls or sports equipment. (Infographic attached)

Objective 4: Share Findings

- These reports have been shared with several media outlets, which are linked below.
- This final report and infographics will also be shared with NC Department of Water Resources Basin planners, who are beginning to grapple with the issue of microplastics and macroplastics as a major source of pollution across the state.
- This work has also been developed into social media content, which will allow all of our Waterkeeper programs to share easily and widely with our memberships.

Completed Project Activities & Estimate of Environmental Impact

The funds from this grant and matching funding allowed the project team to complete the installation of fifteen litter collection devices in our streams, build our litter reduction programs to do more outreach and increase volunteer engagement, and better understand the presence of microplastics in our surface waters.

Microplastic Monitoring and Analysis

Using sample collection methods established by Adventure Scientists, each Waterkeeper collected surface and sediment samples at two locations. The first round of surface water samples were analyzed by Dr. Bonnie Monteleone and her team at Plastic Ocean Project using a NOAA approved analysis method. The data we received from the Plastic Ocean Project not only showed the presence of microplastics, but the actual chemical makeup of these compounds. This allowed us to better understand the sources of specific types of microplastics.

All other samples were processed by MountainTrue using the same collection methodology. This analysis was less descriptive, but showed how many microplastics particles were present in each sample. Since the beginning of the sampling program, the Watauga Riverkeeper office has processed 262 surface water samples. Microplastics were found in 100% of the samples collected from January 2021-December 2022. Fibers were the most common type of microplastic found across all samples. The most common microplastic type, fibers, were found on average 13 times per 1 liter sample jar. Whereas overall average number of microplastics per sample was 14, across all basins sampled.

Soil samples were collected and analyzed by UNC Wilmington using the Adventure Scientists standard operating procedures. However, after the project started, POP determined that the procedure and lab equipment was unable to accurately process sediment samples. Upon further review, it was

determined that accurate data could not be obtained from sediment samples. WKC then chose to focus on surface water sampling and analysis.

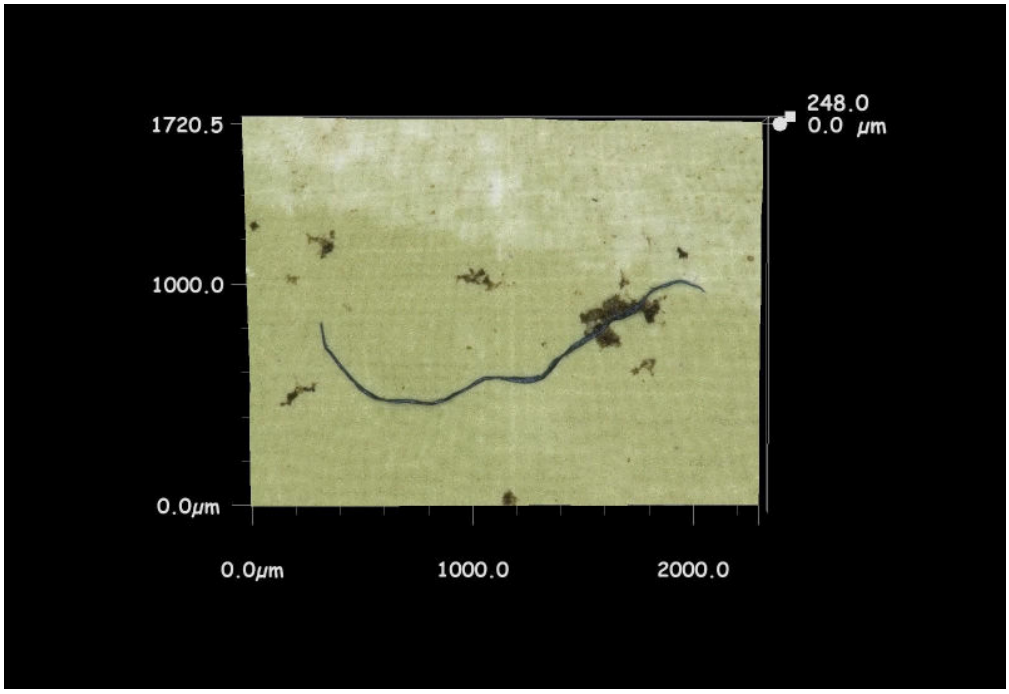


Figure 1: Photo of microplastic fragment under microscope.

Litter Collection Devices Installation

In year 2, each Waterkeeper program installed a Trash Trout, passive litter collection device, in an urban stream. To accomplish this, Waterkeepers worked with the local government in their jurisdiction to gain permits or approval via MOUs or access agreements. Each Waterkeeper program assumed liability and responsibility for maintaining each trap and removing them if emergency conditions arise.

These trash traps also built our relationships with stormwater utilities within our watersheds. Many stormwater staff members joined for installations or were active volunteers in the clean outs. These relationships helped us to expand our programs. Some municipalities even purchased their own trash traps or worked with our Waterkeepers to install more.

Figure 2: Left: Trash trap installation in Jacks Creek, Washington, NC. Right: Catawba Riverkeeper volunteer conducting trash audit.

Organization	***Local Government Jurisdiction***	***Stream Name where Trap installed***	***Watershed***
Haw River Assembly	City of Durham	Third Fork Creek	Haw River
MountainTrue	Shelby Watauga County Asheville Hendersonville	Hickory Creek South Fork New River Haw Creek (Swannanoa) Brittain Creek	Broad River Watauga River French Broad River Green River
Sound Rivers	Raleigh New Bern Washington	Little Rock Creek Duffyfield Canal Jacks Creek	Walnut Creek (Neuse) Neuse Tar-Pamlico
Catawba Riverkeeper	Old Fort	Mill Creek	Catawba River
Yadkin Riverkeeper	Winston Salem	Silas Creek	Yadkin River
Cape Fear Riverwatch	Wilmington	Northeast Cape Fear	Cape Fear River
Good Stewards of Rockingham	Eden	Matrimony Creek	Dan River
Coastal Carolina Riverwatch	Jacksonville	Scales Creek	New River
Winyah Rivers Alliance	Lake Waccamaw Scotland County	Waccamaw Lake Canal Drowning Creek	Waccamaw River Lumber River

Table 1: Location of installed trash trap devices.

Figure 3: Map of installed trash traps across NC by Waterkeepers Carolina.

Macroplastic Data Collection and Analysis

The macroplastic data collection has been the bulk of our volunteer engagement. We have amassed over 1100 volunteers across the state to participate in the macroplastic data collection. Our volunteers get in the streams with boots and waders, gloves and trash pickers and bags, and sort the trash into bags based on simple categories: styrofoam, plastics, and glass/metal/other. Then the bags are brought up to another team on land who sort and count the litter into more specific categories. Many of us have partnered with universities and community colleges to help to count and analyze this data. This dataset is the most robust of its kind across our state. We will continue to gather data into the coming years to submit to NCDEQ and EPA.

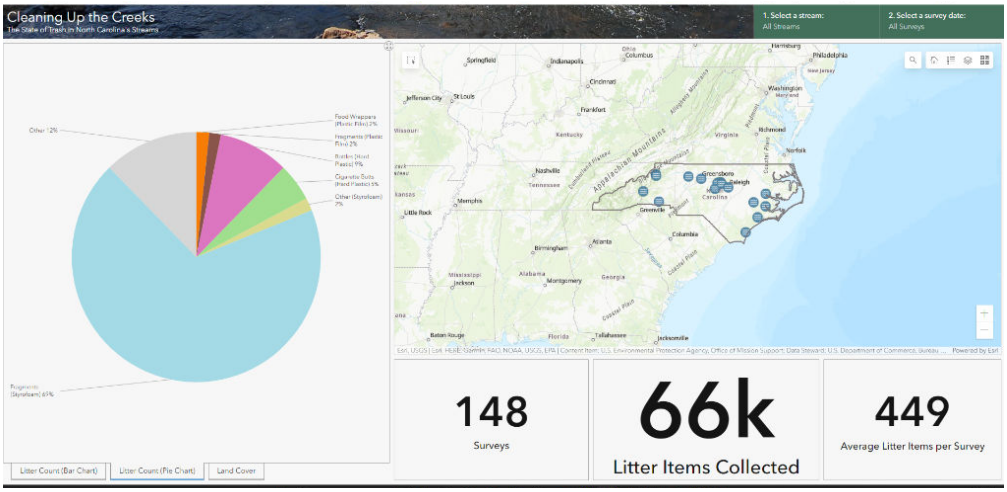


Figure 3: Duke University trash audit dashboard that includes 148 audits of data across NC (https://www.arcgis.com/apps/dashboards/23948571370d4d45b179f599ad98ea9a)

Environmental and Educational Benefits

Every waterway in North Carolina is impacted by plastic pollution and plastics comprise the bulk of marine debris. These plastics break down over time into microplastics, which are an ecosystem and public health issue. Though we see the evidence of plastic pollution on a daily basis, very little is known about the amount of microplastic pollution in the state's waterways Microplastics transport both the chemical additives originally included during production as well as pollutants the microplastics may encounter in the environment after disposal. They have serious health risks to aquatic life and human health when ingested through seafood consumption and drinking water.

Currently, NC DEQ does not sample for or regulate plastics. This project will provide valuable information to DEQ, researchers and the public regarding the potential need for expanded monitoring, regulations, and/or policies to protect water quality. To effectively address this issue and offer future solutions, reliable and accurate data is needed to fully understand the extent and nature of the pollution. This project is unique in its scope as it will provide data from 14 different watersheds with differing geography and natural physical characteristics. All of the data will be shared with NCDEQ and interested researchers to allow for further assessment.

We have begun working with staff at NC Department of Water Resources, who have been pushing for the state to target microplastic and macroplastic pollution. We have been able to provide recommendations for protocol and data collection towards this goal. Many other states have used regulatory tools like a Total Maximum Daily Load and water quality standards for plastic pollution in waterways. This data, which was collected with advocacy goals in mind, will be used to assist state regulatory agencies in setting those limits. Our partners at Duke Law and Policy Clinic have begun evaluating existing laws that give authority to NCDEQ to set these limits without legislative action.

This program has increased education, advocacy, and volunteer engagement for all of our Waterkeeper programs in the state. Each trap is estimated to collect 1,000, 1,500 pounds of trash per year. The total impact, per year, of the 37 traps is the removal of 19 - 28 tons/year from North Carolina waterways.

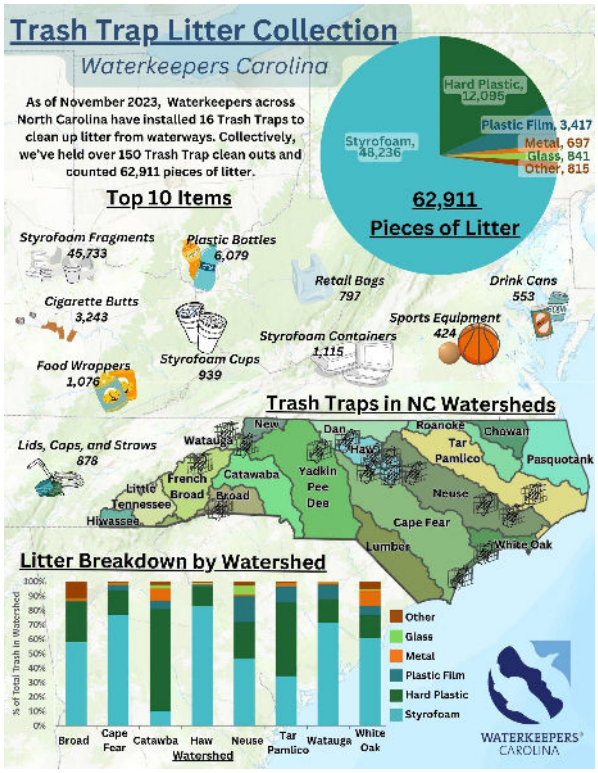
Education and Outreach

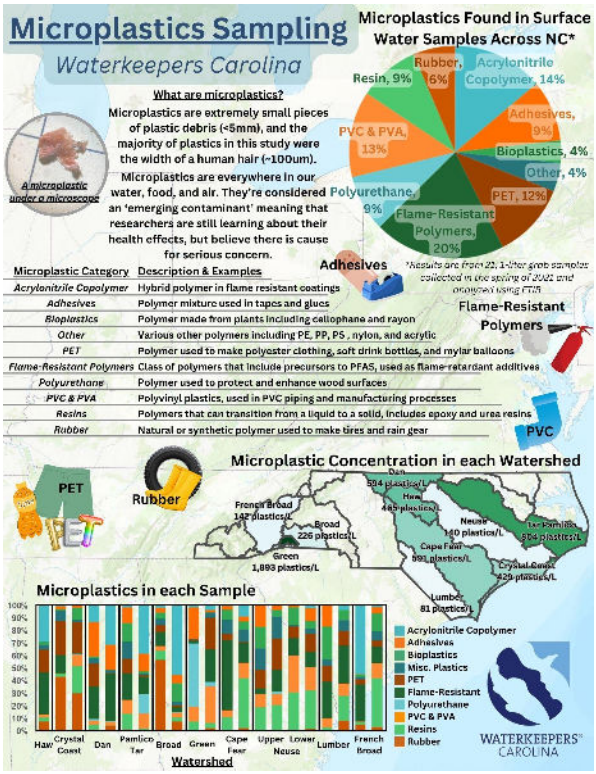
The information we have collected has been used in Story Maps to create a visual tool to easily share with the public.

https://storymaps.arcgis.com/stories/c07e3c25059b47a2b7f464b47f36835d

https://www.arcgis.com/apps/dashboards/23948571370d4d45b179f599ad98ea9a

We have also used this data to create many videos, infographics, and social media content to educate the public on the plastic pollution problem across the state.





Infographics created by Madison Haley

Screenshot of Plastics Education video - ***https://vimeo.com/688103248***

Media Stories Highlights

Many media stories have highlighted or mentioned our statewide project and the work we have been able to accomplish across the state. This is not an exhaustive list.

- https://spectrumlocalnews.com/nc/charlotte/news/2022/05/13/microplastics-waterway-study
- https://www.northcarolinahealthnews.org/2022/05/19/waterkeepers-have-a-three-part-strategy-to-plastic-waste-in-nc-waterways/
- https://wcti12.com/news/local/testing-the-waters-a-microplastic-study-to-begin-on-the-new-river
- https://coastalreview.org/2022/05/groups-are-setting-traps-to-reduce-plastics-in-nc-waters/
- https://www.carolinacoastonline.com/news_times/article_26e409ce-1e16-11ec-a89d-3fada0d8ad0d.html
- https://greensboro.com/community/rockingham_now/news/microplastics-study-to-measure-impact-on-dan-and-other-n-c-waterways/article_45a52276-77cc-11eb-a254-4bae20ddca3a.html
- https://www.northcarolinahealthnews.org/2022/05/19/waterkeepers-have-a-three-part-strategy-to-plastic-waste-in-nc-waterways/
- https://www.thewashingtondailynews.com/2022/05/07/jacks-creek-litter-trap-good-for-creek-and-research/
- https://wfuogb.com/20794/environment/trash-trout-catches-trash-in-reynolda-village/

Highlights of web and blog postings from WKC partners

- https://waterkeeperscarolina.org/plastics
- https://hawriver.org/plastics/
- https://soundrivers.org/microplastics-and-the-purpose-of-trash-trouts/
- https://soundrivers.org/riverkeepers-take-on-statewide-microplastics-monitoring/
- https://capefearriverwatch.org/plastics-reduction/
- https://coastalcarolinariverwatch.org/microplastics-study/
- https://winyahrivers.org/microplastics-study-on-nc-waterways/
- https://mountaintrue.org/category/clean-waters/green-riverkeeper/page/3/
- https://www.plasticoceanproject.org/plastic-in-freshwater.html

Project Evaluation

The measures below help to evaluate the success of the project.

A. Percent of proposed project activities completed within project timeline

    a. 75% of the originally proposed project activities were completed within the project timeline, however the 25% that was not completed as originally planned was amended to be more achievable

B. Estimated microplastic loading at each location
    a. Microplastics were found in 100% of the samples collected from January 2021-December 2022. Fibers were the most common type of microplastic found across all samples. The most common microplastic type, fibers, were found on average 13 times per 1 liter sample jar. Whereas overall average number of microplastics per sample was 14, across all basins sampled.
    b. 20% of the microplastics present were flame-resistant polymers.
C. Estimated loading based on source and land use
    a. This was not completed by our network of Waterkeepers, but by Dr. Barbara Doll with NC State. Microplastics are dispersed throughout urban and rural landscapes, but increase in areas of higher development in stormwater catchment areas.
D. Feedback and evaluations from Waterkeepers on sampling methods and techniques
    a. Though it was exciting to be a part of methodology and research to improve the sampling methods and techniques as the science is developing, we found it frustrating to have so many setbacks with time constraints and evaluation.
E. Number of media hits
    a. 12 traditional media stories
F. Number of outreach publications from final report
    a. We have created six publications from this final report, all of which are included in the appendices.
G. Number of volunteers involved in macroplastic sampling
    a. 1163
H. Amount of funding leveraged for additional monitoring and outreach activities
    a. $254,600

Lessons Learned

The amount of macroplastic reaching out streams across the state was truly astonishing. However, by sorting these macroplastics into the categories we have identified in our data surveys, we are able to move forward with advocacy goals. This data was helping to make progress to push several cities to reduce their plastic waste by setting bans on styrofoam and plastic bag fees, but a preemption law from the NC General Assembly was passed to prevent local governments from setting mandates to reduce plastic waste. Now we are using this data to push local governments to make ordinances and incentives to encourage businesses to voluntarily eliminate these types of plastics.

The science of microplastics is still developing. There are no EPA approved methods for processing microplastics, though there are many types of analysis and collection methods to review. Cross contamination was a major concern for microplastic sample collection. Microplastics are in our air, in

our clothes, in our cars transporting our sampling equipment. Additionally, the procedure of collecting the sample in the water is still being finalized. Samples collected in flowing water will differ from samples collected in stagnant water. Results can vary depending on the depth of where the sample was collected in the water column. This project allowed us to be a part of this growing field of research and work with scientists to better understand and develop a standard operating procedure.

Acknowledgements

Waterkeepers Carolina is grateful for funding from the Environmental Enhancement Fund Grant Program to aid in implementation of beneficial projects that will ultimately lead to improved water quality and stream habitat as well as improvements in public attitudes toward clean water.

We would like to acknowledge the excellent work by our partners at Plastic Ocean Project, Bonnie Monteleone and Kayla West for their work processing samples and continuing to investigate sampling methods. We would like to thank Nancy Lauer with Duke Law and Policy Clinic, who created the protocol for our macroplastic sample collection, collected the data to display in a visual data hub, and worked long hours with Emily Sutton at the Third Fork Creek Trash Trout to count and sort thousands of pieces of litter. We would like to thank Hannah Woodburn, who took the initiative to process our microplastic samples manually by physically counting microplastic particles through the lens of a microscope for hours, and helped to create a microplastic report with those results, which are included in this report. We would like to thank Madison Haley, the Plastics Program Assistant with Haw River Assembly for creating the infographics, a Story Map displaying our data, and for her dedication to this project as we continue to remove and reduce the litter that reaches our streams.

Final Accounting of EEG Money Spent

WKC PRE 020				
Budget Categories	**EEG Grant Funds Expended**	**Match**	**Total**	**Match Notes**
Personnel/Salary (Project Management & Grant Admin)	$16,000		$16,000	
Contractual	$109,984.60	$89,600	$199,584.60	Waterkeeper groups private and grant funding to maintain 22 additional traps
Materials (Trash Traps)	$45,000	$150,000	$195,000	Waterkeeper groups private and grant funding to install 22 additional traps
Printing/Design/ Data Interpretation	$1,000		$1,000	
Lab Analysis	$15,939.16		$15,939.16	
Indirect / Administrative	$0	$18,792	$18,792	10% Match by Sound Rivers / Z.Smith Reynolds
Grand Total	$187,923.76	$258,392	$446,315.76	
% of Total Budget	42%	58%		