

EPA's Microplastic Beach Protocol

A Community
Science Protocol
for Sampling
Microplastic
Pollution

September 2021



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The Microplastic Beach Protocol is designed to help community scientists collect data on microplastic pollution along both freshwater and marine beaches and shorelines. Using this protocol, volunteers can collect important data that can be used to characterize current levels of microplastics pollution and look for local, regional, and global trends.

INTRODUCTION: WHAT ARE MICROPLASTICS?

Microplastics are, in general, small plastic pieces that are less than 5 mm in size. Plastic fibers smaller than 5 mm in width but larger than 5 mm in *length* are also considered microplastics. Research tells us that microplastics are found in freshwater rivers and lakes, and in all of the world's oceans. This protocol helps you find microplastics at your local beaches.

There are two types of microplastics:

- Primary microplastics, which are intentionally produced (for example, plastic microbeads, which are used in some cosmetic products such as face scrubs).
- Secondary microplastics, which result from the breakup of larger plastic items during use or after disposal (for example, plastic microfibers, which originate from synthetic fabrics such as polyester).



Figure 1. Secondary microplastics, or fragments of macroplastics broken down over time.

This protocol focuses on microplastics 1-5 mm in size because these particles are relatively easy to find and can be identified with the naked eye or using a magnifying glass. Microplastics smaller than 1 mm in size (such as microbeads) are more difficult to find, and more sophisticated technology is required to conclusively identify them.

This Microplastic Beach Protocol focuses on collecting and identifying microplastics on the sandy beaches or shorelines of oceans and bays, lakes, and rivers. The protocol relies on the use of the Marine Debris Tracker app for smartphones or tablets to record and submit data, although hard copy data sheets are also provided for those who prefer not to use the app or wish to back up their data on paper (see Appendix A for these data sheets; use one data sheet per quadrat and see below for more information on quadrats).

WHAT YOU NEED TO GET STARTED

Supplies for collecting your sample:

- 1-Millimeter sieve*
- Cup, scoop, or flat dustpan
- 4-Meter rope or string tied to form a quadrat (1 x 1-meter square)
- Wooden stakes
- 100-Meter tape measure
- 5-Gallon bucket (2)
- Mobile device (smartphone or tablet) with the Marine Debris Tracker app, or data sheets
- Bags, jars or other sealable containers, one for each quadrat you sample
- String or additional tape measure to lay out transects
- Marker and labels for containers

* See the FAQs on page 19 for more information about sieves.

Supplies for analyzing your sample:

- Ruler
- Magnifying glass
- Forceps or tweezers
- Small brush (paint brush or hand brush)
- Mobile device with Marine Debris Tracker app
- Size grid (Figure 7)
- Visual identification guide (Figure 9)

Other materials that may be useful if multiple volunteers will be sampling:

- Digital camera (if smartphones are not being used)
- Additional 4-meter string quadrats
- Additional wooden stakes
- Additional sieves
- Additional buckets
- Additional cups or scoops



Figure 2. Clockwise from upper left: Tape measure, sieve with magnifying glass and glass bottles, bucket, metal cup, ruler and data sheets, all within the 1 x 1-meter quadrat.

INSTALLING THE MARINE DEBRIS TRACKER ON YOUR SMARTPHONE

About the Marine Debris Tracker App

Marine Debris Tracker (MDT) was developed in 2010 by the NOAA Marine Debris Program and the Southeast Atlantic Marine Debris Initiative (SEA-MDI) of the University of Georgia College of Engineering. The MDT app contains different “lists” for tracking different types of information.

The MDT app allows you to log information about your microplastics sample and upload it to the Marine Debris Tracker website where you can access it later. The app also lets you use other functions of your smartphone, such as GPS and your camera, as part of your sampling trip. For more information, visit the MDT website at: <https://debristracker.org/>

Note that it is not essential that you use this app; data sheets are available in Appendix A. If you are taking samples away from the beach to another location to count, you can use paper data sheets to record site information at your sampling location, then enter data directly to the MDT website.

Installing MDT Before Sampling

Before you set out on your sampling trip where cell service may or may not be limited, install the MDT app and set it up for microplastics sampling (see instructions below). Once the app is set up on your phone, you can enter and save data on your device without cell service, but it will not upload until you are connected to WiFi.

To install the app on your smartphone:

- A.** Go to the Google Play Store (Android) or the Apple App Store (iOS).
- B.** Search for and select “Marine Debris Tracker.”
- C.** Click “Install” and accept permissions. You will need to enable locational services to get GPS data for your site as well as allow access to your camera.
- D.** Open the MDT app (Figure 3). Create an account by typing in the login information requested. Note: You will not be able to use the EPA Microplastic Beach Protocol itemized list if you select the “Quick Track” function.

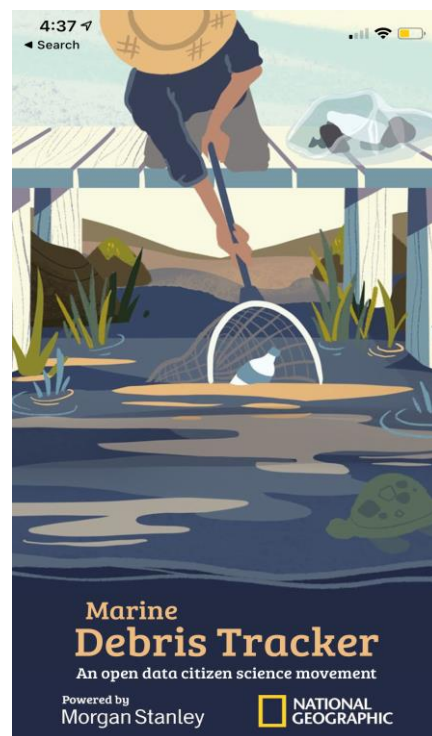


Figure 3. Home screen of the MDT app.

- E. Use the search bar or scroll down until you find “EPA’s Microplastic Beach Protocol” as shown in Figure 4 and tap this list. For repeat users, there will be a button to “Continue tracking for EPA’s Microplastic Beach Protocol” so you don’t have to search for the list each time.
- F. Once you have selected the icon, tap “Continue” to confirm using this list. The following screen will allow you to immediately begin entering data on the amount of plastics you have found. Further instruction on how to enter data into the MDT can be found in “Using the MDT App.”

Note: If you know you will sampling in an area with limited internet connection, select 4 random numbers before your trip as part of the sample site selection process. See the “Setting Up Your Sampling Area” section for instructions on how to use a random number generator to facilitate this process.

For a general overview of how to use the MDT app for first time users, we recommend checking out the “Getting Started with Debris Tracker” guide, accessible here: <https://debristracker.org/resources>

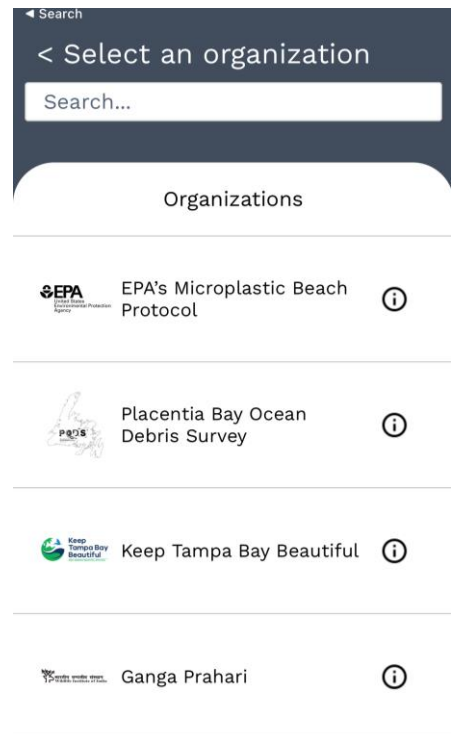


Figure 4. Scroll down and select “EPA’s Microplastics Beach Protocol” from the list. Note that its location will change as new lists are added to the app.

SETTING UP YOUR SAMPLING AREA

Identify a sandy beach or shoreline you want to sample for microplastics. At ocean or estuarine/bay beaches, your sampling area will be between the line of the last high tide (also called the high water line or wrack line, where seaweed and other organic debris are deposited by the tide) and the back of the beach where the sand ends at a seawall or path, or where vegetation grows, as shown in Figure 5 below. At freshwater beaches, your sampling area will be from the water's edge to where the sand ends and vegetation grows or there are paths, walls, etc.

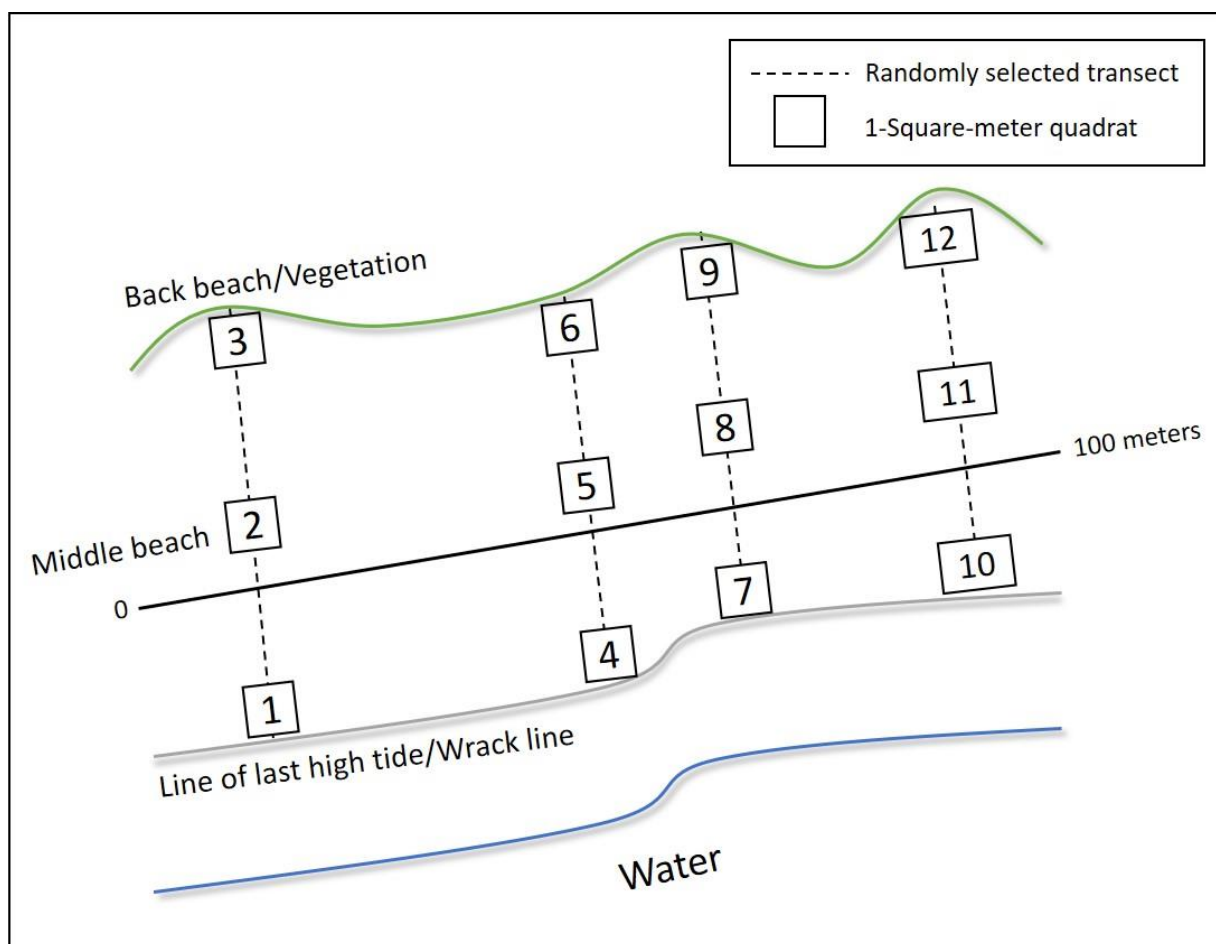


Figure 5. Sampling sites along a 100-meter line on a marine/estuarine beach. Note that on a freshwater beach, the middle beach is between the back beach and the water's edge (not the wrack line) so quadrats 1, 4, 7, and 10 would be at the water's edge.

To set up your sampling area, place the 100-meter measuring tape mid-beach and parallel to the water as shown in the diagram, and measure off 100 meters. Assign one end of the line as 0 and the other end as 100.

If your beach or shoreline is not at least 100 meters long, measure as far as you can, note this distance in the app or on your data card, and use this number in the random number generator as noted below.

Once this distance is measured, you will set up transects at random intervals along the line, using a random number generator (see below). A transect is a line perpendicular to the 100-meter line along which three 1-meter square areas (quadrats) will be selected and sampled (Figure 5).

How many quadrats should I sample?

The number of quadrats you sample depends on the purpose of your sampling trip and how many volunteers are present. **Always be sure to indicate how many quadrats you sampled in the MDT app or on your field data sheets. This is valuable information for potential data users.**

Priority: Beach Characterization

To best characterize the level of microplastics pollution in a 100-meter section of beach, 12 quadrats should be selected along 4 transects, as noted in Figure 5. This allows potential data users to compare your section of beach to others, or to establish a baseline of information for future trend analysis. Since sampling 12 quadrats is time consuming, this is best done with **6 or more volunteers**. To save time, you may wish to save microplastics samples in labeled jars or other containers for analysis later in a lab or office.

If you cannot sample 12 quadrats because of time or volunteer labor limitations, sample along 2 or 3 complete transects (6 or 9 quadrats) if possible. Multiple quadrats selected randomly following the procedures in this protocol allow for better characterization of microplastics pollution.

Priority: Education

If your sampling trip is educational in nature with **only one or two volunteers**, you may wish to select a quadrat at random to sample.

If four or more volunteers are present, one transect with three quadrats from the high tide line to the back beach (such as quadrats 1-3 in Figure 5) will provide volunteers with opportunities to engage in sampling and learn about the types and abundance of microplastics that might be present at different points of the beach. One transect, however, does not fully characterize the 100-meter section of beach.

To identify your four (recommended) transect points, use a random number generator, which can be found online using your smartphone. Go to www.random.org and enter a minimum value of 1 and a maximum value of 100. (Note: If your beach is less than 100 meters long, enter the length of your beach as the maximum value in the random number generator.) Click “Generate” four times and write the four numbers down. These numbers are where you should mark the positions of your four transects along your 100-meter distance. Using string or another measuring tape, lay a perpendicular transect across the transect point, from the high water line to the back beach. You may be able to simply establish the transect visually, especially if the water line and the back beach are close together.

Place three of the 1 x 1-meter quadrats along the transect (refer to Figure 5). One quadrat should be at the wrack line (last high tide or high water line), one at the middle beach, and one at the back beach (next to vegetation, seawall or path). Do the same for the other three transects so that you have four transects within your 100-meter distance as shown in Figure 5. Note: If you are sampling a freshwater beach, one quadrat should be placed just above the water's edge, one at mid beach, and one at the back beach where vegetation or man-made structures begin.

You may wish to draw a quick diagram of your sampling area with your quadrats labeled, for future reference.

COLLECTING YOUR SAMPLES

You can start collecting your samples after a quadrat is set up. In each quadrat, remove any big pieces of natural debris and litter, like seaweed, wood and trash. Brush these items off with your supplied brush (or rinse with water) into your 1-mm sieve so that you collect any microplastics that might be attached.

If the debris is difficult to brush off (such as large clumps of seaweed), try submerging it in a bucket of water and gently agitating it to release any material that is stuck. Once the debris is clean, pour the water through your 1-mm sieve to collect the particles. Be sure not to do this near the quadrat.

Most of your sample will consist of sand, either dry or wet. Sieve your sand carefully and in small batches to avoid losing any microplastics over the edge.

A. To Sieve Dry Sand:

- a. Evenly scrape the surface of the sand within the quadrat using a metal cup or flat dustpan to a depth of *about an inch* (2.5 cm). Deposit some of the sand you have scraped from the quadrat into your 5-gallon bucket until it is half filled with sand. Do your best to keep a consistent depth as you are scraping the sand.
- b. Scoop the sand back out of the bucket and pour it through the 1-mm sieve. Tap the sieve gently or use a brush to gently move the material through the sieve. Do this away from the quadrat.
- c. Once the first half-bucket of sand has been sieved, continue scraping sand from within the quadrat and placing it in the bucket. You may need to fill the bucket 1-2 more times. If you have enough volunteers, one person can scrape the quadrat while another filters sand.

B. To Sieve Wet Sand:

- a. Fill the 5-gallon bucket a little less than half full with water.
- b. Evenly scrape the surface of the sand within the quadrat using a metal cup or flat dustpan to a depth of *about an inch* (2.5 cm). Deposit some of the sand you have scraped from the quadrat into your bucket partially filled with water. Be careful not to overflow the bucket, and add the sand in small batches using the scoop to prevent the bucket from getting too heavy.
- c. Once enough sand has been added to the bucket, slowly pour water from the bucket through the sieve, or use the scoop to transfer all floating particles into the sieve. Do this away from the quadrat.
- d. After pouring the first bucketful of water through the sieve, remove the sand remaining in the bucket and discard it outside the quadrat. Then start again at step (a) and continue filling and emptying the bucket until all of the sand from your quadrat has been sieved.

As you sieve the sand or water, remove any suspected microplastics from the sieve using the tweezers and place them in a labeled, sealed bag, jar or bottle for later analysis. Depending on the purpose of your sampling trip (e.g. education versus in-depth characterization), you may want to combine the samples into one or two containers or use one container for each quadrat sample. For the latter more intensive

purposes, a container for each quadrat is recommended. Be sure to label the containers (see Figure 5 for quadrat numbers). Labels should include the beach name, the date of the sampling trip, the quadrat number(s), and the name of the volunteer(s).

Take note of other plastic items (larger than microplastics) you may find in your quadrat in the "Other items" section of the MDT app or data sheet.



Figure 6. Volunteers sorting through samples. Photo courtesy of Kris Stepenuck.

ANALYZING YOUR SAMPLES

Once suspected microplastics have been separated from the sand, use the size grid (Figure 7) to determine which of your particles are smaller than 5 mm. *You may wish to print the size grid and laminate it for use in the field.* If any particles are larger than the individual boxes in the grid, this means they are larger than 5 mm and thus are *not* microplastics (Figure 8). The exception is plastic lines (fibers), which may be larger than 5 mm in length, but smaller than 5 mm in width. These should be counted as microplastics.

Microplastics can be grouped into 5 broad categories: fragments, pellets (nurdles), lines (fibers), films, and foams. Each of these groups has a characteristic appearance. Figure 9 is a visual guide to the different types of microplastics.

Particles can be identified as plastic using a few methods:

- A. Visual identification using a magnifying glass and the visual guide in Figure 9.
- B. A 'sink test' to differentiate shells from plastic—shells and shell fragments will sink, while many plastics will float.
- C. A 'squish test' to differentiate hard plastics, such as polypropylene or polyethylene, from soft organic matter. Use your tweezers to gently squeeze the particle. Hard natural materials like shell fragments will crack under tweezer pressure, while plastics will generally bend, but not break (some harder plastics will not bend). Foam microplastics will also 'squish,' but not in the same way as organic matter. Foam microplastics can usually also be visually identified.

Note: Weathered plastics—plastics that have been in the environment for a long time—may not have the same properties as “new” plastics. Weathered plastics may appear faded in color, they may break more easily and may be more difficult to identify. If you are not sure that a particle is plastic, consider it non-plastic.

Count the number of plastics in each category and enter the information into the Marine Debris Tracker app, as described in section “Using the MDT App to Log Data,” below. If you want to record separate information for each quadrat, make sure to note which quadrat(s) you are analyzing.

Figure 7: Use this grid to determine if your microplastics are larger than 5 mm— each box is 5 mm x 5 mm.

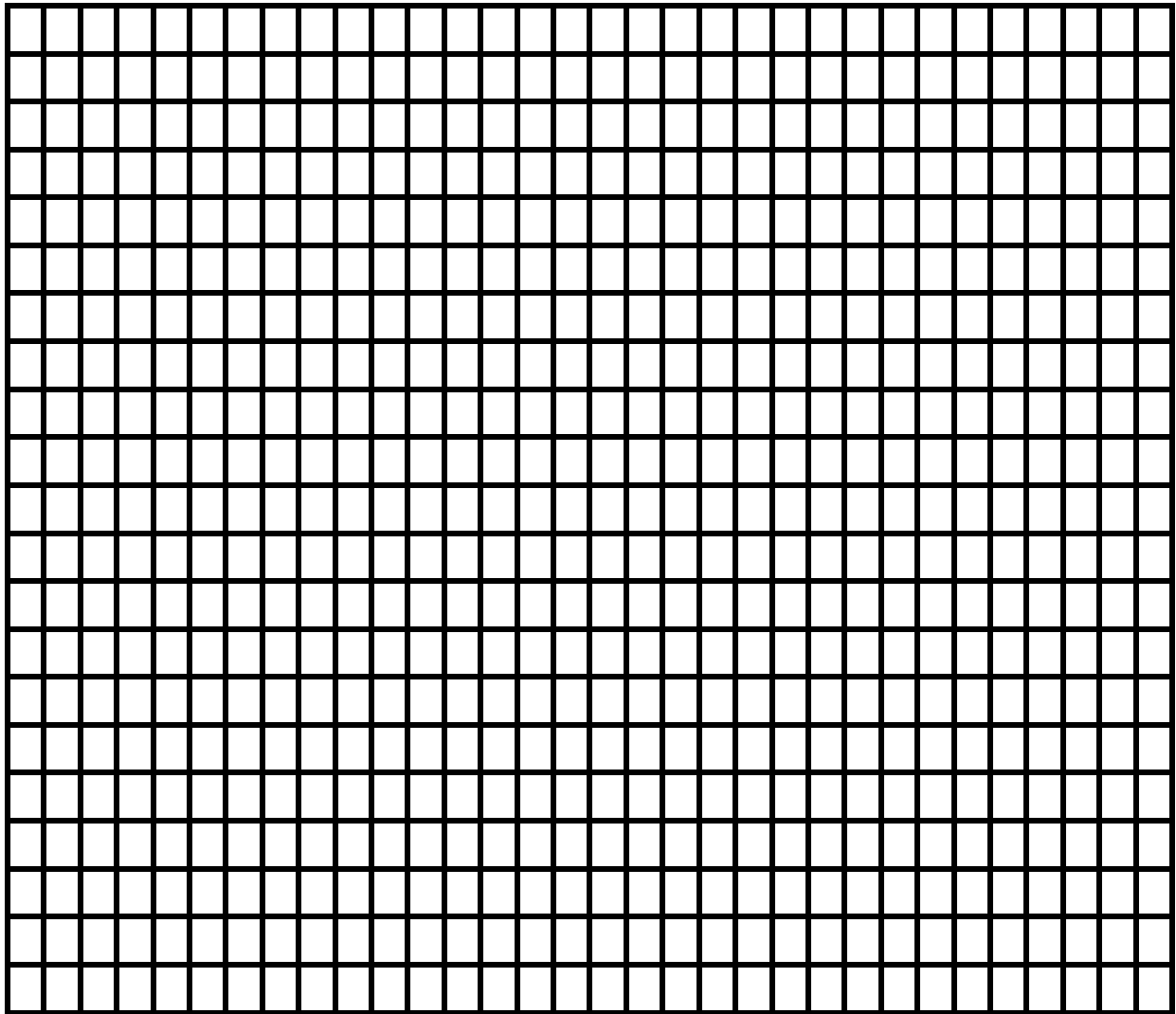


Figure 8: Use these size guides to measure other plastic pollution

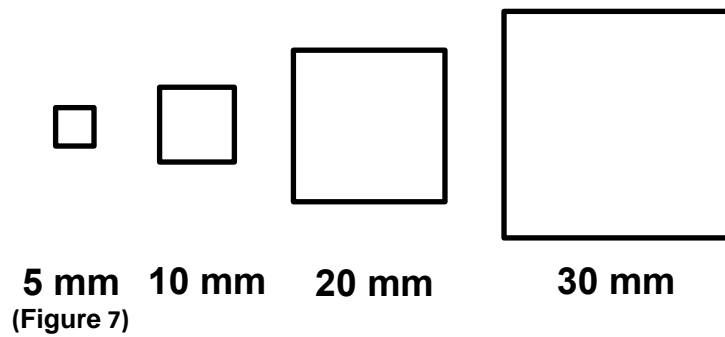


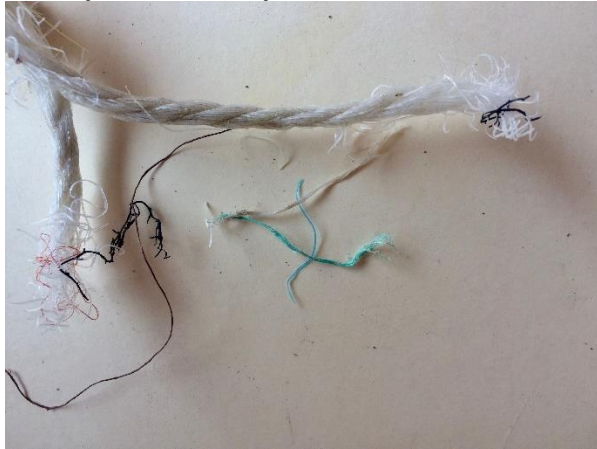


Figure 9: Visual Guide for Identifying Microplastics

<p>Fragment</p> 	<ul style="list-style-type: none">• Result from the break up of larger plastic items• Represent many types of plastic• Generally rigid• Occur in many colors and shapes• May become brittle over time due to weathering
<p>Pellets (Nurdles)</p> 	<ul style="list-style-type: none">• Used in the production of plastics• Can be made in many colors, but white pellets are common Usually have a round, smooth, manufactured appearance and feel

Line (Microfibers)



- Plastic fibers from synthetic textiles and synthetic ropes
- Occur in many colors
- May fray over time due to weathering
- May be larger than 5 mm in length, but are smaller than 5 mm in width

Film



- Pieces of plastic bags and wrappers
- Usually flexible
- Occur in many colors, but white/clear particles are common
- May become brittle over time due to weathering

Foam



- Pieces of expanded or extruded polystyrene (one example is Styrofoam™ insulation)
- Generally have a softer texture, but may also be brittle

USING THE MDT APP TO LOG DATA

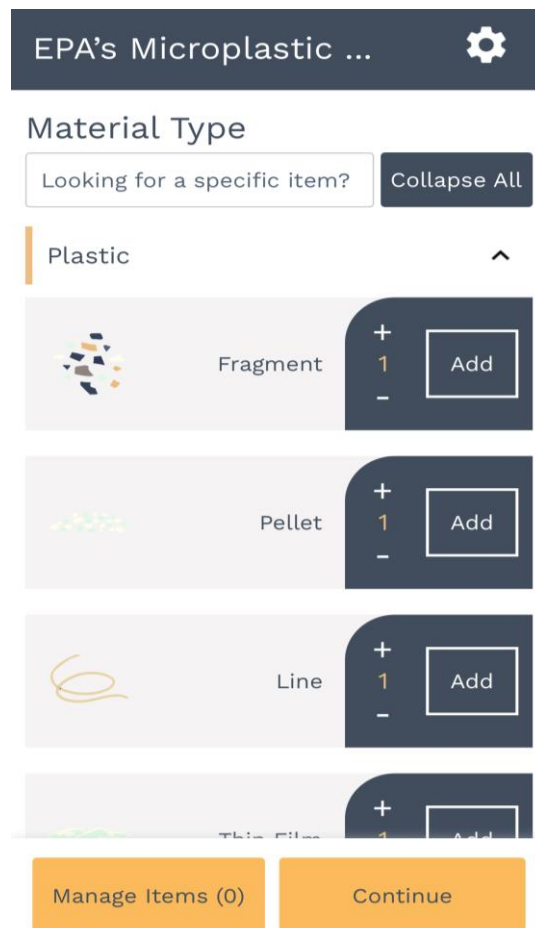
Revisit the “Installing the Marine Debris Tracker on Your Smartphone” section for a reminder of how to access the MDT app and set it up for microplastics data entry.

To enter information on the number of microplastics you have collected during sampling, click on the plus or minus signs under each microplastic type you have found (e.g., fragments, pellets, lines) (see Figure 10). You can also click on the number directly and type in the quantity. When you have finished counting how many of each plastic type to add, click the “Add” button.

The “Other Items” section found below the “Plastic” dropdown categories can be used to enter information on non-plastic litter or items larger than microplastics.

You will see the total number of items added in the bottom left box titled “Manage Items.” By clicking “Manage Items,” you can edit the amounts of each type of plastic found and review GPS information regarding your sampling location.

Note that location services must be enabled on your mobile device for this function to work. If you plan on counting and entering microplastics data off-site, we recommend using the paper forms in Appendix A to record site information at your sampling location, and then enter data directly to the MDT website at: <https://debristracker.org/>. This will prevent the MDT app from automatically assigning the GPS location of your alternative location as your sampling site.



The screenshot displays the EPA's Microplastic data entry interface. At the top, there is a dark header with the text "EPA's Microplastic ..." and a gear icon. Below the header, the section is titled "Material Type". A search bar contains the text "Looking for a specific item?" and a "Collapse All" button is to its right. A dropdown menu is open, showing "Plastic" with an upward arrow. Under "Plastic", there are three items: "Fragment" with a plus sign, the number "1", and an "Add" button; "Pellet" with a plus sign, the number "1", and an "Add" button; and "Line" with a plus sign, the number "1", and an "Add" button. Below these items, there is a partially visible "Other Items" section. At the bottom of the screen, there are two orange buttons: "Manage Items (0)" and "Continue".

Figure 10. MDT microplastics data entry screen. Enter how many pieces of each type of microplastic or other items were found, and click “Add.”

When you have finished submitting item data, click “Continue” at the bottom right of your screen. This will take you to the site data volunteer survey entry screen (Figure 11). Click on each text box to type in information on beach name, quadrat, etc. The astricks on certain survey prompts denote that this box is required. (Note that if you prefer not to enter certain information, simply put an X in the text box). When you have finished entering information, click “Save” at the bottom of the screen.

On the following screen, you can elect to share images from your mobile phone library to add as context for the data by clicking “Select images” (Figure 12). For example, take a photo of the microplastics collected from each quadrat layed out on the Figure 7 grid to represent your sample. In the future, uploaded images will be available for viewing via a photo database on the MDT website.

Figure 11. MDT site data volunteer survey screen.

Figure 12. Final data review screen for uploading images and reviewing GPS coordinates and the number of items collected during sampling.

After you have entered all information into the app and are comfortable with what you see on the final data review screen (Figure 12), select the appropriate upload option. Click “Upload Session” if you want to submit your data to the MDT app. Select “Upload Later” if you want to save the session so you can return to it later to make any changes before submission. When you return to the app, you will be able to click on “Continue

tracking for EPA’s Microplastic Beach Protocol” under “Recent Tracking Sessions” on the Marine Debris Tracker home page to pick up where you left off.

When you decide to “Upload Session”, you will see a banner pop up at the bottom of your screen notifying the upload was successful (Figure 13).

Any information you upload can be viewed publicly on the Marine Debris Tracker website (all data is anonymous unless you choose to share it on social media). You can download your data anytime by logging into the Marine Debris Tracker website at <https://debristracker.org/>. By clicking on “Data” on the top menu banner, you will be able to view a map containing information submitted by users across the world. Use the filter function to narrow your search by MDT list – select “EPA’s Microplastic Beach Protocol” to view all submissions using this protocol.

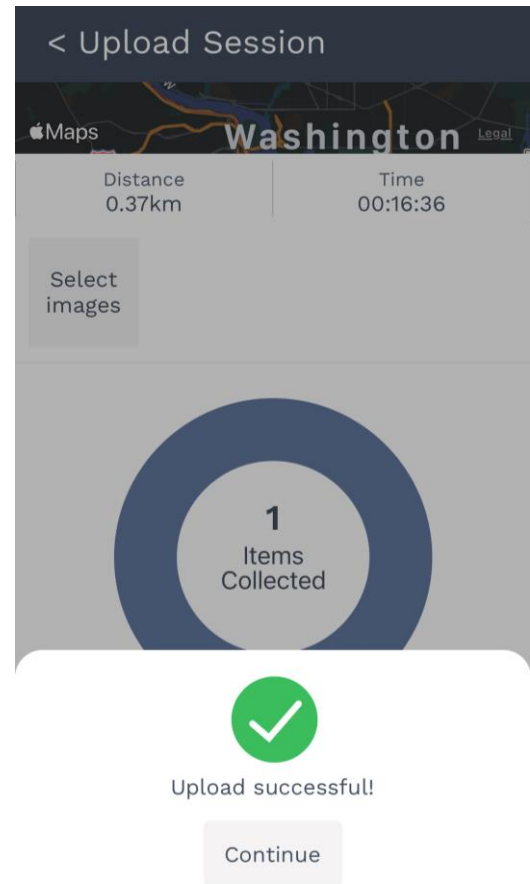


Figure 13. Successful data submission notification.

FREQUENTLY ASKED QUESTIONS

- **Where can I buy a sieve?**
Durable, high-quality stainless steel or brass sieves can be purchased from biological or scientific supply companies. Look for a #18 sieve with a mesh size of 1 mm.
- **Can I make my own sieve?**
Yes. You can use stainless steel mesh and a wooden or metal frame to make your own sieve. US #18 mesh (Tyler 16 mesh) is equivalent to 1-mm mesh. A 12" x 12" square frame with 1-mm stainless steel mesh securely attached to it (for example, with staples) will work well as a sieve.
- **Will I find plastic microbeads in my sample?**
No. Microbeads are much smaller in size than 1 mm, so they will not be trapped by your sieve.
- **I only have access to a small beach. Can I still collect microplastics?**
Yes—all information on microplastics is valuable! Follow the instructions in the protocol for how to measure your beach and set up your transects and sampling quadrats.
- **I don't have a lot of time. Can I still collect microplastics?**
Yes—any information you can collect on microplastics is valuable! Follow the instructions in the protocol for how to measure your beach and set up your transects and sampling quadrats. Sample only as many quadrats as your time allows, taking care to record your location and microplastic information on the data sheets or using the MDT app. Your sampling and analysis skills will improve with time, which means that you can analyze more samples in a shorter time.
- **Will the MDT app use my network cellular data to upload my sampling information?**
No. The app will only use WiFi to upload information. The information will be held on your phone until you access WiFi.
- **Who will be using the data in the MDT?**
As you can see from the number of lists that are included in the app and the amount of data available on the website, Marine Debris Tracker is already being used by many groups and organizations who are interested in tracking plastic pollution. As it is publically accessible, your microplastics data can be used by you, your organization, or by someone in your area, to understand local microplastic pollution. As more people use the app to collect microplastic data, scientists may use the data collected from larger areas (for example, counties, states, regions or the entire

United States) to examine and analyze broader trends in microplastic pollution over space and time.

- **How do I properly dispose of the microplastics collected during sampling?**
We recommend disposing microplastics collected during sampling in a secure container to ensure the contents don't leak back out into the environment after proper disposal. Do not dispose of your microplastics via municipal recycling.

GLOSSARY

Back beach: The part of the beach farthest from the water where plants (grasses, shrubs and/or trees) are growing and/or there are seawalls, boardwalks, paths, parking lots, etc.

Human use of beach: Classify human use of beach as low if there are usually few or no people who use that beach during the beach season; medium if there are usually scattered individuals or small groups of people who use that beach during the beach season; or high if there are large numbers of people who use that beach during the beach season.

Microplastics: Generally, plastic pieces smaller than 5 mm. Plastic lines (fibers) larger than 5 mm in *length*, but smaller than 5 mm in *width*, are also considered microplastics.

Nurdles: Small plastic pellets that are the raw material from which many plastic goods are made.

Quadrat: A 1-meter x 1-meter square that is used to mark off a sampling location for collecting microplastics.

Transect: A line perpendicular to the water line along which the quadrats are placed for microplastics collection (see Figure 5). Random numbers are used to identify where you should establish your transects along the 100-meter (or less) distance.

Weathering: A change in the appearance or other characteristics of microplastics due to exposure to the environment. Wind, water, salt and microbial activity can all cause weathering of microplastics. Signs of weathering include changes in color, shape or texture.

Wrack line: A visible line of natural (for example, seaweed, drift wood, or shells) or manmade (for example, plastic litter) debris on the beach that is parallel to the water and reflects a recent high tide. The wrack line also indicates **the high water line**.

APPENDIX A: DATA SHEET FOR RECORDING MICROPLASTIC COUNTS

Use one sheet for each quadrat sample

Beach Name:		Nearest City or Town:			State/Province/Country:	
Human Use of Beach: (circle one) Low Medium High		Organization/Group Name: _____ Volunteer Name(s)(optional): _____			Quadrat #: (per Figure 5) _____	
Recent Rain/Storms: (circle one) Yes No		Beach Type: (circle as many as apply) Urban Rural Remote River Lake Bay Ocean Island			Location of Quadrat on Beach: (circle one) Last High Tide* Middle Beach Back Beach	
Sampling Date:	Time of Day:					
	Number of Fragments	Number of Pellets	Number of Lines	Number of Films	Number of Foam Items	Other Plastic Items
1-5mm						
>5mm						
Notes: (include whether a photo of the microplastics was taken)						

*Last High Tide or High Water Mark applies to marine/estuarine beaches. For rivers/lakes, this is the Water's Edge.