Suggestions for teaching K-12 youth about microplastics

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Grade level			Resource/Activity
Elem	Middle	High	
X	X	X	There's a fabulous TedEd video (5 minutes) that does a great job of summarizing the issue and "setting the scene." I'd suggest showing this as an introduction to the topic of microplastics. It's at https://www.youtube.com/watch?v=KpVpJsDjWj8
X	X	X	Beanie Babies are stuffed with plastic "nurdles"--the form in which pre-consumer plastic is shipped to manufacturers. This term is introduced in the TedEd video mentioned above. Carefully cut through some of the stitches on one of the seams, and you'll discover a surprising number of these tiny beads (see photo-- there were 371 nurdles in that tiny Beanie Baby). The hang tag will say whether the beads are polyethylene (PE) or PVC. 

X (with help/ over-sight)	X	X	If you have an opportunity to work with the students on a shoreline, you can have them look for microplastics in sand/sediment. I'm attaching (below) a protocol that I wrote and used with 12-14 yr-old students one summer. If it's not feasible to bring sediment to a classroom and use water to float out the plastics, you can simply have them visually pick out all of the plastics they can see from within a quadrat. I've done this with high school students (and with elementary students who were paired with high school students) and used quadrats that were 0.25 m x 0.25 m, then had them mark an X in the sediment when they had removed all of the plastic they could see, and repeat that 16 times. That way they had sampled an entire square meter, and had made sure they didn't sample an area that had already been sampled before. They collected their plastics in film canisters, and I later went through their collections and counted the number of nurdles, as well as sifted the samples to obtain just the microplastics. I gave the teachers small vials containing the microplastics their students had found.
X	X	X	The Marine Debris Tracker App from NOAA provides lots of cool opportunities for logging data, then generating maps/viewing data etc. If you haven't checked it out, I suggest you play with it (both the app and the website). http://www.marinedebris.engr.uga.edu/
		X	Sampling water samples for microplastics is somewhat more complicated, and requires more expensive equipment--there is a volunteer manual, as well as a series of YouTube instructional videos showing the Florida Microplastic Awareness Project protocols on the FMAP website. (www.plasticaware.org) I am happy to send a supplies list if you decide you want to pursue that route--it costs about $600 for one set of equipment, and you'd probably want to have supplies for students to be able to work in groups of 2 or 3, so add about $250 per group to that...
X	X	X	There are some additional resources under the K-12 tab on the plasticaware.org website.

Sampling for Microplastics in Beach Sand

(Maia McGuire, PhD, UF/IFAS Extension Sea Grant Agent)

Microplastics can be found in the sediment and in the water column. Here are some simple methods for investigating this type of pollution in beach sand samples. These methods are appropriate for upper elementary school-aged students through adults. They do not require the use of chemicals.

Materials needed: Quadrat (25 cm x 25 cm—see construction description at the end of this document), container to hold sand (gallon zipper-seal bag, sealable bowl or tub), small trowel or large spoon, paper plate(s), sieve (window-screen size, or 0.25 mm if using graded sand sieves), tweezers, 2-3 large cups, water[1]

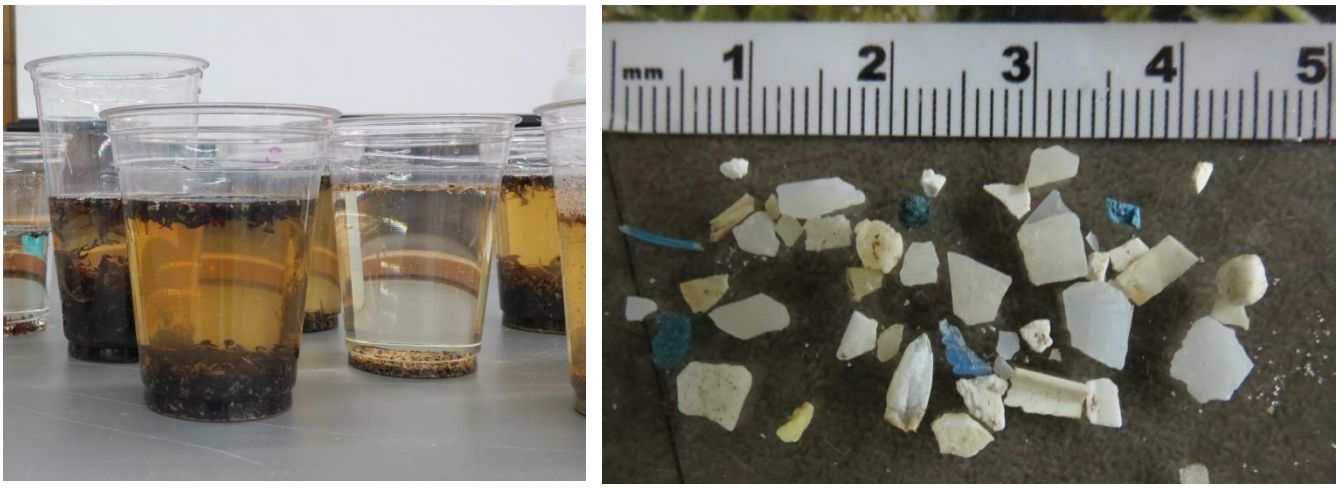
Procedure:

1. At the field site, randomly place the quadrat in the area of the wrack line.
2. Use the trowel/spoon to scrape about the top ¼ to ½ inch of sediment/wrack and scoop it into a container or bag (see footnote below). Seal the container.
3. Indoors, pour the contents of the container onto paper plates and spread out the sediment to dry (see footnote below). Leave at least overnight. If the sediment is already dry, you can skip this step.
4. Sift the sediment through the sieve. Capture the fine sand that comes through the sieve and save it to return it to the field location.
5. Visually look through the sediment and debris left in the sieve (you can pour it back onto

[1] If you want to analyze the sample for microscopic fibers, be sure to use pre-filtered water and pre-rinse containers that will be used three times with pre-filtered water. You will need to take steps to prevent contamination of samples (see information in section titled "In the water.")

a clean paper plate to help with this step.) Look for any obvious pieces of plastic and pick them out. Set them aside in a small container.

6. Take the remaining sediment/debris and pour it into one or more large cups. Fill the cups about ¾ full with tap water (or filtered water, if you will be looking for microscopic fibers.) Stir well. If you see plastic pieces rise to the surface immediately, go ahead and pick them out and add them to the ones previously found.
7. If there is plant material in the debris, it will also float (as will pieces of crab shell and small snail shells that have air trapped in them). The longer the plant material soaks, the more likely it will be to sink. If possible, leave the cups overnight and stir and check them again the next day before discarding the contents. If you will be analyzing for microscopic fibers, be sure to cover the cups at this point.
8. If you wish to look for microscopic fibers, treat the sample from step 7 as a water sample and analyze as described in the section below.



Sediment/wrack samples soaking (left); microplastics found in beach sand (right): Photo credits: Maia McGuire

In the water

If you wish to examine your sample for microscopic fibers, follow the steps below.

Materials needed: Vacuum filter apparatus that can take 47-mm filters; 0.45 micron gridded filters; filter forceps; squirt bottle, tap water; 1-liter separatory funnel and stand/clamp, dissecting microscope (20-30 or 20-40 X).

Procedure:

1. Run about 100 ml of tap water through a 0.45 micron filter (vacuum filter it). Use this to rinse the inside of the side-arm flask (the one you've used to collect it in) and discard. Repeat 2 more times. (Essentially you are triple-rinsing the flask with filtered water). Similarly triple rinse a squirt bottle with filtered tap water. Collect the next 500 ml of filtered water and use it to stock the squirt bottle. You will use this filtered water for rinsing the funnel, etc.
2. When ready to process your sample, triple rinse a 1-L separatory funnel. Pour the sample into the funnel (supported by a clamp on a heavy-duty stand). Let sample stand for at least a few minutes. Drain off the sand/silt from the bottom of the sample into a cup (this will be discarded). If the sample contains large pieces of plant material (e.g. Sargassum seaweed), you will probably not be able to drain it through the separatory funnel. Instead, you will need to carefully pour as much of the liquid into the filter apparatus as you can without getting the plant material on the filter.
3. With no filter inserted, rinse the inside of the filter apparatus with pre-filtered water. Use a petri dish or other flat object as a cover for the filter apparatus (only remove when adding more sample). This will help reduce environmental contamination of the sample (e.g. by lint in the air).
4. Insert the filter (gridded) into the apparatus. Add sample to fill the filter funnel. Put

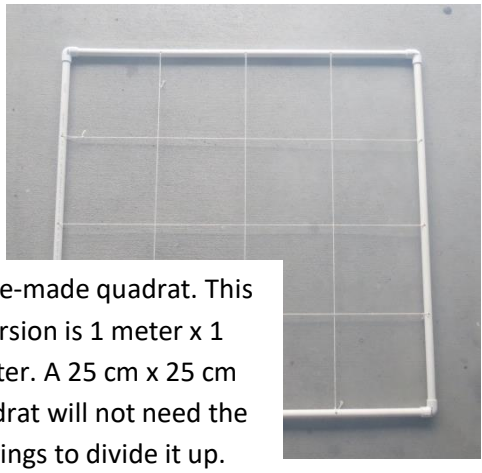
remaining sample back on the clamp and allow to further settle (keep the separatory funnel or sample bottle stoppered). Drain sediment from the separatory funnel as needed.

5. With the cover over the filter funnel, vacuum filter the sample. Add more sample until it has all been run through the filter. Rinse the sides of the filter funnel with a small amount of filtered water once your sample has been entirely filtered.
6. If you get large pieces of plant material on the filter, carefully pick them out with forceps and rinse with filtered water (so the water runs back onto the filter) before discarding.
7. Release the vacuum pressure. Remove the filter and place into a clean petri dish. Cover with the petri dish lid. Remember to label the sample (either on the petri dish lid, or with a small strip of paper placed inside the petri dish, but not on the filter).
8. Let the filter dry at least overnight before viewing under a microscope (not required, but it's easier to differentiate plastics from plankton once the plankton have dried out somewhat. It's also easier to scan without the reflection from the wet filter).
9. If processing several samples collected in the same general location one right after the other, you do not need to rinse the separatory funnel or filter funnel in between...but should do so before switching sample locations.
10. Observe the filter papers under a microscope at 20X magnification. Scan the filters systematically, moving row by row to prevent double-counting or missing plastics. Plastic will generally be milky/white or colored (not clear). Sand grains are easily mistaken for plastics. Many of the fibers seen on the filters will be extremely small. Natural fibers can be differentiated from plastic fibers by carefully heating them over a candle flame and observing under a microscope.
11. See helpful videos at http://sfyl.ifas.ufl.edu/flagler/marine-and-coastal/microplastics/get-involved/

Making a Quadrat

Quadrats are relatively simple and inexpensive to make. You will need the following materials and supplies:

- ½ or ¾" PVC pipe (there are different grades of pipe—look for the cheapest kind)
- ½ or ¾" PVC elbows (90°)
- PVC cement (optional)
- Hacksaw or PVC cutters
- Tape measure



Home-made quadrat. This version is 1 meter x 1 meter. A 25 cm x 25 cm quadrat will not need the strings to divide it up. Photo credit: Maia McGuire

<u>Instructions:</u>

1. Cut the PVC pipe into four 25-cm pieces
2. *(This step is optional.)* Working in a well-ventilated area, use PVC glue to attach elbows to one piece of PVC. It is best to do this on a flat surface, so you can make sure that the elbows are in the same plane. Use PVC glue to attach the rest of the PVC together in a square. You can simply push the pieces together without gluing if you wish to be able to take them apart to store.
3. The inside dimensions of the finished product should be approximately 25 cm (1/4 meter) on each side.

To make a larger quadrat, simply increase the size of the PVC to the desired length. Larger quadrats can be subdivided into sections using string that is run through holes that have been drilled through the PVC, as in the photo above.