Teachers Hands on Activity Guide

Delta Kids

Hands-On Activities!

📷 Would you like to try your hand at some nature photography like **John**? Read on to find out how you can become a scientist by taking photos!

Quadrat Photography

What is a *quadrat*? A quadrat is a square frame ecologists use to identify random plots of ground that they then take measurements from. They might toss the quadrat without looking and then count the number of insect or plant species within the square. Then they can toss the quadrat again and get another count so that larger spaces can more easily be sampled. In this activity, you will just be focusing on one spot mapped out by your quadrat, but you will be making observations over different spans of time.

What you will need:

- A camera (a phone will do just fine)
- A good spot where your quadrat can stay for a while
- Option 1:
    - A wire clothes hanger
- Option 2:
    - 4 sticks of about same size
    - Duct tape
- Optional:
    - String
    - Clear Tape

How to make your quadrat:

Option 1

1. Unwind the neck of the wire clothes hanger
2. Bend the wire into a square shape as best you can

3. Twist the ends together to close the hanger into a square.

Option 2

1. Gather 4 sticks of about the same size from your yard or other greenspace (each stick should be slightly larger than a foot)
2. Lay the 4 sticks out into a square shape
3. Using duct tape, secure the corners so that you have a sturdy square

Optional

1. Cut a few lengths of string, each just a bit longer than the length of your square
2. Space these strings out evenly going from left to right and tie into place. Use clear tape to secure.
3. Cut out a few more lengths of string (the same as before)
4. Space these strings out evenly going from top to bottom and tie into place. Use clear tape to secure.
5. You should now have a number of mini-squares within your larger square. These mini-squares can better help you see when changes occur in your quadrat over time.

What to do:

1. Either pick a spot on the ground outside that you are really interested in OR gently toss your quadrat and just watch where it lands! NOTE: Be sure that wherever your quadrat ends up, it is in a safe place and will not be moved.
2. Choose the time scale you want to work in.
    a. Over a day: snap a photo at the top of every hour from 6am to 6pm
    b. Over a month: snap a photo every day at the same time from the 1st to the last of the month
    c. Over a season: snap a photo once a week on the same day and at the same time for several months
3. Notes you can take in a notebook or digital device:
    a. How many different kinds of insects do you see?
    b. How many of each kind of insect do you see?
    c. What about other invertebrates (animals without backbones) that are not insects?

   d. What about vertebrates (animals with backbones)?
   e. How many different kinds of plants do you see?
   f. How many of each kind of plant do you see?
   g. What color is the soil, if visible?
   h. What is the weather like when you take each photo.
4. Because your photos will be digital, you can give each photo a file name that identifies the date and time when the photo was taken. Ex. 9_12_6am which would be September 12th at 6 am OR 11_3_430pm which would be November 3rd at 4:30 pm.

Activity Follow-Up

1. Did what you see in your photos change over time?
2. How long did it take for any changes to appear?
3. What changed the most? Plants? Animals?
4. What did not change that much?

 Do you have an interest in birds like **Evie**? Try out this activity to learn how different beaks lead to different niches for a variety of bird species!

<u>Competing Beaks</u>

What you will need:

- At least 2 players and 1 timekeeper
- "Food"
  - 10 ping pong balls
  - 20 mini marshmallows
  - ½ cup of rice
  - 10 rubber bands cut in half
- "Beaks" - each player will use 1 of the following beaks at a time
  - Tweezers
  - Bamboo skewer

    - Spoon
    - Salad tongs
- 1 cup per player
- 1 data table per player
- 1 plate for the game area
- Timer

How to set up:

1. Spread the "food" out over the plate so that everything is intermixed. This will be your game area.
2. Select 1 beak per player.
3. Give each player a cup.

What to do:

1. You have 15 seconds to pick up the food items and place them in your cup.
2. Try picking up all the different food items but consider which items are the easiest to pick up.
3. Try to get as many food items as possible.
4. After 15 seconds, count out all the food items you have collected and record on the data table below. Each player should have their own data table.
5. Switch beaks and repeat Steps 1-4.
6. You can continue switching beaks until all players have tried each beak type.

Data Table

	Ping Pong Balls	Mini Marshmallows	Rice	Cut Rubberbands
Round 1 Beak Type: _____				
Round 2 Beak Type: _____				
Round 3 Beak Type:				

_____				
Round 4 Beak Type: _____				

Activity follow-up:

1. Did all beaks collect the same types and amounts of food?
   No, different beak types were better at collecting different food types.
2. What kind of food was easiest for each beak to collect?
   a. Tweezers
   b. Bamboo skewers
   c. Spoon
   d. Salad tongs

   This may vary depending on the players, but a pattern should emerge.
3. Do all bird species have the same types of beaks?
   No, different birds have different types of beaks from short and spikey to long and rounded and everything in between.
4. If different bird species have different types of beaks, what does this allow to occur within a single ecosystem? And why?
   It allows for more bird individuals of more species to live at the same time in one ecosystem. If you have a bird species with one type of beak that makes it easier to eat small seeds and you have a bird species with another type of beak that makes it easier to eat large seeds, then both types of birds can have substantial populations in the same ecosystem because they are not competing for the same food (resources). One eats from plants that produce smaller seeds, and one eats from plants that produce larger seeds. These are likely different species of plants.
   Eating specific plant types is part of a bird's *niche*, or its place in the ecosystem. When each bird species has a different niche, more bird species can live in the same place at the same time!

Kareem tells of his experiences seeing less and less marine life on his father's shrimping expeditions. He also notes an oily sheen to the water. Have you ever noticed litter and pollution in the natural world around you? Check out this activity to practice your hand at cleaning up an oil spill!

Oil Spill Clean-Up

What you will need:

- Clean-up Methods
    - String/yarn and straws cut into thirds (thread the string through a few straws and tie off to create a containment boom for the oil)
    - Cotton balls/Q-tips
    - Spoons
    - Dish soap
- Oil mixture
    - 1 cup vegetable oil
    - 1 teaspoon cocoa powder
    - A spoon
- Water
- A large bowl or plastic Tupperware container
- A cup
- A tablespoon measure

What to do:

1. In the cup, mix together the vegetable oil and cocoa powder with the spoon.
2. Fill the bowl with water up to a couple of inches from the top of the bowl.
3. Measure out 1 tablespoon of the oil mixture and carefully pour into the water.
4. Try the 4 different clean-up methods and compare them to see which you think works the best to remove the oil. You might find that combining several different methods works the best.
    a. String with straws cut into thirds (containment boom)
    b. Cotton balls or Q-tips (absorption)

c. Spoon (skimming)
d. Dish soap (dispersal)

Activity Follow-Up:

1. Was it difficult to remove the oil?
2. What specific challenges did you face in trying to remove the oil?
3. How do you think these challenges align with challenges that actual environmental engineers face when they are cleaning up oil spills in the ocean?
4. What was the best method you used?
5. Did combining different methods together work better than one method alone? If so, which ones?
6. Did the containment boom work to corral the oil?
7. Did the cotton balls/Q-tips work to absorb the oil?
8. Did the spoon work to skim the oil from the surface?
9. How did the dish soap work to disperse/break up the oil?
10. Are there any other methods you think would work? Clean out your bowl and then use another tablespoon of your remaining oil mixture to reset your oil spill. Try this new method and compare it to the suggested methods.

 Do snakes scare you? Or do they fascinate you like they do **Noah**? Snakes can be fierce predators, but they are also amazingly unique creatures. Try your nose at this activity to see if you can smell as good as a snake!

Scent Search and ID

A snake uses its tongue to collect scent particles from the environment around it. Its tongue then carries these particles to its Jacobson's organ which is in the roof of its mouth. The Jacobson's organ interprets these scents and sends necessary information to the snake's brain. This is why you might see a snake flicking its tongue around in the air--it is tasting and therefore smelling the scents on the

wind. While you will not be using your tongue, these two activities *will* test your sense of smell both in distance and identification.

What you will need:

- At least 2 people
- 5 different essential oils (see some suggestions below)
    - Peppermint
    - Lavender
    - Rosemary
    - Orange
    - Eucalyptus
    - Rose
- 5 cotton balls
- 5 Ziploc bags
- 1 toothpick
- 1 Sharpie

Set up:

1. Poke several holes in each Ziploc bag using the toothpick.
2. Using the Sharpie, label each bag with a number 1-5.
3. Soak each cotton ball in a different essential oil.
4. Place 1 cotton ball in each bag, being sure to make a note of which number goes with which essential oil.
5. Hide the bags around the room while the person(s) who will be doing the searching have their eyes closed.

What to do:

1. Once all the bags are hidden, have the person doing the searching open their eyes.
2. Give the searcher 5 minutes to sniff out as many of the 5 bags as they can.
3. After 5 minutes, retrieve any unsniffed-out bags and put all the bags in a row on a table. Record which bags were found on the data table below.

4. Starting with Bag 1, have the searcher hold the bag close to their nose and squeeze the bag a few times while sniffing the air. Can you identify the scent? Use the data table below for writing down your predictions.
5. Repeat Step 4 for Bags 2-5.
6. Now reveal the correct scent IDs, add these to the data table, and see how well the sniffer was able to smell!

Data Table

	Bag Found?	Scent Prediction	Scent Actual
Bag 1			
Bag 2			
Bag 3			
Bag 4			
Bag 5			

Activity follow-up:

1. Were you able to find all 5 bags?
2. Which bags were the easiest to find? Why do you think this is?
3. Were you able to identify all 5 scents?
4. Which scents were the easiest to identify?
5. Why do you think this is?

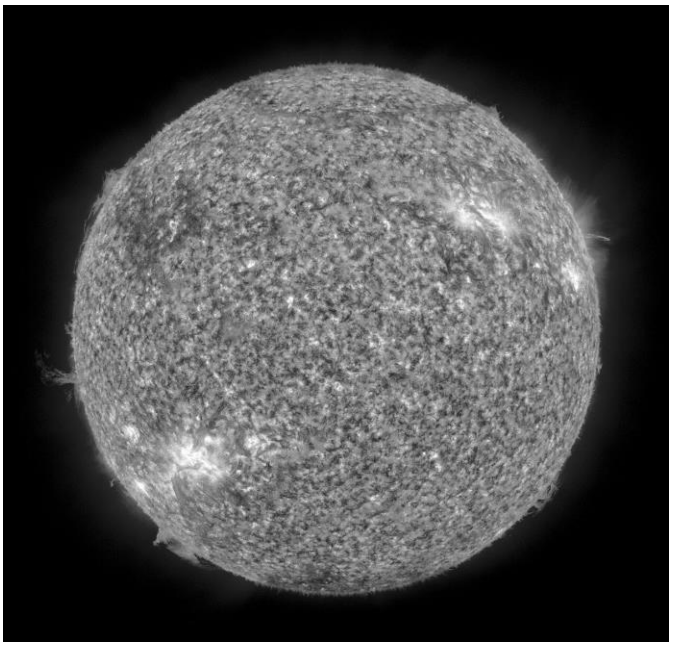
From birds to insects, there are so many creatures that make up the ecosystem of the Mobile-Tensaw Delta. **Evie** finds herself enamored by these animals, but they could not exist without a wide variety of plants to help support them. Try out this activity to see just how interconnected the delta ecosystem really is!

Delta Food Web

What you will need:

- 5 or more participants (preferably)

- Ball of yarn
- Image of the sun
- The images below of Mobile-Tensaw Delta plants (4) and animals (5) (note the descriptions below the images that describe how each plant/animal is connected to other plants/animals in the ecosystem—the names of connected plants/animals that have their own cards are italicized)


Public Domain

The Sun – This celestial body provides ultraviolet light to plants so that they can undergo photosynthesis and turn sunlight into food.



Michael Martin - https://commons.wikimedia.org/wiki/File:Bald_Cypress_Swamp_-_Flickr_-_pinemikey.jpg ; Public Domain

Bald Cypress (*Taxodium distichum*) – These hardwood trees grow in thoroughly saturated or even flooded soils. They produce cones with scales that contain two triangular seeds each. These seeds are eaten by a variety of species, including *Wood Ducks* and *Gray Squirrels*, which also help disperse them.

USFWS Public Domain; Public Domain

Muskrats (*Ondatra zibethicus*) - These semi-aquatic rodents are primarily herbivores, eating *Duckweed* and *Cattail* plants and *American Sycamore* fruits among a wide variety of other plants. Muskrats build lodges with underwater entrances out of non-woody or herbaceous plants such as *Cattails*.

Walter Siegmund - https://commons.wikimedia.org/wiki/File:Aix_sponsa_05819.JPG

Wood Ducks (*Aix sponsa*) - These birds nest in pre-excavated tree cavities formed by other animals or rotting branches. One example of a tree that grows large enough for such cavities is the *American Sycamore*. As for food, Wood Ducks eat everything from invertebrates (including *Dragonflies*) to plants (*Bald Cypress* seeds, *Duckweed* plant matter, and acorns from oak trees...to name a few). In turn,

Wood Duck eggs are at risk of predation by raccoons and young Wood Ducklings are at risk of predation by *Snapping Turtles*.


Mundhenk - https://commons.wikimedia.org/wiki/File:American-Sycamore-Bark.jpg
Jeff Turner - https://commons.wikimedia.org/wiki/File:American_sycamore_(Platanus_occidentalis).jpg

American Sycamore (*Platanus occidentalis*) – These hardwood trees grow in bottomlands and along streams. Their fruits (which each contain a multitude of fuzzy seeds) are eaten by a variety of different birds as well as *Gray Squirrels* and *Muskrats*. Cavities excavated in these trees by raccoons, woodpeckers, and rotting branches are the perfect nesting site for *Wood Ducks* and *Gray Squirrels*.

Public Domain

Cattails (*Typha latifolia*) – These herbaceous plants act as food for many species including *Muskrats* and *Wood Ducks*. They also provide protective cover for young *Wood Ducklings*, building material for *Muskrat* lodges, and cover for *Snapping Turtles* waiting to ambush their prey. Additionally, Cattails provide food for the

prey *Dragonflies* hunt while also acting as a perch for *Dragonflies* to hunt from. And they are a suitable surface for *Dragonflies* to attach their eggs to.


NOAA Public Domain

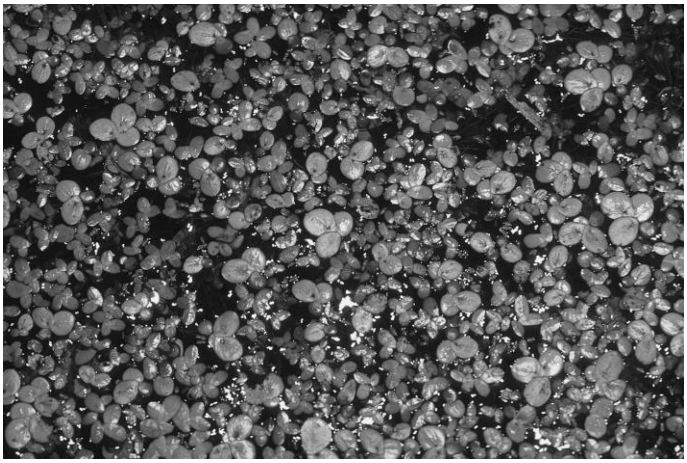
Eastern Pondhawk Dragonflies (*Erythemis simplicicollis)* - These insects are aquatic (they live underwater) from birth until adulthood when their wings fully develop and they become semi-aquatic and start flying. They act as protein-rich food for a variety of animals including *Wood Ducks*, especially the ducklings, and *Snapping Turtles*. As they are fierce predators, Dragonflies perch on *Cattails* to await prey feeding on the plants. And, when laying eggs, Dragonflies may attach them to *Cattails*.


Brian Gratwicke - https://commons.wikimedia.org/wiki/File:Common_snapping_turtle_-_Chelydra_serpentina.jpg

Common Snapping Turtles (*Chelydra serpentina*) - These omnivorous reptiles eat a wide variety of food including *Duckweed*, *Cattails*, *Dragonflies,* and young *Wood Ducks*. Their eggs are preyed on by raccoons and great blue herons among other animals. Snapping Turtles also use *Cattail* stands and *Duckweed* mats as cover for avoiding predators and to hide for ambushing prey.

Robert Taylor - https://commons.wikimedia.org/wiki/File:Gray_Squirrel_4663_(5837545110).jpg

Eastern Gray Squirrels (*Sciurus carolinensis*) - These opportunistic omnivores primarily eat plant matter, including *American Sycamore* fruits and *Bald Cypress* seeds. When food is scarce though, they might even be found eating *Wood Duck* eggs. Just like Wood Ducks, Gray Squirrels also use pre-excavated cavities in *American Sycamores* for their nests.



Public Domain

Common Duckweed (*Lemna minor*) - This tiny herbaceous aquatic plant grows very densely and acts as food for *Snapping Turtles*, *Wood Ducks*, and *Muskrats*. Because

of its dense growth, it can also provide cover for a variety of animal species, including *Snapping Turtles*, whether hiding from predators or lying in wait to ambush prey.

What to do:

1. Assign someone to be the sun and have them hold up the sun image.
2. Pass out animal and plant images to the remaining participants—1 image per person. (There are enough images for 10 people total to participate.)
3. Have everyone stand in a big circle.
4. Give the ball of yarn to the sun.
5. The sun then throws the yarn ball (while still holding on to the end) to a plant. Plants need sunlight to photosynthesize their food. In this way, all plants are connected to the sun!
6. The person with a plant image who just caught the yarn ball then reads aloud the description below their plant image to see what animals or plants are connected to their plant. They then throw the yarn ball (while still holding on to the yarn) to the person holding one of these animals or plants.
7. The person who caught the yarn ball then reads aloud their description and repeats Step 6.
8. Continue repeating Step 6 until everyone is holding on to the string.
9. Now comes the really interesting part--choose a plant or animal to become extinct and therefore no longer be a part of the ecosystem. This person must drop their string, and everyone must adjust in the circle to take up the slack.
10. Look over the card for the plant or animal that just became extinct and if there are any other plants or animals that rely on this living thing, have the people holding those plants or animals drop their string as well.
11. Continue with Step 10 until you come to a stopping point.
12. Repeat Steps 9-11 until no living things are left in your ecosystem.

Activity Follow-Up

1. Once one animal/plant became extinct, how many others followed suit? None? Just one or two? Or many?

2. Did this trend differ depending on the plant or animal that became extinct?
3. What does this tell you about the interconnectedness of ecosystems? Do all living things exist as individual self-sufficient beings? Or are they dependent on other living things in the ecosystem?

 Have you ever wondered what it would be like to walk a mile in your relatives' shoes when they were your age? Follow in **Mae**'s footsteps and learn about the experiences your parents, grandparents, aunts, uncles, and other family members had with nature in their youth.

Family Interview

What you will need:

- An older family member or mentor (teacher, family friend)
- A recording device (a smart phone will work)
- A notebook and a pen
- At least 30 minutes to dedicate to your interviewee (you might be surprised to watch the time fly by!)

What to do:

1. Pick out a comfortable spot without much external sound interference.
2. Start recording and ask the questions below. Take physical notes of the most important points that come up.
    a. What is your name and how are you related to me?
    b. What year was it when you were ___ years old *[your age]*?
    c. How much time did you spend outside when you were young?
    d. What were your favorite things to do outside when you were young?
    e. Did you ever go on trips into nature?
        i. Where did you go?

   ii. What kind of ecosystems did you experience? (beaches, mountains, deserts, plains, forests, etc.)
   iii. What did you do there?
   iv. Did you ever see any interesting plants or animals? What were they?
f. Can you describe your favorite experience outside when you were young?
g. How has your relationship with nature changed as you have grown up?
h. Have you noticed any changes in ecosystems throughout your life? Do you think we are doing a better or worse job protecting our ecosystems than when you were younger?
i. What would be your one word of advice regarding the great outdoors?

Activity Follow-up:

1. Interview several different people of different ages.
2. Compare notes/recordings from these different interviewees to see if you can find any trends in people's relationship with nature through time. What are the similarities? What are the differences?
3. Consider how you might take what you learned and apply it to your own life!

 **Noah** loves spending his free time out in nature, getting to know all the many plants and animals that make it their home. Have you ever wondered what plants and animals live around you? Try out this activity to guide such an exploration!

Forest Biodiversity Walk

What you will need:

- Yourself
- An adult
- 30 minutes to an hour
- A notebook and pen or pencil

- Optional
    - Binoculars
    - Magnifying glass
    - A way to take photos (either a camera or a smartphone will work)

What to do:

1. Choose a natural forested area that you are curious about exploring. This could be as simple as your backyard or a local park or could involve a trip to a state or national park.
2. If you have any of the following items on hand, bring them along to enhance your experience: binoculars, magnifying glass, camera/smartphone.
3. In your notebook, write down the month, day, and time of day that you start your walk. Consider what the weather is like and make a note of that as well.
4. Give yourself at least 30 minutes, if not an hour, for your walk. If you are walking down a trail, set a timer for half the amount of time of your planned walk so that you know when to turn around.
5. As you walk, look at all the plant and animal species around you. Use the binoculars to look at birds high in the sky. Use the magnifying glass to examine little invertebrates crawling down on the ground. Use the camera or smartphone to take photos of any interesting species you come across.
6. If your parents allow, there are several naturalist apps for smartphones that you can use to help identify all sorts of living things. You can even make your own contributions with photos that *you* take!
7. Hints:
    a. If you see a decent-sized rock, try turning it over and seeing what is underneath it. You might find worms, isopods (roly-polys), beetles, centipedes, and any number of fun animals that like the dark.
    b. Be sure to look up into trees and see if you can spot squirrels, raccoons, or birds.
    c. If you come across a flower, you might see bees, butterflies, or other insects hovering around them.
    d. Take a close look at the bark of trees and see if you can find any moss or lichens.

    e. Listen with your ears and look around to try and see what it is you hear.
    f. If you run into a pool of water, dig in the sediment around the edges to see if anything might be hiding—you could find a frog, salamander, or aquatic larval invertebrate.
8. These hints just scratch the surface of ways you can thoroughly explore the nature around you. Follow your instincts and if you see something interesting, look closer!
9. As you come across intriguing plants and animals, write notes about them or draw pictures of them in your notebook. Snap photos of them with your camera or smartphone. In your notebook, be sure to describe where you found the plants or animals—On the ground? In the air? In a tree? In a bush? In a small plant? In water? Under a rock?
10. One thing to remember during your walk if you are in a park: Leave no trace! You do not want to harm any plants or animals as you explore, so do not pick any leaves or stomp on any bugs. Remember that you are in *their* home!

Activity Follow-Up:

1. We call the area where a plant or animal lives its habitat. What kinds of habitats had the most plant or animal species? How many plants turned out to be habitats in and of themselves?
2. How many different plant species do you think you saw?
3. How many different animal species do you think you saw?
4. What different varieties of animal species did you see?
    a. Birds
    b. Reptiles
    c. Amphibians
    d. Mammals
    e. Invertebrates
        i. Isopods (roly-polys)
        ii. Insects
        iii. Arachnids (ticks, spiders, and scorpions)
        iv. Myriapods (centipedes and millipedes)

   v. Mollusks (snails and slugs)
5. What different varieties of plant species did you see?
   a. Trees
   b. Mosses
   c. Herbaceous plants
   d. Woody bushes
6. Can you think of any environmental threats that this habitat might be facing? What are some possible causes and some potential solutions?
7. What kind of ecosystem do you want to explore next??

Mae notices pollution in the water around the Africatown bridge. Have you ever noticed pollution in bodies of water around you? Many people rely on surface water (lakes, reservoirs) for their drinking water, but what if these bodies of water become polluted? How do we get rid of the pollutants? Water treatment facilities have filtration systems to do just this. Check out this engineering experiment and make your own personal filtration system to clean up some yucky water!

<u>Water Filtration</u>

What you will need:

- Scissors
- Plastic water/soda bottle – either a small size or 2-liter size will work
- Coffee filters
- Gravel
- Sand
- Activated charcoal (can be bought at pet stores in the fish section)
- Water
- Dirt
- Vinegar
- Yellow food dye
- Teaspoon measure

- Tablespoon measure
- Cup measure
- 2 cups and a spoon
- Paper and a pen or pencil

Set up:

1. Filtration device:
    a. Using the scissors (you may want to get an adult to help with this part), cut the top 1/3 of the bottle off.
    b. Remove the lid.
    c. Turn the top upside down and place it inside the bottom 1/3 of the bottle.
2. Polluted water:
    a. Fill one of the cups up 2/3 with water.
    b. Measure out a tablespoon of dirt and dump into the water.
    c. Measure out a teaspoon of vinegar and dump into the water.
    d. Squirt a few drops of yellow food dye into the water.
    e. Mix with the spoon until thoroughly combined.

What to do:

1. Set out the available materials for designing your filter:
    a. Gravel
    b. Sand
    c. Activated charcoal
    d. Coffee filters
2. Think through the size, shape, and function of these 4 different materials and decide the order you want to place them into the top 1/3 of your bottle.
3. With the paper and pen or pencil, draw out your plan.
4. Put the filter together the way you designed, being careful not to be too messy!
5. Measure out 1 cup of the polluted water and slowly pour it into the filter. Watch how the various pollutants get filtered out as they pass through the different filter layers.

6. Once all the water has trickled out into the bottom 2/3 of the bottle, pour the filtered water into the second cup and record your observations in the data table below.
7. Reset the top 1/3 of the bottle upside down into the bottom 2/3 of the bottle and pour the filtered water back through the filter. Record your observations in the data table.
8. Repeat Step 7 at least 3 times or until the water is as clear as you think it will get.

Activity follow-up:

1. How many filter runs did you conduct?
2. Did the water ever look super clean?
3. What pollutants still remained in the water after the final filter run? Why do you think this might be? Consider particle size.
4. In the real world, do humans have to filter large amounts of dirty (or even already somewhat clean) water for any reasons? What challenges do you think they face, and are they similar to what you experienced? Think on a large scale about where we get the water that comes into our homes as well as where that water goes after we use it!
5. Do you think your filter would have worked better if the materials were in a different order?
6. If you would like, try out a different order of materials in your filter, fill out the data table again, and compare the two different filters. Which was actually better?

Data Table

	Color	Smell	Transparency	Other Notes
Filter Run 1				
Filter Run 2				
Filter Run 3				
Filter Run 4				
Filter Run 5				

 Do you dislike litter as much as **John**? Have you ever seen lots of litter out in the natural world and wished there was something you could do about it? What if you could invent something to help? This is your chance to dream up an engineering solution to the litter problem…try your hand at the Engineering Design Process and design your own litter collector!

Engineering Challenge: Litter Collector

What you will need:

- Clean recyclables (thin cardboard boxes, plastic tubs, plastic jugs, cartons, water/soda bottles of all sizes, plastic lids, etc…use your imagination!)
- Scissors
- Tape
- Paper and pen or pencil
- Optional additional supplies:
    - Craft sticks
    - Pipe cleaners
    - Aluminum foil
    - Paper clips
    - Rubber bands
    - Binder clips

What to do—The Engineering Design Process:

1. Identify the Problem – The Pristine River is a beautiful place, but despite its name, many people treat it like a dumping ground, throwing everything from cans to wrappers to used napkins in its sparkling waters. We need you to design a device that can continually remove all this litter and return the river back to a state that matches its name.
2. Imagine/Brainstorm - Think big! Imagine all the different ways that you could design such a litter collector. Would it have wheels? Fins? Would it float? Crawl on the river's bottom? How would it grab the litter? What would it do with the litter? Write down as many ideas as you can.

3. Select – Choose one of the ideas from your list to move forward with and design. Do not forget to give it a fun and catchy name!
4. Design – Now you need to figure out how to translate your big idea into something you can make with the materials you have on hand. How could you make each part of your big idea using the recyclables and other materials in front of you? Draw out your design, being sure to label the material(s) you will be using to build each part.
5. Build – Now for the fun part...start creating your design! Using the recyclables and other available materials, build your imagination.
6. Test and Evaluate – While you will not be able to functionally test your device, treat this step as a thought experiment. Did your build go the way you expected? Is there a part or material that did not work the way you thought it would? Write down all these thoughts in preparation for Step 7.
7. Improve – Consider the evaluation of your initial build. How could you build your litter collector differently? What different materials could you use for various specific parts of your litter collector?
8. Iterate – This is a fancy word for doing everything over again. Redraw and rebuild your design. Then Test, Evaluate, and Improve all over again until you feel you have the best iteration (version) possible!

Activity follow-up:

1. How many iterations (repeats of steps 6-7) did you go through?
2. Do you feel that you ended up with a solid design that could be built in real life?
3. How does your litter collector function? How does it move? How does it pick up litter? What does it do with the litter?
4. What are your thoughts on the Engineering Design Process? Consider using the EDP in the future whenever you run across a challenge or problem you cannot come up with a solution to off the top of your head. You will be amazed at how helpful and useful it can be!

 **Kareem** has noticed many fish and other marine creatures dying off in the waters where his dad takes his fishing boat. While this is sad because of the lost life, it is also a detriment to Kareem's dad who makes his living on selling the shrimp he catches. These creatures have to be dying off for a reason...could it be something in the water? Put on your detective hat and try your hand at this experiment testing mystery water to see what could have caused it to become so dangerous.

Mysterious Fish Kill

What you will need:

- pH Testing
  - 3-4 red cabbage leaves
  - A blender
  - Water
  - A strainer
  - A large bowl
  - A cup
- Dissolved Oxygen Testing
  - Dissolved Oxygen test kit tablets (can be found at various online retailers)
- Nutrient Testing
  - Ammonia test strips (can be found in the fish section of pet stores—you can also find multi-test strips that include a pH test along with the ammonia test)
- Mystery water
  - A tablespoon measure
  - 3 ceramic mugs
  - A spoon
  - A kettle
  - Garden fertilizer containing ammonium sulfate
- Safety Equipment
  - Safety goggles

- Nitrile gloves

Set up:

1. pH Testing – Making the pH indicator (unless you have multi-testing strips)
    a. Fill the blender half full with water.
    b. Tear up 3-4 big red cabbage leaves and add the pieces to the water in the blender.
    c. Blend this mixture on high for 30 seconds.
    d. Strain the resulting liquid into the bowl to separate the remaining leaf chunks from your pH indicator liquid.
2. The Mystery Water
    a. Heat up water in the kettle (Be careful to heat for no more than 30-45 seconds. You do not want the water to get to a boil.)
    b. Pour the hot water into one of the ceramic mugs up to about an inch from the top – being careful not to burn yourself!
    c. Mix in 1 tablespoon of the garden fertilizer containing the ammonium sulfate.

What to do:

1. Divide the Mystery Water mixture evenly into the 3 separate mugs.
2. Follow the ammonia test strip instructions and test the water in one of the 3 mugs for ammonia levels. Note your results in the data table below.
3. Follow the dissolved oxygen test tablet instructions and test the water in one of the 2 remaining mugs for dissolved oxygen levels. Note your results in the data table below.
4. Measure out a tablespoon of the red cabbage pH indicator into the 3rd mug and note the color change (red = acidic, green = basic, neutral = color remains the same). Record your results in the data table below. Or use the multi-test strip in the same mug as Step 2.

Data Table

	Ammonia	Dissolved Oxygen (DO)	pH
Mystery Water			

Activity follow-up:

1. A safe level of ammonia in water would be less than 0.2 mg/L or 0.2 ppm. Was your water above this level? Or was it within safe limits?
2. A safe level of dissolved oxygen in water would be above 5 mg/L. Was your water below this level? Or was it within safe limits?
3. A safe pH level in most water would be between 6.0 (not too acidic) and 8.5 (not too basic). Was your water within this range? Or was it below 6.0 (acidic) or above 8.5 (basic)?
4. Considering all of the above, why do you think there are fish dying off in this water?
5. What do you think could have caused the toxic conditions in the water? With your parents' help, look online to find some real-world examples of environmental pollution that could cause pH changes, ammonia spikes, or low levels of dissolved oxygen.

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