Full Lesson Plans
2019-2020

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Intro to the Aquarium

What are the different parts that go into the Bioma Beta and how is it different from most aquariums? What role does each part play in the tank? Have your students watch this video to learn more about the tank and why it is designed that way.

SWBAT:

- Understand the basic components of the aquarium and their function
- How each component in the aquarium relates to processes in nature

Video: https://youtu.be/baC4DAblDxw
Aquarium Setup: https://www.youtube.com/watch?v=JdrWVypW8Ss&feature=share

Before the video	Have your students observe the tank. Discuss what purpose they think each component of the tank serves, and what would happen if it would be taken away.
After the video	Discuss with your students some things they have learned from the video. What purpose does each part fill and why is it vital to the tank?

The Tank and the Stream Matching Game

It's important that your students understand how each part of a tank and its function relates to a component of a healthy stream ecosystem. In this activity, students will brainstorm

what they think would be an essential feature to the health of a stream ecosystem (the stream ecosystem couldn't function without it) based on what they know already, and match them to the aquarium cards (pg 2) based on their function in the aquarium (the filter card could be matched with water flow; both oxygenate the water, prevent it from being too hot in the summer, and wash away pollutants).

SWBAT:

- Understand the basic needs of a healthy stream ecosystem and how they can be met with the parts of the aquarium.

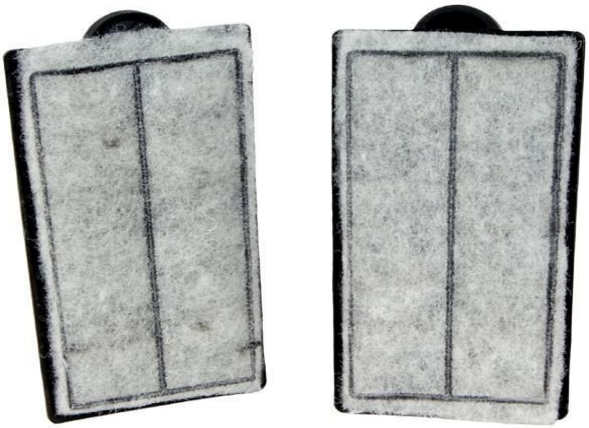
Estimated Time: 10-15 minutes

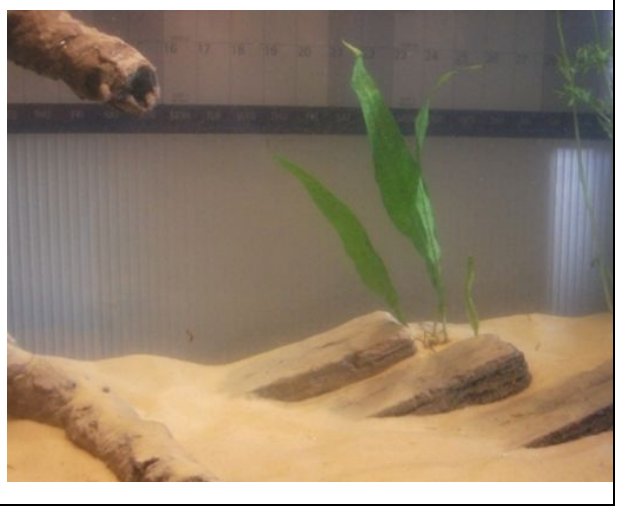
Before the activity	Discuss with your students about what they already know about stream ecosystem health: what are some essential parts of a stream existence and what necessary functions does it provide?
After the activity	Discuss with your students about what they have learned: How does each component of the aquarium and its function relate to a process in nature? How can they improve the layout of the aquarium to better meet the needs of the critters?

Procedures:

1. Determine if you will split the students into groups; in large classes, this may be necessary. Print out sets of the aquarium cards accordingly.
2. After dividing students into groups, give them each a pile of notecards or sticky notes to brainstorm the question: what components of a stream ecosystem are essential to its health (sun, current, etc)? It may be helpful to show pictures of local streams, such as the Middle Patuxent, on the projector.
3. After brainstorming, ask your students to meet and discuss what they wrote down. See if there are any overlaps in answers; put these in a pile marked as the "essential" cards. Discuss each card with the class and see what their reasoning is. Put cards with items that are nonessential in a nonessential card pile.
4. Have your students review the essential cards and match with the aquarium cards. If you are doing the activity as one class, this should be done under a projector.
5. After matching the two sets of cards, discuss with your students their rationale for matching each card; what similarities did they spot?

Aquarium Matching Cards

Filter	
Filter Cartridge	

Driftwood	
Rocks	
Sand Substrate	

Aquarium Lid	

-Keeps the tank water clean without human effort -Must be cleaned out, since it contains the dirty filth that arises in the tank -Suction could be dangerous to the critters, this is something to watch out for	-This part of the tank contains the filth that arises in the tank -It must be changed on a weekly basis to ensure that the water remains as clean as possible -The filter part of this is made of cotton/white fibers
-This type of wood helps the tank resemble a normal natural habitat for the critters -This can be found anywhere in the forest near a stream, lake, river, pond, etc. -This is mainly for tank design, also as a home for the shrimp	-These stones are another design feature of the tank, which helps resemble a normal stream environment. -These also keep the substrate sand at the bottom of the tank, while also preventing water currents in the tank

-This substrate is something you would find at a nearby stream, or at a beach. -This is the backbone of the tank, because this acts as a resting bed for all of the plants and nonliving things inside the tank, while also keeping everything organized.	-This item prevents outside contamination of the aquarium. -It also insulates the water and keeps it the right temperature, by preventing the room temperature from adding heat to the water -Large, around the length and width of the tank. Covers the top of the tank.

The Volume Game

It's a good idea for your students to have an idea of the dimensions of the tank so they can have a better understanding of their maintenance roles. In this activity, the students will gain perspective on the metrics and volume of the tank by comparing them to everyday objects.

SWBAT:

- Understand how the dimensions of the tank and how they relate to tank maintenance.

Estimated Time: 15-20 minutes

Before the activity	Discuss with your students. What do they think the volume of the tank is? What do they think the dimensions are?
After the activity	Discuss with your students about their findings. Based on they discovered, establish some basic procedures for interacting with the tank. Here are some ideas: 1. Before interacting with the tank, all students should roll up their sleeves. 2. Al water changes should be supervised a teacher

Procedures:

1. Find the materials for this project. You would need:
    a. A ruler/measuring tape
    b. A normal 4 function calculator for the class
2. Ask your students to estimate the volume, length, width, and height of the tank, and write their estimates down.
3. Ask your students bring in common items from home that are used to store things, such as gallon jugs for milk (empty), water bottles, etc, along with the volume for each item. It should be enough to have 3-4 common objects.
4. After collecting all the items, record the volumes for each item.
5. Ask your students to measure the lengths of everyone's arm with the ruler, in inches. Record the data on a chart on the board. Then, write the formula to find the arithmetic

mean on the board and have the students use their calculators to find the average arm length for the class. Record this on the board.

6. Next, have your students find the length, width, and height of the tank with a ruler. Record these measurements on the board. Next, show the formula to calculate the volume and have your students calculate the volume of the tank. Their end product will be in inches cubed, so find the conversion rate into gallons. Make sure that the end result is in gallons.
7. Have your students compare the volume with those of their common household containers, and find how many of those are needed to fill up the tank (it would take 10 gallon jugs of milk to fill up the aquarium, etc), by dividing the volume of the tank with the volume of the objects. Record this on the board.
8. After completing this activity, have your students compare the measurements.

Aquarium Food Chain Activity

In this activity, students will connect what they learned in the Food Chain activity with the aquarium. They will creatively brainstorm and create their own food chains with the critters and plants in the aquarium ecosystem, which they will present to the class. In Part 2 of this activity, students will join their food chains together into one single food web for the aquarium ecosystem, displayed on a poster.

SWBAT:

- Understand the concept of a food chain and how it relates to a food web
- Creatively generate theories and defend them

Estimated Time: 50 minutes

Before the activity	Complete the Food Chain game activity or another activity that familiarizes the students with the concept of a food chain. Also, compete the Species Profile activity to familiarize the students with the inhabitants of the tank.
After the activity	Aquarium Food Web (Part 2)

Procedures:

1. Have your students watch this video as a refresher on the topic of food chains and food webs.

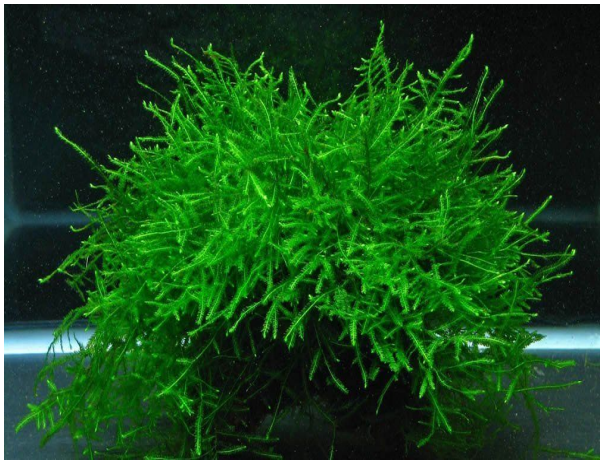
https://m.youtube.com/watch?v=FFloV2J-eKI

2. Discuss with your students about the differences between a food chain vs a food web; which is more diverse? which encompasses the other? What kinds of food chains may be found in the classroom?
3. If you have a large class, split your class into smaller groups. Print out a set of the Food Chain cards and the Food Chain Combinations worksheet (found on the next pg) for each group. The goal of this activity is for each group to brainstorm as many possible food chains as possible and write down the combinations on the Food Chain Combinations worksheet.

4. After the activity, bring all the groups together and have each group present their combinations. Find if there are any differences in each and have the groups explain their reasoning.
5. Make sure to collect your students' Food Chain Combinations worksheet if you plan to do the second part of this activity.

Food Chain Cards (Worksheet)

# Freshwater Clam -Eats leftover fish food and bits of plant material	
# Pond Snail -Eats algae, elodea, and sometimes leftover fish food.	
# Blacknose Dace -Eats fish food, and sometimes algae	

# Grass shrimp -Eats leftover fish food, dead fish, and bits of java moss.	
# Java Moss -Uses light to photosynthesize and produce its own food.	

# Elodea -Uses light to photosynthesize and produce its own food.	
# Duckweed -Uses light to photosynthesize and produce its own food.	

Fish Food	
Algae -Uses light to photosynthesize and produce food for itself	

Food Chain Combinations (Worksheet)

Name:_____

Directions: Use the Food chain cards to create as many food chains as possible by arranging and rearranging critters, then write down your combination in its appropriate boxes. After you are done, wait for your classmates to finish and compare answers.

Remember that not all boxes need to be filled out, and that fish food counts as a producer.

	Producer- Makes food for itself but eaten by others	Primary - Eats the producers	Secondary- Can eat the primary consumer	Tertiary- Can eat the secondary consumers. (lions, wolves)
Combo 1				
Combo 2				
Combo 3				
Combo 4				

Aquarium Food Web Activity

In this activity, students will use the food chains they created in Aquarium food web (Part 1) to create a comprehensive poster displaying all of the food chains in the aquarium and how each organism interacts with another. This activity is a great way to engage the more artistically inclined members of your class.

SWBAT:

- Understand how the food chains in the aquarium tie into each other and how each organism relates/interacts to another.
- Understand the progression of the nitrogen cycle in the aquarium

Before the activity	Complete aquarium food chain
After the activity	Find a place to display the students' posters.

Procedures:

1. Bring the students back into their prior groups and give back the Food Chain Combinations worksheet to each group, along with a piece of poster paper to display their work.
2. Bring out coloring materials for the students to use.
3. Brief the students on the guidelines of this project:
    a. The poster must include all of the species in the aquarium
    b. The students must use arrows to show the progression of energy in the system (eg, arrow from algae to snail), as animals eat.
4. After completing this activity, have all of the groups present their food webs and discuss how each board is similar or different. Have the students ask constructive questions to critique the boards of each other. Here are some helpful questions to enrich the discussion:
    a. What kind of species could we substitute in for each step of the food chain?
    b. How could microbes play an important role (decomposer, etc) in the tank food chain?
    c. If you removed x animal/plant from the food chain, what could go wrong?

d. Do any of the critters compete for the same food/nutrient sources? What may happen if they didn't have to?
e. What kind of environmental changes could disrupt the food web (eg, removal of light sources) and how?

Water Testing Activity

When most people think about polluted water, an image of a dirty, stinky sludge usually comes to mind. However, the most harmful pollutants are often odorless, colorless, and look just like water. In fact, if you didn't do a water test, you wouldn't know they were there.

Ammonia and nitrates are two toxins that are produced from decomposing matter, such as fish waste or leftover fish food. Even in small concentrations (2 ppm), they still can be harmful to fish. It's important that the students understand how the nitrogen cycle works and how they can detect these toxins before they poison the fish.

SWBAT:

- Understand what kinds of pollutants are present in the tank and nature and how they can be detected.
- Perform the nitrate and ammonia water test
  Estimated Time: 20-30 minutes

Before the activity	Have your students discuss what they already know about pollutants and toxins to the watershed. See if they can name a few that may cause water quality issues in the aquarium.
After the activity	Compare data from different groups and discuss with your students on what they have learned. How may the conditions in different environments influence the nitrate or ammonia levels there? Make sure everyone knows how water tests should be done in the future

Procedures:

1. Before the experiment, ask the students to each bring in a sample of water from a local waterway with life, and mark down what kind of environment each sample came from (pond, creek, lake, etc).You can also use their samples in the pH lesson plan or the plankton lesson plan. If you are doing the plankton lesson plan, make sure to store the

water samples in a cool, dark place, and to use the samples within 5 days of collection to prevent die-offs of plankton.

2. Have the students wash their hands with soap and water before this activity.
3. Find the nitrate and ammonia test kits. Assign students into different groups and give each group a nitrate and ammonia test kit and a data collection sheet (second page). The groups should take turns using the water samples to collect data on the nitrate and ammonia concentration of all the samples and record their data on the data sheet.
4. Have the students wash their hands with soap and water again after the activity.

Data sheet

	Water sample 1	Water sample 2	Water sample 3	Water sample 4	Water sample 5	Water sample 6
Ammonia concentration (ppm)						
Nitrate concentration (ppm(						

Trimming Plants Activity

In nature, the growth and distribution of plant species is not by accident; the taller plants usually crowd out the shorter plants, who grow in the shadows of the taller plants, requiring less light. However, in the confines of the aquarium, the taller plants may begin to grow in the living space of the fish and shrimp, crowding them out and stopping all water flow in the aquarium; thus, it's important that the plants in the tank are trimmed from time to time.

SWBAT:

- Understand how taller plants can crowd out and starve shorter plants of light

Before this activity	Make sure that the aquarium plants have been in the tank for at least a month and show signs of steady growth.
After this activity	

Procedures:

1. Have your students inspect the tank to determine if it is in need of trimming; are there any plant stems that are at least 8" long (a ruler will be helpful)? Do plants take up more than a quarter of the surface of the aquarium? If so, the tank is in need of a trim.
2. Have your students watch this short video on trimming aquarium plants https://www.youtube.com/watch?v=1oW3PmH7pNw
3. Fill up a tub or another container with tank water
4. Assign three or four students the job of finding plants to trim, and place those plants into the tub. Assign another three students the job of trimming plants, and give them fine scissors and rulers. Make sure that only two or three inches are cut off from the top of the tank. Put the plants back into the tank after trimming. Dispose of the trimmings in a sealed plastic bag
5. If duckweed is the culprit, have the students scoop out the excess plant material with a cup and dispose into a sealed plastic bag.

Tying Moss to Structure Activity

In the wild, underwater mosses and algae attach to driftwood and other sources of structure, providing ample hiding places for fish fry and gathers organic detritus for your shrimps and snails to eat. It also provides an aged look to your aquarium that will make it even more attractive.

During the school year, the moss doesn't have sufficient time to attach itself to structure, so in this activity the students will tie the moss to pieces of driftwood and larger stones in order to anchor it and jumpstart this amazing natural process. Overtime, the moss will grow additional fibers to attach itself to structure.

SWBAT:

- Understand how attaching moss to structure provides for a more vibrant tank environment

Before this activity	Complete the Species Profile activity so that the students understand the basic care and niche of the moss. Make sure that the tank has been up and running smoothly for at least a month, and that the moss colony is healthy. Healthy moss is green (not brown or yellow) and should exhibit some signs of growth since you first introduced it to the tank.
After this activity	Closely monitor the moss after placing them back into the tank. In the rare case that the moss have a die-off, remove the brown/yellow strands (dead moss) and closely monitor ammonia/nitrate levels.

Procedures:

1. Discuss the layout and design of the aquarium with your students. Do they see any aspects of the aquarium that need to be improved? How can the layout of the aquarium be changed to best accommodate the needs of each species? It may be helpful to put a bird's-eye view of the tank on the projector.

2. Introduce the idea of tying moss to the driftwood to improve growth to segway into this activity. Pick out some pieces of driftwood and large rocks that your students would like to use to tie on moss.
3. Have your students draft designs for each piece of structure, to be brought in next class. The designs should include where on driftwood/rock there should be moss and how dense.
4. At the beginning of the next class, gather a pair of scissors, and roughly 2' of sewing thread/cotton thread for each student. Lay down paper towels and newspaper on the table that the students will be using.
5. When the students come to class, review each design and have the students select a design for each piece of structure.
6. Have your students watch this video to learn the basics of tying moss to structure beforehand.

https://m.youtube.com/watch?v=HATpDRVmwM4

7. Have the students remove the driftwood and the wad of moss from the tank and place them inside a tub or another container filled with dechlorinated water. They should inspect both for snails or other hitchhikers and gently remove them and put them back into the tank.
8. After placing the driftwood and moss into the tub, have the students gently slosh them around to wash off any debris.
9. The students should then place the driftwood/rock pieces on a piece of paper towel and break off a wad of moss for each location the design specifies to tie on moss. Tying on the moss is simple; just place the moss on the desired location and tie it on with the thread. Make sure that the students don't tie the moss down too tightly. Keep the moss in the water as much as possible.
10. After a piece of moss is tied onto a piece of structure, put the moss+structure back into the tub. Gently slosh it around to remove loose bits before putting it back into the main tank. Loose bits of moss should be reused for other structures.

Stream Scavenger Hunt (Field-trip)

An outdoor scavenger hunt in the critters' natural habitat (a local park or patch of wood with a creek) will allow students to better grasp the connection between their classroom education and processes in nature. Students enjoy hands on activities in which they can physically interact with their environment, and the scavenger hunt allows them plenty of opportunities to do so. Make sure to bring chaperones if you are bringing a large group of students and to stay together.

SWBAT:

- Understand how components of the aquarium (filter, light, etc) resemble features in nature
- Learn more about how organisms on land interact with those in the water

Estimated Time: 1-1.5 hours

Before the activity	Discuss with your students on what kinds of critters they expect to see on this trip. Ask them if they can identify what factors a stream ecosystem needs in order to thrive (sunlight, well oxygenated water, etc). Print and hand out the observation sheets for the students to record a noteworthy observations.
After the activity	Ask the students about their observations. Did they find anything noteworthy? What parts of a stream did they find to be absolutely essential to its health and what components in the aquarium have the same function?

Procedures:

1. Also decide what size groups you would like and if you would need chaperones.
2. Hand out copies of the scavenger hunt worksheet. Remind students that objects need to be seen but not collected. Send students on their hunt in pairs. They can record answers on their sheet. Parents can assist with this activity.

3. As students hunt assist with clues as to where they can find their objects. For example, you can say, " I wonder where we could find some ants. I know they dig tunnels, I wonder where they put all the soil they move from their home."
4. After most items have been found, gather all students in a meeting area. Have students share their findings.

Wrap-up:

In the following weeks back at your school, you can schedule a trip to a nearby park and complete another scavenger hunt there. Spend time discussing and comparing the two environments. Did they find the same animals and trees? Was it easy to find all they were searching for?

Stream Scavenger Hunt Questions:

1.Three different kinds of leaves. Can you name them, if not sketch them below._____
_____
2. An insect. Where did you find it?_____
_____
3. Something living under a log or rock._____
4. Something that shows an animal may have passed there (animal track, scratches, droppings).
_____
5. A seed built to float in the air._____
6. One thing trout need to survive._____
7. Sit quietly with your eyes closed for a minute or two. What sounds do you hear? (Try to ignore people sounds.) _____
_____
8. Something that is not native to the area. How do you think it got there? (e.g. bottle caps, candy wrap)_____
9. One thing trout eats._____
10. An animal home on a tree or other plant._____
11. An egg or larva _____

Creating Your Own Maintenance Calendar Activity

In this activity, students will be able to create their own calendar for tank maintenance. This will make the maintenance process more orderly. This mini-project should be very fun for the students!

SWBAT:

- Understand how an ecosystem needs to be maintained based on interdependence
- Create a schedule for tank care

Estimated Time: 2 class periods

Before the Activity	Students will engage in a discussion about the importance of having a calendar and an orderly schedule. They then will be able to design their own schedules.
After the Activity	Have students work collaboratively on completing the final calendar, and encourage volunteering for maintenance groups.

The final product will use a large piece of white paper, about the height of the whiteboard and half the length of a whiteboard. Just a calendar large enough to fit an entire month.

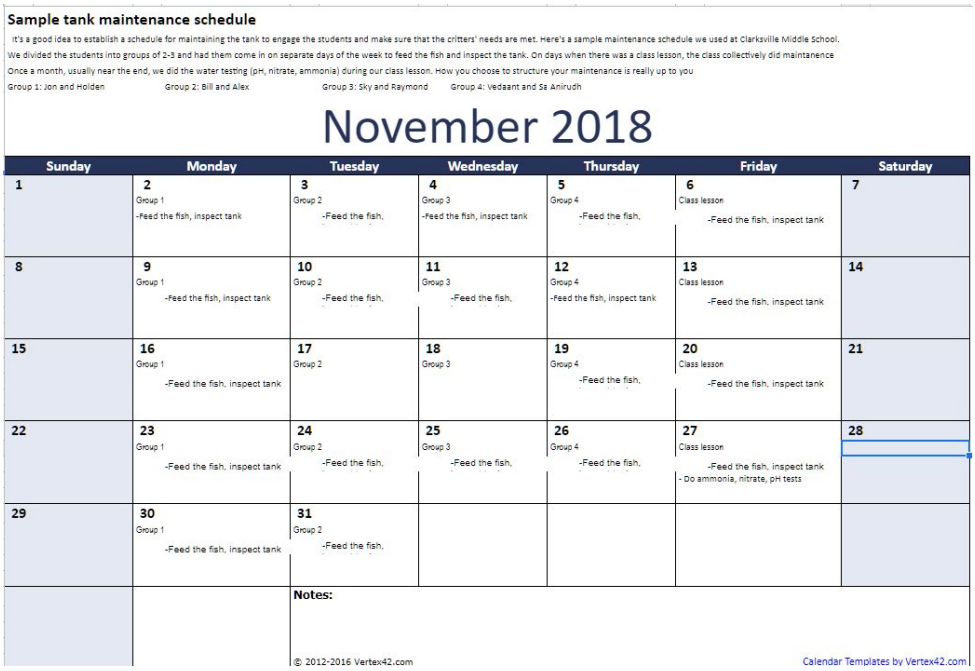
Materials:

-Large white paper
-Printer paper
-Markers
-Crayons
-Colored Pencils
-Rulers
-Anything artsy

Procedures:

1. Have each student grab a piece of printer paper. On this printer paper, they should make their own design of a calendar. It can be anything. All it will need is 4-5 rows with 5 columns as students are only in school for 4 weeks in a month and 5 days a week.
2. First, they should start out with drawing blocks for each day in the month.
3. Next, they should draw small tabs to label the days of the week at the top of each column.
4. At this point, the students should have a very simple calendar. Next, design a theme for the calendar. It of course would be nice if it was related aquatically to the curriculum, so all students know what the calendar is for.
5. After everyone completes their design, a class vote will take place for the best design. The teacher will decide how the vote gets done.
6. Once the best design is picked, the students will collaboratively work together to transfer the best design to a larger piece of white paper that will be posted up on the wall somewhere in the class.
7. Once the final calendar is complete, the students will need to be assigned into maintenance groups, and that group will be in charge of maintaining the tank for a given week.
8. Once the students have been assigned their groups, you are ready to go for maintaining the tank in an orderly fashion.

Example Calendar:



Sample tank maintenance schedule

It's a good idea to establish a schedule for maintaining the tank to engage the students and make sure that the critters' needs are met. Here's a sample maintenance schedule we used at Clarksville Middle School. We divided the students into groups of 2-3 and had them come in on separate days of the week to feed the fish and inspect the tank. On days when there was a class lesson, the class collectively did maintanence. Once a month, usually near the end, we did the water testing (pH, nitrate, ammonia) during our class lesson. How you choose to structure your maintenance is really up to you

Group 1: Jon and Holden Group 2: Bill and Alex Group 3: Sky and Raymond Group 4: Vedaant and Sa Anirudh

November 2018

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
1	2 Group 1 -Feed the fish, inspect tank	3 Group 2 -Feed the fish,	4 Group 3 -Feed the fish, inspect tank	5 Group 4 -Feed the fish,	6 Class lesson -Feed the fish, inspect tank	7
8	9 Group 1 -Feed the fish, inspect tank	10 Group 2 -Feed the fish,	11 Group 3 -Feed the fish,	12 Group 4 -Feed the fish, inspect tank	13 Class lesson -Feed the fish, inspect tank	14
15	16 Group 1 -Feed the fish, inspect tank	17 Group 2	18 Group 3	19 Group 4 -Feed the fish,	20 Class lesson -Feed the fish, inspect tank	21
22	23 Group 1 -Feed the fish, inspect tank	24 Group 2 -Feed the fish,	25 Group 3 -Feed the fish,	26 Group 4 -Feed the fish,	27 Class lesson -Feed the fish, inspect tank - Do ammonia, nitrate, pH tests	28
29	30 Group 1 -Feed the fish, inspect tank	31 Group 2 -Feed the fish,				
		Notes:				

Rainbow Celery Experiment

Chances are, your students already know a thing or two about aquarium plants: they provide a hiding place and . Some of them even may already know that plants can oxygenate the water in take in CO2. But another vital yet often overlooked benefit that plants provide to a stream ecosystem is their ability to absorb nitrites and other nutrients in the water that may be detrimental to the health of the fish (phosphorous, for example, can cause a dangerous algae bloom in the water if there aren't enough plants to absorb it). In this experiment, students will see how plants absorb nutrients from the water.

SWBAT:

- Understand the benefits that plants provide to an ecosystem and their role in the nitrogen cycle.
- Explain how the lack of plants in a stream with a lot of nutrient rich water may cause the ecosystem to suffer.

Before the activity	Discuss with your students about what they already know about plants in a stream ecosystem; what benefits do the plants provide? What kinds of nutrients do they help absorb? What might happen if they were removed from a stream?
After the activity	Discuss with your students on the results of this experiment: based on what they observed in this experiment, what conclusions can they reach about the importance of plants in keeping nitrite and nutrient levels in check? How can they use what they learned to improve the overall health of the tank and the Bay?

Materials:

4 6-8” stalks of celery, with leaves on the top.
A knife.
4 jars or plastic water bottles cut in half
1-4 colors of color coloring (for an added “wow” effect, you might want to have different colors for each celery stalk)

Procedures:

1. Have the students fill each jar with water and add the food dye to each so that the water is visibly stained. The stained water represents the nitrites.
2. Ask your students what they believe will happen once the celery stalks are put into each jar. After getting and writing down everyone’s hypothesis, add one stalk to each jar.
3. Every 20 or so minutes, have the students revisit the celery stalks (they inspect the plants) and see if there are any changes. Record their observations.
4. Have your students check back on the stalks the next day. If they cannot, take a picture of the stalks. The leaves should be fully stained at this stage

Waste Management Area Assessment

Materials:

• 3 laminated Visual Benchmark Guides
• 3 laminated Environmental Features Guides
• Satellite Schoolyard Map (provided by school)

Procedures:

Carefully examine the waste management area of your schoolyard. Look at the parking lot, dumpsters, grease containers, recycling bins, etc. Identify the pollution you see in the yard and record what you see on page 4 of the schoolyard packet.
Use the Visual Benchmark Guide to complete the waste management chart in your packet.
Use the satellite map of your school and also student observations of the schoolyard to complete the Environmental Features Bonus Assessment on page 4 of the Schoolyard Packet. Note that if the environmental feature is present the score entered into the table is -1, since a better score is a low score for the entire Schoolyard Assessment packet.

VISUAL BENCHMARKS

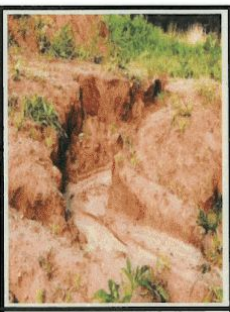
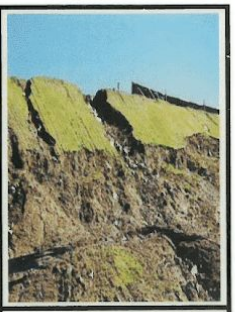
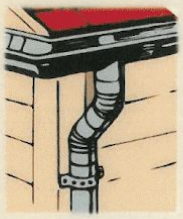
Type of benchmark	Low severity	Medium severity	High severity
Parking lots 	 Clean lot	 Lot with cracking and some stains	 Lot breaking up into pieces, old, many stains
Dumpsters 	 Lid closed, no evidence of leakage	 Lid open, stains indicating past leakage	 Overflowing, actively leaking
Grease Containers 	 Lid closed, under cover	 Some stains around container	 Lid open, actively leaking
Turf 	 Low management - bare patches	 Moderate management	 High management – fertilizer and pesticide use, lush green lawn

Howard County Public School System

Howard County Conservancy
connecting people to nature

CHESAPEAKE BAY TRUST

VISUAL BENCHMARKS

Erosion and bare soil 			
	Some exposed soil	Isolated locations of gully formation or sediment being washed away	Actively eroding areas over a larger area
Curb, gutter and storm drain inlets 			
	Clean inlet, no accumulation of debris	Moderate accumulation of leaves and/or debris	Large accumulation of material
	Disconnected	Directly connected	Indirectly connected
Downspouts 			
	Drains to grass or pervious surface	Piped underground	Drains to impervious surface then to curb and gutter

Howard County Public School System

Howard County Conservancy
connecting people to nature

CHESAPEAKE BAY TRUST

Grades K-2

Next Generation Science Standards

3-LS2-1 Partial-additional focus on constructing an argument for animals forming groups for survival needed.

www.MaineAgintheClassroom.org

Exploring Marine Science and Aquaculture Grades K-2

Sharks and Minnows

Developed by the University of Maine Cooperative Extension
Revised and formatted by Maine Agriculture in the Classroom

Activity Description:

This activity explores the concept of interconnectedness within an ecosystem and adaptations needed for survival.

Learning Objectives:

Students will:

- Use gross motor skills to play the game, Sharks and Minnows.
- Describe how the population of minnows keeps getting smaller, while the population of sharks keeps growing.
- Discuss what the minnows and sharks need to survive, and describe why fish travel in schools

Essential Questions:

- What is an ecosystem?
- What are predators? Prey?
- What do predatory sharks need to survive?
- What do prey minnows do to survive?
- What happens as the number of predators increases?

Background Information:

All of the organisms in an ecosystem are connected. The success or decline of one species will have an impact on the population of another species that is connected to it. The most obvious example of this connection is a predator-prey relationship, such as sharks and minnows. Animals display a variety of behaviors during predator-prey relationships. These behaviors are adaptations needed to survive.

Vocabulary List:

Predator: an animal that lives by killing and eating other animals.
Prey: an animal that is hunted and killed by another for food.
School: a large number of fish or aquatic animals of one kind swimming together.
Shark: a large usually gray saltwater fish that has sharp teeth and a skeleton of cartilage
Minnow: a very small fish that is often used as bait to catch larger fish

28 State House Station, Augusta, ME 04333
maitc@maine.gov 207.287.5522

Materials:

- 4 cones (or equivalent "goal" indicator")

Procedure:

Engage

1. Access the student's prior knowledge: Ask them to brainstorm the things that they need to survive.
    a. *What are the things you need to survive?*
    b. *Are some things more important than others?*
    c. *Do all animals need the same things to survive? Why or why not?*
    d. *How do you know?*

Explain

2. Introduce the activity by explaining that ocean animals are all connected to each other in an ecosystem. If one group of animals keeps growing and growing, they will need a food source to sustain themselves. Their survival depends on the availability of food. We are going to demonstrate this idea by playing the game "Sharks and Minnows".
3. Let the students brainstorm but make sure they understand that sharks eat minnows before starting the game.
    a. *What is a shark? What is a minnow?*
4. Explain the game rules:
    a. *To start the game, everybody will line up on one side of the field/gym/area behind the cones.*
    b. *I will choose one shark to come to the middle of the field/gym.*
    c. *The shark is very hungry! Everybody else, will be minnows. Sharks love to eat minnows.*
    d. *When everybody is ready, the shark will say, "Fishy, fishy, come cross our ocean." When the shark says this, the minnows will all try to run to the other side of the gym/field, behind the cones without getting tagged by the shark.*
    e. *If you get tagged by a shark, then you become a shark and will stand in the middle on the next round.*
    f. *Once everybody has crossed the ocean, the sharks will say again, "Fishy, fishy, come cross our ocean" and he minnows will run back across the gym/field.*
    g. *The game continues until there are only 2 minnows left.*
    h. *The last minnows left will start the next round as sharks.*
    i. *Behavioral expectations/rules:*
        I. *No running - only "swimming" - everyone's two feet (prey and predator) must stand on the ground at all times. Walking fast is permitted.*
        II. *Please be honest, if you have been tagged, please take your place as a shark.*
        III. *Please be careful when tagging somebody, only use one hand to tag.*
        IV. *No pushing.*
5. Ask the students if they have any questions about the rules.
6. Play a practice round to ensure that the players understand the game rules.
7. After students have played (teachers and adults should play, too!) several rounds, sit in a circle to cool down and have a discussion.

Explore

8. Engage the youth in a discussion about the following:
    a. *What did the sharks need to survive? What did the minnows do to survive?*
    b. *What other things they might need to survive, that weren't part of this game?*
    c. *What did you notice about the number of sharks after each round? How about the minnows?*
    d. *Did the game get easier or harder after each round? Why do you think this?*
    e. *If you get tagged by a shark, then you become a shark and will stand in the middle on the next round.*

f. *Why do you think fish travel in large numbers (schools)? Does it help them to stay safe? How do you know?*

Elaborate

9. Elaborate on these ideas by playing a variation of the Sharks and Minnows game.
10. Explain the game rules:
    a. *The object of this next game is for each player (the minnows) to cross the ocean to the other side, pick up a food card, and return back to the side of the ocean where you started.*
    b. *But, there is a predator shark out there, lurking, trying to tag (eat) its prey: the minnows!*
    c. *The hula hoops represent shelter areas where fish like to hide: plants, rocks, docks, underwater debris.*
    d. *You can stop in one of these shelter areas to escape a predator on your journey to get food. You are not allowed to stay there more than 5 seconds. Only 2 minnows can fit in a shelter area at one time.*
    e. *The predator shark is not allowed to "babysit" the shelter areas.*
    f. *Players will continue to play until the food is gone. If a minnow goes out of bounds, runs, or is tagged, then that player is out and must sit on the side.*
    g. *Behavioral expectations/rules:*
        I. *No running - only "swimming" - everyone's two feet (prey and predator) must stand on the ground at all times. Walking fast is permitted.*
        II. *Please be honest, if you have been tagged, please step to the sideline.*
        III. *Please be careful when tagging somebody, only use one hand to tag.*
        IV. *No pushing.*
11. Ask for one volunteer to be the predator shark. (Disabled students could act as monitors/referees).

Evaluate

12. After each round of the game, ask students to raise their hands to indicate who collected 1 piece of food, 2 pieces, 3 pieces, etc.
13. After several rounds of play, sit in a circle to cool down and have a discussion.
    a. *Did the hula hoop shelter areas help you escape the shark?*
    b. *Why do you think only 2 minnows could fit in a shelter at one time?*
    c. *What happened to the minnow who couldn't fit in the shelter when they tried?*
    d. *Was it easier to stay alive swimming in a school or by yourself?*
    e. *We learned that schooling and moving fast can help minnows escape prey; Can you think of any other adaptations that might help minnows escape prey?*
    f. *The second game added hiding, what is important when you hide?* (That you blend in, not stick out. This is called camouflage).
    g. *What helped the shark as a predator? How is the shark able to eat minnows?* (Sharks move fast, they are bigger than minnows, they have sharp teeth).

Additional Resources:

The Three Little Fish and The Big Bad Shark by Will Grace and Ken Geist; Audiobook available: https://www.youtube.com/watch?v=L5qcLP6P2Lc

This activity is supported by National Science Foundation award #1355457 to Maine EPSCoR at the University of Maine.

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Shark

Minnow

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Brine Shrimp Hatchery Activity

In order to create a proper aquatic ecosystem, both the nonliving and living aspects must interact with each other. The ecosystem must provide a place for the species towards the bottom of the food chain to reproduce in such a manner that there always exist enough of them to sustain the carnivorous species. Brine shrimp are a classic model organism that form a large portion of the diets of many species; they are also quite similar to the zooplankton that the tank critters eat in their native stream ecosystem. A brine shrimp hatchery perfectly creates this model by allowing the tiny shrimp to reproduce, creating a sustainable food source for the fish while allow your students to observe the life cycle of the small but vital critters that form the backbone of the food chain.

SWBAT:

- Understand both the living and nonliving elements of an ecosystem
- Understand how a brine shrimp hatchery creates an entire ecosystem
- Understand the role of brine shrimp within an ecosystem

Estimated time: 24 hours for one cycle of hatching, 50 minutes of class time

Before the activity	Ask your students what they know about an ecosystem. Explain all of the aspects required to create a sustainable ecosystem. Explain the purpose of the brine shrimp hatchery within an ecosystem.
After the activity	Ask your students to explain how the brine shrimp hatchery will create a sustainable ecosystem. Ask your students to think of any differences between the hatchery and a natural ecosystem (answer: The hatchery we are creating uses plastic bottles to maximize hatching rates. Since the hatchery is seperate from the fish, the plastic will not cause any harm).

Materials:

- two 1-liter bottles

- an air pump (separate from the fish tank pump)
- a lamp
- flexible airline tubing
- rigid airline tubing
- brine shrimp eggs
- baking soda
- salt
- scissors for cutting
- turkey basker

Procedures:

1. Cut the bottom 1-2 inches off of one bottle and discard the bottom piece. The remaining portion will be inverted and act as a reservoir to hatch brine shrimp in. This inversion allows brine shrimp to hatch the best.
2. Cut the bottom 6 inches off of the second bottle and discard the top piece. The remaining portion of the bottle will be used as a base for the entire hatchery. Place the two bottles together in a position in which the bottle from Step 2 acts as a support for the upside down bottle from Step 1. Tape the two bottles together for extra reinforcement. The bottle from Step 1 should sit upside down inside the bottle from Step 2.
3. Cut a length of rigid airline tubing to roughly the same height as the kept piece of the inverted bottle from Step 1. Attach a length of flexible airline tubing to the rigid tubing at the end. Attach the other end of flexible airline tubing to an air pump. The rigid airline tubing should be placed into the inverted bottle so that the end of it is at the bottom.
4. Fill the reservoir about 4/5 full with warm water. The water can be tap water and does not have to be distilled, thus the chlorine can remain. Power on the air pump, and add 1 tablespoon of salt and a pinch of baking soda.
5. Add the brine shrimp eggs to the inverted bottle.
6. Power on the lamp and direct the light towards the hatchery to maximize the hatch rate.
7. After 24 hours, the hatchery water will be orange due to the color of the brine shrimp. Turn off the air pump and allow the brine shrimp to remain in the bottle. Do not proceed until the shrimp reach the bottom of the inverted bottle.
8. Remove the brine shrimp with a turkey baster as a suction. Add shrimp to the fish tank, where they will be fed to the grass shrimp and dance.
9. Clean the hatchery in preparation for the next cycle. This process can be used every day as a meal for the fish, or shrimp can only be hatched once in a while, and other meals can be provided.

Build your own Macroinvertebrate Game

In this activity, students will take a closer look at the biology of the macroinvertebrates they are studying by building models. They will also examine the physiology of these organisms and how they are adaptations for these organisms to survive and thrive in the wild. This activity serves as a nice Segway into the macroinvertebrate unit.

SWBAT:

- Identify several common macroinvertebrates
- Understand the physiology and characteristics of macroinvertebrates and how certain traits (hard shell, pinchers, etc) help them survive and reproduce

Before this activity	Make sure that the students are familiar with the term macroinvertebrates and the niche they occupy in the ecosystem.
After this activity	Understand the anatomy and physiology of a macroinvertebrate.

Materials:

a set of rainbow colored pipe cleaners
construction paper
glue sticks
scissors

Procedure:

1. Discuss the term macroinvertebrate with your students. Have they ever heard of it? What kinds of macroinvertebrates do they know live in stream around their community?
2. Have your students watch this very quick video on macroinvertebrates

https://m.youtube.com/watch?v=uPfKG6OhS_c

3. After the discussion, segway into this activity. Use the projector to display images of macroinvertebrates on the screen. Here are some nice galleries:

https://stroudcenter.org/macros/gallery/
http://macroinvertebrates.org/#/

http://lifeinfreshwater.net/

4. As you move through the images, discuss with your students the physiology and adaptation each macroinvertebrate has. Why might the water penny have a shell?
5. Have each student select a macroinvertebrate that they like and build it using the pipe cleaners and the construction paper. It may be helpful to display the gallery as one page so the students can view all of the macroinvertebrates at the same time.
6. After 20-30 minutes, call an end to this activity. Have the students come up and present their work to the class. Compare their macroinvertebrate to the one in the gallery. Here are some good questions to ask them:
    a. Which macroinvertebrate does their model most closely resemble? What is different about their creation?
    b. What niche might it occupy in a stream ecosystem and how does it contribute to stream health?

Build Your Own Snail Trap Activity

This activity is a great way to engage your students and find out how many snails are in the tank since introduction. It allows students to study the behaviors of scavengers in an in-depth manner, such as when scavengers are usually active and what they feed on. It also is beneficial when there is a surplus of snails in your tank (you'll know when you come into class in the morning before the lights are turned on and see dozens of snails plastering the tank walls; snails are nocturnal). High snail populations are a sign of overfeeding.

SWBAT:

- Understand the behavior of aquatic scavengers
    - what they eat
    - when they are most active

Estimated Time: 30-40 minutes

Before the activity	Spend a few classes observing the scavengers in the tank with your students during feeding time. Ask them: 1. Who usually gets to the food first? The scavengers (shrimp, snails, etc) or the fish? 2. Can you see any snails right now? If not, what may be the reason (nocturnal?) and why? Where may the snails be hiding?
After the activity	If you have a surplus of snails and are raising terrapins, you can try feeding the snails to them as a source of calcium.

Procedures:

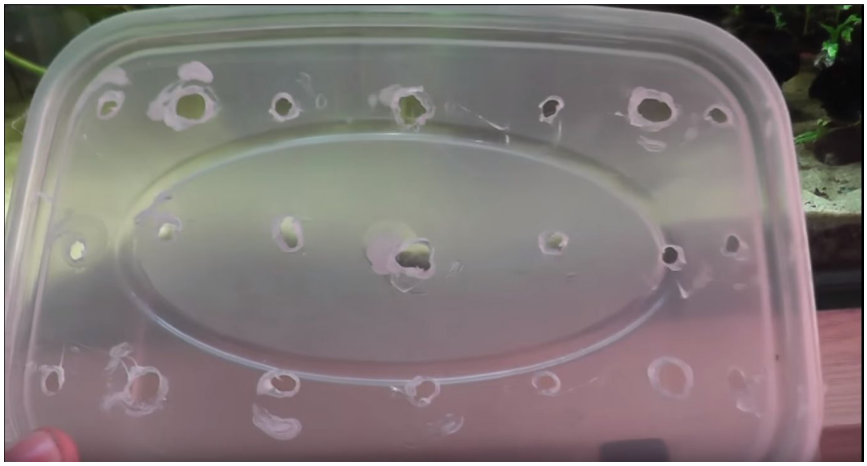
1. Aftering spending time with your students observing the tank, ask them to estimate the number of snails in the tank. Write their predictions down on the board.
2. Bring up the questions of whether snails are nocturnal or not again. Have your class vote on it and write the class hypothesis down on the board. The traps, which will be in the

tank for both day and night, will prove or disprove their hypothesis; if the snails are active during the day, the traps will have a lot of caught snails.

3. Introduce this activity and have some students bring in old, empty plastic food containers, small enough to fit inside the tank, for tomorrow. Teachers of course can provide some.

Like This:

4. Scissors and snail bait are required to continue from here. If your students are younger it may be a good idea for you to cut out the holes beforehand; cut plastic can be sharp.
5. After the bait is ready, students will divide into groups, and will be using scissors to carve out holes in the top of the container that are about the size of the snail. This will be simple as the students are going to have had the critters for quite some time, and will be able to estimate their size.



This is an example of the final product^

4. Open the container, and place the bait inside the container. Firmly put the lid back on so we can prevent the dissociation of the snail trap.

5. The trap should be ready to go. Place it near the grassy areas in the tank as the snails like to aggregate their. This trap should be effective in removing snails in as little as 24-48 hours.

6. After some of the snails have been wiped out, it is best that the teacher takes out the trap and disposes of the snails in the woods for them to decompose and begin the process of the nature cycle.

DIY Screen Lid

It's important for aquarium to have an environment best suited to hosting life. Unlike actual ecosystems in the wild, aquariums often suffer from the lack of gas exchange inside a closed room. To combat this problem, students can construct a screen mesh on top of the tank to improve gas exchange between the air and water.

SWBAT:

- Understand the purpose of a screen lid for gas exchange in an aquarium
- Understand the reasons for a lack of gas exchange without a screen lid
- Construct and implement a screen lid onto the aquarium

Estimated Time: 20-30 minutes

Before the activity	Ask your students to think about the importance of gas exchange for hosting any form of life. Explain why aquariums often suffer more problems involving gas exchange rather than external ecosystems. Explain how a screen lid improves gas exchange in an aquarium.
After the activity	Ask your students what they have learned about coordination when attempting to build the lid. Ask your students about any possible problems with the screen lid, and how they can mitigate the issue.

Materials:

- 4' by 2' ¼ in. screen netting/wire mesh
- Wire snips (to be used by teacher)
- Highly adhesive tape (recommended) or glue
- Ruler or measuring stick
- Black sharpie

Procedures:

1. Measure the dimensions of the top frame on your aquarium. Make sure the frame is measured to the outside edge
2. Have your students draw out an outline of the top of the aquarium on the screen netting with the sharpie measuring the measurements.
3. Cut the screen to the dimensions of the aquarium (done by teacher).
4. Place cut screen on top of aquarium frame
5. Glue or tape the screen to the frame.
6. Clean up and dispose of extra screen

Invasive Plant Game

In this activity, students will be going online to research about the native plants in Maryland, and some invasive plants. This will help them understand the current state of our watersheds.

Note: You will need a computer lab for this activity

SWBAT:

- Understand how native plants contribute to water quality (cool, clean, clear).
- Understand the benefits of native plants including their habitat value for wildlife.
- Identify the key features of invasive plants (quick reproduction, hard to remove, etc.)

Estimated time: 2 day activity.

Before The Activity	Engage a class discussion regarding invasive plants, and see what the students already know. Introduce the essential question for this activity, “How do native plants increase the health of streams and habitats in aquatic life?”
After The Activity	Have students create their own games and have them play it amongst themselves.

Procedures:

1. Engage in a class discussion regarding invasive plants and see what the students already know.
2. Have students get into a group of 2, and show them the websites that they should be using to find information on our invasive plants.

3. These are the resources: Students should spend 15-20 minutes learning about these species. Note: They may need to take notes about each species for the game that will follow up this research.
   https://www.invasivespeciesinfo.gov/aquatics/main.shtml
   http://www.nwf.org/Wildlife/Threats-to-Wildlife/Invasive-Species.aspx
4. After students learn about the invasive species, divide them into groups of 2-4, depending on the # of students in the seminar, and provide them with white construction paper so they can make flashcards for a game that they will be playing.
5. The game that they will be playing is an identification game. On the flashcards that they make, they will draw a picture of the invasive species, and provide a short description of that invasive species. Each group of 2-4 students will be making 16 flashcards.
6. After each group completes their flashcards, have them swap their flashcards with another group.
7. Once the cards are swapped, place the cards in a neat stack with the descriptions facing up.
8. Have a student read off the description, and the others in the group will have to try to guess which one it is. Whoever gets it right, gets a point.
9. The student with the most points after all 16 cards wins, and earns a prize designated by the teacher.

Natural Disaster Game

Many people believe that erosion and the loss of wetlands to absorb runoff is a purely environmental issue; in reality, the loss of plants to anchor the soil concerns all of us. Hundreds of lives and billions of dollars worth of property are lost around the world each year due to floods, mudslides, and other disasters that result from deforestation and the removal of wetlands, especially around rivers. cIn this activity, students will use computers to play the Stop Natural Disasters game (stopdisastersgame.org), in which they will firsthand see consequences of clearing wetlands and unsustainable development.

SWBAT:

- Comprehend the impact that unsustainable development has not only on the environment but on society.
- Brainstorm ways they can help prevent natural disasters that result from erosion.
- Understand the connection that their work in the classroom with the real world.

Before the activity	Discuss with your students about their prior knowledge or any experience regarding floods; how are floods formed? What causes floods? How do vegetation, wetlands, and erosion related to floods? What is a riparian buffer and how can it stop floods?
After the activity	Discuss with your students about any new insights they gained after playing this game. What kinds of areas were most vulnerable to floods? What are some features that those areas had in common (buildings built very close.to rivers, lack of wetlands, etc) What are somethings they can do locally (even at school) to decrease the likelihood that local streams over flood (like in Ellicott City) and decrease their impact?

Procedures:

1. Reserve the Computer Lab for an hour or so beforehand.

2. Have your students go to stopdisastersgame.org and select “Flood” (this option should appear after they select the “Play” button. Make sure you have Adobe Flash installed. If the “stopdisastersgame.org” link doesn’t work even after installing Flash, go to the homepage and play the game from there after permitting the Flash application to run.
3. The game puts the player in a scenario in which he/she is the leader of preparation efforts for an incoming flood. Have your students play two games and experiment with different tactics. Ask them to make or write down observations in their planning process.

Macroinvertebrate math game

Scientists and other natural resource professionals often need survey rivers and creeks to assess their health. To do so, they use dip nets and other equipment to gather macroinvertebrates from the body of water and examine the demographics of their catch. Different macroinvertebrates have different levels of tolerance to pollutants, and scientists assess how many macroinvertebrates of each tolerance level are in their catch to assess the health of the stream. A high level of low pollution tolerant macroinvertebrates, such as water pennies and damselfly larvae, for example, are a sign that the body of water is healthy. In this activity, students will use an online game by the NPS to assess stream health.

SWBAT:

- Understand the methodology used to calculate stream health.
- Understand how the presence of certain organisms can act as an indicator of stream health

Before this activity	Reserve a set of computers or the computer lab. It also may be helpful to give your students calculators.
After this activity	

Procedures:

1. Discuss with your students about what they already know about macroinvertebrates; can anyone name any specific examples? What kinds can be found in local streams?
2. Have your students log into their computers and go to the following link: https://www.nps.gov/webrangers/activities/waterquality/

Pass out a piece of looseleaf paper for the students to record their data and do their calculations.

3. After completing 3-5 stream health calculations, discuss with your students about their findings and if any species' pollutant tolerance surprised them.

Resource Poster and Sticker Activity

In this activity, students will create public awareness stickers out of note cards to place near water fountains, sinks, and light switches to remind their classmates and others to conserve resources. They will gain an understanding of why it is so important to maintain our Earth's resources. Through this activity, they will be able to spread the awareness to the entire student body in their school via the posters that they create.

SWBAT:

-Understand the importance of protecting our natural resources (water, oil, air, trees, etc.)
-Engage and spread awareness to their peers regarding how important our natural resources are

Estimated time: 40 minutes

Before The Activity	Have a class discussion on current environmental standing, and get a grasp of how students feel about their environment
After The Activity	

Procedures:

1. Discuss with your students about their prior knowledge regarding water and energy use. Here are some good questions to ask:
    a. How do we produce energy? What is our most common source of energy?
    b. Are our energy/water resources infinite? How long do you think they will last?
    c. What are some areas with water pollution/drought issues and what may be the cause?
    d. How does excessive use of water/energy threaten our stream ecosystems?
    e. What are some common ways we waste water/energy?
2. Introduce this activity to the class. Have each student pick a sticker topic (Water or energy), and then a location they would want to put their sticker in (water fountain, bathroom/classroom sink, or light switches).
3. For students making a poster for the sinks or water fountains, they should be using paper the size of copy paper for their posters. For students that are assigned the light switches, they should use index cards for their "poster". Allowing the students to make

their own poster will allow them to convey their message in their own way, which is exactly what we want.

4. After students are done, have them post up the posters/index cards next to the water fountains, sinks, or light switches in the school. Split the students into groups and give each group enough tape.
5. Make sure that they post the posters up in the correct places, and in spottable places where other students/teachers could see it.

Build A Watershed

Follow The directions on the PDF
https://drive.google.com/file/d/1B8hnRn6YrIB5XEL-iZo54-s4J9Qdenn7/view?usp=sharing

Aquarium Art Mural Project

As the time nears to release your critters back into their native habitats, it is a great idea to create a classroom art mural of the aquarium. The students and the teachers will be working cooperatively to create a visual representation of the aquarium and what they learned. The mural shows their peers, their teachers, and parents what the students have done and learned this year and is a great display piece for enrichment fair night.

Procedures: (start out with pencil before painting!)

1. Acquire a 15’ x 3’ sheet of white butcher paper or art paper. This will be for the final draft of the mural.
2. Determine where on the wall you would want to hang the mural. You may want to trim the mural if you cannot find enough wall space.
3. Determine what kinds of materials you would like your students to draw the mural with; we recommend crayons and colored pencils for younger students who may be prone to creating messes. Older students are usually mature enough to use watercolors, and markers are a good option for mixed groups. Watercolors and paint equipment can usually be acquired from the art teachers. We recommend spreading newspaper on the work area if the students are using paints.
4. Introduce this project to your students. Pass out pieces of printer paper and colored pencils to each student and have them brainstorm or create drafts for the mural. It may be helpful to split the students into groups.
5. The students should be allowed a lot of creative autonomy in this project; the rules are that the mural designs should include all of the critters and plants that were in the tank.
6. Gauge where the students are in this activity; if they seem behind, give them part of next class to work on it or assign this to be done at home. After the students are done with their design drafts, have each student present his/her draft under the projector. Discuss with the class on what features like or dislike about the drafts. Have the class vote on which design they like best.
7. After voting, leave the favored design on the projector to act as the model. For the mural, start out tracing with a pencil, later to be erased. Split your class into teams for this project; you may want to have the good artists do the tracing, as that tends to be delicate work, and the less experienced artists do the coloring.

You may also want to split groups based on what side of the mural they are working on; for example, having separate group to color the left side and another to color the right side to prevent disorder.

8. After the mural is done, leave it to dry. Inform your other students to not disturb or touch the mural.

Daphnia Culture

With the gradual rise of overfishing in large water bodies such as lakes and rivers, efforts to repopulate endangered fish species as well as aquatic life can be bolstered with one specific resource, food. Daphnia, commonly referred to as “water fleas”, are crustaceans native to many rivers and lakes across North America being able to withstand both acidic and normal conditions. They primarily serve as filter feeders, consuming algae and other such particulates found in the water, however, their true importance can be seen from other organisms as they serve as a food source for many fish species.

It will be an interesting activity to cultivate a daphnia population in a classroom setting so that students can understand how these creatures play a central role in providing food for fish and aquatic life. Your students will construct Daphnia cultures in order to supply native freshwater bodies with the goal of providing food for growing fish species.

SWBAT:

Students will be able to…

- Identify the basic anatomy and taxonomy of Daphnia and how these organisms can perform their environmental role
- Identify the role Daphnia play in an aquatic ecosystem

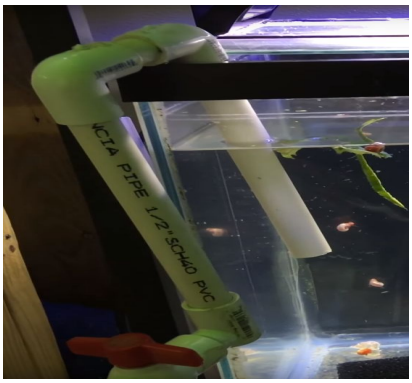
Estimated time: 150 minutes

Before the Activity	Discuss with students ● What do you think Daphnia are? ● What role do you think Daphnia play the ecosystem? ● How do Daphnia relate to other organisms in the ecosystem?
After the Activity	Discuss with students ● How did the Daphnia change over the course of the culturing process? ● What did you observe in the Daphnia as time went on? ● How will these Daphnia benefit the environment?

Procedures:

1.) Gather all materials and resources necessary for culturing Daphnia
2.) Set up 10 Gallon tank with an air pump fixture in order to ensure aeration of water for Daphnia

3.) Watch the two videos provided for tank setup and Daphnia anatomy
    - https://www.youtube.com/watch?v=ca3x8Pmuh74
    - https://www.youtube.com/watch?v=yZOu1tMfPUw
4.) Fill tank with 10 gallons of water(Type of water does not matter)

5.) Attach PVC Tubing fixture for safe filtration of water as well as removal of waste particles 

6.) Once room temperature, add Daphnia into the tank and attach lighting fixtures to see the culture as needed
7.) Provide food for daphnia (Can be purchased or gathered from local water bodies- They consume mainly algae)
8.) Every week filter out 1 gallon of water and replace with fresh water to ensure a clean environment
9.) Observe the maturation stages and when old enough removed from tank and feed to fish and other aquatic life

Growing Land Mosses Underwater

In order to create a successful ecosystem, both plant life and fish are needed. The plants provide oxygen which they release through photosynthesis. The fish then use this oxygen in order to create energy from their food through cellular respiration. Although the air pump provides both oxygen and carbon dioxide, this process amplifies the living conditions of the aquarium. Mosses are one of the first plants to arise as a distinct species through evolution, hence they are extremely simple, making them easy to raise.

SWBAT:

- Understand the interaction between fish and plants inside an aquarium, and how both organisms benefit tremendously
- Understand how the masses are versatile plants that allows them to grow in all kinds of environments, unlike the other plants.

Estimated Time: 1 hour after soaking moss

Before the activity	Ask your students about the purpose of plant life in any ecosystems. Explain to them the true importance of a cohesion of animals and plants in order for both to survive. Explain the usefulness and extreme flexibility of mosses as a plant species
After the activity	Ask your students about the process of setting up the mosses. Explain that the early origin of the plant species allows such as simple setup.

Materials:

- Gravel
- Moss
- Water
- Scissors

Procedures:

1. Ask the students to bring in some mosses they have collected from their backyards or on their way to school. You can also bring the students outside on the sidewalk or blacktop and look for mosses growing cracks in the pavement.
2. Soak the moss in water for at least a day.
3. Cut the moss into semicircular strips of any size.
4. Fill the aquarium with gravel along the bottom floor.
5. Place the strips of mosses along the bottom edges of the aquarium.
6. Push the strips of mosses down underneath the gravel slightly. The moss should still be visible, but the gravel should hold it in place.
7. After 1 month, the moss will grow significantly, thus fulfilling the ecosystem.

Preparing for the fish release

At the end of the school year, the fish will be released by your students back into their native habitats. Here are the steps that you should take to ensure a seamless release:

Procedures:

1. Check the weather forecasted for the release date. Make sure that your students are dressed appropriately for the weather. Make sure that all of them bring water bottles, wear outdoor shoes and long pants.
2. The day before the release, put two water bottles into a freezer and leave it overnight. This will keep your critters cool before the release. Procure two buckets with lids to keep your critters in before the release, filled halfway with dechlorinated water.
3. Double check that you have the state approved release permits on hand.

4. On the morning of the release, plug all electrical equipment and remove the aquarium light and acrylic cover from the tank and set it aside. Put one water bottle into each bucket.
5. Have your students use a dip net to catch all the fish and other critters. You may need a sieve to sift through the sand for the snails. Put all the critters in one of the buckets.
6. Next, take the driftwood pieces and other pieces of structure covered with java moss and put them in the other bucket. Remove all other plants from the tank and put them in this bucket.
7. Put the lids on the buckets. You're ready to go!

Cleaning and storing the tank

After the release, here are the steps you should take to safely clean and store the tank and equipment.

Procedures:

1. Remove the aquarium light, the acrylic covering, filter, and drain your tank.
2. After draining the tank, set the tank and the substrate outside in the sun until the sand and substrate are completely dried out
3. Take apart your filter and leave it outside with the tank.
4. Remove the substrate from the tank and put it inside a tub or another clean container for storage.
5. Fill a tub with a mix of water and soap and wash the tank, acrylic covering, and filter components. Make sure that any mineral stains or other discoloration (usually signs of algae colonies) are removed. After doing this, set your tank and filter components once again in the sun to dry.
6. After checking to ensure that both the tank and filter components are dry, reassemble the filter and put it, along with the dried tank, into somewhere dark and cool for storage.
7. Usea lightly moistened cloth to wipe down your aquarium light. Make sure that there is no dust obstructing your light source. Store it in a dark and cool place, along with your fish food, net, and any other aquarium equipment.
8. Determine if you use to continue with this program next year. If not, we'll come by and pick up your aquarium equipment.

Procedures:

1. First, assemble your materials. You will need

    - Stones of varying sizes, from small to large
    - Gravel
    - Sand
    - Cotton ball
    - Dirty water (have your students mix soil with water)
    - Coffee filter
    - String
    - 2 plastic water bottles (per group)
    - Scissors

2. Divide your students into groups of 2-4. Give each group two water bottles.

3. Have your students sort the rocks into three piles: Small, medium, and large.

4. Have the students cut off the very end of one of the water bottles, leaving one end of the bottle open (it might be a good lesson idea to have thee students make their filters as tall or short as they want, and to have them compare water filtering results at the end; the taller the filter, the more filtering area and thus it will be better at filtering out pollutants/particles.

5. Cut the other plastic bottle at 3/4th of the height, from the end of the bottle with the bottle cap.

6. Take the bottle with the bottom end cut off, and have the students tie a coffee filter onto the top end of the bottle after removing the cap. Then, put the bottle upside down in the mason jar and make sure it is secure.

7. Have your students stuff the cotton ball into the top of the bottle (not too deep that it may rip the filter), and then layer the other materials in this order:

1. Sand
2. Small rocks
3. Medium rocks

4. Large rocks

The sand, rocks, and coffee filter represent permeable surfaces in nature.

8. Have your students create their own dirty water by mixing sine soil with water. Observe how dirty the water is; it may be helpful to take a picture.

9. Pour a cup of dirty water into the top of the filter.

10. Sit back and watch the water seep through the filter. Compare the water that was just filtered with the dirty water.

The Nitrogen cycle

Even if your aquarium has clear water, it still may not be safe just yet for your critters. Ammonia and nitrates are colorless waste products products produced by fish waste and leftover fish food. Even in low concentrations, they can be dangerous to your fish. However, by growing some beneficial bacteria in our tank, we can convert the ammonia and nitrates into harmless substances. Have your students watch the videos below to learn more about the nitrogen cycle.

SWBAT:

- Define the nitrogen cycle
- Understand what processes happen in each stage and how nitrate and ammonia is generated
- The importance of preserving low levels of nitrate and ammonia and how to do so.

https://www.youtube.com/watch?v=zeggc8JE8rM *

After having watched one of the videos, have a quick group discussion on what you have learned.

https://www.youtube.com/watch?v=v1vIyGf9kRI&index=10&list=PLmyz3rvn32qoGL4N_SjFiMVfPaEex0ISW

https://www.youtube.com/watch?v=dFk6m-1zxyE&index=8&list=PLmyz3rvn32qoGL4N_SjFiMVfPaEex0ISW

Before the video	Have your students discuss what they already know about pollutants and toxins to fish; what kinds of toxins may they encounter inside the aquarium?
After the video	After having watched all the videos, hold a group discussion on how nitrogen cycle inside the tank. 1. How do the components of the tank, such as the filter and sand substrate, aid in the nitrogen cycle?

	2. What can we do to help the beneficial bacteria perform their job?

Species profile game

In this activity, the students will learn about the individual plant and animal species that will inhabit the tank by matching cards matching the a picture of a plant or animal species to their description, care requirements, and function in the ecosystem. This activity is a fun way to have the students to learn a lot of material that may otherwise be very monotonous to read.

SWBAT:

- Identify each species
- Understand the care requirements of each species
- Understand what niche each species occupies in the ecosystem and how it can be replicated in the aquarium

Estimated Time: 20-35 minutes

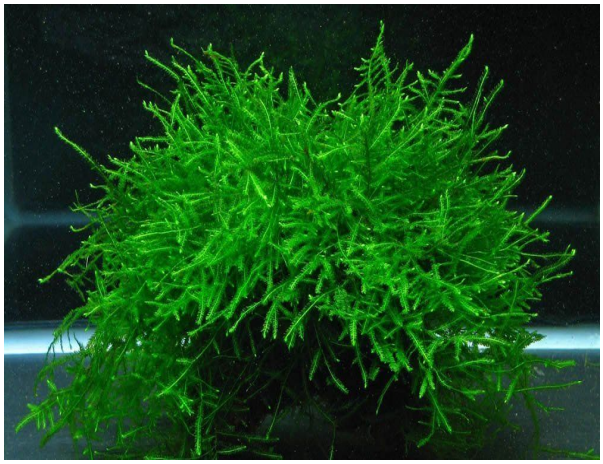
Before the activity	Ask your students if any of them keep or have kept aquariums at home; what kinds of critters do they keep and what are their care requirements? How may these care requirements mimic their natural habitats (example: clownfish need salt water and a heater to mimic their natural habitats in tropical reefs)? What kinds of requirements may the critters going in the tank need and how would they be different/similar from those of the fish kept at home?
After the activity	Discuss with your students about what they have discovered; how was the care of the critters going into the tank different/similar to those of the fish kept at home?

Procedures:

1. Decide if you would want to split your students into groups. It might be a good idea to split your students into groups if you have more than 10 students.
2. Print out a set of cards (you can find the set on the 2nd page) for each group, and cut out each card.
3. Explain the directions for the game to the students:
    a. There are 6 species and each species has 4 cards: its picture, its description and function in the tank, and where it can be found in the tank.
    b. The students are to match the picture of each critter with the 3 other corresponding cards

c. After the students have matched each species with its 3 cards, they should ask the instructor to check their stack (the correct card stacks are in corresponding order on the next page)

Freshwater Clam	
Pond Snail	
Blacknose Dace	

Grass shrimp	
Java Moss	

Elodea	
Duckweed	

-Peaceful -Not harmful to its environment -Encased in an elliptical shell -Creates natural pearls -Filters out algae and plankton	-Pointed and Curved Shell -Originated in Asia but naturalized all over the East Coast. It is now naturalized part of the ecosystem. -Shell is white/light brown -Eats potentially harmful algae that may grow in the tank to protect the native critters and fish
-Very tiny fish -Prevalent all over the East Coast -Can range from 5mm-100mm in size -Lateral line across scales can be dark brown or olive green	-1 to 2 inches long, ¼ inch wide -Transparent grey with red, yellow, white, or blue spots on their back -Very pollution tolerant, can handle non ideal conditions for a while -Elongated bodies. Skinny legs, edible.
-Bright green in color -Mossy -Thrives in a wide variety of water types and temperatures (60-85 degrees Fahrenheit) -Provides refuge for fish fry and attaches to driftwood.	-Must be maintained in modest amount -Cannot be allowed to overgrow, or it will be detrimental towards the aquatic life (Skinny green plant with many stems and small leaves poking out)

-Must be maintained in modest amount -Cannot be allowed to overgrow, or it will be detrimental towards the aquatic life (Mini lily pads)	
-Can be found among the substrate at the bottom of the aquarium	-Can be found crawling and roaming around the surface of the aquarium on the rocks and pebbles at the bottom of the tank
-Can be found swimming around in the tank, hiding inside the Elodea, or feeding off of it	-Can be found roaming around the bottom of the tank around the moss and the elodea. Loves to hang around the grassy/mossy areas.

-Will be found around the surface of the substrate, providing cover and preventing strong water currents.	-Will be found sticking out of the substrate or floating Looks like a garden weed, but helps remove nitrites from the water and absorb excess nutrients.
-Light green in color, with roots hanging down into the water, providing hiding places for small fish fry. - May shade out the other aquarium plants if it is too numerous; it's important to cull this plant once it occupies more than a quarter of tank space.	Can be found floating at the very top of the aquarium.

New cards:

Ludwigia	
Bacopa	

Azolla	
Salvinia	

Glowing Algae Experiment

In this experiment, students will grow their very own bioluminescent strain of dinoflagellate, an algae found in sea waters around the globe. Though most dinoflagellates fail to emit light under any circumstances, dinoflagellates in the genus *Pyrocytus* display the unique ability to luminesce (or glow) when disturbed by rapid movements. Explain to the students that in nature, this phenomena is used as a defense against predators in an attempt to scare the predator out of its meal. However, the dinoflagellates will not glow at all hours of the day, even when disturbed by vigorous shaking. Just like humans, dinoflagellates require awake and sleep cycles tuned to a precise circadian cycle. This consists of 12 hours awake photosynthesizing light to energy and turning CO2 into O2, as well as 12 hours of sleep at which time bioluminescence can be seen in dim lighting.

SWBAT

- Understand the benefits that algae provide to an ecosystem and their role in the Carbon cycle.
- Explain how the circadian cycle the dinoflagellates live on impacts their periods of bioluminescence.
- Explain how bioluminescence might be used by a prey to prevent itself from being eaten by a predator.

Before the activity	Discuss with your students about what they already know about algae; what benefits do the organisms provide? Can students think of a plant or animal that produces light on its own? Explain what a circadian cycle is to your students.
After the activity	Discuss with your students on the results of this experiment: based on what they observed in this experiment, what conclusions can they make regarding the importance that bioluminescence might play in a predator/prey dynamic?

Materials:

- A culture of bioluminescent *Pyrocystis fusiformis* algae
- Erlenmeyer flasks to expand culture into
- 150 mL of algae growth medium
- A lamp with an outlet power timer

Procedure:

Set-up

1. Students will wash Erlenmeyer flasks to ensure the algae grows in the most sterile environment possible.
2. Students will carefully pour 150 mL of algae growth medium into each Erlenmeyer flask.
3. Students will empty a culture of *Pyrocystis fusiformis* algae into each Erlenmeyer flask and gently mix.

Waiting Period

4. In order to change the timing of the circadian cycle of the algae and allow the algae's bioluminescence to be seen through the day, the algae must be tricked into thinking that day is night and night is day. To do this, a lamp with a power timer will be used to give the algae light at night, while remaining off in a dark room during the day.
5. Over the span of a few days to a week, the algae will adopt the newly set circadian cycle and visibly luminesce in the day (in dim lighting), while photosynthesizing through the night.

Observation of Bioluminescence and Moving Forward

6. Over time, the algae culture will grow in size and the glow from each shaking of the dinoflagellates will gradually increase. After around 3-4 weeks the culture will need another 150 mL of algae growth medium to continue its survival and growth.
7. At this point, students may take small samples of the algae home in small vials.

Introduction to Basic Ecology Activity

The study of ecology is the study of organisms and their interactions with their environment. To create a better understanding of the aquarium and the environment, students can use this activity to start learning about basic ecology. In this activity, students will learn about basic vocabulary about general ecology.

SWBAT:

- Introduce basic vocabulary concepts of ecology to students.
- Explain different studies of ecology
- Explain concepts to students with the use of examples

Instructions:

1. Have the definition boxes cut out and the term and example bosex still together
2. Have students try to match the definition with the right term and example
3. Have students check if they are right or wrong when they finished

Term	Example	Definitions
Ecology	Studying the food chain in a desert area.	The study of organisms and their interactions with their environment
Population	The numerous New York City residents	A group of a specific species that is individual and that live in one area. They have the ability to interbreed and interact with each other
Community	A forest with animals and fungi that live in the specific area	All organisms living in one area
Ecosystem	Tundra, aquatic, deserts, and urban areas	All organisms in an area, including the abiotic factors that they interact with

Abiotic Factors	Rocks, Soil, Air	Nonliving factors
Biotic Factors	Animals, Plants, Fungi	Living factors
Biosphere	Space on or near the Earth;s surface	Global ecosystem
Community Ecology	Observing snakes and lizards in a jungle and how they hunt for food	The study of communities and how they interact in their environment
Organism Ecology	Observing lions specifically in their natural habitat	The study between organisms and their environment
Population Ecology	Observing New York residents and how they travel in their city	The study between populations and their environment
Ecosystem Ecology	Observing the relationship between soil and trees and how they affect the area they occupy	The study of living and nonliving factors in an ecosystem and how their intersection create the framework of that ecosystem

Carbon Cycle

In the real lakes and aquatic habitats, plants perform photosynthesis. One of the key chemicals in photosynthesis is the carbon. The Carbon Cycle is essential to understand because it is one of the building blocks to our environment.

SWBAT:

- Define carbon cycle
- Show importance of carbon cycle in aquatic life

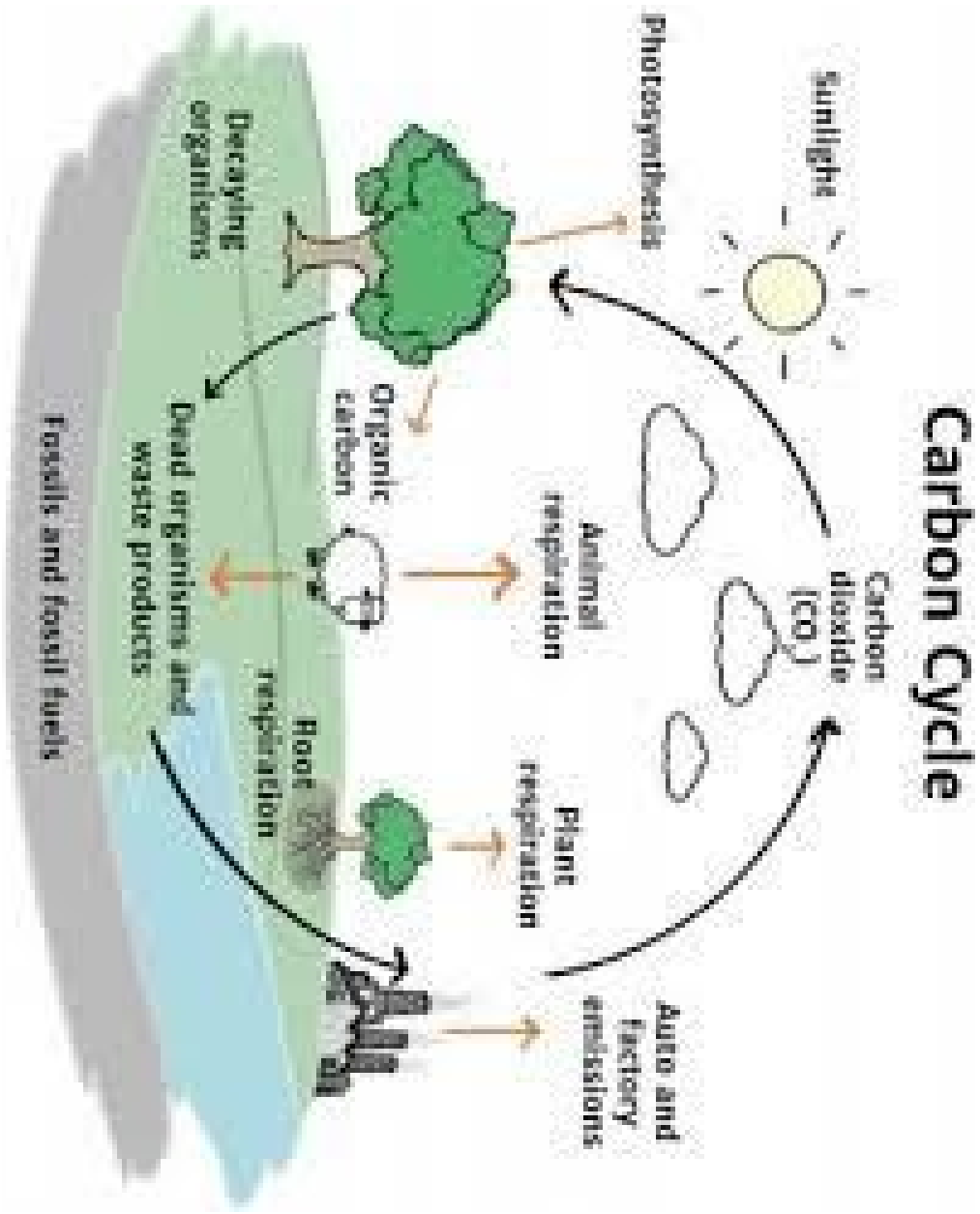
Instructions:

1. Show students steps to Carbon Cycle:

Steps to Carbon Cycle:

1. Plants photosynthesize using light energy from the sun.
2. Plants decay or give carbon to living organisms. They all decay into fossil fuels.
3. Those fuels are used for root restoration in plants or in factory emissions.
4. Carbon emissions from plants or factories are back in the sky.
5. Carbon is used by plants for photosynthesis and this restarts the cycle.

2. Have students create their own carbon cycle on a separate sheet based on the Steps to Carbon Cycle
3. Have students view and study the key below and make any necessary corrections of needed
4. Have students answer the question: How does the carbon cycle relate to aquatic life and environments;
    a. Answer: Carbon is still taken in by plants in the ocean and lakes. These plants can still photosynthesize and partake in the carbon cycle. Dead organisms also add to the fossil fuels in our Earth.



From: https://www.solarschools.net/knowledge-bank/climate-change/carbon-cycle

Acid Rain

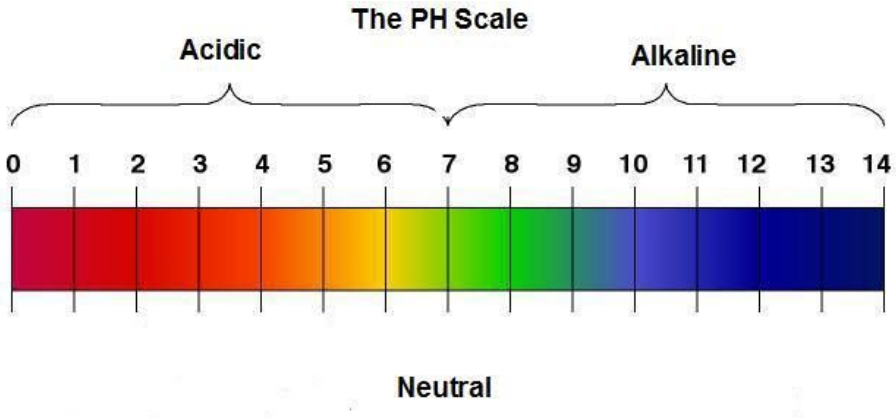
Acid rain is a major problem that harms aquatic life and is caused from pollution. It is important to understand how it occurs, causes, it, and what measures can be taken to prevent it. This explanation will help to protect your local watershed from contamination and help protect the environment.

SWBAT:

- Define pH
- Identify examples of pH and its effects
- Connect knowledge of Ph to acid rain

Instructions:

1. Have a class discussion on what everyone thinks acid rain is based off its name. Have students use prior knowledge and previous lessons to draw as many conclusions as possible.
2. Keywords to try to hit are:
    a. Pollution
    b. pH
    c. Fossil Fuels
3. After discussion, define pH
    a. pH: The measure of hydrogen ion concentration. The scale of pH is from 1 to 14. The lower the number the more acidic the solution is and the higher the more basic it is. The more acidic means the higher the concentration of hydrogen ions there are. The more basic, the lower the concentration of hydrogen ions.
    b. Show pH scale:



From: https://www.thinglink.com/scene/477563074732097537

    c. Give examples of pH levels
        i. 2- Stomach Acid
        ii. 4- Tomato juice
        iii. 7.0 Neutral - Pure Water
        iv. 7.4 - Human Blood
        v. 10- Hand soap
        vi. 12- Bleach
    d. Discuss effects of pH on molecules and organisms
        i. The polarization of the positively charged hydrogen ions (H+) eutectic itself to organisms and their negatively charged molecules and begins to pull them apart.
4. Predict what pH acid rain has
    a. Answer: less than 5.6, can range from 1.5 - 5.4
5. Discuss acid rain and define it
    a. Acid rain: Caused by **pollutants** in the air from **fossil fuels**. Specifically nitrogen and sulfur pollutants cause the rain to be less than 5.6 **pH**. This low pH that reaches aquatic life can harm and kill them.
6. Discuss how acid rain/ pollution can be prevented could be prevented
    a. Examples: Less harmful chemical products in the air (hairspray), less air pollution, etc.