TEXAS STREAM TEAM

WATER EDUCATION CURRICULUM

KINDERGARTEN THROUGH HIGH SCHOOL

The Meadows Center
for Water and the Environment
Texas State University
Texas Stream Team

www.TexasStreamTeam.org

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Contents

WHAT IS WATER?

K-2ND

OBJECTIVES

- Use your senses to describe the qualities of water.
- Identify the three states of water (liquid, solid, gas).
- Discuss how water moves between these three states.

BACKGROUND INFORMATION

Water can exist in three states: liquid, gas, and solid. Water can be found almost everywhere on earth, including in: animals, plants, soil, and people! As a gas it is found in steam, fog, and even your breath. The solid form of water is visible in ice or crystal formations. In its liquid state, you can find water in rivers, lakes, oceans, rain, clouds, and even inside the stems of plants. Water is everywhere!

MATERIALS

- Construction Paper
- White Paper
- Colored Markers
- 6 Containers (sandwich bags or ice cube trays)
- Ice Cubes
- Fruit Juice
- Lemon Juice
- Soapy Water
- Watermelon
- Magnifying Lens (1 per group)

ANTICIPATORY SET

As a class, fill out the first two sections of the K.W.L. (Know, Want to Know, Learned) chart found at the end of this lesson. Ask your students what they already Know about water, and what they Want to Know about water and write these answers under K and W. At the end of the lesson, fill out the Learned section as a class!

See if your students can answers these tricky riddles!

- What do you call a snowman in the summer? A puddle
- What runs but never walks? Water

MAKE A LAB JOURNAL

Have students create lab journals in class or ahead of time.

1. Give each student one sheet of construction paper and three white papers.
2. Students will fold the construction paper in half to create the cover of their journal, then fold the white pages and insert them into the cover to create the pages of their journal.
3. The teacher should staple each booklet along the spine.
4. Allow your class time to decorate! Be sure each student includes their name on the cover.

MAKE OBSERVATIONS USING YOUR SENSES

1. Ask your students to name each of the five senses used to explore the world (Ex: smell, sight, taste, touch, and hearing).
2. Using soda pop, demonstrate how to use their senses to determine characteristics of the sample. Do not allow them to use their sense of taste for this exercise.
    - Feel the stickiness of dried soda, smell the sugar, hear the carbonation, see the dark color and bubbles.
3. Demonstrate how your students will fill out the first page of their lab journal to record observations. They can use words like "sticky," or "dark brown" to describe the soda. They can also choose to draw pictures.
4. Once your class is done observing the sample of soda, give each group of four students a different substance to make similar observation about (fruit juice, lemon juice, ice cube, soapy water, watermelon, etc.).
5. On a new page in their journal, ask them to draw or write what they see, smell, hear, and feel for this new sample. Students should predict the identity of the sample and write this at the bottom of their observation page.
6. Groups will move around the room, observing the different samples on new pages in their journal.
7. Once your class has made observations about each sample, reveal what each sample was!

THINKING/DISCUSSION

Ask your class what each of these samples had in common. Can they predict what the main ingredient in each sample was? Water!

Ask your class which "States of Matter" were represented in these samples. Liquid and Solid (the ice cube!) Can they guess the missing State of Matter ?

WATCH: CHANGING STATES OF MATTER VIDEO

Watch Annie and Moby's video: "Changing States of Matter." Link under Resources.

Ask: What was the third state of matter that was not represented in the observation activity? Gas! Tell your students that water vapor, or water as a gas, is all around us all the time! Water vapor is an ingredient in the air we breathe.

MAPPING

1. Divide your class into groups of four students, and give each group a large piece of paper and a marker.
2. Each group will create a Tree Map with "Water" written at the top, and the three branches of the tree should say, "Liquid," "Solid," and "Gas."
3. Around the room, hide four sets of the Water State cards (Located at the end of this lesson). There will be multiple copies of each card hidden around the room.
4. Each group will send one student out at a time to retrieve a card and bring it back to the table. As a group, they will place this card on the branch it represents.
5. Once the card is classified, they should send another student out to retrieve a new card. Continue these steps until all the cards have been found and classified.
    - If a group finds a card they have already classified, they should put it back and find a new card.

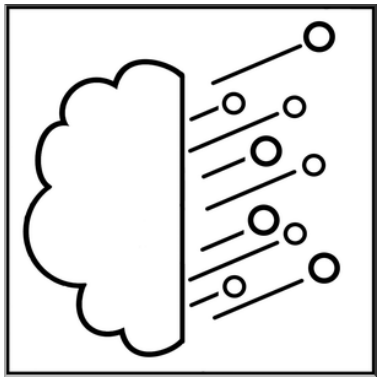
PONDER

Ask your students to think about how water moves between the three states of matter. For example, how can an ice cube become a puddle of water? How can a puddle of water become water vapor (gas)? How can a puddle of water become ice?

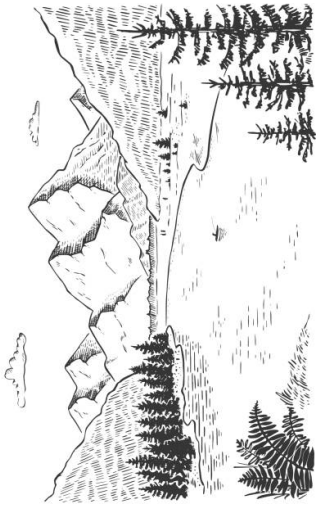
KWL CHART: WATER

Know	Want To Know	Learned

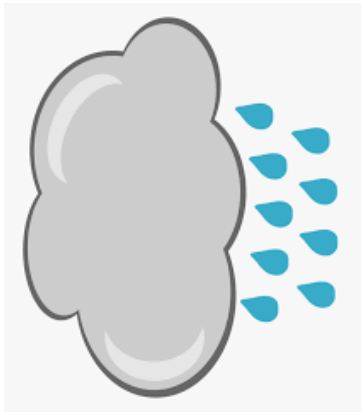
WATER STATE CARDS (PG 1) PRINT 4 COPIES OF BOTH PAGES



Hail



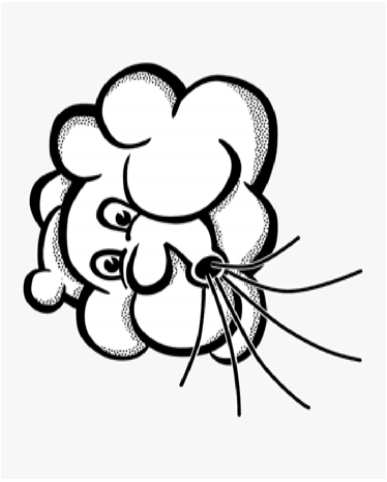
Lake



Rain

Snow

Air



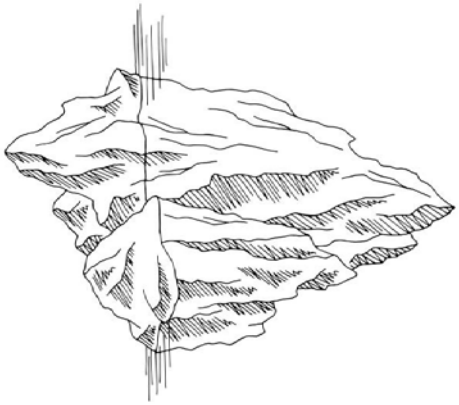
Wind

WATER STATE CARDS (PG 2)

Breath

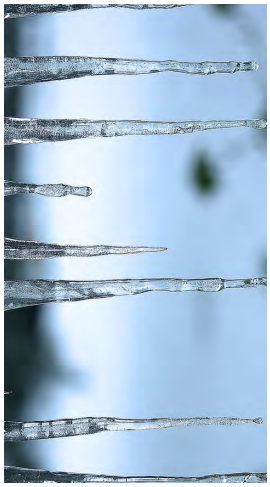
Steam

River



Iceberg

Waves



Icicle

RESOURCES

- Annie and Moby: "Changing States of Matter." Available from https://jr.brainpop.com/science/matter/changingstatesofmatter/
- “Water Match” Lesson Plan from Project Wet Curriculum & Activity Guide. Bozeman, Montana; The Water Course.

TEKS ALIGNMENT

Science, Adopted 2021:

- Kinder: (a) 1Ai, 1B. (b) 1A, 1B, 1C, 1D, 1E, 1F, 1G, 2B, 3B, 3C, 5E, 5G, 6, 11
- 1st: (a) 1Ai, 1B, 5. (b) 1A, 1B, 1C, 1D, 1E, 1F, 1G, 2B, 3B, 3C, 5A, 5E, 5G, 6A, 6B
- 2nd: (a) 1Ai, 1B, 5. (b) 1A, 1B, 1C, 1D, 1E, 1F, 1G, 2B, 3B, 3C, 5A, 5E, 5G, 6A, 6B

English Language Arts and Reading, Adopted 2017

- Kinder: (b) 1A, 1C, 1D, 5C
- 1st:(b) 1A, 1C, 1D
- 2nd: (b) 1C, 2D

Mathematics, Adopted 2017

- Kinder: (b) 8A, 8C
- 1st:(b) 8A, 8C
- 2nd: (b) 10D

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HOW MUCH DRINKING WATER

5TH-7TH

OBJECTIVES

- Estimate the percentage of water in different locations around the world.
- Evaluate the distribution of usable fresh water vs. salt water.

BACKGROUND INFORMATION

Water covers approximately 71% of the Earth's surface. Of that total water supply on Earth, around 97% is found in oceans. This means that about 3% of all the water in the world is freshwater. Of this freshwater, as much as 2.4% is locked up in icecaps and glaciers. In fact, only about 0.419% of all the water in the world is usable drinking water for humans!

MATERIALS

- Inflatable Globe
- 5-Gallon Aquarium Tank
- Blue Food Coloring
- Measuring Cup
- Ice Cube Tray
- Clear Cup Filled with Sand
- Large Sheet of Paper
- Pipette

ANTICIPATORY SET

Toss a globe from person to person around the room and record how many times a left thumb lands on water when caught. If you throw the globe 100 times, your left thumb would land on water around 70-75 times!

PRIOR KNOWLEDGE ACTIVATION

Ask your students: Can we drink all the water on Earth? Why not?

As a class, estimate the percentage of Earth's surface covered with water, and take a vote on the percentage of water that is available for humans to drink. Record their answers on the board or a large piece of paper. At the end of this lesson, return to their answers and discuss as a class.

HOW MUCH WATER?

1. Inform your class that all quantities of water used for this lesson are relative, and not meant to serve as exact quantities.
2. Fill an aquarium tank with 5-gallons of water. This water represents all the water on Earth.
3. Ask the class to list locations where water is found on earth. Write these on the board. **Answers:** *Rivers*, *Lakes*, *Groundwater*, *Icecaps/Glaciers*, *Atmosphere*, *Oceans*.
4. Next, have your class predict the percentage of Earth's water found at each location (Ex: 10% rivers, 50% oceans). Create a pie chart on the board for the class's predictions.
5. Have a student volunteer remove 532 ml from the tank.
6. Add blue food coloring to the water remaining in the aquarium. This represents all the water found in the oceans.
7. From the water you just removed, have a new volunteer scoop out an additional 443 ml. Pour this water into an ice cube tray to represent freshwater locked up in icecaps/glaciers. Float this tray on top of the "ocean" water in the tank. This symbolically represents how water locked up in icecaps/glaciers is unusable.
8. The last 89 ml represent all the available freshwater on Earth. Place one dropper-full of this water in a student's hand to represent all the freshwater located in lakes and rivers.
9. Pour the remaining water into a clear cup filled halfway with sand. This represents groundwater, where water is held in pore spaces between rocks.

MATH TIME!

Groundwater and Surface water are two sources of freshwater available for human use. If groundwater consists of 0.0397% of Earth's water, and surface water consists of 0.022%, how much is usable?

Only 0.419% of Earth's water is usable by humans.

PONDER

As a class, discuss the following:

1. While the majority of Earth's surface is covered with water, only 0.419% of that water is available for human use. We use surface water from lakes and rivers, as well as groundwater, in our daily lives. How does this knowledge impact the way you think about your own water usage?
2. What would you do if your town were to run out of water?
    a. How would your life be different?
3. How can you positively influence environmental practices in your community, at school, and at home?

ASSIGNMENT: WATER FOOTPRINT CALCULATOR

Each student will go home and complete the Water Footprint Calculator found under the Resources section. They may need help from a parent or guardian to answer some of the questions. The next day, discuss as a class whether they were surprised by their individual daily water use and their household daily water use.

FINAL PROJECT

Students will choose a specific water body to conduct a research project about (Ex. Atlantic Ocean, Canyon Lake, San Marcos River, Groundwater from the Edwards Aquifer). Encourage students to choose a water source close to the community they live in. Students will look for ways in which Climate Change has impacted the volume and quality of the water body and identify sources and solutions. Students can generate a presentation using PowerPoint, make a poster, or info-graphic.

RESOURCES

- All the Water in the World: EPA Activity, Retrieved from https://www.epa.gov/sites/default/files/2015-08/documents/mgwc-gwa5.pdf
- TED Talk: Are We Running Out of Clean Water? Retrieved from https://www.youtube.com/watch?v=OCzYdNSJF-k
- California's Drought: A City Without Water, Retrieved from https://www.youtube.com/watch?v=xbj18_IJHO4
- Water Footprint Calculator: https://www.watercalculator.org/wfc2

TEKS ALIGNMENT

Science, Adopted 2021:

- 5th: (a) 1Ai, 1D, 5. (b) 1A, 1C, 1D, 1E, 1G, 2A, 2C, 3B, 3C, 4A, 5A, 5B, 5C, 5D, 11.
- 6th: (a) 1Ai, 1D, 5. (b) 1A, 1C, 1E, 1G, 2A, 2C, 3B, 3C, 5A, 5B, 5D, 11A, 11B.
- 7th(a) 1Ai, 1D, 5. (b) 1A, 1C, 1E, 1G, 2A, 2C, 3B, 3C, 5B, 5D, 11A, 11B.

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THE WATER CYCLE

2ND-5TH

OBJECTIVES

- Make observations about water.
- Demonstrate part of the water (hydrologic) cycle.
- Explore how water moves through the hydrologic cycle.
- Explain how the hydrologic cycle works and define relevant vocabulary.

BACKGROUND INFORMATION

The water cycle (or hydrologic cycle) is the movement of water on our planet. The amount of water on earth does not change, but it does change state of matter such as from solid to liquid to gas. The temperature of water plays an important role in how water changes states and moves through the environment.

MATERIALS

- Clear Plastic Jar
- Small Plate or saucer
- Hot Water
- Bag of Ice
- Food Coloring
- Water Cycle Posters
- (9) Station Tubs
- Laminated Station Cards
- Markers
- Water Droplet "Passports"
- Dry Cloth & Water

ANTICIPATORY SET

1. As a group, discuss the locations on earth where you can find water.
2. Ask your students: How does water get from one location to another?
3. Watch the StudyJams! video called "The Water Cycle." Link under Resources.

PRIOR KNOWLEDGE ACTIVATION

As a class, map out the water cycle (i.e., liquid water evaporating into the air, then condensing to form a cloud, then back to liquid as rain).
Depending on grade level, discuss vocabulary such as evaporation, precipitation, run-off, accumulation, transpiration, and condensation.

DEMONSTRATION: WATER CYCLE IN A JAR

MATERIALS

- Hot Water (the hotter the better)
- Large, Clear Jar
- Food Coloring
- Ice Cubes
- Small Plate
  - This should fit over the mouth of the jar

INSTRUCTIONS

1. Pour hot water into the clear jar, filling it about 1/2 way.
2. Add several drops of food coloring.
3. Place the small plate on the jar opening and fill it with ice.
4. Observe the hot water evaporating toward the top of the jar, then condensing back into rain drops.
5. Ask students to add labels to their water cycle diagram (Ex: heat, evaporation, and precipitation).

WHY DOES THIS HAPPEN?

The hot water at the bottom of the jar represents any large water body on earth that has been warmed by the Sun. The warm water evaporates and rises into the atmosphere as a water vapor (gas). The higher the water vapor rises, the cooler it gets. This causes the water vapor to condense into droplets that form clouds. After a few minutes, "rain" forms and drips down the edges of the jar back to the original body of water. This process demonstrates part of the Water Cycle!

ACTIVITY: JOURNEY OF A WATER DROPLET

MATERIALS

- (1) Laminated Passport for Each Student
- (1) Washable Marker for Each Student
- Station Cards for each Tub
- Labeled Station Tubs
  - Plant, Ocean, Animal, River, Groundwater, Glacier, Lake, Cloud, Soil
- Dry Cloth and Spray for cleaning the passports after the activity

INSTRUCTIONS

1. Set the (9) station tubs in a large, spread-out circle, and place the designated station cards in each tub.
2. Give each student a Water Droplet Passport and a marker. Explain to the students that they will act as water droplets moving through the water cycle.
3. Assign an even number of students to start at each water station (River, Ocean, Groundwater, etc.)
4. Using the marker, each student should color in one square on their passport to represent the station where they started (i.e. If they start at "River," they should color in the square closest to the River label on their passport).
5. Students will pick up one card from this station tub and read the information on the card. This card will tell them which station they should travel to next.
6. Before heading to the next station, they must place their card at the back of the stack in that station tub!
7. Once they get to the second station, students will color in a square to represent this next location in the water cycle.
8. Students will pick up a card at their second station, read it, then place the card at the back of the stack before heading to their next station.
9. Students will mark a square on their passport for EVERY TURN they take! They may pick up a card that says "STAY," at one location for multiple turns. Students will still mark a square for each time they had to "STAY."
10. Allow students to go through the stations for several minutes before stopping them to discuss the activity.

JOURNEY OF A WATER DROPLET DISCUSSION

Once your group has gone through the stations for several minutes, have them sit down where they are. Tell students to turn their passport on its side with the station names at the bottom. They have created a bar chart of their journey through the Water Cycle! This bar chart should show them where the most water is located within the Water Cycle. Some of your students may have felt frustrated that they kept getting "STAY" cards at the Ocean station. This just goes to show how much water is in the ocean, and how long it takes for a water droplet in the ocean to get cycled through to the next location.

EXTENSION

1. Have your students brainstorm locations where they can see the water cycle in action in their community. Can they think of local streams, rivers, lakes or even puddles that may be part of the process?
2. Have your students write a creative short story about the life of a water droplet moving through the water cycle.
3. Have your students work together to create a 3-dimensional model of the water cycle.

TEKS ALIGNMENT

Science, Adopted 2021:

- 2nd: (a) 1Ai, 1B, 1E, 3A, 5. (b) 1A, 1C, 1D, 1E, 1F, 1G, 2B, 2D, 3B, 3C, 5A, 5D, 6A.
- 3rd: (a) 1Ai, 1B, 1E, 3A, 5. (b) 1A, 1C, 1D, 1E, 1F, 1G, 2B, 2D, 3B, 3C, 5A, 5B, 5C, 5D, 6C.
- 4th: (a) 1Ai, 1B, 3A, 5. (b) 1A, 1C, 1D, 1E, 1F, 1G, 2B, 2D, 3B, 3C, 5A, 5B, 5C, 5D, 5E, 6A, 10A.
- 5th: (a) 1Ai, 1B, 3A, 5, (b) 1A, 1C, 1D, 1E, 1F, 2B, 3B, 3C, 5A, 5B, 5C, 5D, 5E.


OCEAN

OCEAN STATION CARD

Print 10 copies of this station card

STAY

(Color in the next empty box in this row and place this card at the bottom of the stack. Then pick a new card!)

OCEAN STATION CARD

The sun warms the surface water of the ocean.

This water evaporates and goes into the atmosphere.

Print 4 copies of this station card

OCEAN STATION CARD

Whales filter salt water when eating krill and other small marine animals.

Go to the animal station.

Print 2 copies of this station card


RIVERS

RIVER STATION CARD

Print 3 copies of this station card

A deer drinks from the river.

Go to the animal station.

RIVER STATION CARD

All rivers eventually flow into the ocean.

Print 4 copies of this station card

RIVER STATION CARD

River water flows into a lake.

Print 3 copies of this station card

RIVER STATION CARD

Print 3 copies of this station card

The sun warms the surface water of the river. This water evaporates and goes into the atmosphere.

RIVER STATION CARD

Water is absorbed into the banks of the river.

Go to the soil station.

Print 3 copies of this station card


LAKES

LAKE STATION CARD

Water is absorbed into the banks of the lake.

Go to the soil station.

Print 3 copies of this station card

LAKE STATION CARD

The sun warms the surface water on a lake. This water evaporates and goes into the atmosphere.

Print 4 copies of this station card

LAKE STATION CARD

Water flows from a lake into a river.

Print 3 copies of this station card

LAKE STATION CARD

A bear comes to the lake to get a drink.
Go to the animal station.

Print 2 copies of this station card

LAKE STATION CARD

STAY

(Color in the next empty box in this row and place this card at the bottom of the stack. Then pick a new card!)

Print 4 copies of this station card


SOIL
MOISTURE

SOIL STATION CARD

Print 3 copies of this station card

STAY

(Color in the next empty box in this row and place this card at the bottom of the stack. Then pick a new card!)

SOIL STATION CARD

Water is absorbed by the roots of a plant.

Print 5 copies of this station card

SOIL STATION CARD

Water filters into cracks in the Earth and enters the Edwards Aquifer.

Go to the groundwater station.

Print 4 copies of this station card

SOIL STATION CARD

Soil is warmed by the sun and the heat causes water to evaporate and enter the atmosphere.

Print 4 copies of this station card

ATMOSPHERE (CLOUDS)

ATMOSPHERE STATION CARD

Water condenses and falls as rain into the ocean.

Print 5 copies of this station card

ATMOSPHERE STATION CARD

Water condenses and falls as rain into a lake.

Print 2 copies of this station card

ATMOSPHERE STATION CARD

Water condenses and falls as rain onto the soil.

Print 4 copies of this station card

ATMOSPHERE STATION CARD

Water condenses and falls as snow onto a glacier.

Print 3 copies of this station card

ATMOSPHERE STATION CARD

Water condenses and falls as rain down a hill side, entering the river.

Print 2 copies of this station card


PLANTS

PLANT STATION CARD

Print 5 copies of this station card

STAY

(Color in the next empty box in this row and place this card at the bottom of the stack. Then pick a new card!)

PLANT STATION CARD

Plants release water through transpiration.

This water enters the atmosphere.

Print 8 copies of this station card

PLANT STATION CARD

Water flows down the stems of plants and reaches the soil.

Print 3 copies of this station card


ANIMALS

ANIMAL STATION CARD

Animals excrete water through feces and urine. This water returns to the soil.

Print 8 copies of this station card

ANIMAL STATION CARD

Breathing, panting, or sweating allows water to evaporate into the atmosphere.

Print 8 copies of this station card

GLACIERS

GLACIERS STATION CARD

Glacier ice melts and this water flows into a river.

Print 4 copies of this station card

GLACIERS STATION CARD

Glacier ice melts into liquid water, then evaporates into the atmosphere.

Print 4 copies of this station card

GLACIERS STATION CARD

STAY

(Color in the next empty box in this row and place this card at the bottom of the stack. Then pick a new card!)

Print 4 copies of this station card

GLACIERS STATION CARD

Glacier ice melts into liquid water, which filters into the ground. Go to the groundwater station.

Print 4 copies of this station card


GROUND
WATER

GROUNDWATER STATION CARD

Someone pumps water through a well, then drinks the water.

Go to the animal station.

Print 4 copies of this station card

GROUNDWATER STATION CARD

Groundwater flows up through the Edwards Aquifer into Spring Lake.

Print 4 copies of this station card

GROUNDWATER STATION CARD

Groundwater is pumped up through a well, and is used to water crops.

Go to the plant station.

Print 4 copies of this station card

GROUNDWATER STATION CARD

Print 4 copies of this station card

STAY

(Color in the next empty box in this row and place this card at the bottom of the stack. Then pick a new card!)

WATER DROPLET PASSPORT

Ocean												
Glaciers												
Groundwater												
Lakes												
Rivers												
Atmosphere												
Soil Moisture												
Plants												
Animals												

RESOURCES

- Thirstin's Water Cycle Adventure, Retrieved from https://www.epa.gov/sites/production/files/2016-03/documents/graphic_grades_k-3_watercycle.pdf
- Thirstin's Ground Water Movement Activity, Retrieved from https://www.epa.gov/sites/production/files/2016-03/documents/activity_grades_k-3_groundwatermovement.pdf
- Follow a Drip Through the Water Cycle, Interactive water-cycle diagram, Retrieved from https://water.usgs.gov/edu/watercycle-kids-adv.html
- That Magnificent Ground Water Connection: The Water Cycle and Water Conservation, 1-2. Retrieved from http://www.epa.gov/region1/students/pdfs/gndw_712.pdf
- Video: The Water Cycle: A StudyJams!, Retrieved from https://www.scholastic.com/teachers/activities/teaching-content/water-cycle-studyjams-activity/

GROUNDWATER 101 K-2ND

OBJECTIVES

- Recognize the difference between groundwater and surface water.
- Understand the role of precipitation for groundwater capture.

BACKGROUND INFORMATION

Groundwater is water that has flowed underground through cracks and holes in the earth's surface. Water will continue to flow underground through holes and cracks until it hits a solid rock layer. Water that is trapped between two underground rock layers creates what is called an aquifer. If the rock layer above the water is has holes and cracks in it, this will allow water to flow upwards until it reaches earth's surface through a well or spring!

MATERIALS (PER GROUP OF 4)

- Clay
- Pea-sized Gravel
- 1 Large Glass Jar
- Large Piece of Paper
- Pen or Pencil
- Rocks (Smaller than fist sized)
- 1 Sponge
- Sand
- Water

ANTICIPATORY SET

Ask your students to brainstorm locations on earth where water can be found. Take several answers, then remind them that there is a lot of water stored underground! Groundwater is the focus of the activities within this lesson.

After brainstorming as a class, watch the following videos.
Links found under Resources.

- YouTube - What is Groundwater?
- YouTube - Groundwater Animation

MODELING GROUNDWATER

“Today we are going to make a model of the physical earth in a jar!"

1. Distribute the following materials to each group of 4 students: 1 Large Glass Jar, 1 Sponge, Water, Sand, Gravel, and Rocks.
2. Ask each group to pack 1/3 of the jar as tightly as possible with the earthen materials to fill in all possible spaces.
    - Note: your students may layer the materials in whichever order they choose. They must use each type of material.
3. Ask the students to use the sponge as a rain cloud and squeeze to simulate rain coming down on the earth materials. They will need to give their sponge a few good soaks to make it rain sufficiently.

QUESTION TIME!

- Did the water stay on top of the jar, or did the water soak through to the bottom? As the water settles, explain that this is known as "groundwater."
- Explain that the topmost line where the water reaches is called the water table.

ACTIVITY CONTINUED

4. Have your students continue to squeeze the sponge to simulate rain until the water reaches above the surface of the rock material. This creates "surface water."
    - This also shows what a high water table might look like. You can find high water tables at the coast, beaches, etc.

HOW DOES ROCK TYPE IMPACT GROUNDWATER?

Let's take this a step further!

1. Each group will take a new jar and fill it 1/3 with only one rock material type.
2. Assign each group with one of the rock types to experiment with.
3. Ask your class for predictions on which earth materials will allow rain to flow underground, and which will not. Write these predictions on the board.
4. Using the sponge, each group should rain on their land surface jar three times.
5. Compare the differences in water table and surface water.
6. Look back at the predictions to see if they were correct.

GAME: MOVING WATER MOLECULES

Let's demonstrate why it is easy for water to move through rock, gravel, and sand, but not through clay. Split your class into two teams: Team Water and Team Earth.

Round #1: have the Team Earth students stand in a mass in the center of the room with their arm stretched out to their sides, not touching a partner and not within one foot of any other fingertips. Team Water will act as water molecules, walking through the spaces between “large rocks.”

Round #2: Team Earth will be "gravel," with arms extended but fingertips touching. Team Water will walk through the spaces between the "gravel."

Round #3: Team Earth will be "sand," with hands on hips and elbows lightly grazing. Team Water will walk through the spaces between grains of "sand."

Round #4: Team Earth will be "clay," with hands down at their sides and shoulders lightly grazing. Team Water will try to walk between the "clay".

Have your students rank the rock types from most difficult for water to travel through to easiest. **Ask**: Which types of rock would it be easier to retrieve groundwater from?

PONDER

Ask your students, "Where do you think your drinking water comes from?"

Believe it or not, most of us get our drinking water from groundwater found in an aquifer!

- Use the Texas Water Development Board’s Major Aquifer 3D Viewer (link is located under Resources) to find an aquifer near your school.
- What do you think happens to the groundwater levels during a drought?
  - What about during a flood?
  - What will happen if we use too much water in our daily life?
- What do you think happens to the organisms that depends on groundwater during these times?

RESOURCES

- Aquifer in a Cup, Retrieved from https://groundwater.org/wp-content/uploads/2022/10/Aquifer-In-A-Cup.pdf
- Groundwater Animation. Retrieved from http://www.youtube.com/watch?v=uQRvN6MUajE
- Texas Water Development Board, Major Aquifer 3D Viewer Retrieved from https://www3.twdb.texas.gov/apps/waterdatainteractive/gamsdataviewer
- What is Groundwater? Retrieved from https://www.youtube.com/watch?time_continue=128&v=oNWAerr_xEE&feature=emb_logo

TEKS ALIGNMENT

Science (Adopted 2021):

- Kinder: (a) 1Ai, 1B, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2A, 2B, 3B, 3C, 5C, 5D, 10A, 11.
- 1st: (a) 1Ai, 1D, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2A, 2B, 3B, 3C, 5A, 5C, 5D, 10A, 10B, 11A.
- 2nd: (a) 1Ai, 1D, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2A, 2B, 3A, 3B, 3C, 5A, 5B, 5C, 5D, 5F, 5G

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WATER POLLUTION GRAPHING

2ND-5TH

OBJECTIVES

- Understand the connection between land-use activities and water quality within a watershed.

BACKGROUND INFORMATION

Pollutants accumulate in watersheds due to various human driven and natural events. These pollutants, while sometimes inevitable, drastically alter the state of the ecosystem. If we can determine the type of pollutant and its cause, then we can classify the source of the pollutant and take preventative measures to reduce any further contaminants. Below are examples of land uses and their potential problems:

LAND USE	ACTIVITIES	POTENTIAL POLLUTION
Agriculture	Tilling, pest control, fertilization, animal waste	Sediment, fertilizer, pesticides, bacteria
Construction	Land clearing and grading	Sediment
Forestry	Timber harvesting road construction, fire control, weed control	Sediment
Land Disposal	Septic System	Bacteria, nitrate, phosphate
Surface Mining	Dirt, gravel, and mineral excavation	Sediment, heavy metals, acid, drainage, nutrients
Urban Runoff	Lack of automobile maintenance, lawn and garden care, painting	Oil, gas, antifreeze, nutrients, pesticides, paints

BACKGROUND INFORMATION- CONTINUED

A watershed is an area of land from which all the water drains to the same location such as a stream, pond, lake, river, wetland, or estuary. A watershed can be large, like the Colorado River drainage basin, or very small, such as all the water that drains to a small farm pond. Large watersheds are often called basins and contain many small watersheds.

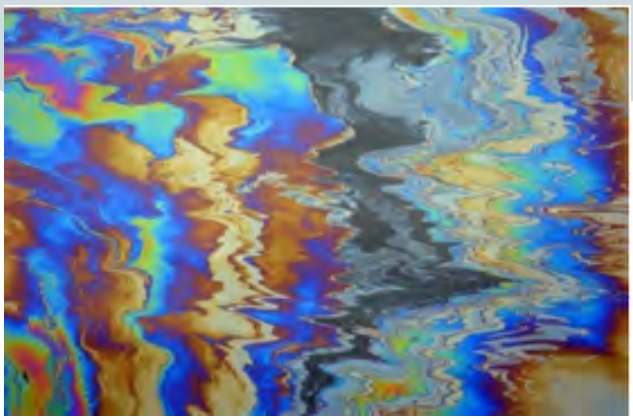
Watersheds can transport non-point source pollution. Non-point source pollution is associated with rainfall runoff moving over and through the earth's surface, carrying natural and human made pollutants into water sources. Examples of non-point source pollutants include fertilizers, pesticides, sediment, gas, and oil.

MATERIALS

- 2 Plastic Baggies per Group filled with assorted Skittles
  - One bag with more Skittles (all colors)
  - One bag with less Skittles (only two colors)
- Colored Pencils
- Graph Paper

ANTICIPATORY SET

Ask the students to guess what this is a photo of:
Answer: oil pollution on water.



Show your students the website "Vacation Hot Spot" found under Resources.

Ask your students how they feel seeing these pictures. What would it be like to live here? Discuss how some pollution is obvious, but other types are not so obvious.

TREE MAP: TYPES OF POLLUTION

As a class, create a Pollution "Tree Map." Write the word, Pollution on the trunk of the tree. Each of the branches will represent a different type of pollution. Help your students come up with the following types of pollution, and write them on each branch: *Sediment*, *Pesticides*, *Fertilizer*, *Oil/Gas*, *Toxic Waste*, *Trash*.

As a class, discuss how each of these pollutants can be used, and whether they are be beneficial, harmful, or both.

GRAPH IT!

Distribute two plastic bags to each group. These bags represent water samples from two locations. One bag should be filled with more Skittle (pollutants). The other bag should have fewer Skittles of only one or two colors. Each group will fill in a bar graph for each sample . Be sure they do not combine or mix up the Skittle bags! Graph paper for this activity can be found at the end of the lesson.

The Skittles will represent the following:

- Purple = Trash
- Red = Pesticides
- Green = Fertilizers
- Yellow = Oil and Gas
- Orange = Toxic Waste

WHAT STORY DOES YOUR SAMPLE TELL?

Upon completion, have each group try to determine what type of land-use practice may have caused that type of pollution. For example, a sample bag with mainly Sediment and Pesticides could indicate that the land was used for agriculture.
A sample bag with mainly Oil/Gas and Trash could indicate an urban setting.

PONDER

Discuss how pollutants can affect the food web within an ecosystem.
What might happen if the plants within the food web were negatively impacted by pollution? What might happen to the animals that rely on those plants for food?

RESOURCES

- Gambier20. (n.d.). Rainbow Pollution, [photograph]. Retrieved August 12, 2013, from http://www.flickr.com/photos/gambier20/3208414588/.
- Bugs Don't Bug Me, Retrieved from https://extension.usu.edu/waterquality/files-ou/Publications/Bugs-dont-bug-me.pdf
- Vacation Hot Spots Ruined By Trash: https://www.loveexploring.com/gallerylist/86221/vacation-hot-spots-ruined-by-trash-and-tourism

TEKS

Science, Adopted 2021:

- 2nd: (a) 1D, 5. (b) 1A, 1C, 1D, 1E, 1F, 1G, 2A, 3B, 3C, 4A, 5B, 5G, 11A, 11B, 12A.
- 3rd: (a) 1D, 5. (b) 1A, 1C, 1E, 1F, 1G, 2A, 3B, 3C, 4A, 5B, 5D, 5F, 5G, 11A, 11B, 11C.
- 4th: (a) 1D, 5. (b) 1A, 1C, 1D, 1E, 1F, 1G, 2A, 3B, 3C, 4A, 5B, 5D, 5F, 5G, 10A, 11A, 11B, 11C.
- 5th: (a) 1D, 5. (b) 1A, 1C, 1D, 1E, 1F, 1G, 2A, 3B, 3C, 4A, 5B, 5D, 5F, 5G, 11, 12C.

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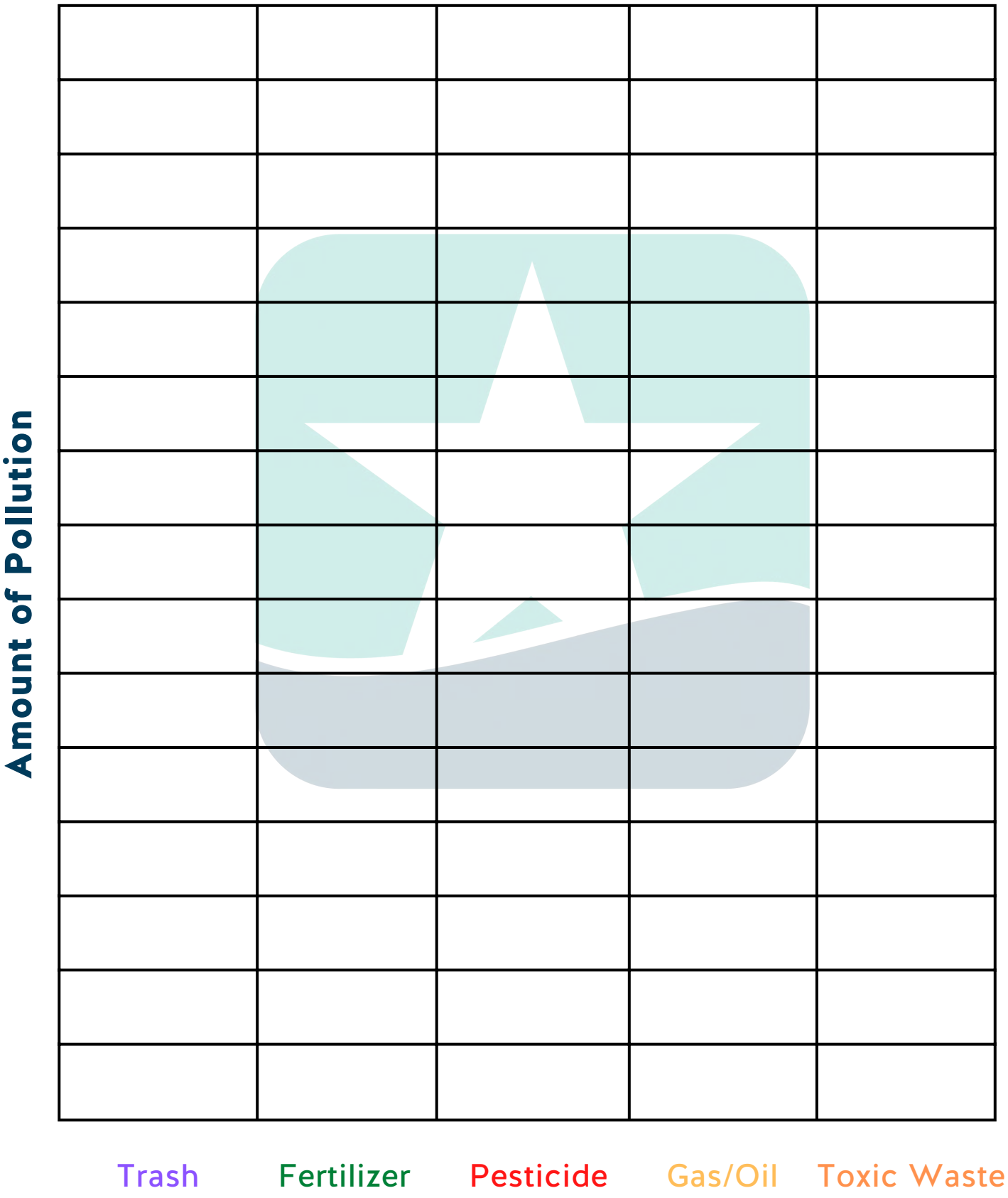
Name: _____

Date: _____

Water Pollution Graphing Activity



WHAT'S GOING ON UNDERGROUND?

3RD-5TH

OBJECTIVES

- Demonstrate how the water table can change.
- Examine how non-point source pollution contaminates groundwater.
- Discuss how different types of rock affect groundwater movement.

BACKGROUND INFORMATION

Groundwater is any water located beneath the earth's surface. Groundwater is important because it is used for drinking, eating, bathing, and more. Groundwater accumulates beneath the earth's surface in underground cave systems called aquifers. The highest level of water in the aquifer is known as the water table. The water table can be seen above earth's surface depending on depletion and repletion of water into the system. People use wells to reach these water reserves but must be careful to maintain a balance between using the water and rainfall recharging the groundwater supply to prevent it from running out of water. Pollutants can travel from earth's surface into the aquifer, leading to a contaminated groundwater supply. This can affect people and animals alike.

MATERIALS (PER GROUP OF 4)

- 4 Clear Plastic Cups
- Clay
- Sand
- Aquarium Gravel
- Gravel
- Rocks
- Nylon Stocking
- Spray Bottle
- Water
- 1 Teaspoon Kool-Aid Powder
- 1 Pie Tin
- Food Coloring

ANTICIPATORY SET

Before students arrive, add orange and green food coloring to a glass of water to make it appear dirty. When the students arrive, inform them that you took this water from the dirtiest local water supply in town. Ask why they think the water is discolored. Remind the students that all water sources have some level of pollution, even groundwater. Then, watch the following videos. Links under Resources.

PBS: Groundwater Beneath the Surface YouTube: What Is Groundwater

GROUNDWATER SCAVENGER HUNT

1. Beginning in the classroom, have students work in groups to draw a cross section of what they think groundwater may look like.
2. Take the class outside and have them look for locations where water moved after the last rain event. Off the roof? On the road? In the grass? Through a crack? Walk around the school grounds looking for different escape routes the water may have taken.
3. As a demonstration, pour a cup of water onto pavement and onto unpaved ground. Observe what happens. Ask your students to discuss why the water acted this way.

AQUIFER IN A CUP

1. Give four clear cups to each group of four students. Students will add a different earth base about half way up each cup (clay, sand, gravel, and rock).
2. Groups should spray water on the surface of each cup to simulate rain. Record what happens after three "rain storms" on each earth base. How does this connect to what they observed outside?
3. Using a spray bottle nozzle with nylon stocking material over the bottom of the tube, have the students examine how efficiently a water well would pump water out of the ground for each earth base type. Which base is the easiest for the well to draw water from?

WATER QUALITY CONNECTIONS

1. Give each group of students a pie tin and aquarium gravel. They will spread the gravel into the pie tin and create a small depression in the center.
2. Carefully, fill the tin with water along the pie tin wall until the water seeps and rises into the depression. This represents a man-made pond or lake!
3. Use the spray bottle nozzle with nylon hose as a water well, and pump (spray) water out of the tin into a cup until you can see the water level change in the central pond. This example shows how the water table can change. The level below the water table is called the saturation zone while the level above is called the unsaturated zone.
4. Sprinkle red Kool-Aid powder on the gravel away from the pond. "Rain" on this gravel with your spray bottle and observe what happens to the water table and the water quality (color) in the pond. This demonstrates how groundwater can become contaminated.

PONDER

What do you think happens to the level of the water table between spring and summer? Did you notice how easily the water became contaminated even when the pollution source was a distance away from the pond? This is called non-point source pollution. Discuss with your class how can this be prevented.
All of the groundwater in an aquifer is connected. Pollution in one area can have negative impacts on water everywhere.

PROJECT

Have the students research the history of groundwater or surface regulations for your state, county, or city. Have students write a short report on why groundwater and surface water regulations are important. How have these regulations improved our water quality?

RESOURCES

- That Magnificent Ground Water Connection: Deep Subjects: Well and Ground Water, 1-8. Retrieved from https://www.epa.gov/sites/default/files/2015-08/documents/mgwc-ww-well.pdf
- Northern California Public Media: What is Groundwater. Retrieved from https://www.youtube.com/watch?v=83qBb7KRkAE
- PBS: Groundwater Beneath the Surface. Retrieved from https://klru.pbslearningmedia.org/resource/20196d0e-5cab-408c-8ee0-9141a7d28b83/groundwater-beneath-the-surface/

TEKS ALIGNMENT

Science, Adopted 2021:

- 3rd: (a) 1Ai, 1E, 3A, 3B, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2D, 3B, 3C, 4A, 5A, 5B, 5D, 11B, 11C.
- 4th: (a) 1Ai, 1E, 3A, 3B, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2D, 3B, 3C, 4A, 5A, 5B, 5D, 5E, 11B, 11C.
- 5th: (a) 1Ai, 1E, 3A, 3B, 5. (b) 1A, 1B, 1C, 1E, 1G, 2D, 3B, 3C, 4A, 5A, 5B, 5D, 11, 12C.

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WHAT IS A WATERSHED?

7TH-10TH

OBJECTIVES

- Create a watershed model.
- Describe how topography impacts water's movement through a watershed.

BACKGROUND INFORMATION

A watershed is an area of land from which all rainfall drains into a common location such as a stream, pond, lake, river, wetland, or estuary. A watershed can consist of varying scales. The Colorado River Drainage Basin is a very large watershed spanning from the Rocky Mountains all the way to Mexico. Large watersheds are often called basins and contain several small watersheds. Watersheds can also be very small, such as the rainfall that drains off a landscape and into a small farm pond. The topography of the land surrounding a watershed plays an important role in how quickly the watershed is depleted and recharged.

MATERIALS

- Aluminum Foil
- Desk
- Water
- Topographic Map of your Region
- Science Notebook
- Internet Access

ANTICIPATORY SET

Write the following question on the board for your students to contemplate when they arrive for class. Encourage group discussion.

"How does a river's water level rise if it does not rain directly on the river?"

You will want to revisit this question at the end of the lesson to ensure they learned the objective. This could also be an essay question on a post-lesson evaluation.

PRIOR KNOWLEDGE ACTIVATION

Looking on a topographic map of your region, identify locations of high elevation. Challenge your students to determine the path any rainfall will take as it makes its way to an area of lower elevation.

Take a walking field trip around the school to document potential destinations for water. What clues can you find to indicate the direction the water moved? (Sloped land, bare rock on an incline, pipes, heavily eroded areas, etc.).

Watch the following videos (links under Resources):

- WGCU Curiouskids: What Is A Watershed?
- Oregon State University Ecampus: Understanding the Watershed
- PBS: A Watershed Moment

CREATE A WATERSHED

1. In groups of 4, slightly crumple a 15-inch piece of aluminum foil. Spread the foil out on a flat surface while still protecting the folds and indentations. This represents a land surface with varying elevations.
2. Students should observe the contours to determine where hilltops and valleys are located in this artificial landscape. Which pathways will rain follow across the terrain of this land surface?
3. In their science journal, ask students to write a definition of a watershed in their own words. Students should then identify how many watersheds are found on their aluminum foil land surface.
4. One student from each group should carefully sprinkle a small amount of water over the foil and watch the movement of water over the land surface.
5. As a group, students should hypothesize which areas are more susceptible to flooding than others. Using water, simulate heavy rain to see if their hypothesis is supported or not. If not, challenge students to explain why.

EXTENSION: CREATE A WATERSHED

Using the same foil from the previous activity, challenge each group to create the following watersheds:

- Water moving quickly across the land surface
- Water moving slowly across the land surface
- A watershed within a watershed
- Two side-by-side watersheds

PONDER

Non-point source pollution occurs when runoff from rainfall carries pollution into waterways. It is difficult to identify the exact source of this type of pollution.

Based on what we learned about how topography impacts water flow, what problems could develop in watersheds from non-point source contaminants? Can you think of specific examples of how humans have impacted watersheds over time? Do you think these impacts can be reversed? How?

Watch the following video (found under Resources)

- National Geographic: 50 Years Ago, This Was a Wasteland. He Changed Everything.

PROJECT

Have your students use the websites listed below to identify your school's watershed, as well as the health of the water in your community. Links to the websites can be found under Resources. Then, have your students compare your school's watershed to two other locations of their choice. Do these locations have anything in common, such as the watershed or river basins? Challenge your students to create a report explaining why your community's watershed is healthy or impaired.

- EPA: Enviromapper for Watersheds
- EPA: How's My Waterway
- TPWD: Texas Watershed Viewer

RESOURCES

- Enviromapper for Watersheds (n.d.). In Environmental Protection Agency Website. Retrieved from https://www.epa.gov/waterdata/waters-geoviewer
- How's My Waterway (n.d.). In Environmental Protection Agency Website. Retrieved from https://www.epa.gov/waterdata/hows-my-waterway
- Texas Parks and Wildlife: Texas Watershed Viewer https://tpwd.texas.gov/education/water-education/Watershed%20Viewer
- Project Wet Water Education Today: Explore Watersheds Retrieved from https://www.discoverwater.org/explore-watersheds/
- WGCUCuriouskids: What Is A Watershed? Retrieved from https://www.youtube.com/watch?v=yhsHS1sYfdc
- Oregon State University Ecampus: Understanding the Watershed Retrieved from https://www.youtube.com/watch?v=b98kdNGYZt0
- PBS: A Watershed Moment Retrieved from https://klru.pbslearningmedia.org/resource/729d87c8-ea5f-456d-826d-f4da88e8d101/a-watershed-moment/
- National Geographic: 50 Years Ago, This Was a Wasteland. He Changes Everything Retrieved from https://www.youtube.com/watch?v=ZSPkcpGmfIE&t=16s

TEKS ALIGNMENT

Middle School, Science (Adopted 2021):

- 7th: (a) 1Ai, 1Aii, 1D, 3A, 3B, 3C, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2D, 3A, 3B, 3C, 5A, 5B, 5C, 5D, 5F, 5G, 11A, 11B.
- 8th: (a) 1Ai, 1Aii, 1D, 3A, 3B, 3C, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2D, 3A, 3B, 3C, 5A, 5B, 5C, 5D, 5F, 5G.

High School, Biology (Adopted 2020):
(b) 1, 3A, 4A, 4B, 6. (c) 1A, 1B, 1C, 1D, 1E, 1F, 1G, 2D, 3A, 3B, 3C, 4A.

Aquatic Science (Adopted 2021):
(b) 1, 3A, 4A, 4B, 6. (c) 1A, 1B, 1C, 1D, 1E, 1G, 2D, 3A, 3B, 3C, 4A, 10A, 10B, 10C, 10D.

Environmental Systems (Adopted 2021):
(b) 1, 3A, 4A, 4B, 6. (c) 1A, 1B, 1C, 1D, 1E, 1G, 2D, 3A, 3B, 3C, 4A, 6B.

Earth Systems Science (Adopted 2021):
(b) 1, 3A, 4A, 4B, 6. (c) 1A, 1B, 1C, 1D, 1E, 1G, 2D, 3A, 3B, 3C, 4A, 9A, 9B.

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BUILD A BUG

K-3RD

OBJECTIVES

- Introduction to adaptations found in insects.
- Explore how adaptations help an insect survive in their environment.

BACKGROUND INFORMATION

Any organism that lives underwater is considered an aquatic organism. Examples of aquatic organisms include fish, worms, snails, crayfish, and even baby dragonflies! Aquatic organisms have different specialized body parts that help them survive and thrive in their environment. These traits are called adaptations. Organisms that live in fast moving waters may have an adaptation that helps them attach to surfaces. Organisms that attach to surfaces might also have an adaptation that helps them to filter the water that passes by for food particles!

MATERIALS

Materials for the Game "Cooties"

- Game instructions
- 1 Dice Per Group of 4 Students
- 1 Piece of Paper and Pencil Per Student

Assorted Materials including (but not limited to):

- Pool Noodle
- Rope
- Sunglasses/Googly Eyes
- Furry Hat/Wig
- Pipe Cleaners
- Feather Boa
- Play-Doh
- Vampire Teeth
- Fishing Net/Felt Fabric
- Googly Eyes
- Feathers
- Puff Balls
- Beads
- Toothpicks
- Straws
- Paper
- Markers
- Balloons

ANTICIPATORY SET

Play the game, "Cooties" as a class. This fun game will review the body parts of a typical insect. You can find the instructions for this game on the next page.

"COOTIES" GAME INSTRUCTIONS

WRITE THE FOLLOWING ON THE BOARD

1=head	2=body	3=antennae	4=eye	5=wings	6=legs

RULES OF THE GAME

Divide the class into groups of four students. Give each student a piece of paper and a pencil. Each group of four students will also need a six-sided dice.

- Each student will take turns rolling the dice. The number they land on will tell them which body part they get to draw on their paper. If they already have that body part, they must pass the die to the next student. They do not get to roll again.

  Emphasize that they MUST get a head and body before they can draw the remaining body parts!!

- The team member who gets all the necessary body parts first is the winner! If you would like to play this game "tournament-style," you can have the winner from each group play against each other.

STUDENTS WILL NEED ALL OF THE FOLLOWING IN ORDER TO WIN:

- 1 head
- 1 body
- 2 antennae
- 2 eyes
- 2 wings
- 6 legs

WHAT IS AN ADAPTATION?

1. Ask your students, "Why do bears have thick fur?" *Answer: It helps keep them warm!* "Why do fish have gills?" *Answer: It helps them breathe under water!*
2. Each of these body parts are examples of an adaptation. Adaptations are physical traits that help animals survive in their environment.
3. Show your class the "Example of Aquatic Insect Adaptations" page found at the end of the lesson. As a class, discuss the different body parts that help those insects survive in their environment.
4. Watch the video: Adaptations. Link found under Resources.

DRESS THE CLASS PET!

1. Before class, place an assortment of items on your desk to be used in this activity (feather boa, sunglasses, pool noodle, wig, etc.)
2. Tell your class that we are going to imagine we have a new class pet that happens to be an aquatic insect.
3. Ask the class to help you create a list of adaptations for our make-believe class insect. *Ex: sharp teeth for eating other insects, a long tail for balancing, etc.*
4. Ask for a student volunteer to be the "class insect."
5. One student at a time will walk up to the items on your desk to find an item to represent on of the adaptations on the class list. Once they found an item, they can carefully place it on the volunteer "class insect."
6. After about 5 volunteers, your insect will be ready to show off their adaptations! Have them do a little strut across the room to show off their adaptations!
7. Have a class discussion about why these adaptations would help this insect survive and thrive underwater.

CREATE YOUR OWN INSECT

Using assorted craft materials, instruct each student to create their own insect. Organize a Show-and-Tell so that each student can present their insect to the group. Students should explain why each adaptation is important for their insect.

PONDER

Ask your students to ponder the following question. Students can answer this question through an essay, short story, or picture.

"If you could have any adaptation, what would it be and how would it help you?"

RESOURCES

- Bugs Don't Bug Me, Retrieved from https://extension.usu.edu/waterquality/files-ou/Publications/Bugs-dont-bug-me.pdf
- Generation Genius Video, Adaptations: Retrieved from https://www.youtube.com/watch?v=s-OMDnCFf2g

TEKS ALIGNMENT

Science, Adopted 2021:

- Kinder: (a) 1Ai, 1E, 3B, 5. (b) 1C, 1D, 1G, 2D, 3B, 3C, 5D, 5F, 5G, 12B, 13B.
- 1st: (a) 1Ai, 1E, 3B, 5. (b) 1C, 1D, 1G, 2D, 3B, 3C, 5D, 5F, 5G, 13A.
- 2nd: (a) 1Ai, 1E, 3B, 5. (b) 1C, 1D, 1G, 2D, 3B, 3C, 5D, 5F, 5G, 13B.
- 3rd: (a) 1Ai, 1E, 3B, 5. (b) 1C, 1D, 1G, 3B, 3C, 5D, 5F, 5G, 13A.

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SUGGESTED ITEMS FOR INSECT TRAITS

Adaptations	Use	Items Representing Adaptions for Build A Bug	Items Representing Adaptions for Create An Insect
Legs, Claws, Hooked Feet, Suction Cups, Hairs on Legs	Holding on to rocks and hard substrate, scraping algae off rocks, attacking prey	Water noodle with hooks on the end	Pipe cleaners
Tails	Swimming and maneuvering	Garland or rope	Paper Clip or Wire
Compound Eyes	Helping insects detect motion	Sunglasses with googly eyes glued on	Google eyes
Hairs on head or body	Help detect movement or chemical changes in water	Wig or furry hat	Puffy balls or felt fabric
Antennae	Sensing food, water, surroundings	Store bought or homemade antennae	Play-Doh
Gills	Breathing dissolved oxygen in the water	Feather boa	Feather
Air Bubbles	Capturing oxygen from the surface for breathing	Balloon	Plastic necklace beads, bouncy ball
Breathing Tube	Breathing oxygen from the surface air	Straw	Straws
Specialized Mouth Parts	For scraping, piercing, shredding, etc. The mouth parts reflect food choices of the insect.	Vampire teeth	Toothpicks
Device for catching food, i.e., net (made by the insect or part of their body structure) or special hairs	Catching food in the current	Fishing net	Fabric netting

EXAMPLES OF AQUATIC INSECT ADAPTATIONS

The **Blackfly larva** has a net on its head for collecting food.

The **Cranefly larva** has tiny hairs and suction cups along its body so it can hold on to rocks and hard substrates in fast flowing water.

EXAMPLES OF AQUATIC INSECT ADAPTATIONS

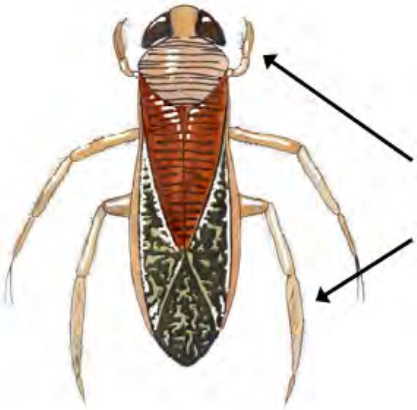
The **Stonefly** nymph has claws for capturing prey and holding on tight to rocky substrates.

The **Stonefly** nymph has gills in its "armpits" for breathing dissolved oxygen in fast flowing streams.

The **Mayfly** nymph has hooks for holding on tight to rocky substrates.

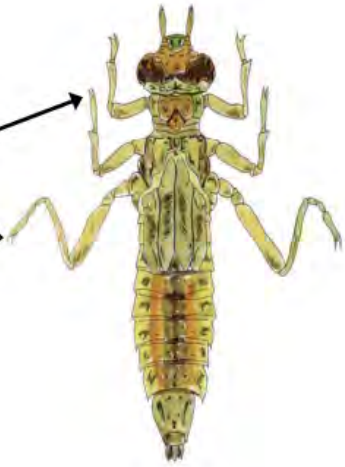
The **Mayfly** nymph has gills on its abdomen for breathing dissolved oxygen in fast flowing streams.

EXAMPLES OF AQUATIC INSECT ADAPTATIONS



The **Water boatman** has paddle-like legs for swimming in slow moving water.

The **Dragonfly nymph** has claws on its legs for capturing prey and for climbing emergent vegetation.



MACRO-INVERTEBRATE INDICATORS

1ST-5TH

OBJECTIVES

- Explore the concept of "indicator species."
- Understand that aquatic organisms are an indicator of an ecosystem's water quality.

BACKGROUND INFORMATION

Pollutants accumulate in a watershed as a result of various human driven and natural events. These pollutants, while sometimes inevitable, drastically alter the state of the ecosystem. If we can determine the type of pollutant and its cause, then we can identify the source of the pollutant and take preventative measures to reduce any further contamination.

One of the most effective methods in detecting declining trends in water quality are through biological surveys of aquatic macro-invertebrates (small animals without backbones that live underwater). Because different species have different tolerance levels to pollution, they respond rapidly to changes in water quality.

To evaluate the health and productivity of a stream, biologists look at the types of macro-invertebrate species that live there. If many pollution-intolerant organisms, such as stonefly or caddisfly nymphs, are present, then water quality is probably good. Although the presence of certain species is an indicator of good water quality, the absence of these species does not necessarily indicate poor water quality. Other factors besides pollution may account for their absence.

MATERIALS

- 2 Plastic Bags per Group with colored candies
  - Bag #1 contains candy of all colors
  - Bag #2 contains only a few candies of two colors
- Graph Paper (found at the end of the lesson)
- Colored Pencils
- Pictures of the macro-invertebrates in this lesson

ANTICIPATORY SET

Watch the video "From Nymph to Wings" (under Resources) and discuss with your students how lots of juvenile insects start their life underwater, then emerge from the water and fly away as adults- like the Dragonfly in the video!

Next, watch the video "Aquatic Macro-invertebrates" to see first-hand how a diverse community of macro-invertebrates in a stream is an indicator of good water quality.

STREAM SAMPLE: GRAPHING

1. Ask your students to imagine that they are scientists studying the water quality of a local stream in your community. They have collected two samples of water from two different locations along the stream.
2. Distribute two bags of colored candies to each group. Be sure they are labelled Bag #1 and Bag #2.
    a. Bag #1 should contain a variety of all the candy colors.
    b. Bag #2 should contain only a few candies of two colors only.
3. Using the "Count your Macro-Invertebrates" page at the end of this lesson, have each group work together to tally the candies in the appropriate data table based on color. Remind them not to mix up the candies in their bags!
4. After completing the data tables, students should work together to answer the two reflection questions at the bottom of the page.
5. Inform your class that each color represents a different type of macro-invertebrate. Each type of macro-invertebrate can tolerant different levels of pollution. Students will then use colored pencils to fill in the bar graph for Bag #1 and Bag #2 based on the quantities they recorded on their data tables.
6. Upon completing their two graphs, move onto the next section, "Real World Connections."

REAL WORLD CONNECTIONS

Using colorful markers, write the following descriptions on a large piece of paper for the class to see.

- Red and Orange = CANNOT Tolerate ANY Pollution (only lives in clean water)
- Yellow and Green = Somewhat Tolerant of SOME Pollution
- Blue and Purple = Can Tolerate ANY Level of Pollution (can live in polluted OR clean water)

YOUNGER STUDENTS:

To conclude this lesson, have your students work in their groups to discuss which bag represented a healthy ecosystem and why?

- Remember- the more diversity of species in your ecosystem, the healthier it is. If their ecosystem only had Blue and Purple, the ecosystem is likely polluted.
- If the ecosystem only contains Red and Green, it is likely that this ecosystem is very clean. Yellow and Green insects can live in some pollution, but they will also live in clean water. In other words, they *can* tolerate *some* pollution.

OLDER STUDENTS:

To conclude this lesson, have your students work in their groups to discuss which bag represented a healthy ecosystem and why?

- Students will work in groups to select and research one of the macro-invertebrates in this lesson. Questions each group can answer include:
    - What type of water body might you find this type of macro-invertebrate?
    - What adaptation might this species have that allow it to be successful in this type of water body? Does this species have any limitations?
    - Create a model of this organism and label it's body parts.
    - Present about your organism to the class!

RESOURCES

- Bugs Don't Bug Me, Retrieved from https://extension.usu.edu/waterquality/files-ou/Publications/Bugs-dont-bug-me.pdf
- National Geographic Video: From Nymph to Wings, Retrieved from https://www.youtube.com/watch?v=OlfXSe0wyUs
- NYSDEC Video: Aquatic Macro-Invertebrates, Retrieved from https://www.youtube.com/watch?v=HtE70kzYDPM

TEKS

Science, Adopted 2021:

- 1st: (a) 1Ai, 1E, 5. (b) 1A, 1C, 1E, 1F, 1G, 2A, 2B, 3B, 3C, 4A, 5A, 5F, 5G, 11A, 11B, 12C, 13A.
- 2nd: (a) 1Ai, 1E, 5. (b) 1A, 1C, 1E, 1F, 1G, 2A, 2B, 3B, 3C, 4A, 5A, 5F, 5G, 12A, 13B, 13D.
- 3rd: (a) 1Ai, 1E, 5. (b) 1A, 1C, 1E, 1F, 1G, 2A, 2B, 3B, 3C, 4A, 5A, 5F, 5G, 11B, 13A.
- 4th: (a) 1Ai, 1D, 5. (b) 1A, 1C, 1E, 1F, 1G, 2A, 2B, 3B, 3C, 4A, 5A, 5F, 5G.
- 5th: (a) 1Ai, 1E, 5. (b) 1A, 1C, 1E, 1F, 1G, 2A, 2B, 3B, 3C, 4A, 5A, 5F, 5G, 12A, 12C, 13A.

Name: _____

Date: _____

Count Your Macro-Invertebrates!

- Count the candies in Bag #1, and record the number of each color in the table.
- Repeat for Bag #2.
- Answer the reflection questions at the bottom of the page.
- Turn to the next page and create a bar graph for each bag you counted!

Bag #1	
Candy Color	Quantity
RED	
ORANGE	
YELLOW	
GREEN	
BLUE	
PURPLE	

Bag #2	
Candy Color	Quantity
RED	
ORANGE	
YELLOW	
GREEN	
BLUE	
PURPLE	

How are Bag #1 and Bag #2 different?

_____

_____

Which Bag do you think represents a healthy ecosystem? Why?

_____

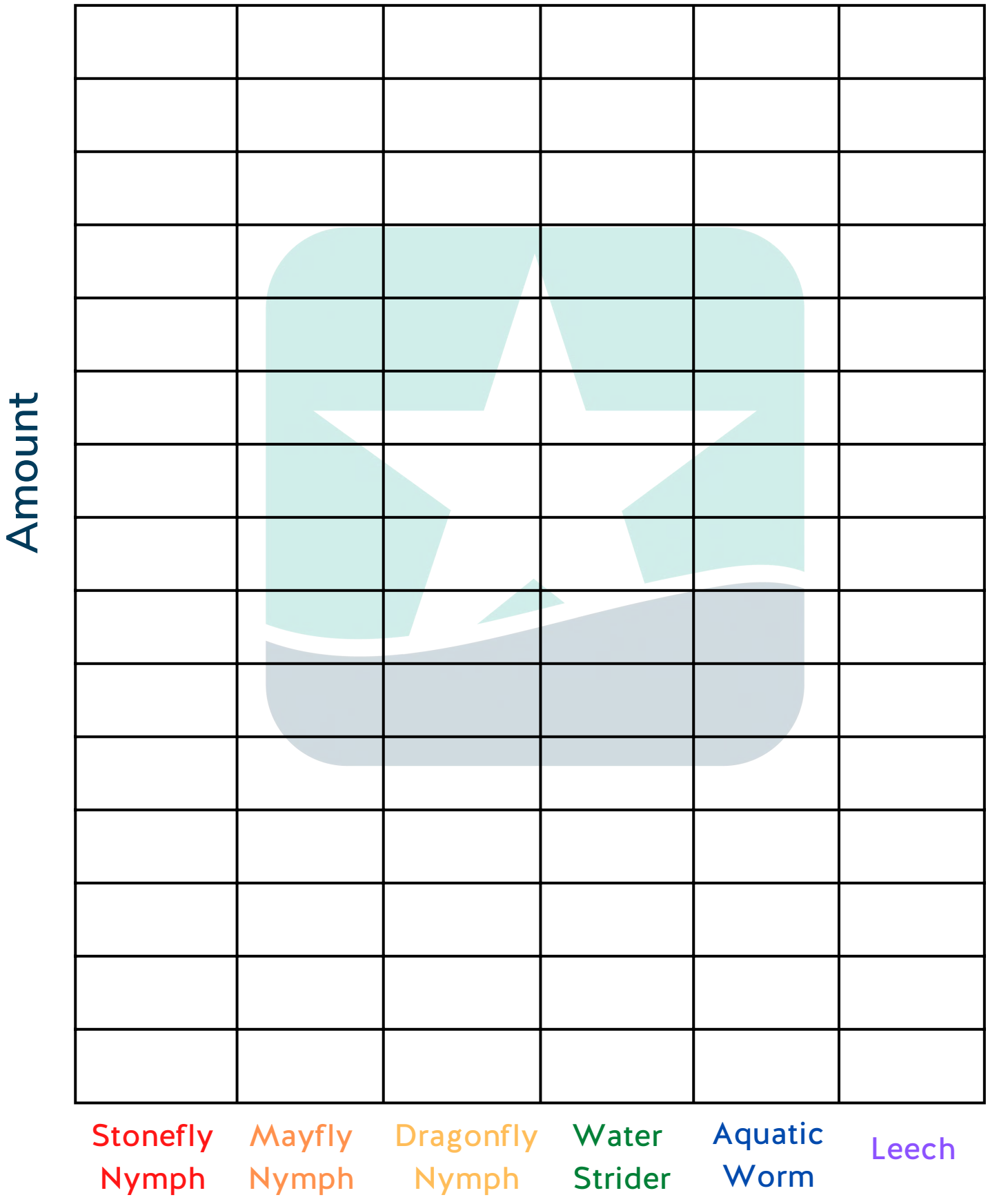
_____

_____

Name: _____

Date: _____

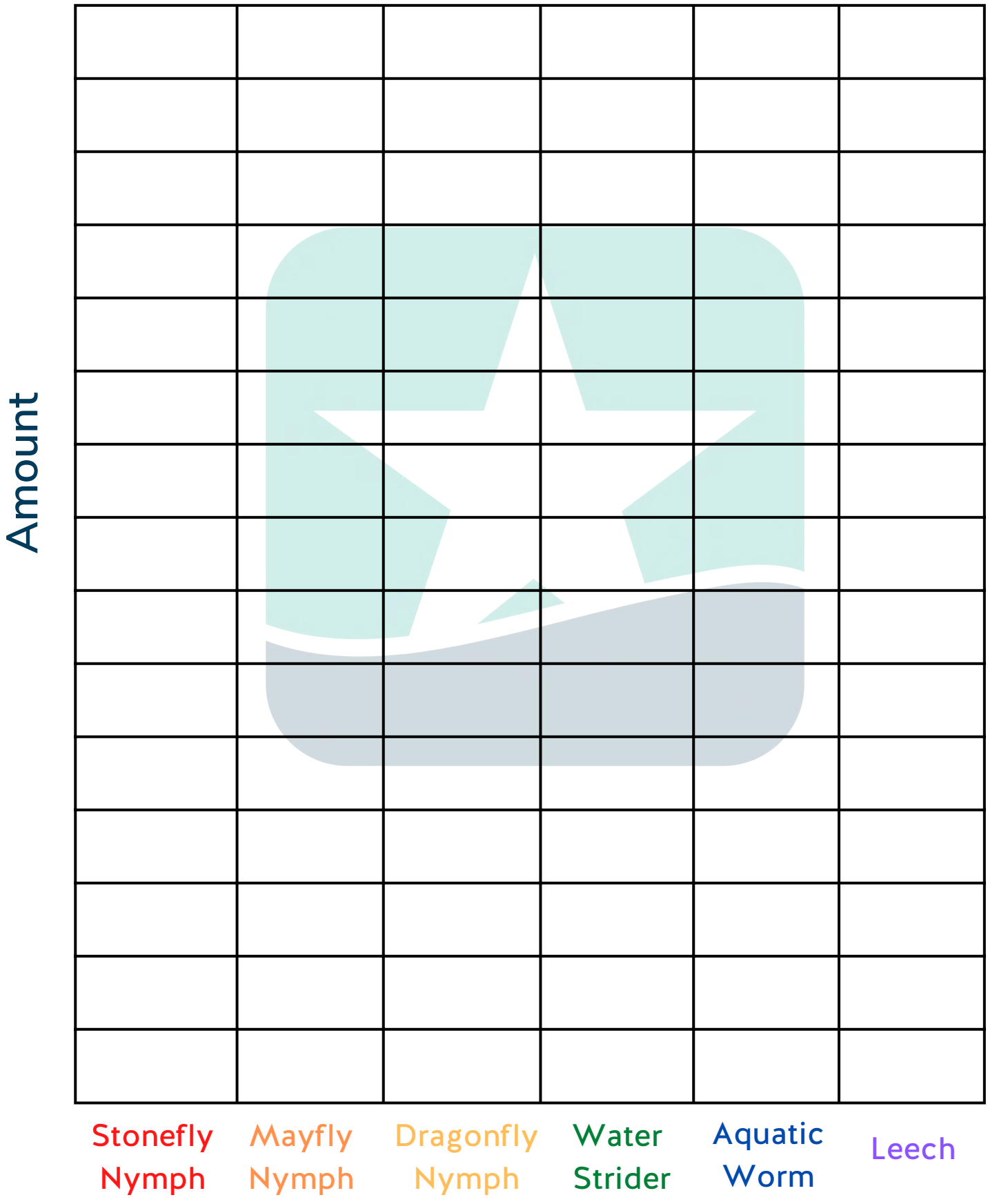
Macro-Invertebrate Population of Bag #1



Name: _____

Date: _____

Macro-Invertebrate Population of Bag #2



Name: _____

Date: _____

Macro-Invertebrates Images

Found in Clean Water Only

Stonefly Nymph

Has two "tails" and
a long, slender body.

Mayfly Nymph

Has three "tails" and
a shorter body.

Found in Clean, or Slightly Polluted Water

Dragonfly Nymph

Has a rounded body
and large eyes.
This is a baby Dragonfly!

Water Strider

Moves on top of the
water's surface. Has
two long legs in the back!

Found in Clean, Slightly, or Very Polluted Water

Aquatic Worm

Long, slender body with
segments. Can be found
burrowing in sediment!

Leech

Has a suction mouth,
and found in shallow,
warm water.

MACRO-INVERTEBRATE FIELD STUDY

2ND-5TH

OBJECTIVES

- Describe and identify the quality of a stream or water body by analyzing the aquatic macro-invertebrates that live there.

BACKGROUND INFORMATION

Sometimes it is easy to tell if a stream is polluted. Strange colors and dead fish are often indicators of poor water quality; however, biologists need to track water quality problems long before they reach this point. One of the most effective methods in detecting declining trends in water quality are through biological surveys of aquatic macro-invertebrates (small animals without backbones). Because different species have different tolerance levels to pollution, they respond rapidly to changes in water quality.

To evaluate the health and productivity of a stream, biologists look at the types of macro-invertebrate species that live there. If many pollution-intolerant organisms, such as stonefly or caddisfly nymphs, are present, then water quality is probably good. Although the presence of certain species is an indicator of good water quality, the absence of these species does not necessarily indicate poor water quality. Other factors besides pollution may account for their absence.

LEVELS OF SENSITIVITY IN MACRO-INVERTEBRATES

SENSITIVE (INTOLERANT) SPECIES:

Organisms easily killed, impaired, or driven off by bad water quality.
Includes many types of stoneflies, dobsonfly, and mayfly nymphs, caddisfly larvae, and water pennies.

SOMEWHAT TOLERANT SPECIES:

Organisms with the ability to live in good or poor-quality water.
Includes amphipods, scuds, beetle and cranefly larvae, crayfish, and dragonfly nymphs.

TOLERANT SPECIES:

Organisms capable of withstanding poor water quality.
Includes most leeches, aquatic worms, midge larvae, mosquito larvae, and sow bugs.

MATERIALS

- Plastic Tubs (1 per group of 4)
- Plastic Petri Dish (2 per group)
- Magnifying Lens (2 per group)
- 2 Large Buckets
- Pipettes (2 per group)
- Data Sheet (1 per group)
- Pencil (1 per group)
- 2 Large Nets
- Identification Sheets (1 per group)
- Latex Gloves
- Download the "Creek Critter App"

ANTICIPATORY SET

Bring your students out to a small body of water around your school yard. This could be a large puddle, stream, small pond, or even a retention ditch. Ask your students to make observations about this body of water and form a hypothesis about the water's quality. Once they have constructed a hypothesis, have them raise their hand for their hypothesis as you call out the three levels of water quality. *"Raise your hand if you think the water is very polluted.... somewhat polluted... etc."*

SETTING UP FOR THE INVESTIGATION

1. Discuss safety in the field with your class prior to the field exercise. Show them the boundary zones for this investigation. Be aware of your student's health concerns, and communicate with your school's administration and nurse about where you will be taking your class.
2. It is helpful to assign student roles prior to beginning this investigation. Have each group decide on two people to collect bugs, and two people to sort through the sample and pick out individual bugs onto Petri dishes. One student can be the designated Recorder, who writes down the types of bugs the group finds. Distribute gloves to the students sorting through plant material.
3. Once you are at your field location, have your students split into groups of four. Distribute all materials as stated in the "Materials" section.
4. Fill the two class buckets with water from your sample site. Distribute this water equally into each group's plastic tub. They should be filled about half way.

CONDUCTING THE INVESTIGATION

1. Depending on the water source your group is analyzing, the method for bug collection will vary.
    a. Small Pond or Stream: Carefully collect floating vegetation using your large net. Place this vegetation in the group's tub and have your students sift through the plant matter to find bugs. It's okay to pick up leaf litter from the bottom of the water body, or even small rocks!
2. Once each group has a collection of aquatic plants in their tubs, have your students carefully sift through the material to isolate individual bugs. They may have to agitate the plant material or the bottom of rocks to get bugs to reveal themselves. Individual bugs can be placed into the group's Petri dishes (just be sure they put water in their dishes first!)
3. As your students find individual bugs from their sample, they should work to ID them based on the identification sheets found at the end of this lesson. For each type of bug they find, they will mark a tally. The recorder for each group will take notes on the data sheet as their group is finding and identifying bugs. Encourage your students to use the magnifying lens to get a closer view at each bug! They may use the Creek Critter app if they are struggling to identify anything in the sample.
4. After about 15-20 minutes of investigating their water samples, instruct each group to place their bugs back into the water sample, and pour their water sample back into the source they retrieved it from.
5. Complete the lesson back in the classroom.

POST-INVESTIGATION ANALYSIS

1. Once your students are back in the classroom, give them plenty of time to talk as a group and determine if their original hypothesis was supported by the data they collected in the field.
2. Groups should analyze the tally marks they have in each group to determine whether the water quality was clean, somewhat polluted, or very polluted.
3. Each group will designate a Speaker, who will announce their group's findings to the class. Once all groups have shared out, come up with a class conclusion for this investigation.
4. **Discuss**: what do you think contributed to the water quality at the sample site?

RESOURCES

- Bugs Don't Bug Me, Retrieved from https://extension.usu.edu/waterquality/files-ou/Publications/Bugs-dont-bug-me.pdf

TEKS ALIGNMENT

Science, Adopted 2021:

- 2nd: (a) 1Ai, 1E, 3A,3B, 3C, 5. (b) 1A, 1B, 1C, 1D, 1E, 1F, 1G, 2B, 3B, 3C, 4A, 5A, 5B, 5C, 5D, 5F, 5G, 11B, 12A.
- 3rd: (a) 1Ai, 1E, 3A,3B, 3C, 5. (b) 1A, 1B, 1C, 1D, 1E, 1F, 1G, 2B, 3B, 3C, 4A, 5A, 5B, 5C, 5D, 5F, 5G, 11B, 11C, 12C, 13A.
- 4th: (a) 1Ai, 1E, 3A,3B, 3C, 5. (b) 1A, 1B, 1C, 1D, 1E, 1F, 1G, 2B, 3B, 3C, 4A, 5A, 5B, 5C, 5D, 5F, 5G.
- 5th: (a) 1Ai, 1E, 3A,3B, 3C, 5. (b) 1A, 1B, 1C, 1D, 1E, 1G, 2B, 3B, 3C, 4A, 5A, 5B, 5C, 5D, 5F, 5G, 11, 12A, 12B, 12C, 13A.

512.245.1346
txstreamteam@txstate.edu
www.TexasStreamTeam.org

Name: _____

Date: _____

Macro-invertebrate Field Investigation Data Sheet

Group A: Sensitive to Pollution

These organisms can not thrive in any level of pollution. Their presence indicates that the water is not polluted.

Tally each Individual that you find in the boxes below.

Caddisfly Larvae

Water Penny

Aquatic Mite

Riffle Beetle

Mayfly Nymph and Adult

Dobsonfly Larvae and Adult

Total individuals from "Group A" found in your water sample:

_____

Name: _____

Date: _____

Macro-invertebrate Field Investigation Data Sheet

Group B: Somewhat Tolerant to Pollution

These organisms can thrive in some level of pollution, though they prefer clean water. Their presence indicates that the water may either be slightly polluted, or clean.

Tally each Individual that you find in the boxes below.

Crawfish

Scud

Dragonfly Larva

Clam

Water Strider

Damselfly Larva

Total individuals from "Group B" found in your water sample:

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Texas State University
Texas Stream Team

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www.TexasStreamTeam.org

Name: _____

Date: _____

Macro-invertebrate Field Investigation Data Sheet

Group C: Tolerant to Pollution

These organisms can thrive in any level of pollution (clean, somewhat polluted, or very polluted). If you only find Group C organisms, this could indicate higher levels of pollution

Tally each Individual that you find in the boxes below.

Aquatic Worm

Mosquito Larva

Leech

Water Scorpion

Sow Bug

Planarian

Total individuals from "Group C" found in your water sample:

Name: _____

Date: _____

Macro-invertebrate Field Investigation Data Sheet

Investigation Analysis

1.From which category did your group count the most bugs? Circle one.

- Group A- Able to live in clean water only
- Group B- Able to live in clean water, or slightly polluted water
- Group C- Able to live in very polluted water, slightly polluted, or clean water

2.What can you conclude about the water quality of the sample site?

3.What do you think contributed to these results?

4. What questions do you still have? Come up with TWO.

-
-

The Meadows Center
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