Title of the Lesson Plan:

- **Disruptions in Ecosystems**

BIORETS Teacher's Name: Kelly Vance

Intended School Year and Marking Period: 2025-2026, first marking period (before our field trip to the Fish Hatchery)

Subject and Grade Level: Science 6th grade

Overview: In the lesson, students will be introduced to ecosystem disruption, an invasive species. Students will draw on what they have learned previously to begin to ask questions about how the introduction of invasive species might disrupt the Paw Paw River (a local river in the community). Students then explore the introduction of an invasive species through a familiar context to analyze its possible impact. Students will actively investigate the ecosystem in the Paw Paw River through Benthic sampling and analyze their data to determine the health of the ecosystem in the river. Students will transition into looking at long-term data on the effects of invasive species. This allows them to deepen their understanding of dynamic ecosystems, and the importance of looking at disruption to ecosystems in both the short- and long-term. Students conclude with an investigation of another invasive species in the ecosystem, which allows for the evaluation of students' understanding of dynamic ecosystems and the effects of invasive species, while setting them up to investigate possible solutions for future disruptions to ecosystems.

Essential Standards: [

MS-LS2-4 - Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS2-1 - Analyze and interpret data to provide evidence for the effects of resources availability on organisms and populations of organisms in an ecosystem.

Learning Objectives:

1. Ask questions to determine relationships between independent and dependent variables and relationships in models.
2. Analyze and interpret data to provide evidence for phenomena.
3. Apply scientific ideas, principles, and evidence to construct an explanation for real-world phenomena.
4. Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion.
5. Construct an oral or written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.
6. Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s).

Length of Lesson: 5 to 7 class periods (45 minutes each

Introduction/Background:

There are many different ecosystems in the world. One challenge is the introduction of a new species to an ecosystem. If a new species survives and its population increases, it can disrupt the ecosystem. This can affect the health of the ecosystem. In this activity you will learn about invasive species, a non-native organism that, when introduced to a new environment, can cause ecological, economic, or human health harm. You will predict what effect an invasive species might have on the health of these ecosystems.

Key Concepts and Terms Covered:

- Biodiversity
- Macroinvertebrate
- Ecosystems
- Benthic sampling

- Dichotomous key
- Invasive species

Materials:

- Frozen water samples from the Paw Paw River
- Microscope
- Sorting dishes
- Tweezers
- Access to the internet, You Tube videos, and access to projection screen
- KWL Chart
- Scientific Argument Graphic Organizer
- Sorting Data collection Sheet
- Ecosystem Information Sheet
-

Activities of the Sessions:

Engage: (Day1)

Introducing an invasive Species

Guiding Question:

a) How might the introduction of an invasive species affect the health of the Paw Paw River ecosystem?

b) Students begin with an introduction to an ecosystem disruption, an **invasive species**. Students will use their prior knowledge to generate information about how an invasive species could disrupt the Paw Paw River ecosystem by completing the "know" section of a KWL sheet.

c) Watch a video on YouTube introducing what invasive species are in Michigan https://www.youtube.com/watch?v=yIgysZ5Hho8&list=PLXCrWyRfRQVX3xTeIUDWyuMXjlJtbfAVI&index=2

d) Students will fill out the "What" section of the KWL sheet with questions or things they wonder about invasive species.

e) History in Science – facts and history about the Paw Paw River in a story format

f) Jeopardy game to review information learned throughout the hour.

Explore: (Day 2 – 3)

a) Review invasive species and which ones are specific to Michigan (5-minute Jeopardy style warm up)

b) Introduce **macroinvertebrates** (Give some examples)

c)Watch a YouTube video introduction Benthic Sampling https://www.youtube.com/watch?v=CaGRQ02wURo

d) Go over Stroud Identification Guide to Fresh water Macroinvertebrates and discuss the dichotomous Key and how to use it

e) Give frozen Benthic samples from the Paw Paw River to small groups of students

e) Students thaw and dump samples into a dish

f) Use a microscope to sort macroinvertebrates into "like" groups and identify using the Stroud Identification Guide what the order/family is for each macroinvertebrate https://stroudcenter.org/wp-content/uploads/StroudWebsiteMacroKeyFNL.pdf

h) Fill out a data form on the types of macroinvertebrates they found in their samples

Explain: (Day 4)

Guiding Question:

Introduce **biotic** and **abiotic**

What biotic and abiotic factors are affected when an invasive species is introduced to an ecosystem?

a) data spreadsheet analysis (discuss the types of species they found in their samples) Was it mostly non-invasive or invasive?

b) ecosystem system sheet organization sheet in small groups

c) Students predict: Is the Paw Paw River a healthy or unhealthy ecosystem?

Elaborate: (Day 5)

Introduction:

What are the long-term effects of an invasive species on an ecosystem?

a) Students investigate the data on the long-term effect of an invasive species.
b) Students write an explanation
c) Students read about the long-term effects of an invasive species and revise their explanations
d) Students construct an argument about the effect of an invasive species on the Paw Paw River ecosystem.
e) Students share their arguments

Engagement:

Students will participate in group discussions, hands-on microscope activities with samples, and review information from multiple sources.

Evaluation:

Students will work together in teams to investigate a Michigan invasive species and make a presentation to the class about the effects on an ecosystem. Students may choose from a list of invasive species on the Van Buren Conservation District Website https://vanburencd.org/invasive-species/.
Student Presentation must include:
A picture and information about their invasive species
The ecosystem that it is affecting (river, lake, stream, trees and plants etc.)
Abiotic and biotic features of ecosystem.
What are the short-term and long-term effects of this invasive species if a plan is not set in place to get rid of the species from the ecosystem?

Extensions and Modifications:

- Field trip to the fish hatchery: https://www.michigan.gov/dnr/places/v-centers/wolf-lake
- Biodiversity Game: https://academics.lmu.edu/media/lmuacademics/cures/urbanecolab/module06/M6_L6_BiodiversityGame_RPcricle.pdf

Application:

Paw Paw River is a water source that is in our local community. Students will make personal connections to the river through opportunities with hands on exploration using the microscope and benthic sampling. In turn, many of the students fish and kayak on the lake that feeds the river.

Resources:

1. Next Generation Science Standards Resources; Middle School: Disruptions in Ecosystems. https://www.nextgenscience.org/resources/middle-school-disruptions-ecosystems
2. Van Buren Conservation District https://vanburencd.org/
3. Stroud Water Research Center https://stroudcenter.org/
4. Two Rivers Coalition https://www.tworiverscoalition.org/pprw.asp
5. Water on the Web https://www.waterontheweb.org/index.html
6. Southwest Michigan Land Conservancy https://swmlc.org/

Topic: _____ Name: _____

K What I Know	W What I Wonder	L What I Learned

Sorting Data Collection Sheet

Group members:_____

Bug (common name)					
Order: (Use Stroud Identification Guide)					
Count:					
Description:					

Ecosystem Information Sheet

Name:

Date:

Ecosystem	Description	Biotic Factors	Abiotic Factors	Types of Invasive Species	Other Notes
Paw Paw River System					

Claim - Evidence - Reasoning

Name: _____

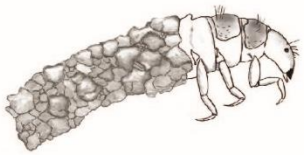
Date: _____

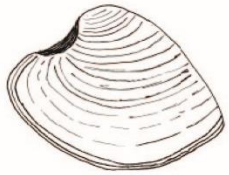
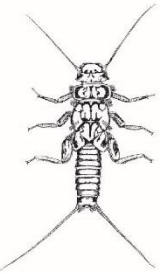
Question:

Claim: Your answer to the question

Evidence: Data from investigations or research

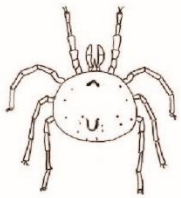
Reasoning: Explain how the evidence supports your claim.

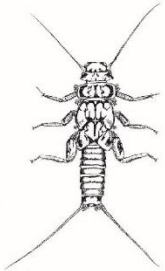
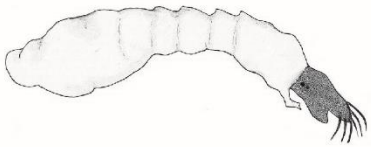
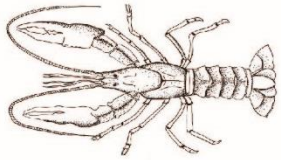


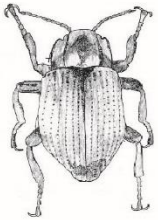



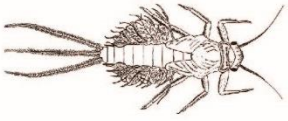

STROUD
WATER RESEARCH CENTER
www.stroudcenter.org

Identification Guide to Freshwater Macroinvertebrates








Major Characteristics of Aquatic Larvae

GLOSSARY

Abdomen: posterior body segment(s) of insect

Dorsal: the top surface, the back

Filaments (tail): hair-like structures

Jointed leg: true legs, legs capable of bending

Lateral: at the side

Portable case: structure made of leaves, twigs, or sand that some caddisfly and midge larvae carry with them

Posterior: tail end of the body

Prolegs: short leg-like structures (not jointed)

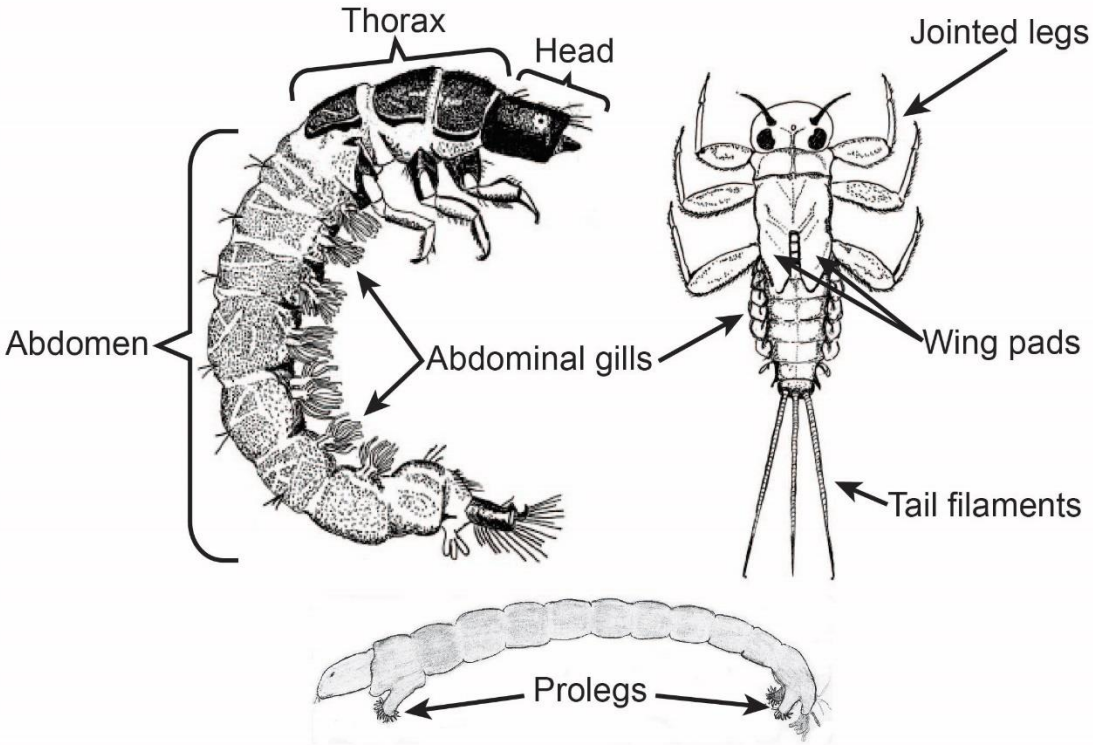
Protrusion: part of the body that sticks out

Segment: a section of body

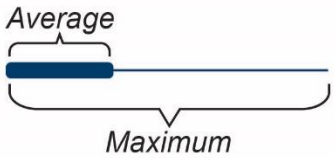
Thoracic: the middle region between the head and the abdomen

Ventral: underside

Wing pads: developing wings, often W in shape



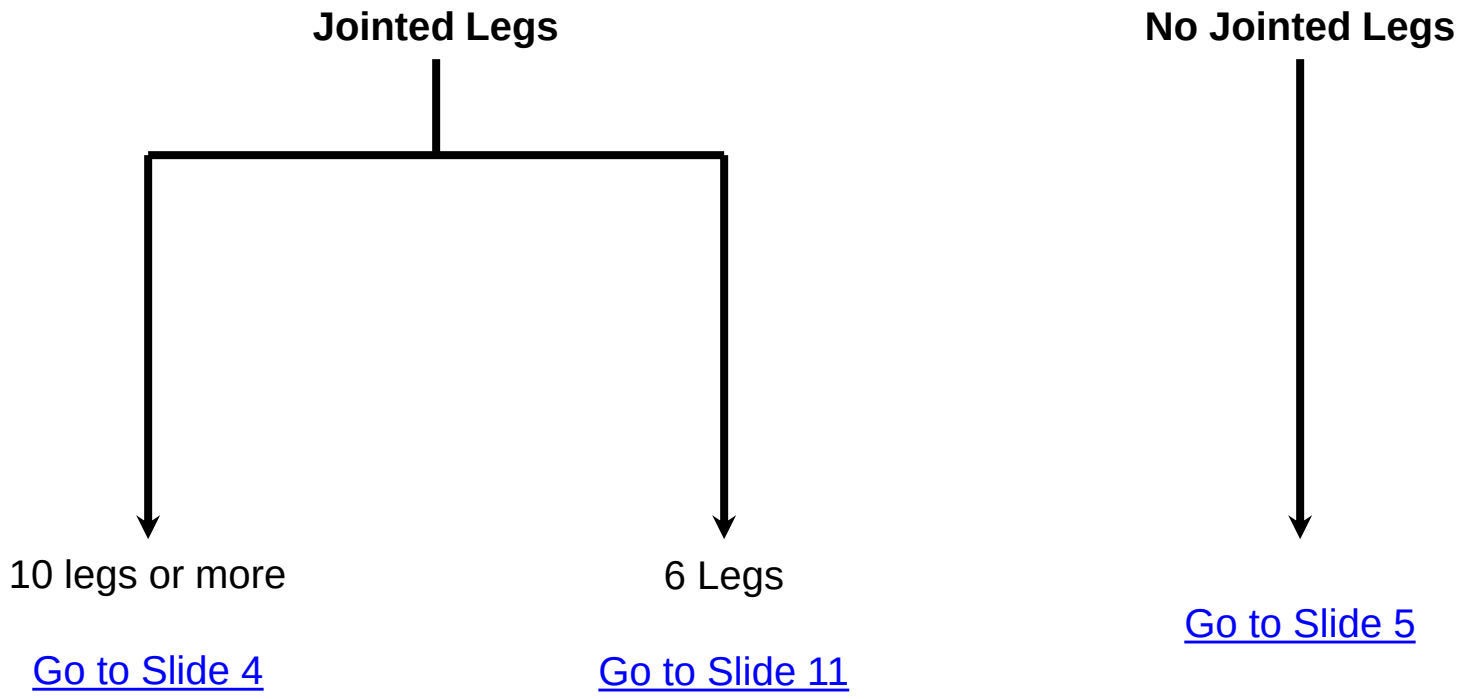
Approximate Size Range



Pollution Tolerance

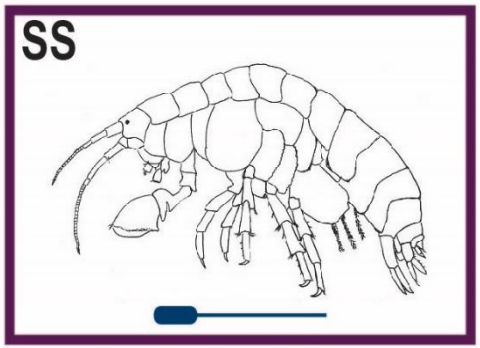
- Sensitive (S)
- Somewhat Sensitive (SS)
- Tolerant (T)

STROUD WATER RESEARCH CENTER

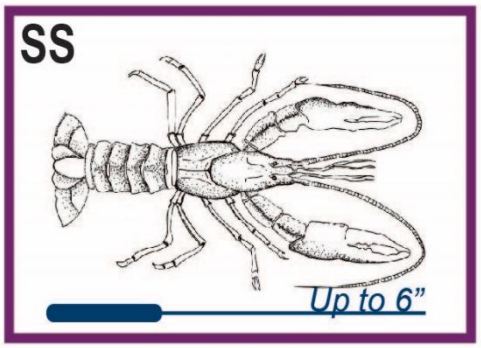


STROUD WATER RESEARCH CENTER

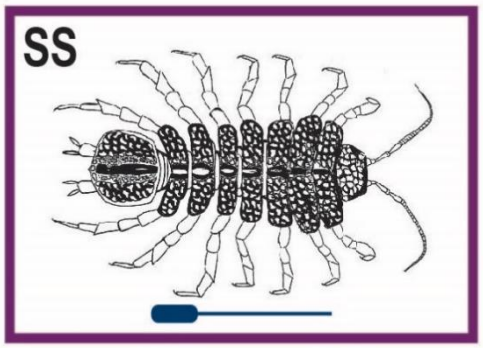
10 Legs or More



SCUDS
Amphipoda



CRAYFISH
Decapoda

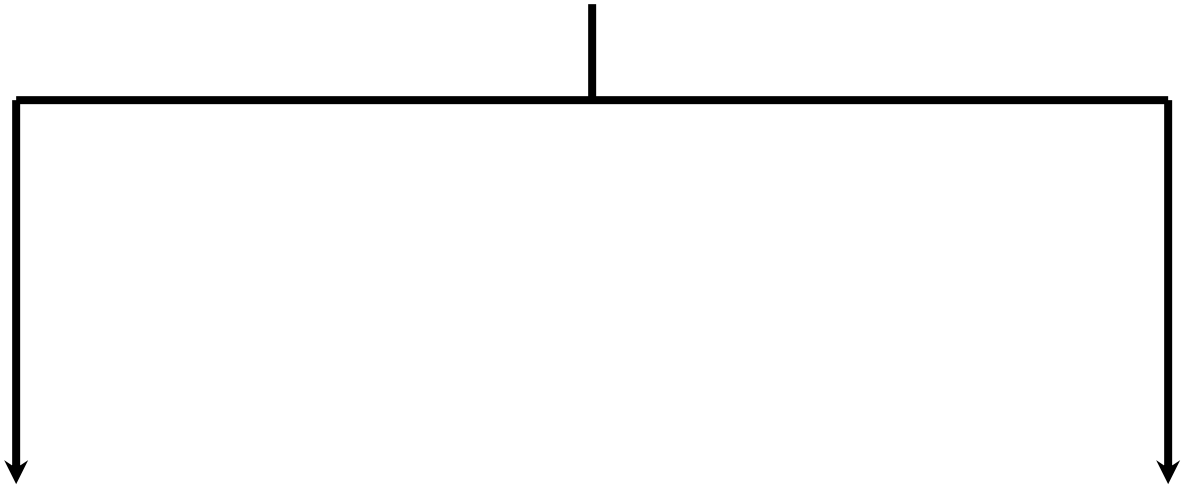


SOWBUGS
Isopoda

Crustaceans

STROUD WATER RESEARCH CENTER

No Jointed Legs



Worm-like (no shell)

Go to Slide 6

Body encased in a hard shell

Go to Slide 7

STROUD WATER RESEARCH CENTER

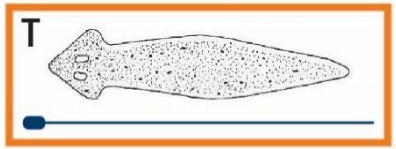
Worm-like (No Shell)

Segmented Worms

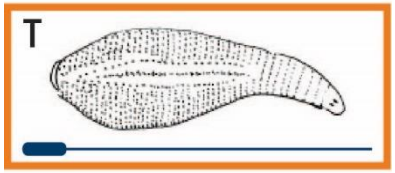
Head and/or fleshy protrusion

Non-segmented worms/flat-worm

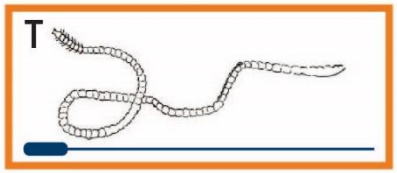
Go to Slide 8



PLANARIANS/FLATWORMS
Turbellaria



LEECHES
Hirudinea

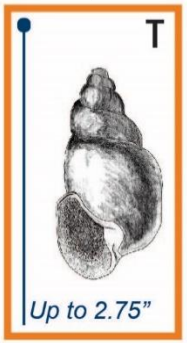


AQUATIC WORMS
Oligochaeta

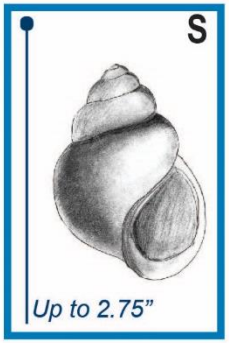
Body Encased in a Hard Shell

Single Shell
(snail or limpet-like)

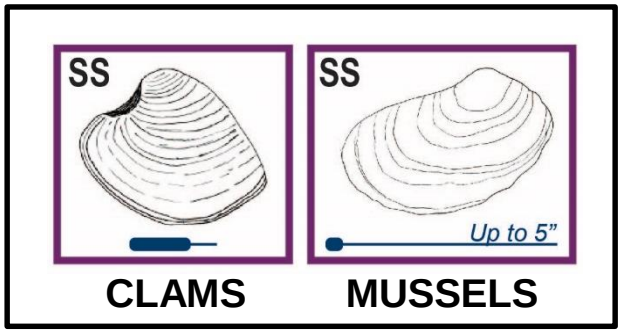
Double Shell
(Bivalve) – connected
with a single hinge



LEFT-HANDED/
LUNGED SNAILS
Gastropoda



RIGHT-HANDED/
GILLED SNAILS
Gastropoda

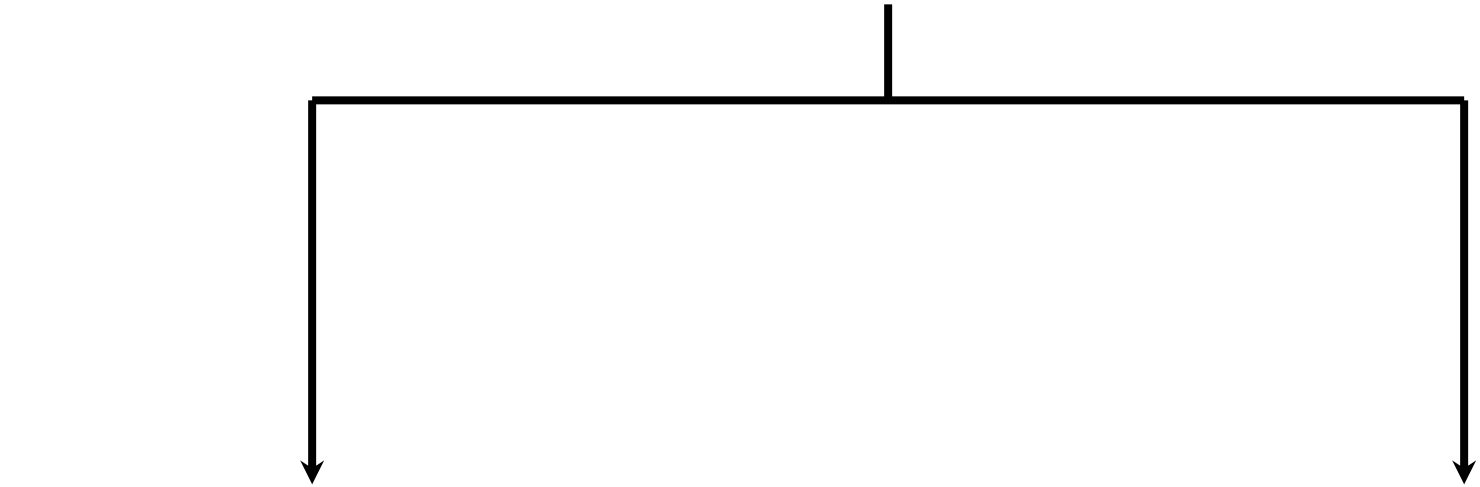


Mollusca

STROUD WATER RESEARCH CENTER

Worm-like with Distinct Head or Fleshy Protrusion

DIPTERA *True Flies*



Small head often hidden from view

Go to Slide 9

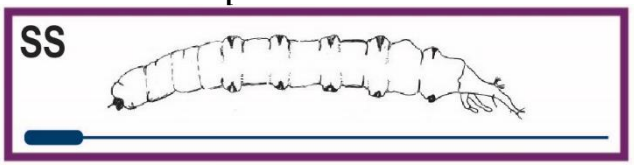
Distinct head

Go to Slide 10

STROUD WATER RESEARCH CENTER

Small Head Often Hidden From View

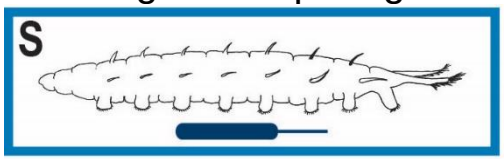
Fleshy protrusions at posterior end



CRANE FLIES
Tipulidae

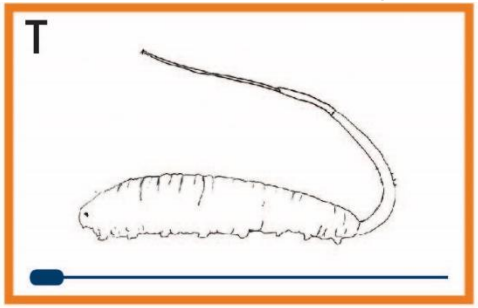
Other

Fleshy projections; posterior with 2 pointed protrusions longer than prolegs



AQUATIC SNIPE FLIES
Athericidae

Long tail; prolegs may be present on underside of body

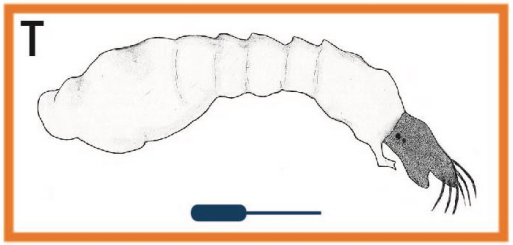


RAT-TAILED MAGGOTS
Syrphidae

STROUD WATER RESEARCH CENTER

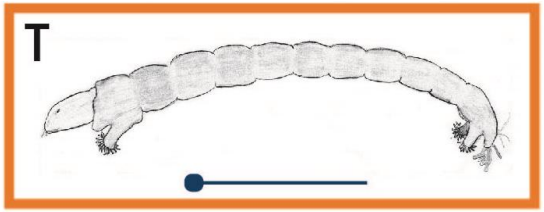
Distinct Head

One end wider than other;
no posterior prolegs

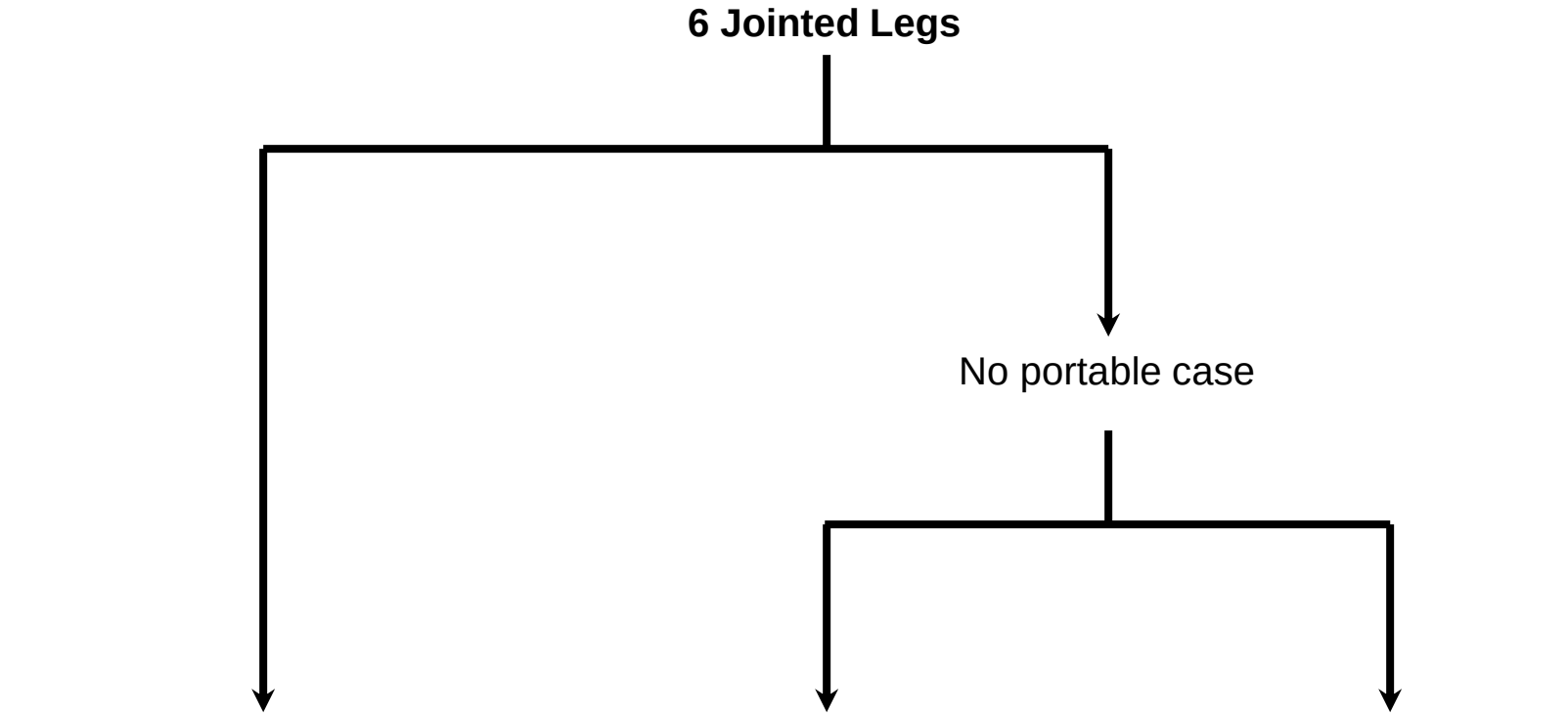


BLACK FLIES
Simuliidae

Both ends similar width; small
anterior and posterior prolegs



MIDGE FLIES
Chironomidae



STROUD WATER RESEARCH CENTER

Portable Case

No Observable Wings or Wing Pads

Observable hooks at end of body

No observable hooks at end of body

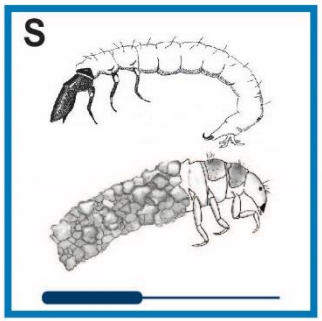
Go to Slide 13

Without lateral filaments

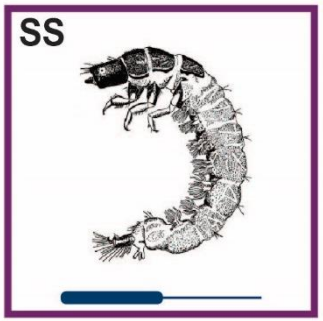
With lateral filaments

No branched gills

Branched gills on underside of abdomen; dorsal plates on all three thoracic segments

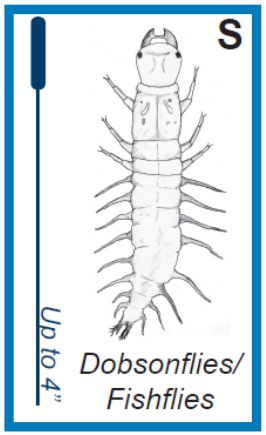


OTHER CADDISFLIES



NET-SPINNING CADDISFLIES

Trichoptera



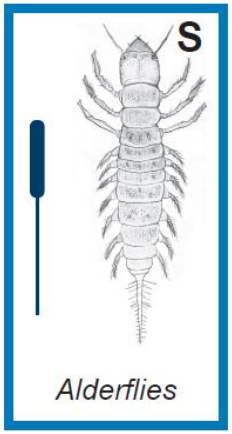
DOBSONFLIES/FISHFLIES

Megaloptera

STROUD WATER RESEARCH CENTER

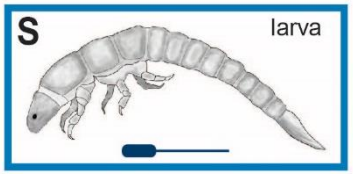
No Observable Hooks at End of Body

With lateral filaments; body ends in a single, long filament

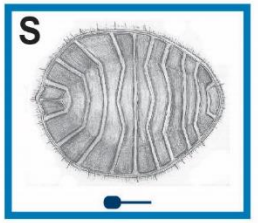


ALDERFLIES
Megaloptera

Without lateral filaments

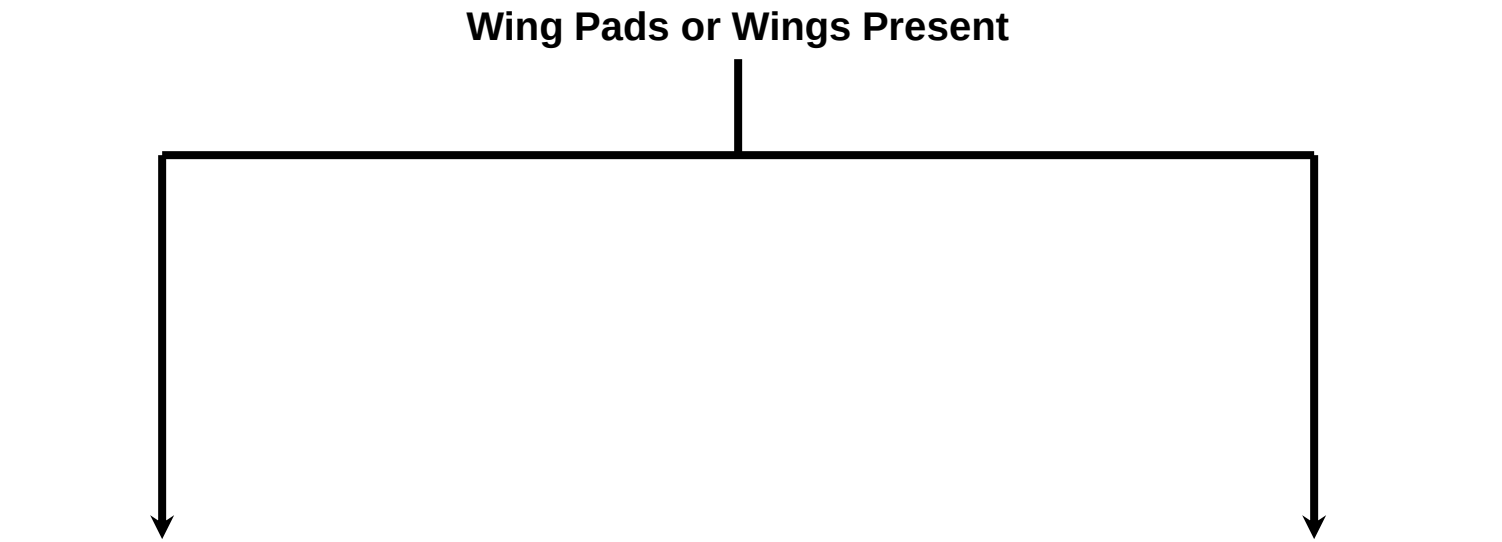


RIFFLE BEETLE LARVAE
Elmidae



WATER PENNIES
Psephenidae

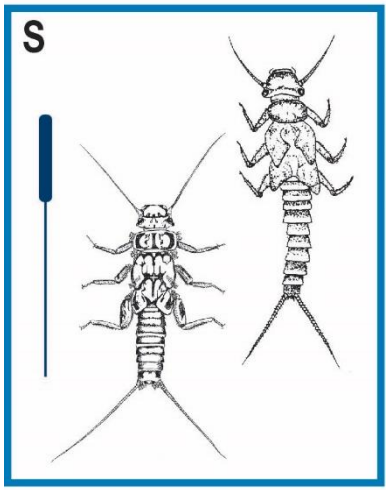
Coleoptera



STROUD WATER RESEARCH CENTER

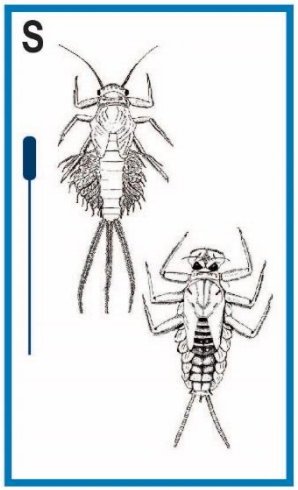
With Tail Filaments

Two tail filaments, without abdominal gills



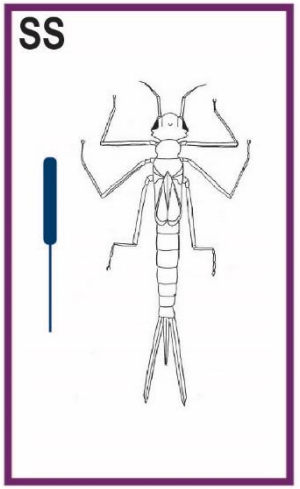
STONEFLIES
Plecoptera

Two or three tail filaments, with abdominal gills



MAYFLIES
Ephemeroptera

Three flat tail filaments, without abdominal gills; large hinged mouth



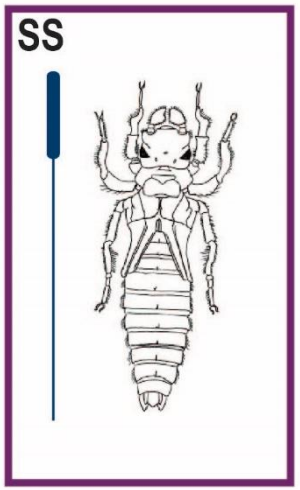
DAMSELFLIES
Odonata

STROUD WATER RESEARCH CENTER

Without Tail Filaments

Wing pads

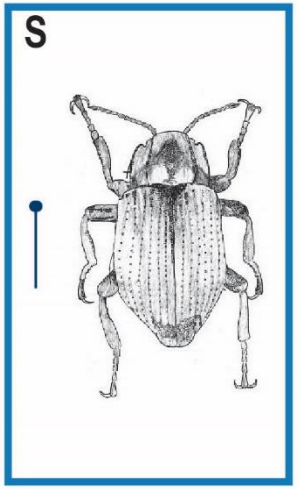
Large, hinged mouth



DRAGONFLIES
Odonata

Wings

Hard wing coverings with centerline



ADULT RIFFLE BEETLES
Elmidae

STROUD WATER RESEARCH CENTER

MODULE 6 LESSON 6

Welcome to Lesson 6: Biodiversity Game

Introduce the Circle Process:
Read the suggested script and the guidelines to the group.

SUGGESTED SCRIPT
This year, we are trying something a little different at _____ (school name). We are holding Community Building Circles to give us the opportunity to get to know each other better. This allows us to talk about things that are important such as celebrations, current events, ways to problem-solve, and anything else that's meaningful to us. This is our time to talk with one another.

GUIDELINES
Since we want to give everyone a chance to be heard, we can use this talking piece. (Explain its significance, if any.) The person holding the talking piece gets to speak and everyone else gets to listen. Before we begin, let's review a few guidelines. We ask that everyone:

- **Respect the talking piece.**
- **Speak from the heart (share only your own experiences and not those of others).**
- **Listen from the heart (be open and non judgmental).**
- **Trust you will know what to say (no need to rehearse).**
- **Say "just enough" (be considerate of the time when sharing).**

Is there anything missing from this list that we need to add?

One way to show you agree with something that someone says without saying a word is by making a hand sign. The hearing-impaired community uses a sign like this (demonstrate jazz hands). Or we can create our own silent hand-signal.

Are these guidelines something we can all agree to?

OPENING QUESTION
Pick <u>one</u> question from the list below. Offer the prompt to the group and start by answering the prompt yourself. Pass the talking piece to the next person.

- *Where did your first name come from? Are you named after anyone? OR*
- *Use one word to describe how you are feeling right now. OR*
- *What's your favorite _____?*
- *Ask the students what they want to discuss as a "quick round" one-word answer*

CURRICULUM-RELATED QUESTION

As a class we want to explore what are some of the factors that impact an environment to create stability. Offer the prompt to the group and start by answering the question yourself. Pass the talking piece to the next person.

- *What makes our community (e.g. classroom, school, neighborhood) stable / what makes it a healthy community?*
- *Do you feel like we have a stable, healthy community? If not, then how can we improve things?*
- *What are the benefits of having a homogeneous classroom?*
- *What are the benefits of having a heterogeneous classroom?*

CLOSING

Thank the students for sharing their responses and feel free to ask questions or make observations about any of their comments to draw connections.

Now ask the students to return to their work stations and start your lesson.

LESSON #6: BIODIVERSITY GAME

OVERVIEW:

The purpose of this lesson is to help students think about the factors that impact the biodiversity of an ecosystem as well as the characteristics of a community that allow it to be more sustainable. This lesson begins with a discussion on various factors that may impact the biodiversity of an area. Students then play a game to illustrate the idea that the more biodiverse a community, the more likely it is to survive various environmental impacts (it is more sustainable). Students will then read about and discuss factors that reduce biodiversity. When they play the game again, students will now make choices about the biodiversity of their community to try to increase the chances that it will survive a sequence of environmental impacts. The lesson ends with a discussion to summarize the natural and man-made impacts on biodiversity.

SUB-QUESTION:

What impacts biodiversity?

WAYS OF KNOWING URBAN ECOLOGY:

	Students will…
Understand	• Recognize that ecosystems that are warmer, wetter and more stable tend to have higher biodiversity. *(ecosystem state and structure)* • Recognize that natural and man-made changes can greatly impact the biodiversity within a community. *(human impacts, ecosystem changes, forces and drivers)*
Talk	• Provide a rationale for the design of their community.
Do	• Design a community and model the impacts from natural and manmade changes to its sustainability. • Analyze biodiversity indices within a community to form conclusions about those factors within a community that make it more stable.
Act	*No specific goals connected with acting on urban ecology in this lesson.*

SAFETY GUIDELINES:

None.

PREPARATION:

Time:

2 class periods

Day 1: Activity 6.1
Activity 6.2
Day 2: Activity 6.3
Activity 6.4

RP = Restorative Practices embedded

Materials:

Activity 6.2 & 6.3

For each pair of students

2 Post-its
Set of 25 markers (counters) - you may want to place them in a ziploc bag or cups.
Set of species cards (10) (laminated for reuse – recommended)
2 student activity sheets
Computer with Excel Biodiversity Game spreadsheet (optional)

For the teacher:

One set of population cards (laminated for reuse – recommended)
Selected Event Cards

- Round #1: Create a card based on a local event
- Round #2: Decide if you will:
  - Use the same cards in the same order as Round #1
  - Change the order of the cards presented in Round #1
  - Extension: Have students create their own event cards

INSTRUCTIONAL SEQUENCE

Activity 6.1: Discussion -What impacts biodiversity?

RP

1. Ask students to brainstorm what they believe could promote or improve biodiversity. Follow with the factors that might reduce biodiversity. Create a T-chart to capture students' ideas.

Teaching Alternative – Think-Pair-Share to increase oral participation

- Use the brainstorm questions as an individual "Do Now" or written warm up.
- Students then share their brainstormed ideas in pairs and select the best idea to promote and reduce biodiversity to put on a post-it
- Have each pair of students explain their idea and its placement on the T-chart. Repeat with ways to reduce biodiversity.

Ideas to listen for:

- Local climate (rainfall and temperature) has a large impact on biodiversity. As ecosystems become water and warmer they are more diverse.
- More stable ecosystems have higher biodiversity.

2. Ask students what they think it means for an ecosystem to be *stable*. Do they think urban ecosystems are stable? Why or why not?

RP

- A stable ecosystem does not have a lot of change or disturbance.
- Urban ecosystems are not particularly stable because humans are frequently altering them in ways that affect living organisms.

Activity 6.2: Biodiversity Game (Round #1)

Part 1: Play the game

1. Tell students that they are going to play a game to explore some of the factors that impact the biodiversity of urban ecosystems.
2. Read the introduction to the game on the student sheet together. You may want to demonstrate how to stack counters (poker chips may serve as counters) on top of the species cards to keep track of how many they have. For example, placing four blue poker chips on top of the crow card means they have four crows in their population.
3. Organize the students into groups of 2-3 and assign roles (track birds, track plants, record data). Distribute species cards, counters, the starting population card, and recording sheet to each group. Have the students arrange their counters to match the initial population and record this information.
4. Project the first event card and read it with students. Students record the event on their data table (e.g., loss of habitat) and reflect what happened by adding or subtracting counters from their species cards. The recorder lists the remaining number of each species on the recording sheet. Repeat this for each event.

Part 2: Calculate data

5. After reading all event cards, groups count the species richness, the number of bird species, and bird abundance, the total number of individual birds. Repeat this process for plants.
6. Explain that researchers like to quantify their recordings. If they said, "I have a lot of crows," *a lot* could mean different actual numbers to different people. This is why an index for biodiversity, known as the Shannon-Weaver Index, was developed. Students can either use their own devices to access a Shannon-Weaver index calculator, you can provide them with the Excel spreadsheet that has the calculator embedded, or you can hand out a printed table of values (located at the end of this document). Students should record the Shannon-Weaver Index for each species.

Part 3: Analyze data

7. Have students post their results on the board including the initial and end data for plant and bird richness, abundance, and Shannon-Weaver.
8. Teams examine the results and discuss to answer the two conclusion questions on their recording sheet. Encourage students to share their analysis and the evidence they use to support their findings. Point out areas of agreement and disagreement over what constitutes the "healthiest" community. Explore how students defined "healthy". What do the students' think is best for a community to maintain its health when various events occur in an urban area? Listen for the following ideas to highlight:
    - Both evenness and abundance are important for community health.
    - Groups 1, 3 and 5 started with even distributions, which is why they all initially had high biodiversity indices as measured by Shannon-Weaver.
    - After the seven events, it became clear that initial abundance was important.

RP = Restorative Practices embedded

Activity 6.3: Discussion - What factors reduce biodiversity?

1. Ask students to revisit their brainstorm of the question, "What are the factors that reduce biodiversity?" They might also consider observations in their field site and what they experienced during the first round of the game. Add new ideas to the brainstorm and delete those that students no longer agree with (model changing one's thinking when given new information). Listen for the following ideas (those that students don't think of can be introduced or held for future lessons):
    - Habitat destruction, alteration and fragmentation are the largest threats to biodiversity.
    - Introduction of non-native (invasive) species
    - Changing chemical composition (e.g. air pollution, water pollution, soil degradation)
    - Over harvesting (e.g. eating fish, cutting down trees for wood or paper)
    - Global climate change
2. Based on findings from the first round of the game, ask what characteristics of communities help those communities resist environmental changes or disturbances?
    - Ecosystems with a higher biodiversity are better able to resist any environmental changes are less likely to crash.

Teaching Alternative - Think-pair-share to increase oral participation

- This activity can also be used as a "Do Now" or warm up activity where students write down their ideas before the discussion.

Activity 6.4: Biodiversity Game (Round #2)

1. Tell students that now they will have a chance to test their ideas and what they have learned from the first round of the biodiversity game. Their goal is to design their initial community to have the best health after a series of events occurs.
    - Give students time to design their new community, giving them a maximum of 40 birds and 40 plants to distribute as they see fit.
        - If students have access to computers, they can calculate the initial Shannon-Weaver index or they can record richness and abundance.

Teaching Alternatives

- Decide how you want to run Round #2 – same event cards in the same order; same event cards in a new order; new event cards (created by students)
- Decide on the size of the population – students choose whether their community has 20, 35, or 50 organisms to distribute. A larger population will increase variation because different groups will have different abundance.

2. Encourage students to rotate roles.
3. Read through the events again and have students record changes in the population of each species.

4. After all of the event cards have been read, students can share their results on the board or you can simply take a poll to see which team ended with the highest richness, abundance or biodiversity.
    - Similar to the last round, students should observe that greater community stability occurs when there is greater richness and abundance.
    - Students should also observe that some species are more greatly affected by changes in their environment than other species. Some events can have a greater impact on one species compared to another.
5. Have students answer the three conclusion questions on the student activity sheet. Discuss the answers to these as a class.

Concluding the Lesson:

1. Ask students to think about what they have been observing at their field site in terms of bird biodiversity. Revisit the post-it notes from the beginning of the lesson. For each impact listed, ask students if they think they have observed an example at their field site. A sample table might look like this:

Human Impact	Example at Field Site
Habitat destruction and alteration	Paving areas Cutting down trees Removing rain gutters
Global climate change	Temperature higher than average
Over harvesting	People picking flowers
Introducing non-native (invasive) species	Outside cats and dogs Planting other plants Bringing new bugs

    - Encourage students to brainstorm different events that could affect their field site. Include these in the table.
2. Tell students that the next day they will be going out in the field to collect bird biodiversity data. When they are at their field site, remind them to observe for various human impacts.

EXAMPLE TABLES

Blank Table:

	Group 1		Group 2 & 8		Group 3 & 7		Group 4		Group 5		Group 6	
	start	end	start	end	start	end	start	end	start	end	start	end
Bird richness												
Bird abundance												
Shannon-Weaver												
Plant richness												
Plant abundance												
Shannon-Weaver												

Completed table for Round #1 (Assigned Initial Numbers):

	Group 1		Group 2 & 8		Group 3 & 7		Group 4		Group 5		Group 6	
	start	end	start	end	start	end	start	end	start	end	start	end
Bird richness	5	5	3	5	5	4	2	3	5	3	1	2
Bird abundance	50	21	50	14	30	13	30	13	10	5	10	6
Shannon-Weaver	1.61	1.43	1.05	1.45	1.61	1.27	0.63	1.01	1.6	0.8	0	0.63
Plant richness	5	5	5	4	5	5	2	3	5	3	1	2
Plant abundance	50	19	50	21	30	12	30	8	10	5	10	4
Shannon-Weaver	1.61	1.51	1.05	1.18	1.61	1.47	0.63	0.9	1.6	0.8	0	0.69

RP = Restorative Practices embedded