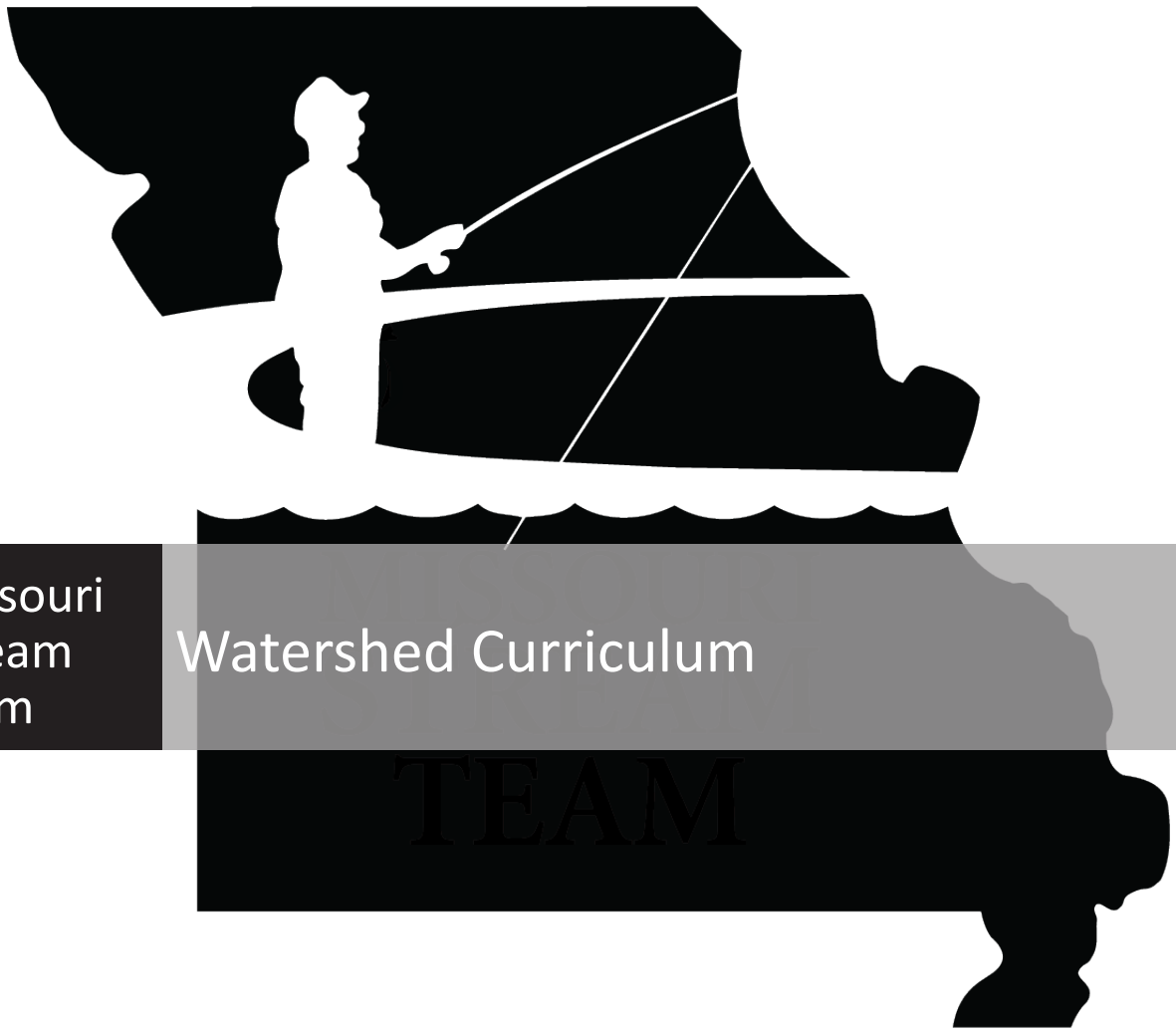

Missouri Stream Team

Watershed Curriculum

11/2020

Missouri Stream Team

800-781-1989 | StreamTeam@mdc.mo.gov | StreamTeam@dnr.mo.gov | MoStreamTeam.org

VOLUNTEER WATER QUALITY MONITORING

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IF YOU DISCOVER A SERIOUS WATER POLLUTION EVENT OR FISH KILL, PLEASE REPORT IMMEDIATELY TO:
MISSOURI DEPARTMENT OF NATURAL RESOURCES
EMERGENCY RESPONSE UNIT 573-634-2436
mdc.mo.gov/fishkills

Curriculum Overview

Through the Missouri Stream Team Watershed Curriculum, teachers will use hands-on activities designed to educate students through adventure and exposure to new ideas and concepts. Unfortunately, many students are not able to have the experience of being raised with nature and miss out on the opportunity to fully understand all that nature has to provide. Educating and exposing students to nature will allow them to know the riches it has to offer. If we do not take the time to teach students about nature and the damaging effects our choices make on the environment, nature will be a concept of the past. The following lesson plans will help to educate students on the variables that coincide with one another to enrich the environment while having a positive impact on the need to preserve nature so that future generations can enjoy its benefits.

This curriculum guide covers a number of topics on the landscape in regions of Missouri, watersheds, wetlands, floodplains, riparian corridors, stream habitat, macroinvertebrates, stream discharge, chemical monitoring practices in water resources, safety, nature journaling, mapping, and much more. The lessons are aligned to the Missouri Learning Standards (MLS) and to the Next Generation Science Standards (NGSS). Each lesson includes a summary, learning objectives, an instructional component, and an evaluation strategy.

The Missouri Stream Team Program provides educators with staff support and resources needed to incorporate water quality instruction into their curriculum, lesson plans, field labs, and assessment strategies. This curriculum guide allows teachers and educators the opportunity to explore and experience the variety of educational resources available to implement water quality and nature curriculum into their science classrooms.

CURRICULUM CREATED
1998

CURRICULUM REVISED
2020

MLS VERSION
2020

NGSS VERSION
2020

Notes

Table of Contents

^ Lesson plans require equipment that is listed in the Safety & Equipment section

* Lesson plans in this section include protocols from Stream Team's Volunteer Water Quality Monitoring (VWQM) program. VWQM certification is not required to complete these lesson plans but may be helpful. To submit water quality data, the educator must be VWQM trained and be listed as the Trained Data Submitter. Information on methods used in these plans and additional VWQM resources can be found on the Stream Team website: mostreamteam.org/training-materials-and-resources.html

Safety & Equipment

Safety protocols

- The stream depth, temperature and current velocity need to be assessed by an adult before allowing participants to enter the stream.
- Clearly define the activity boundaries within the stream and identify potential hazards, such as deep pools, soft substrate, and submerged obstacles.
- Participants should not enter the stream without supervision from their instructor.
- Appropriate clothing and footwear (no open-toed shoes).
- Sunscreen, insect repellent, and water bottle.
- A first aid kit.
- Participants should not drink the water from the stream.

Equipment Suggestions

- *Journal Observations*
  Notebooks, color pencil
- *Stream Exploration*
  Outdoor clothing and appropriate footwear, nets, seines, snorkels and buckets
- *Stream Stewardship*
  Gloves, litter bags, and first aid kit
- *Captured Critters*
  Outdoor clothing, kick net, sorting tray, forceps, biological monitoring data sheet, macroinvertebrate keys
- *Macroinvertebrate Reference Collection*
  Vials, kick net, hand net, 100% ethyl alcohol, 90% isopropyl alcohol, hand sanitizer gel
- *Riparian Corridor*
  Containers to collect sediment, clippers for vegetation collection, and gloves
- *Stream Discharge*
  Two whiffle golf balls, tape measure, dowel rod marked off in 0.1-foot increments with a permanent marker, stopwatch, calculator, and pen or pencil

Resources

Missouri Stream Team

Stream Team is a volunteer-based program organized to protect and improve Missouri's waterways. Biologists provide training and expertise at no charge to help with stream projects and information. The Stream Team program provides an opportunity for all citizens to get involved in river conservation and has three main goals:

Education: Stream Team provides training and resources to better understand our stream systems and the problems and opportunities they face.

Stewardship: Hands-on projects such as stream cleanups, streamside tree plantings, water quality monitoring, and storm drain stenciling are all possible activities. Stream Team can help you plan a project or connect you with an agency or organization effort.

Advocacy: Speaking on behalf of your adopted stream is not as difficult as you might think. Those who have gained first-hand knowledge of issues, needs, and solutions are best equipped to speak out on behalf of Missouri's stream resources. Talking to friends, writing letters, attending meetings, and contacting your elected officials can all be ways to get involved.

Form a Stream Team

Fill out the registration form and you will be assigned a Team number and begin receiving information. Go to mostreamteam.org and click on the "Start a Team" button.

One of the most popular Stream Team activities is the Volunteer Water Quality Monitoring (VWQM) Program. The VWQM Program provides volunteers with training and equipment to monitor Missouri's rivers and streams. The VWQM Program was established to achieve four goals:

- Inform and educate others about the conditions of Missouri's rivers and streams.
- Establish a network of trained volunteers to monitor the quality of Missouri's rivers and streams.
- Enable citizens to make informed decisions about Missouri's waterways.
- Halt water quality degradation of Missouri's water resources.

There are currently four levels of training, each building upon the previous.

Stream Teams United

Stream Teams United is a 501(c)3 nonprofit that supports the Stream Team Program and advances the protection and improvement of Missouri's waterways. streamteamsunited.org

Discover Nature Schools

Another great resource that is offered by the Missouri Department of Conservation is the Discover Nature School curriculum and education grants. You can learn more about these resources at nature.mdc.mo.gov/discover-nature/teacher-portal

Sensory Development

GRADE LEVEL
K-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
K.ETS1.A.1
1.ETS1.A.1
2.ETS1.A.1
6-8.PS1.A.3
9-12.ESS3.C.1

NGSS
K-2-ETS1-1
MS-PS1-3
HS-ESS3-3

Lesson Summary

The natural environment we live in is often taken for granted. We do not always take the time to stop and smell the roses or capture the beauty of a flowing stream. As people better appreciate the beauty of a stream or watershed, they take more ownership in caring for the land and the resources it provides. This lesson will enhance a student's observation skills and strengthen their understanding and role they play in the preservation of ecosystems. One decision can have a detrimental effect on the environment and water resources, downstream and upstream. We must remember every action has a consequence.

Objectives

Students will understand the importance of stewardship and their role in the enhancement of the environment. Students will be able to use their scientific observation skills to promote conservation practices to conserve resources and provide healthy water quality for future generations to enjoy.

Instructional Strategy

1. Have students create a list of things they consider beautiful. Then have students create a word cloud using an online application. Have students compare their word clouds with another student to see if their word clouds have any similarities. Next, ask the students to raise their hand if they had a water body, such as a stream or river, on their list. The students should make the connection that streams and rivers are beautiful resources we have in nature and we need to do our part now so they are sustained for future use and enjoyment.
2. Divide the students into groups and have them discuss what conditions, both natural and human-made, compose a beautiful stream. These can include: water color, rocks, plants, trees, streambank conditions, stream flow, etc.
3. Students will use magazine photos to create a collage of water bodies and landscapes to represent their idea of a natural, beautiful stream. Have the students explain why they chose the pictures they did for their stream collage. Some answers could include:

Sensory Development

plants present, color of the water, landscape around the stream, wildlife or fish present in the stream, etc. Next, students will create a collage to represent a stream they would not consider beautiful. Have the students explain why they chose the pictures they did for this stream collage. There may be a lack of vegetation, erosion, the water color may be offensive, wildlife and fish are not present, or pollution could be observed in the water and on the landscape.

Evaluation Strategy

A. Have students imagine they are early explorers on a river and write about their day's activities in a journal. These activities could include fishing and gathering food, building a fire to make the water safe for drinking, mapping their route, noting the presence of the plants and animals in the area, etc.
B. Students can write a short essay describing any personal relationships or experiences they have relating to nature and water resources. Students can also write about a camping trip or nature event they would like to participate in.

Reflection Section

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VOCABULARY

Erosion

Stewardship

Landscape

Vegetation

Journaling Observations

GRADE LEVEL
K-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
K.ETS1.A.1
1.ETS1.A.1
2.ETS1.A.1
6-8.PS1.A.3
9-12.ESS3.C.1

NGSS
K-2-ETS1-1
MS-PS1-3
MS-LS1-8
HS-ESS3-3

Lesson Summary

Put yourself in nature and think about the variety of ways it provides for you and your needs. Nature is all around us and is part of our everyday life. It is key to educate students and families on the importance of discovering nature and the benefits it offers. Discovering nature through hands-on exercises and observations can be an enlightening way to learn about the endless opportunities of the great outdoors.

Objectives

Students will be able to make detailed observations of their natural surroundings while gaining experience in drawing techniques and writing in a nature journal. They will also be able to engage in their surroundings by formulating questions based on their observations in the field.

Instructional Strategy

Students will use their five senses to complete this lesson. If needed, depending on student age and background, the five senses may need to be covered or reviewed: taste, touch, smell, sight, and sound.

1. Provide notebooks to the students to decorate and personalize with their name and a title, such as Nature Observations, Nature Journal, or Critter Book. Students are encouraged to bring along colored pencils or other coloring utensils to draw observations while in the field.

   The field portion may be conducted in a variety of ways. Take the students to an outdoor space to record or draw their observations. Students should be able to identify that nature is all around them and is experienced uniquely between them. Some examples of outdoor spaces are a stream, wooded area along a trail, playground, pond at a local conservation area or park, an agriculture field, etc. In addition, students can observe the differences of the same area at different times of day, or during different season. The sights, sounds, and smells will change as the day or year progresses. It would also be a valuable comparison to divide the students into groups and have each group observe

Journaling Observations

different areas and share that information with the group to compare what everyone saw.

2. Students may create a journal on experiences from outdoor activities. Educators can provide opportunity for activities such as a fishing clinic, reptile day, stream cleanup and water quality monitoring, habitat improvement projects, or storm drain stenciling. Students could also build bird houses, monofilament recycling containers, or rain barrels. Additional activities could include helping educate younger students about nature and how we can encourage best management practices (BMPs) which benefit nature.

Evaluation Strategy

A. Have students share their discoveries from their journal writing by creating a news report, a publication such as a field guide, newsletter, or movie they can share and present to their class. Students can compare and contrast their findings as students are presenting.
B. Educators can read students' journals and provide written encouragement and questions for further information.
C. Ask students to evaluate their own journal. Provide prompts for students to answer as they are reviewing their journal.
    - Which entries are your favorite and why?
    - Do you see patterns among the entries?
    - What would someone reading your journal 100 years from now discover about changes in nature?

Reflection Section

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VOCABULARY

Ecosystem

Food Web

Monofilament

Best management practices

Missouri Biomes

GRADE LEVEL
K-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom

MLS
2.ESS1.C
2.ESS2.A
2.ESS2.B.1
3.LS3.C.1
3.LS3.D.1
4.ESS2.B.1
6-8.LS1.B.2
6-8.LS2.A.2
9-12.LS2.A
9-12.LS3.B.3
9-12.LS4.B.1

NGSS
2-ESS1.C.1
2-ESS2-1
2-ESS2-2
3-LS4-3
3-LS4-4
4-ESS2-2
MS-LS1-5
MS-LS2-2
HS-LS3-2
HS-LS4-2

Lesson Summary

The landscape and physical features of an area determine the types of plants and animals that will inhabit the land. This is referred to as a biome. There are six major biomes in the world. This lesson will introduce students to biomes and how different landforms, rocks, temperature, and water sources can affect the entire ecosystem.

Objectives

Students will be able to describe the different biomes and identify the biomes that are present in Missouri. They will be able to describe the physical and biological features that make each biome distinct from each other and how these differences impact animal and plant life in the environment.

Instructional Strategy

1. Divide students into seven groups and assign them a biome. Assign six groups the different biomes around the world and assign the seventh group biomes found in Missouri.
    - Desert
    - Grassland
    - Rainforest
    - Deciduous forest
    - Taiga
    - Tundra
    - Missouri Biomes: Forests, grasslands

2. Have students answer the following questions relating to their biome:
    - Name of biome
    - Description of biome
    - List locations of where your biome can found
    - Distinctive characteristics
    - Describe the climate and temperature
    - What type of plants and animals can be found in your biome?
    - How can humans change or impact a biome?
    - Describe the physical features that are present with this

Missouri Biomes

biome and how these will affect the plants and animals that will inhabit the biome.

3. List the biomes that can be found in Missouri:
   - Names of biomes
   - Describe the characteristics, climate, and temperature that make up each biome in Missouri
   - Explain why these biomes are only found in Missouri
   - Name five animals and plants that are found in each biome
   - How can humans change or impact the biomes in Missouri?
   - Describe the physical features that are present with this biome and how these will affect the plants and animals that will inhabit the biome.

Evaluation Strategy

A. Have the student groups present information on their biomes in a creative way. For example, creating a model, illustrations, or a travel brochure.
B. Write a newspaper article describing one of the biomes in detail with facts, location, what makes the area unique, animals and plants that are found in the biome, water resources, climate and temperature, annual rainfall, and any other information pertinent about the biome.
C. Write an article and describe the similarities and differences of what a bird would see as it flew over the different biomes of the world or the specific ones found in Missouri.
D. Have students create an imaginary plant or animal that is adapted to the biome of their choice. Ask them to write a description of the organism, its adaptations, and to make a drawing of it in its environment. Have students share their organisms with the class and display them.

Reflection Section

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VOCABULARY

Biome

Landscape

Watersheds

GRADE LEVEL
K-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom

MLS
K.ESS3.B.1
2.ESS2.A.1
6.8.ESS2.C.1
6-8.ESS3.C.2
9-12.ESS2.C

NGSS
K-ESS3-3
2-ESS2-1
MS-ESS2-4
MS-ESS2-5
HS-ESS2-5

Lesson Summary

Quality of surface and subsurface water is affected by pollutants, their sources, and the land use practices within a given watershed. Students will act as landowners who will impact water quality and quantity by their land use practices and conservation habits.

Objectives

Students will be able to identify how pollution travels throughout a watershed and the downstream effects. They will also be able to compare and contrast the two types of water pollution and how land management practices affect the water quality in the watershed. Students will understand how water quality is affected by the land practices and the impact of point and nonpoint sources have on watersheds and the environment.

Instructional Strategy

1. Students will pretend to own a piece of land in the community. Students will randomly draw Land-Use cards. Land-Use cards may include photos for visualization:
    - Animal agriculture - cow pastures, hog feedlots, chicken houses
    - Crop agriculture - cornfields, orchards
    - Urban - neighborhoods, small parks, schools, roads, apartments
    - Commercial area - shopping malls, roads, hospitals
    - Industrial - factories
    - Recreational - camps, ball parks, amusement parks
    - Wildlife - natural reserve areas
    - Mining - open pit mines, mining shafts, tailing ponds
    - Forests for timber - forests, selective or clear cut
    - Power production - coal burning, nuclear or hydroelectric plants
    - Rural area - small homesteads or farms
    - Utilities - water treatment plant or drinking water plant
2. Have the students make a list of what kind of activities or structures may be on the land they selected and how these uses can affect watersheds, streams, and lakes. In addition, have

the students describe the types of point and nonpoint source pollution sources that may be present and how these can affect water quality in the area. Students will present their land use with classmates.

3. Take students to a nearby stream to identify the land use practices in the surrounding areas and record their observations. Divide the students into pairs to share their observations and compile a list of possible pollution sources. Have them note possible point and nonpoint source pollution that could affect the watershed.

Evaluation Strategy

A. Identify how pollution travels downstream throughout a watershed and how it affects other people downstream.
B. Have students compare the two types of water pollution: point and nonpoint sources.
C. Have the students create ideas for pollution prevention methods to decrease the runoff of pollutants. Ask the students to create a chart and/or map of their direct observations and inferences. The students should also speculate how water quality changes as stream channels combine to form larger rivers.
D. Create a concept map that shows the differences between land use practices and their contributions to negative water quality.
E. Have the students research and redesign their land use practices to decrease the point and nonpoint pollution on their land and what BMPs they could incorporate to assist with this process. They should discuss how the redesign will work and the benefits it will have on water quality.
F. Have the students answer the following questions as part of a summative assessment:
    - Why is stewardship of our environment so important?
    - What is the difference between point and nonpoint source pollution?
    - What evidence can be provided to support a healthy watershed?
    - What are some concerns with surface runoff?

VOCABULARY

Fertilizers

Nonpoint source pollution

Point source pollution

Runoff

Subsurface water

Surface water

Watershed

Best management practice

Mapping Watersheds

GRADE LEVEL
4-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom

MLS
4.ESS2.B.1
MS-ESS2-4
MS-ESS2-5
MS-ESS3-1
MS-ESS3-4
MS-ETS1-1
9-12.ESS2.A.1

NGSS
4-ESS2-2
6-8.ESS2.C.1
6-8.ESS3.C.2
6-8.ESS3.A
6-8.ESS3.C.1
6-8.ETS1.A
HS-ESS2-1

Lesson Summary

Everything that occurs within a watershed affects its water resources. A healthy stream is an indicator of a healthy watershed. Being able to delineate or map a watershed allows for better understanding of how potential pollutant sources can threaten waterbodies.

Objectives

Students will be able to identify and map a watershed. They will also be able to identify potential inputs for a waterbody within a given watershed. Students will understand the impact water has on the surrounding environment and can read a map to determine the area that is affected in the watershed.

Instructional Strategy

1. To prepare students for delineating a watershed, get them familiar with topographic maps by asking:
    - What is a watershed?
    - How are watershed boundaries defined?
    - What is a topographic map?
    - What are contour lines?
    - Where do you look on a map to find the scale?
2. Divide students into groups and give them a topographic map. This can be any map available or a map of where the school is located. The students will use this map to delineate a watershed.
3. Have the students place a star at a given area along a stream, such as a favorite access point near the school. The students will now map the watershed upstream from this point. The area mapped in this activity will include all inputs that can affect the point identified with a star. If there is not a stream close to your area, you could always complete this activity on a satellite image from Google Earth.
4. To delineate the watershed (example map below): Trace all streams and tributaries upstream of the star, including intermittent streams which are represented by a dashed line on a topographic map.
5. Mark all ridge tops along the streams with an X. These are small enclosed shapes, often round.

Mapping Watersheds

6. Connect the Xs with a line following contour lines on the map.
7. Have students discuss the land uses and possible inputs in the watershed.

Evaluation Strategy

Provide a new map to the students or have them select a map of an area important to them. The student will delineate a watershed on the map. The may note at the elevation, water inputs and outputs, and land use to see how these items may influence the water in their watersheds. Have them propose new ideas or implications that could be used to have a positive impact on water quality.

Reflection Section

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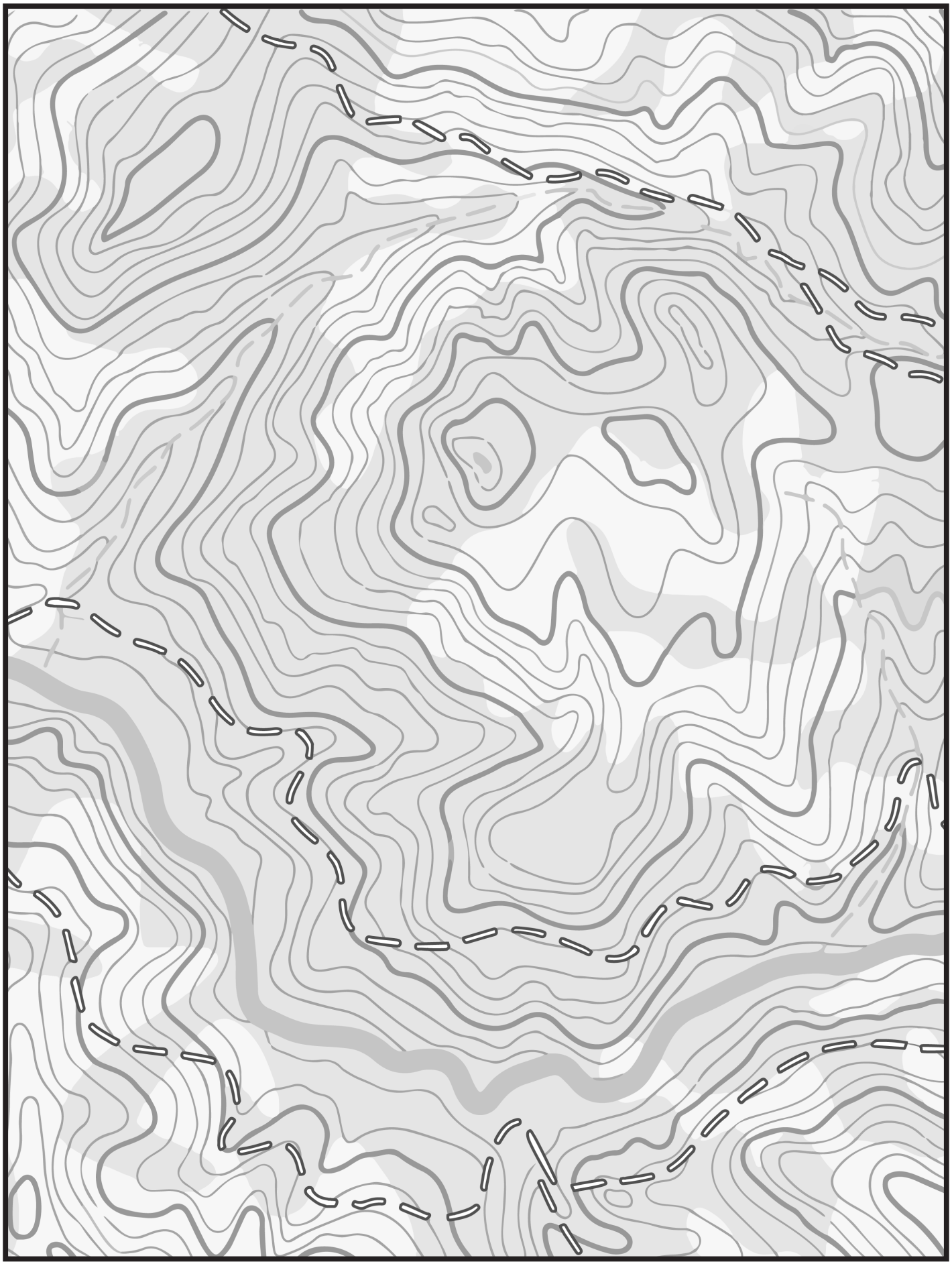
VOCABULARY

Contour Lines

Intermittent Streams

Topographic map

Watershed



Missouri Watersheds

GRADE LEVEL
5-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Classroom

MLS
K.ESS3.B.1
2.ESS2.A.1
6.8.ESS2.C.1
6-8.ESS3.C.2
9-12.ESS2.C

NGSS
K-ESS3-3
2-ESS2-1
MS-ESS2-4
MS-ESS2-5
HS-ESS2-5

Lesson Summary

Watersheds, or river basins, drain an area of land into a single water body. The topographically defined areas have unique characteristics depending on geology and land use. There are four large watersheds that capture water in Missouri. These watersheds are composed of smaller sub-watersheds. The quality of water and life within a watershed is affected by the intrinsic characteristics along with man-made alterations.

Objectives

Students will be able to identify the four major watersheds and their boundaries located in Missouri, and explain that watersheds are composed of smaller sub-watersheds. In addition, students will learn how the geology of the landscape and topography play a vital role in the drainage pattern of the watershed.

Instructional Strategy

Divide the students into four groups and assign each group one major watershed found in Missouri: Missouri River, Upper Mississippi River, Lower Mississippi River, and Arkansas River. Each group will answer the following questions on their watershed:

- Location in Missouri
- Size of watershed in acres or miles
- Water sources
- Plants and animals in the basin
- Habitat
- How much average rainfall does the watershed receive in a year?
- Within which watershed do you live?
- Landscape in and around the river basin

Evaluation Strategy

Have students present their research on the major river watershed they were assigned. In addition, you can have the students partner with someone from a different group and have them compare their

Missouri Watersheds

research and facts on their watersheds. Images of Missouri's major watersheds as well as the Mississippi River watershed are provided.

Reflection Section

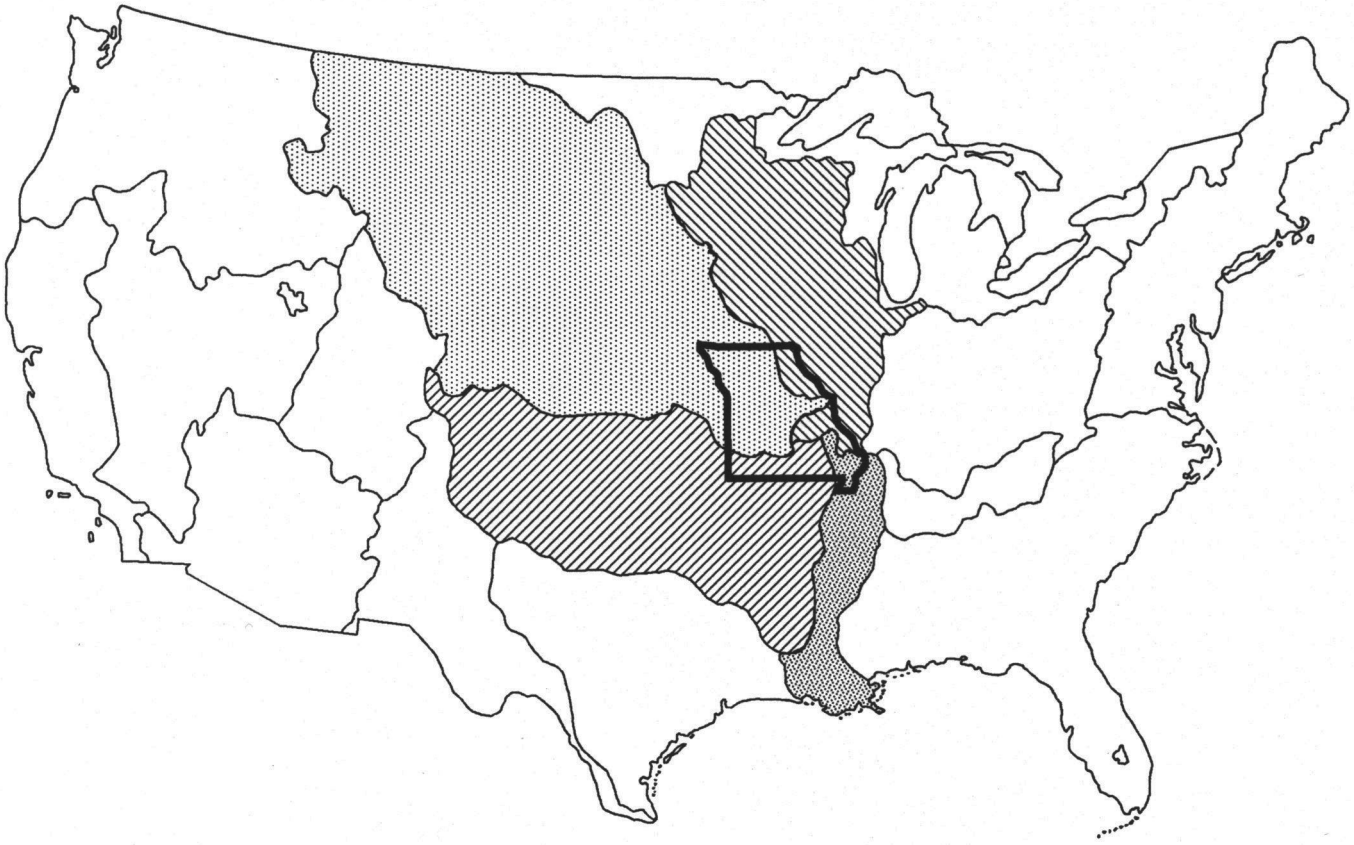
VOCABULARY

Geology

Topographic

Watershed

Mississippi River Watershed



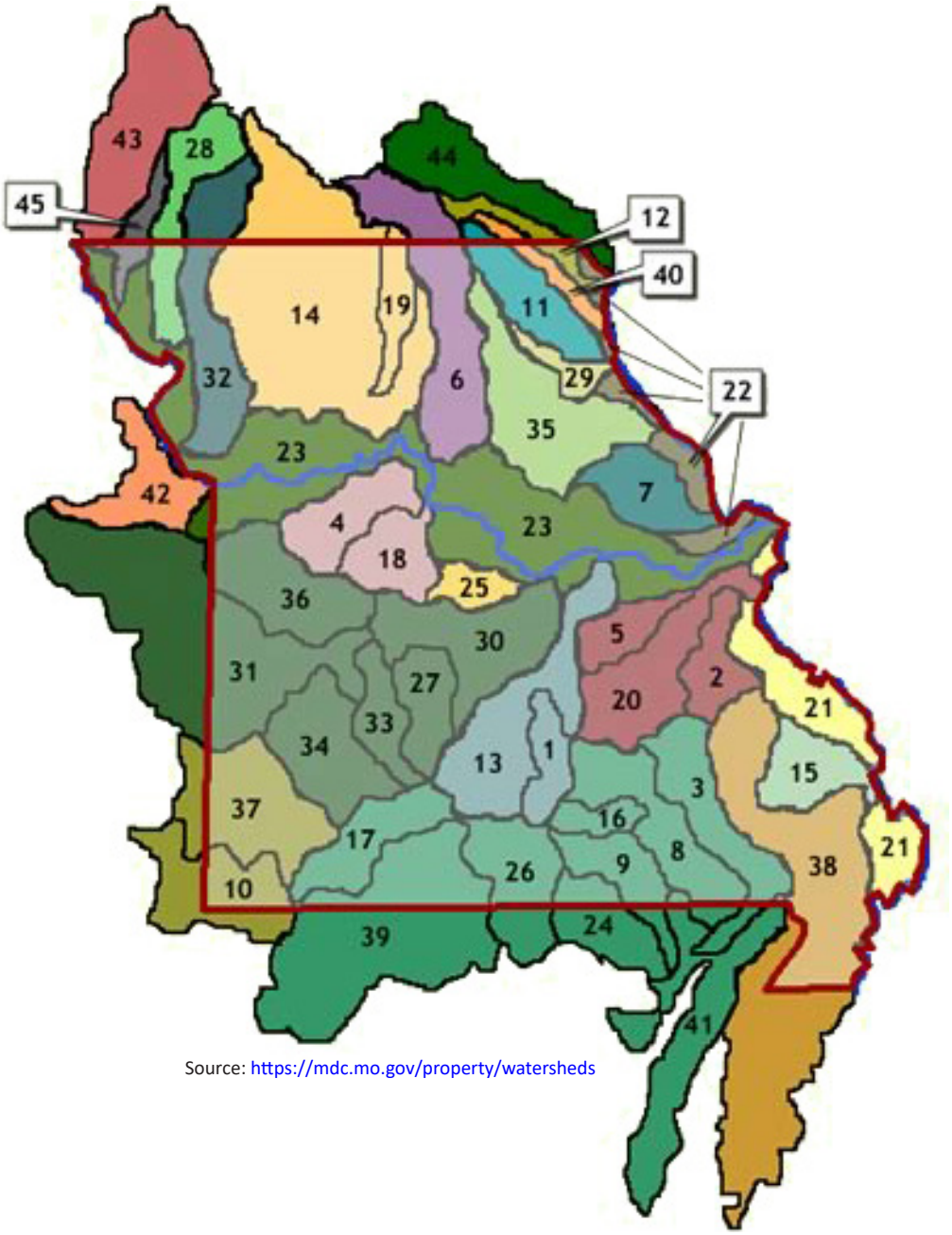
MISSOURI IN THE MISSISSIPPI RIVER SYSTEM

Major River Basins

- Missouri River Basin
- Upper Mississippi River Basin
- Lower Mississippi River Basin
- Arkansas-White-Red River Basin

Source: Missouri Water Atlas, 1986, Missouri Department of Natural Resources, Division of Geology and Land Survey

Missouri Watersheds



Source: https://mdc.mo.gov/property/watersheds

1. Big Piney River
2. Big River
3. Black River
4. Blackwater River
5. Bourbeuse River
6. Chariton River
7. Cuivre River
8. Current River
9. Eleven Point River
10. Elk River
11. Fabius River
12. Fox River
13. Gasconade River
14. Grand River
15. Headwater Diversion
16. Jacks Fork River
17. James River
18. Lamine River
19. Locust Creek
20. Meramec River
21. Mississippi River, Lowe
22. Mississippi River, Upp
23. Missouri River
24. Spring River, South
25. Moreau River
26. North Fork White River
27. Niangua River
28. Nodaway
29. North River
30. Osage River, East
31. Osage River, West
32. Platte River
33. Pomme de Terre River
34. Sac River
35. Salt River
36. South Grand River
37. Spring River, Southwest
38. St. Francis River
39. White River
40. Wyaconda River
41. Cache River
42. Lower Kansas River
43. Nishnabotna River
44. Lower Des Moines River
45. Tarkio River

Wetlands and Floodplains

GRADE LEVEL
4-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Classroom

MLS
4.ESS3.A.1
6-8.ESS3.C.2
6-8.ESS3.B
9-12.ESS3.A.1
9-12.ESS3.C.2
9-12.LS2.C.1

NGSS
4-ESS3-2
MS-ESS3-3
MS-ESS3-2
HS-ESS3-1
HS-ESS3-4
HS-LS2-6

Lesson Summary

Many Missouri communities are located in floodplains and can be affected both positively and negatively by land use practices within the watershed. The floodplain of a river is an area on both sides of the stream channel that carries excess water the channel cannot handle. The floodplain provides an area for flood waters to spread out which reduces the stream's erosive energy and damage downstream. If the floodplain is disconnected and not allowed to function properly, the channel is forced to handle more of the flow causing the stream to erode at an accelerated rate. Floodplains also contain wetlands, which function to further slow, filter, and store floodwaters. Wetlands also provide habitat for a diversity of wildlife.

Objectives

Students will be able to describe how land use practice used in a floodplain affect water quality and will be able to identify the functions of a floodplain. Students will learn about the challenge's residents endure living in a floodplain, the eight types of natural wetlands, the land practices used and how these can affect water quality.

Instructional Strategy

1. Divide students into groups and have them research the floodplain areas in the counties surrounding their school. Have them make a chart stating the land use practices used in the floodplain area and note if these uses are beneficial to the floodplain or if they are limiting the functions of the floodplain. In addition, have them explain why the land use practices are beneficial or harmful to the floodplain and what changes they would make to the floodplain to make it more effective.
2. Divide students into groups and have them research major flood events in Missouri and other major flood events that have happened in the United States. Have them note height of waters during flooding, duration of flooding, rain or snow amounts, rivers and towns affected, levees that broke, the land practices used in the flood plain areas, and if the floodplain served its purpose.
3. Divide students into eight different groups and assign each group one of the eight types of natural wetlands that are

found in Missouri: swamps, shrub swamps, forested wetlands, marshes, wet meadows, fens and seeps, pond and lake borders and streambanks. Have the students research and describe the characteristics that make their wetland unique and the type of habitat the wetland provides for the plants and animals in the area. In addition, have the groups describe the effects that a flood would have on the wetland. Have the students describe how best management practices (BMPs) for wetlands influence the functions of reducing flood heights, improving water quality, and reducing runoff and erosion.

VOCABULARY

Floodplain

Stream Channel

Wetland

Best management practice

Evaluation Strategy

A. Students can create a way to present research and information on floodplains or wetlands to the class.
B. Make an informative Wetland Newsletter for the school community on positive land practices that can improve water quality.
C. Have students monitor a wetland or floodplain area at the same time every month and record changes. Record animals and plants present, temperature, weather conditions, precipitation and any differences they have noted since they started monitoring.
D. Explain several of the physical features that distinguish wetland types from a floodplain and present this information in a brochure.

Reflection Section

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Wetland Madness

GRADE LEVEL
4-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Classroom

MLS
4.ESS3.A.1
6-8.ESS3.C.2
6-8.ESS3.B
9-12.ESS3.A.1
9-12.ESS3.C.2
9-12.LS2.C.1

NGSS
4-ESS3-2
MS-ESS3-3
MS-ESS3-2
HS-ESS3-1
HS-ESS3-4
HS-LS2-6

Lesson Summary

Historically, wetlands have been perceived as obstacles to progress and development. It is not always understood that an entire watershed depends on wetland functions. Since wetlands play a vital role, it is important for students to understand wetland issues and be able to make management decisions. Such experiences will help them to make beneficial decisions as a contributing member of society.

Objectives

Students will be able to define and describe the importance of wetlands the factors that should be considered when implementing best management practices (BMP) for both the economic and environmental well-being. Students will recognize the effects management practices have on wetlands and factors that drive certain practices.

Instructional Strategy

1. To engage students in the lesson, ask the students to share or describe a life decision they had made recently. This will help to generate a discussion around how decisions made have both seen and unforeseen impacts in our lives.
2. Pass out a game board to each group. The board game and playing cards are found in at the end of this lesson for printing or could be drawn on a large poster board.
3. Each player selects a game piece and places it on the starting space. The group decides who will go first (oldest, youngest, closest birthday to the date, etc.) Play proceeds in a clockwise direction.
4. The first player rolls the dice and moves their piece the number of places indicated on the dice. Players move in the direction of the arrows on the board. If the player lands on a blank space, their turn is over. Please read and follow the directions on the space you land on.
5. Players that land on Decision Cards must select the top card from the shuffled deck of cards and cards should be placed face down. An opponent reads the top portion of the card aloud. DO NOT READ THE CONSEQUENCES. The player has a maximum of two minutes

Wetland Madness

to make a decision. When the player announces a decision, the person holding the card now reads the consequences for that decision, which tells how many spaces the player has earned or lost for the decision. Return the decision card to the bottom of the pile and proceed with the next player.

6. Players that land on Law Cards must select the top card from shuffled deck of cards and the cards should be faced down. The person landing on the space reads the card aloud to the group and complies with the directions on the card.
7. The first player to reach the Winner space by an exact roll is the winner.

Adjustments and adaptations can be made to the game and decision cards to fit the lesson being taught.

Evaluation Strategy

Students will demonstrate their understanding of management practices that help protect wetlands by choosing decisions that allow them to move ahead on the game board. In addition, students will identify the considerations that are important when deciding a wetland best management practice.

Reflection Section

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VOCABULARY

Watershed

Wetland

Wetland Madness
START
DECISION CARD
LAW
ROLL AGAIN
LOSE A TURN
DECISION CARD
DECISION CARD
ROLL AGAIN
DECISION CARD
LAW
LOSE A TURN
RO LL AG AIN
DECISION CARD
DECISION CARD
WINNER

Decision Cards

Decisions Decisions!

You are a farmer. You own 100 acres near the water, which you plant in corn. Times are tough and you and your spouse are expecting a child. In the past, you have always left a strip of land along the waterway unplowed. The natural growth of wetland plants helps keep the water clean and provides habitat for many animals. But if you planted corn there instead, you'd have about 15 extra acres of crops.

Will you (A) plow it this year or (B)not plow it?

Consequences:

A. Move back 1 space.
B. Move ahead 4 spaces. That's a tough decision!

Decisions Decisions!

Today is Saturday, and you have tickets to a very cool outdoor concert that you've been looking forward to for months. The tickets cost you a month's allowance but are worth it. Your little brother just came in and told you about the wetland clean-up day near his school. They plan to pick up trash and plant new plants all around the area. He is very excited and wants you to come and help since they need lots of people to get the work finished. If you go, you'll miss the concert.

Where will you go? (A) Little brother, (B) Concert.

Consequences:

A. What a sacrifice! Move ahead 3 spaces.
B. Stay where you are.

Decisions Decisions!

You are very wealthy landowner who is about to build a housing development that will make you even richer! The land contains some wetlands which would be destroyed by the project. You can (A) cancel the project, or (B) go to great expense to build new wetland nearby to replace the one that will be destroyed.

Which do you choose?

Consequences:

A. Move ahead 3 spaces.
B. Move ahead 1 space. The plan to replace the wetland is a decent choice, but the costs (money and habitat) may outweigh the benefits. Natural wetland may be healthier.

Decisions Decisions!

You work for the state's highway department. A new road being built will destroy six acres of wetland. To get the permit to build the road, the department had to promise to replace the wetlands. You are in charge of hiring a company to do the work, and you must choose between two companies. The expensive one guarantees that the new wetlands will survive; the cheaper one doesn't, but thinks their wetland will be good.

Will you (A) save state money and take a chance on the wetlands' survival, or (B) spend more and get the guarantee?

Consequences:

A. Move back 4 spaces.
B. Move ahead 3 spaces.

Decision Cards (continued)

Decisions Decisions!

You've designed your dream house, and you're very proud of it. The plans show a beautiful front that faces a quiet street and a garage in the back with a long driveway around to it. There are wetlands in your backyard that will have to be filled in for the driveway and garage.

Will you (A) build the house as planned, or (B) put the garage and a shorter driveway in front of the house, which will be cheaper, but will wreck your design and obstruct the view of the front of your house?

Consequences:

A. Move back 2 spaces.
B. Move ahead 2 spaces.

Decisions Decisions!

You have inherited $50,000! Now you can buy land and build your dream house. You narrow your choices to two properties. One (A) lies right along the shore of a beautiful bay; the other (B) is nestled in a quiet upland forest. Both properties cost the same.

Which will you choose?

Consequences:

A. Building that close to the water will surely harm or destroy wetlands! Move back 3 spaces.
B. If you cut only enough trees to make room for the house, you will harm less natural habitat than you would in (A). Move ahead 3 spaces.

Decisions Decisions!

You live in a bustling city that is near a large river. It is Election Day for a new state governor. Candidate "A" promises increased economic growth and more jobs. He supports the construction of a huge new shopping mall near the river. Candidate "B" process to increase economic growth by promoting travel and recreation. He also wants to build a mall in an abandoned building site near a major highway.

Will you vote for (A) or (B)?

Consequences:

A. Building close to the water will surely harm or destroy wetlands. The city and state do not seem bad in need of growth and can make money in other ways. Move back 3 spaces.
B. It makes sense to build in an area that is already developed, keeping wetlands intact so they can add to the economy in other ways. Move ahead 3 spaces.

Decisions Decisions!

You are a kind-hearted person who donates $200 each year to a charity or good cause. You have been asked to give money to either (A) a conservation organization that helps protect wetlands worldwide, or (B) a local Boy Scout troop. If you choose "B", you can ask the Scouts to use the money to clean up and restore a small wetland in your community.

Which will you choose?

Consequences:

Both choices have their merits. Move ahead 1 space.

Decision Cards (continued)

Decisions Decisions!

You are a farmer who is getting older and thinking about retiring. Your land was once a wetland (a shallow area that stayed very wet throughout the spring). If you stop plowing the land, it will turn into a wetland again. You need to sell your land to earn retirement money. You are offered money from (A) someone who will develop the land for housing or business and offers you twice as much money, plus (B) a conservation organization that will keep the land as wetland preserve, providing you with a tax break.

Which will you choose?

Consequences:

A. Move back 2 spaces.
B. Move ahead 3 spaces.

Decisions Decisions!

You are a town zoning officer, you decide the number and type of places that can be built in your area. One of the only few wetlands in the town is due for rezoning. The townspeople are encouraging you to vote in one of two ways on the zoning: (A) allow housing for the poor to be built there (this housing is badly needed); (B) zone the area for preservation.

Which will you choose?

Consequences:

A. The housing is needed, but it can be built in another location. The wetland is needed for good water quality. Move back 2 spaces.
B. With so few wetlands in town, too many benefits would be lost by destroying the site in question. Move ahead 2 spaces.

Law Cards

Building a boat ramp on the Missouri River.

Violation of Section 10, The Rivers and Harbor Act; Clean Water Act, Section 404.

LOSE ONE TURN.

Draining wetlands on land that is enrolled in a federal farm land program.

Violation of Food Securities Act.

LOSE ONE TURN.

Discharging heated water from a power plant into tidally-influenced channels that flow through a wetland.

Violation of the Clean Water Act, Section 401, and Coastal Planning & Zoning Act.

LOSE ONE TURN.

Building a private dam on a stream that supports a population of Niangua Darter.

Violation of Clean Water Act, Section 401 and Section 404.

LOSE ONE TURN.

Using federal funds to build a fishing pier next to a least tern and piping plover nesting site.

Violation of Rivers and Harbors Act; Endangered Species Act.

LOSE ONE TURN.

Building a golf course in a wetland adjacent to a bald eagle nest tree.

Violation of Clean Water Act, Section 401.

LOSE ONE TURN.

Planting a grain crop.

No violation.

MOVE ONE SPACE

Grazing cattle in a wetland.

No violation.

MOVE ONE SPACE.

Law Cards (continued)

Mowing cattail vegetation in wetlands.

No violation.

MOVE ONE SPACE

Creating a wetland in an upland area.

No violation.

MOVE ONE SPACE.

Putting a wetland in a wetland bank system.

KEEP AND USE TO PREVENT LOSS OF ONE TURN.

Stream Exploration

GRADE LEVEL
K-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Stream

MLS
K.ESS3.B.1
6-8.ESS3.C.2
6-8.ETS1.A
9-12.ESS3.C.1

NGSS
K-ESS3-3
MS-ESS3-3
MS-ETS1-1
HS-ESS3-3

Lesson Summary

Streams are home to a variety of species, aquatic and terrestrial. This can include: macroinvertebrates, plants, fish, mammals, and more. These species depend on healthy water quality to feed, reproduce, and thrive. If the stream's water is contaminated with pollution, it will degrade the water quality and the kind of aquatic community the stream supports. Students are going to explore a stream and learn about the aquatic organisms that make the stream their home.

Objectives

Students will learn about the variety of life living in a stream. This activity is an exciting way to learn about the natural resources streams offer and to learn about the importance of water quality and how pollution can affect the streams inhabitants. Students will be able to identify the variety of life forms living in a stream and the importance of having good water quality.

Instructional Strategy

1. Students should wear outdoor clothing and sturdy shoes appropriate for in the stream. Travel to a nearby wadable stream with the students. Before they enter the stream, have them stand back and observe. Ask the following questions:
    - What color is the water?
    - Can you see the bottom?
    - What is on the bottom?
    - What lives in the stream?
    - What is along the bank of the stream?
    - Where do you think the animals like to live?
    - What do aquatic creatures require to live in a stream?
    - What happens if the water is polluted and the stream inhabitants are not able to survive?
    - What are some roles we can take to help preserve this natural resource and the creatures that call it home?
2. Students will now be encouraged to use their hands, nets, seines, snorkels and buckets to explore the stream. Students can turn over rocks and logs, explore small pool areas, and look for a variety of creatures in the stream.

Stream Exploration

Evaluation Strategy

After students are done exploring the stream have them answer the following questions. Once the questions have been answered divide the students into groups and have them compare and contrast their answers.

- Did you see evidence of pollution today?
- How does pollution affect water quality?
- How do you think the pollution ended up in the stream?
- What happens when pollution enters the stream?
- What are some damages pollution can cause to creatures living in the stream?
- How does pollution in the stream affect terrestrial creatures and humans?
- What kind of aquatic life did you find? Was it more or less than you expected? Why is that?
- Did you find animals where you thought you would?

Reflection Section

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VOCABULARY

Aquatic

Crustaceans

Macroinvertebrate

Mammals

Seine

Terrestrial

Stream Stewardship

GRADE LEVEL
K-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Stream

MLS
K.ESS3.B.1
6-8.ESS3.C.2
6-8.ETS1.A
9-12.ESS3.C.1

NGSS
K-ESS3-3
MS-ESS3-3
MS-ETS1-1
HS-ESS3-3

Lesson Summary

One way to help conserve the environment and promote good water quality is to conduct a stream cleanup. This can involve other students and volunteers or can be geared towards 4-H groups or other clubs. A cleanup will help promote healthy streams, recycling, and will allow the participants to know they are helping to improve the environment. In addition, they are helping to sustain populations of organisms for future generations.

Objectives

Students will learn the causes of pollutants and how this can be prevented in the future. They will learn how to provide outside receptacles for different types of refuse that can be found in the stream.

Instructional Strategy

1. Litter bags and gloves can be obtained through the Missouri Stream Team Program. Select a stream site with access, such as a playground, or park. Land-based cleanups can also be held because it prevents litter from reaching the streams. Students should wear outdoor clothing and sturdy shoes appropriate for in the stream.
2. Once at the cleanup site, define the boundaries for the cleanup, review safety measures (how to handle glass, needles or other hazards if encoutered), and define a collection area for full bags of trash. A competition can be created by having awards for largest piece of trash, oddest trash, most trash collected, etc. Students can now clean up trash. After the cleanup is complete the following questions can be asked to the group:
    - What was the most common type of trash?
    - How did this trash get here?
    - How does this trash affect the creatures that live in this ecosystem?

Evaluation Strategy

Groups can also help build monofilament containers to be placed at

access points for anglers to deposit old fishing line instead of disposing it on the ground or in trash cans. The fishing line can then be collected and recycled properly. You can have your students graph the amount of line collected (by weight) from each monofilament container placed at different areas. Make sure the containers are emptied at the same time before starting the experiment. You can the record the intervals of when they are checked, evaluate the location of the monofilament container, and answer the question as to why some may have been used more than others?

Reflection Section

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VOCABULARY

Stewardship

Ecosystem

Ponds and Streams

GRADE LEVEL
K-12

SUBJECT AREA
Science

DURATION
1-2 class periods

SETTING
Classroom or Stream/ Pond

MLS
3.LS3.C.1
3.LS3.D.1
6-8.LS1.B.2
6-8.LS2.A.1
6-8.LS2.C.1
6-8.ESS3.C.2
9-12.LS2.C.2
9-12.LS4.C.2

NGSS
3-LS4-3
3-LS4-4
MS-LS1-5
MS-LS2-1
MS-LS2-5
MS-ESS3-3
HS-LS2-7
HS-LS4-5

Lesson Summary

Missouri is home to a number of aquatic habitats. This lesson will cover the difference between a pond and a stream. The aquatic ecosystems and habitat will be compared along with the inhabitants for each source.

Objectives

Students will be able to distinguish the differences between a pond and a stream. The students will compare and contrast the different ecosystems, habitats and macroinvertebrates and create a graphic representation of the number of different species of insects and macroinvertebrates found in these water resources.

Instructional Strategy

1. Divide students into five groups, each group will answer one question and share with the class.
    - What makes a stream a stream?
    - What makes a pond a pond?
    - What creatures might you find in a stream?
    - What creature might you find a pond?
    - What are the steps of the scientific method?
2. Have the students form an hypothesis about their question and gather information around it.
    - Students can look over the water keys and Stream Insect & Crustaceans Card for adaptations and predict water quality differences between the pond and stream to create a hypothesis.
    - Have the students make observations and gather background knowledge and research to support their hypothesis. The students will begin to examine each water sample and conduct their own research to confirm their scientific hypothesis.
3. You can either take the students to a nearby stream and pond or you can bring in water samples collected. Do not label the water samples and hand each group a sample from the pond and stream. Provide the students with forceps, magnifying equipment

and both the pond key and river life key to learn what organism they are viewing.

4. Have the students create a graph of the organisms found in their pond and stream water sample. Have them place the organism along the bottom of the graph (x-axis) and on the side (vertical axis) the number of organisms found. Have the students compare their graphs and provide a conclusion on their findings as far as their organism's relation to pollution, habitat, ecosystem requirements, food chains and water quality.
5. Research and Questionnaire
    - How do aquatic macroinvertebrates help us determine the health of a stream?
    - How do graphs help us show our scientific findings?
    - What requirements would an organism need if it were a fish and it was going to survive in a stream and a pond? Would the requirements be the same or different?
    - Do we interpret the macros the same in terms of water quality for ponds and streams? Why or why not?
    - Have students discuss how adding aeration to the pond and stream sample may have changed from when it was first collected it?

Evaluation Strategy

Have the students answer one question below and then share with the class.

A. Have the students choose on organism from a pond and stream and compare the life cycles. Why do the life cycles differ and how are they the same?
B. How do ecosystems and habitats between a pond and a stream differ and how are they the same?
C. Have the students pick an organism from either the pond or stream ecosystem and draw a sketch of the organism and explain what adaptations the organism has that helps it adapt to the water source it is found in?
D. Students can write a story, A Day in the Life of a Pond Critter or Stream Critter, describing what they imagine living in a pond or stream might be like from the perspective of a near by macroinvertebrate in the water source.

VOCABULARY

Stream

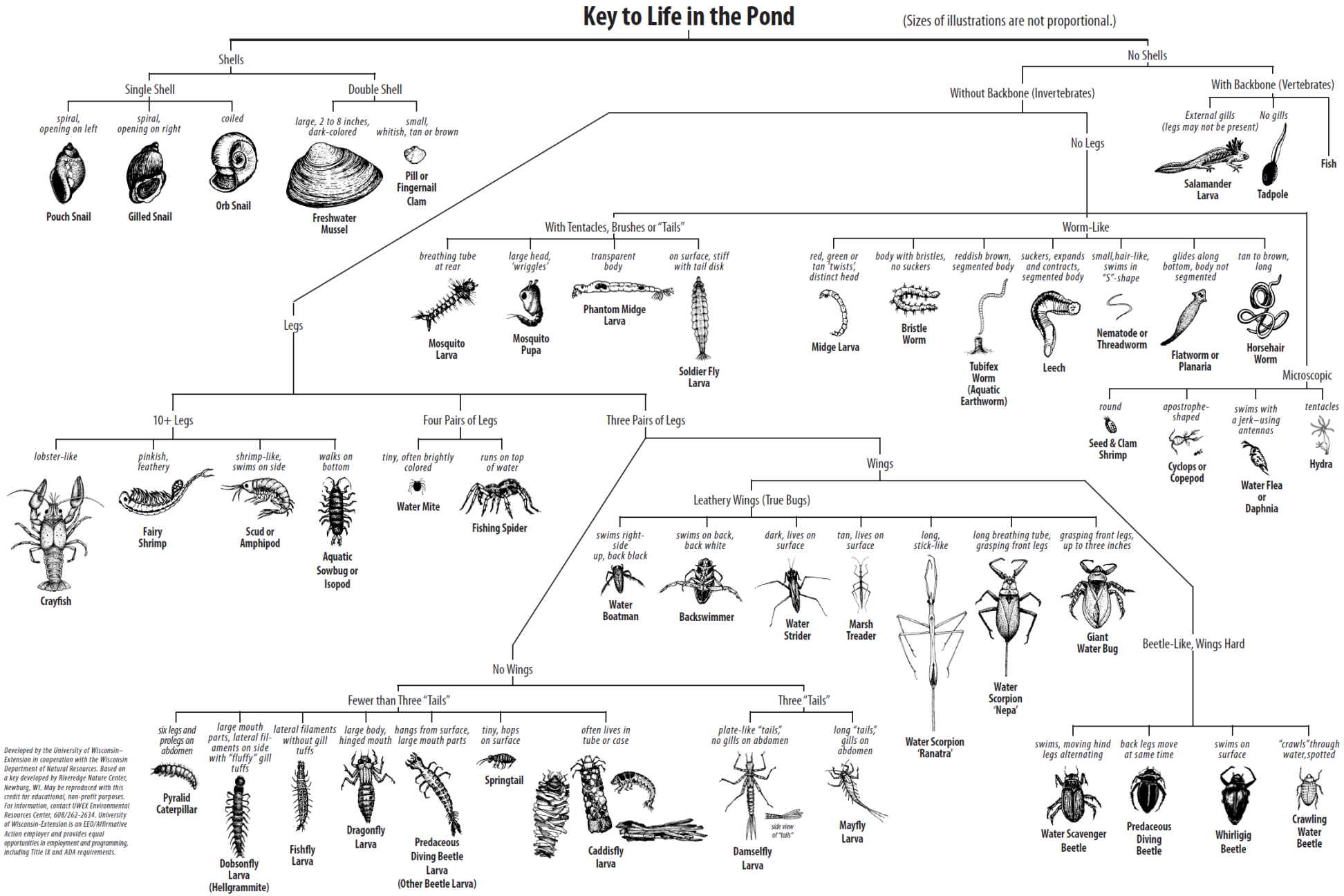
Pond

Ecosystem

Biotic Index

Extension

Educators can also interchange the items being compared in this lesson. For example, students could compare rivers, streams, ponds and lakes. Included are the Pond and River Life keys in this lesson for students to reference.


Key to Life in the Pond
(Sizes of illustrations are not proportional.)
Shells
Single Shell
spiral, opening on left
spiral, opening on right
coiled
Pouch Snail
Gilled Snail
Orb Snail
Double Shell
large, 2 to 8 inches, dark-colored
small, whitish, tan or brown
Freshwater Mussel
Pill or Fingernail Clam
No Shells
With Backbone (Vertebrates)
External gills (legs may not be present)
No gills
Salamander Larva
Tadpole
Fish
Without Backbone (Invertebrates)
No Legs
With Tentacles, Brushes or "Tails"
breathing tube at rear
large head, 'wriggles'
transparent body
on surface, stiff with tail disk
Mosquito Larva
Mosquito Pupa
Phantom Midge Larva
Soldier Fly Larva
Worm-Like
red, green or tan 'twists', distinct head
body with bristles, no suckers
reddish brown, segmented body
suckers, expands and contracts, segmented body
small, hair-like, swims in "S"-shape
glides along bottom, body not segmented
tan to brown, long
Midge Larva
Bristle Worm
Tubifex Worm (Aquatic Earthworm)
Leech
Nematode or Threadworm
Flatworm or Planaria
Horsehair Worm
Microscopic
round
apostrophe-shaped
swims with a jerk–using antennas
tentacles
Seed & Clam Shrimp
Cyclops or Copepod
Water Flea or Daphnia
Hydra
Legs
10+ Legs
lobster-like
pinkish, feathery
shrimp-like, swims on side
walks on bottom
Crayfish
Fairy Shrimp
Scud or Amphipod
Aquatic Sowbug or Isopod
Four Pairs of Legs
tiny, often brightly colored
runs on top of water
Water Mite
Fishing Spider
Three Pairs of Legs
Wings
Leathery Wings (True Bugs)
swims right-side up, back black
swims on back, back white
dark, lives on surface
tan, lives on surface
long, stick-like
long breathing tube, grasping front legs
grasping front legs, up to three inches
Water Boatman
Backswimmer
Water Strider
Marsh Treader
Water Scorpion 'Ranatra'
Water Scorpion 'Nepa'
Giant Water Bug
Beetle-Like, Wings Hard
No Wings
Fewer than Three "Tails"
six legs and prolegs on abdomen
large mouth parts, lateral filaments on side with "fluffy" gill tuffs
lateral filaments without gill tuffs
large body, hinged mouth
hangs from surface, large mouth parts
tiny, hops on surface
often lives in tube or case
Pyralid Caterpillar
Dobsonfly Larva (Hellgrammite)
Fishfly Larva
Dragonfly Larva
Predaceous Diving Beetle Larva (Other Beetle Larva)
Springtail
Caddisfly larva
Three "Tails"
plate-like "tails," no gills on abdomen
long "tails," gills on abdomen
side view of "tails"
Damselfly Larva
Mayfly Larva
swims, moving hind legs alternating
back legs move at same time
swims on surface
"crawls" through water, spotted
Water Scavenger Beetle
Predaceous Diving Beetle
Whirligig Beetle
Crawling Water Beetle
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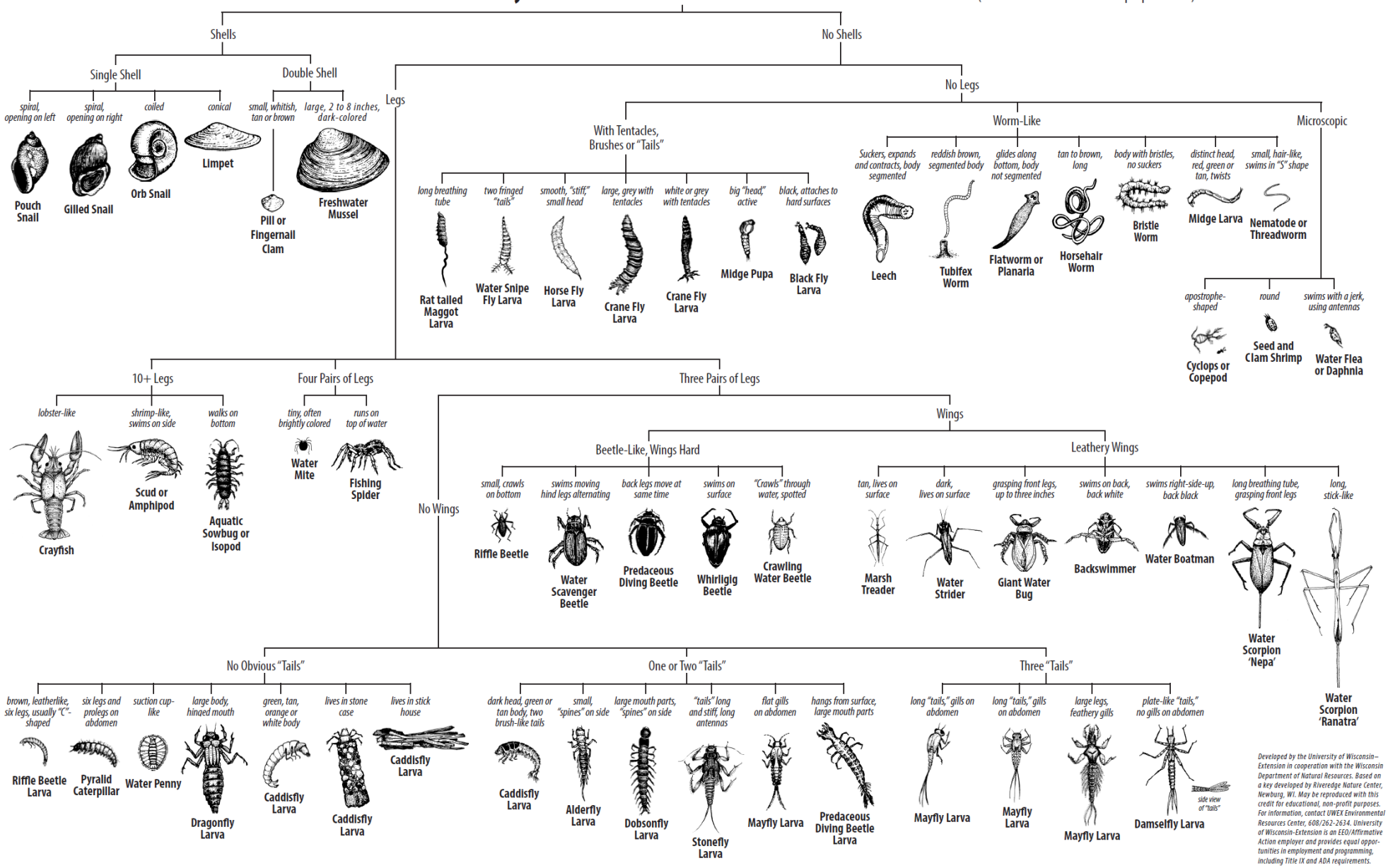
Key to Macroinvertebrate Life in the River

(Sizes of illustrations are not proportional.)



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Stream Substrate

GRADE LEVEL
3-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
3.LS3.C.1
3.LS3.D.1
6-8.ESS3.C.2
9-12.LS2.C .1

NGSS
3-LS4-3
3-LS4-4
MS-ESS3-3
HS-LS2-6

Lesson Summary

Substrate composes the bottom of a stream and determines the type of creatures that can live in the water and along the steam. Benthic, or bottom-dwelling, invertebrates not only require specific chemical parameters, but they need appropriate habitat that provides adequate living space and other amenities to thrive.

Objectives

Students will understand the function and importance that substrate plays in the survival of the macroinvertebrates and other aquatic fauna in a stream. Students will be able to identify types of substrate and will be able to calculate the average size of substrate material.

Instructional Strategy

1. Divide students into at least two groups.
2. Have each team select a stretch of the stream that is no deeper than their knees.
3. Stretch the measuring tape across the stream to measure the stream width.
4. Next, students will remove 10 rock samples from a riffle using a random selection method: Remove one rock from the stream for each random number on the chart where that number is found on the tape measure.
5. Measure and record all stones using a regular bow caliper. Have the students take turns.
6. Measure to the nearest centimeter along the horizontal or longest axis.

In addition, have the students note the aquatic life in the area and under the substrate in their section of stream from the rocks they pickup.

Evaluation Strategy

A. Have the students make comparisons of the macroinvertebrates they find in the small substrate, such as sand and gravel (<2 in), compared to what they find in the large substrate (>2 in). Have

Stream Substrate

them compare the characteristic of each macroinvertebrate in the small substrate compared to the macroinvertebrates in the large substrate. Make sure they note characteristics such as appendages, legs, gills, filter parts, tails, and wings etc. Make sure they explain why they think certain taxa of macroinvertebrates and other fauna are specifically adapted to certain substrates or areas in the stream.

B. The students could use a graphing program or complete the graph by hand on graphing paper. Have the students graph in groupings of five centimeters along the X-axis (dependent variable) and number the stones along the Y-axis (independent variable). The graph is interpreted as the greatest number of points along the Y-axis, the greater the interstitial spaces and the greater the potential for habitat diversity.

Reflection Section

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VOCABULARY

Appendages

Benthic

Bow Caliper

Fauna

Invertebrate

Macroinvertebrates

Riffle

Substrate

Taxon/Taxa

Captured Critters

GRADE LEVEL
3-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
3.LS3.D.1
6-8.LS1.B.2
6-8.LS2.A.1
9-12.LS4.C.2

NGSS
3-LS4-4
MS-LS1-5
MS-LS2-1
HS-LS4-5

Lesson Summary

Macroinvertebrates are organisms without a backbone and are visible to the human eye without the aid of a microscope. Examples include insects, snails, and worms. Some aquatic macroinvertebrates are benthic, which means they live on, under, and around rocks and sediment at the bottom of streams. Macroinvertebrates are important in the food web and they play a vital role in a stream's ecosystem. Their presence or absence in a stream is also an indicator of water quality and the health of ecosystems. This lesson gives students a close-up look at aquatic invertebrates.

Objectives

Students will learn what a macroinvertebrate is and will be able to identify common aquatic macroinvertebrates that live in the stream. They will learn that invertebrate taxa have different tolerances to pollution and the role they have in an ecosystem.

Instructional Strategy

It is recommended the teacher attends an Introductory Level Volunteer Water Quality Monitoring (VWQM) workshop to be well-equipped for collecting and identifying aquatic invertebrates. Electronic resources for this lesson can be found on the Stream Team website at mostreamteam.org.

Classroom Activity

1. Provide copies of the Stream Team Stream Insects & Crustaceans card to the students. Divide students into three groups and assign each group a pollution tolerance group from the Stream Insects & Crustaceans card: Group I – Pollution sensitive, Group II – Pollution somewhat-tolerant, and Group III – Pollution tolerant.
2. Each group will research invertebrate taxa in that tolerance group. Students can research names, characteristics, eating habits, habitat, etc. Each group will present their findings to the other students.

Field Portion

Students should wear outdoor clothing and sturdy shoes appropriate

Captured Critters

for in the stream. Travel to a stream site with a kick net, sorting tray, forceps, Biological Monitoring data sheet, Stream Insects & Crustaceans card, and any other invertebrate ID resources.

Using VWQM Biological Monitoring methods, collect three net sets and complete a Biological Monitoring data sheet.

Evaluation Strategy

A. Have your students create a matching game with photos of aquatic macroinvertebrates and cards including descriptive information on life cycle and/or characteristics.
B. Have students complete a lab practical by having unidentified vials labeled with numbers that correspond to an answer sheet.

Reflection Section

VOCABULARY

Benthic

Ecosystem

Macroinvertebrates

Microhabitat

Riffle

Sediment

Taxon/Taxa

Macroinvertebrate Reference Collection

GRADE LEVEL
6-8

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
3.LS3.D.1
6-8.LS1.B.2
6-8.LS2.A.1
9-12.LS4.C.2

NGSS
3-LS4-4
MS-LS1-5
MS-LS2-1
HS-LS4-5

Lesson Summary

There are numerous types of macroinvertebrates that live in waterbodies. It is often hard for people to accept they are swimming with these creatures in the water. The presence or absence of these creatures is an indicator of the water quality. Being able to identify invertebrates crawling on the bottom of the stream, clinging to rocks, or hiding amongst leaves can tell us a lot about the stream.

Objectives

Students will learn the importance of macroinvertebrates to stream ecosystems. Students will become familiar with collecting, sorting, and analyzing macroinvertebrates as a method for measuring stream health. Students will also be able to correctly identify the macroinvertebrates in their reference collections by their characteristics.

Instructional Strategy

A teacher can collect, preserve, and create a specimen collection for students to examine. If done correctly this collection can be used for multiple years. Students may be able to help collect invertebrates for the preservation process. Vials and other collecting equipment can be obtained through the Stream Team Program if a teacher is at least Introductory Level trained in Volunteer Water Quality Monitoring. Resources from the Capture Critters lesson may be used to help identify collected invertebrates.

1. First, collect aquatic macroinvertebrates at a nearby streams by using a kick net, hand nets, looking under rocks and within leaf litter.
2. Invertebrates should be placed in a jar of 100% ethyl alcohol or 90% isopropyl alcohol to euthanize.
3. After 24 hours, place the invertebrates into separate vials with water-diluted alcohol for preservation. The recommended alcohol dilution is 80% ethyl alcohol or 40% isopropyl alcohol. Fill vials completely to reduce bacteria growth and decomposition of the specimens. Small specimens, (e.g. riffle beetles, black flies, and midges) can be placed in a vial of hand sanitizer gel to make

Macroinvertebrate Reference Collection

viewing easier. Vials can be labeled with a small round sticker placed on the cap.

Evaluation Strategy

A. Give students a lab practical to identify unlabeled vials. Number the vials for the students to correctly identify on an answer sheet. Students may use identification keys and notes.
B. Students can compare their reference collections to each other's to compare the sizes and species collected of their macroinvertebrates. In addition, you could have the students collect their macros from a variety of different sources in the community and have the students compare the different types of macroinvertebrates they find. They can also compare the stream bed composition, the location of the stream in an urban or agricultural area, and potential point and nonpoint sources of pollution to see what factors might contribute to the variety of macros that were found in the stream for their collection. This could identify potential factors leading to differences in benthic macroinvertebrate diversity within a particula area of the stream.

Reflection Section

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VOCABULARY

Macroinvertebrates

Macroscopic

Non-Point source pollution

Sediment

Stream bed

Macroinvertebrate Game

GRADE LEVEL
3-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
3.LS3.D.1
6-8.LS1.B.2
6-8.LS2.A.1
9-12.LS4.C.2

NGSS
3-LS4-4
MS-LS1-5
MS-LS2-1
HS-LS4-5

Lesson Summary

There is a lot more living in a stream, river, or pond than most people realize. Everyone thinks about fish, frogs, and crayfish, but there are many species of aquatic invertebrates that often go unnoticed. The presence or absence of certain macroinvertebrates indicates the quality of a stream. A high diversity of invertebrates, including the presence of pollution sensitive taxa, is a good indicator the waterbody is healthy. Therefore, being able to identify different aquatic macroinvertebrates will be helpful when determining the health of a waterway. This macroinvertebrate review will assist students in learning and recognizing key characteristics that help aid in identification.

Objective

Students will match the illustrations of the aquatic macroinvertebrates with the correct name on a game board. This activity can be used as a review of identifying aquatic macroinvertebrates after a real stream study has been conducted, or used as a preview to what students will find in a stream. This activity can also incorporate the skill of using a dichotomous key.

Instructional Strategy

1. Print the macroinvertebrate match board, ID cards, answer key, River Life Dichotomous key and the bug card at the end of the lesson.
2. Students will try to correctly match the pictures or use the description on the back of the card with the correct name on the board. Students may use the River of Life dichotomous key and the Stream Insects & Crustaceans card to identify the insects.
3. Once all the cards have been placed on the board, the teacher will come by to check their answers. If there are any incorrect answers the students can then attempt to revise the matches on the game board.
4. Once the board has been completed correctly have students answer the following discussion questions.
    - Which physical features did they use to identify the macroinvertebrates? (Presence or absence of tails, number

Macroinvertebrate Game

of tails, where the gills are located, length of appendages, shape or size, etc).

- What kind of characteristics could they observe if these were living insects in their natural environment?
- How does a dichotomous key work?

Evaluation Strategy

A. Use this activity as a quiz.
B. Time students to see who is the fastest.
C. Students could create their own game or a type of matching game to use macroinvertebrates cards.
D. Students could research and color the macroinvertebrates according to their research. (Use link for coloring book).
E. Students can use the coloring pages as review for a quiz with the characteristics of the invertebrate.
F. Students could also label and name the parts of each macroinvertebrate of the coloring page.

Reflection Section

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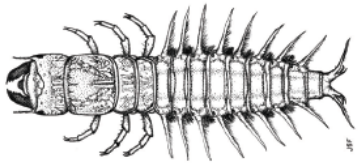
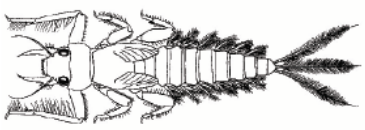
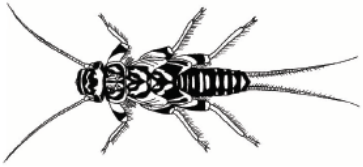
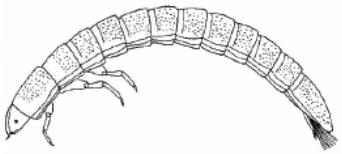
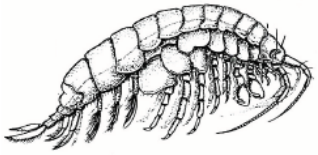
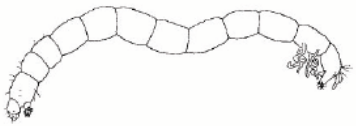
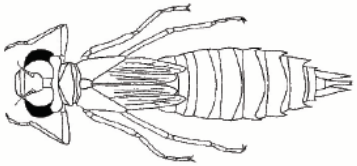
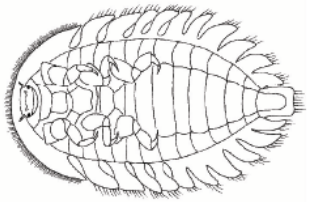
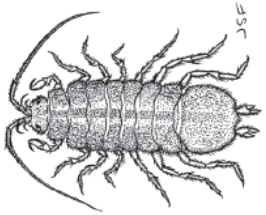
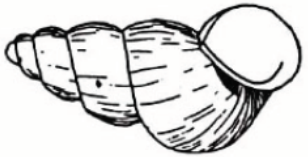
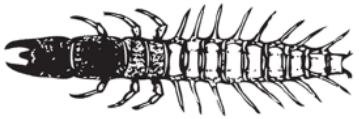
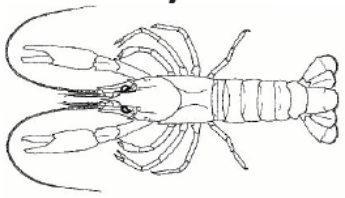
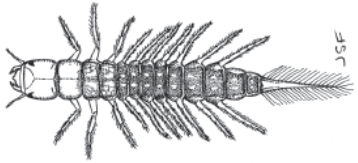
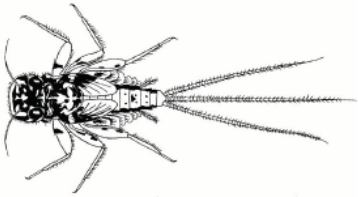
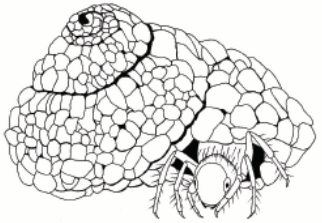
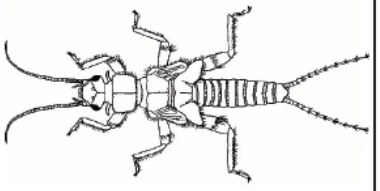
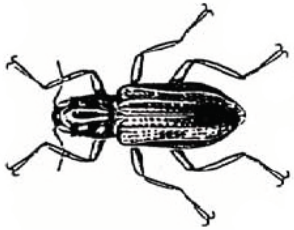
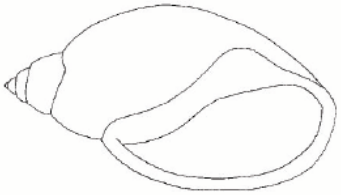
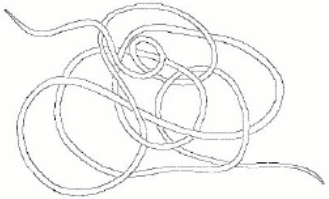
VOCABULARY

Dichotomous key

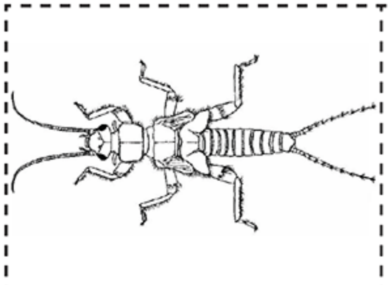
Macroinvertebrate

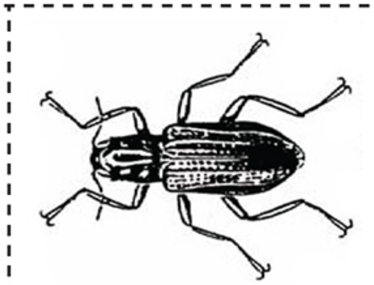
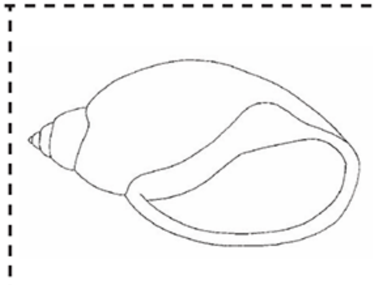
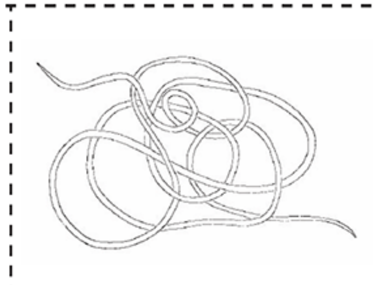
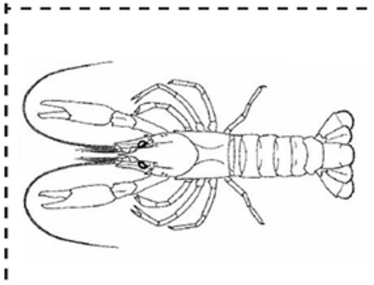
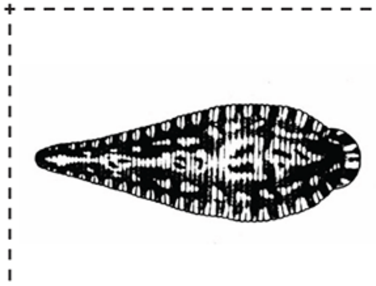
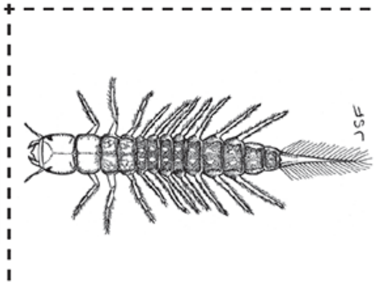
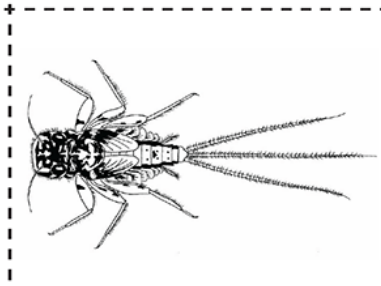
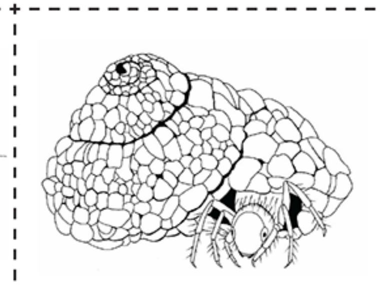
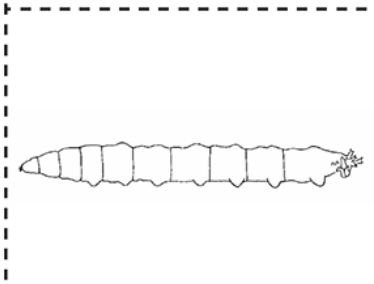
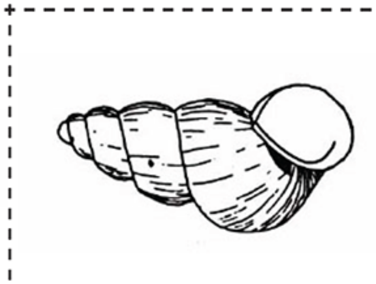
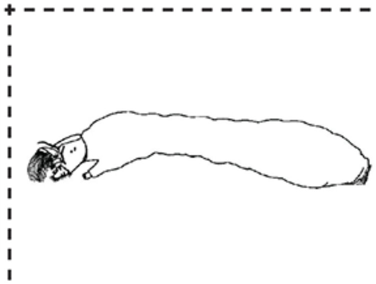
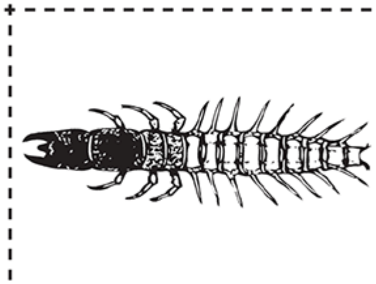
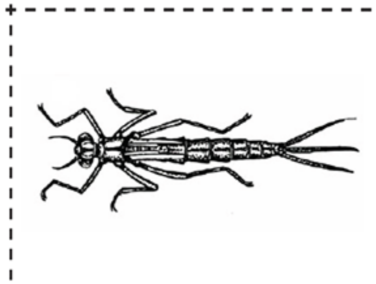
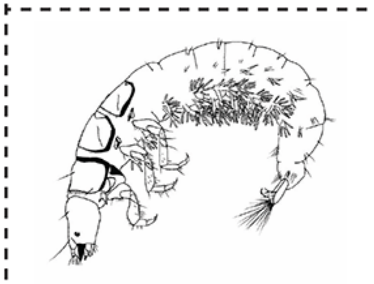
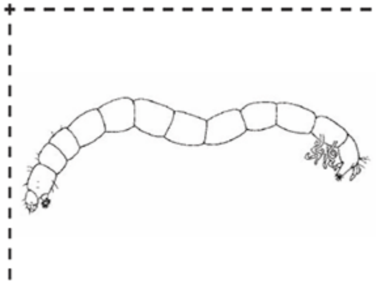
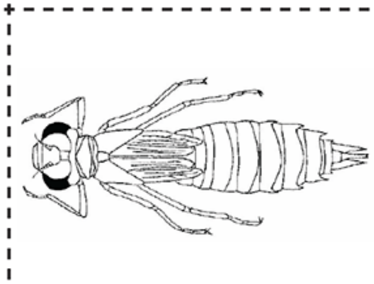
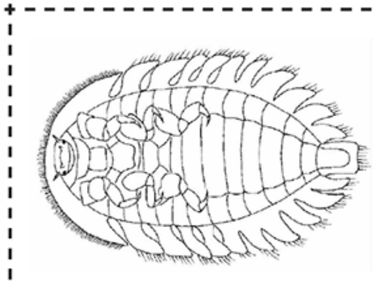
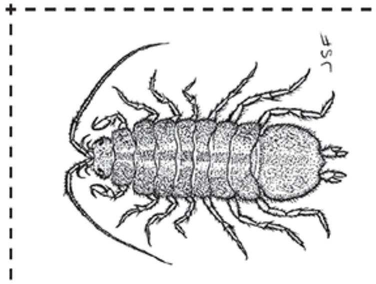
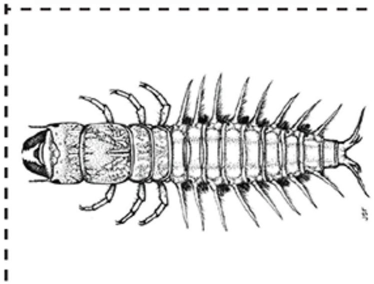
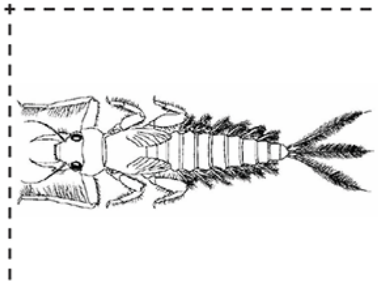
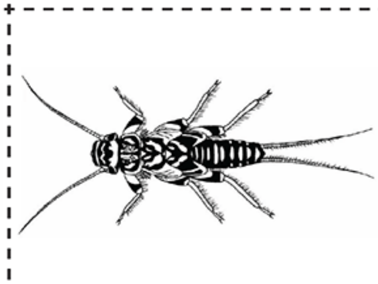
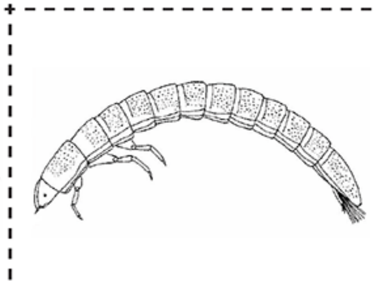
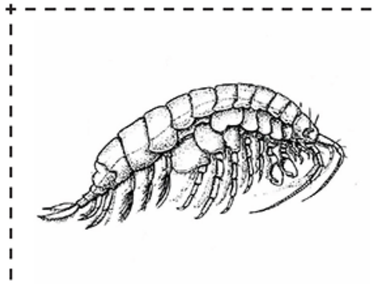
Game Board

Hellgrammite	Mayfly	Stonefly	Riffle Beetle	Scud
Caddisfly	Midge Fly	Dragonfly	Water Penny	Sowbug
Crane Fly	Gilled Snail	Blackfly	Fishfly	Damselfly
Crayfish	Leech	Alderfly	Mayfly	Caddisfly
Stonefly	Mussel	Riffle Beetle	Pouch Snail	Aquatic Worm

Hellgrammite 	**Mayfly** 	**Stonefly** 	**Riffle Beetle** 	**Scud** 
Caddisfly 	**Midge Fly** 	**Dragonfly** 	**Water Penny** 	**Sowbug** 
Crane Fly 	**Gilled Snail** 	**Blackfly** 	**Fishfly** 	**Damselfly** 
Crayfish 	**Leech** 	**Alderfly** 	**Mayfly** 	**Caddisfly** 
Stonefly 	**Mussel** 	**Riffle Beetle** 	**Pouch Snail** 	**Aquatic Worm** 

Cards front

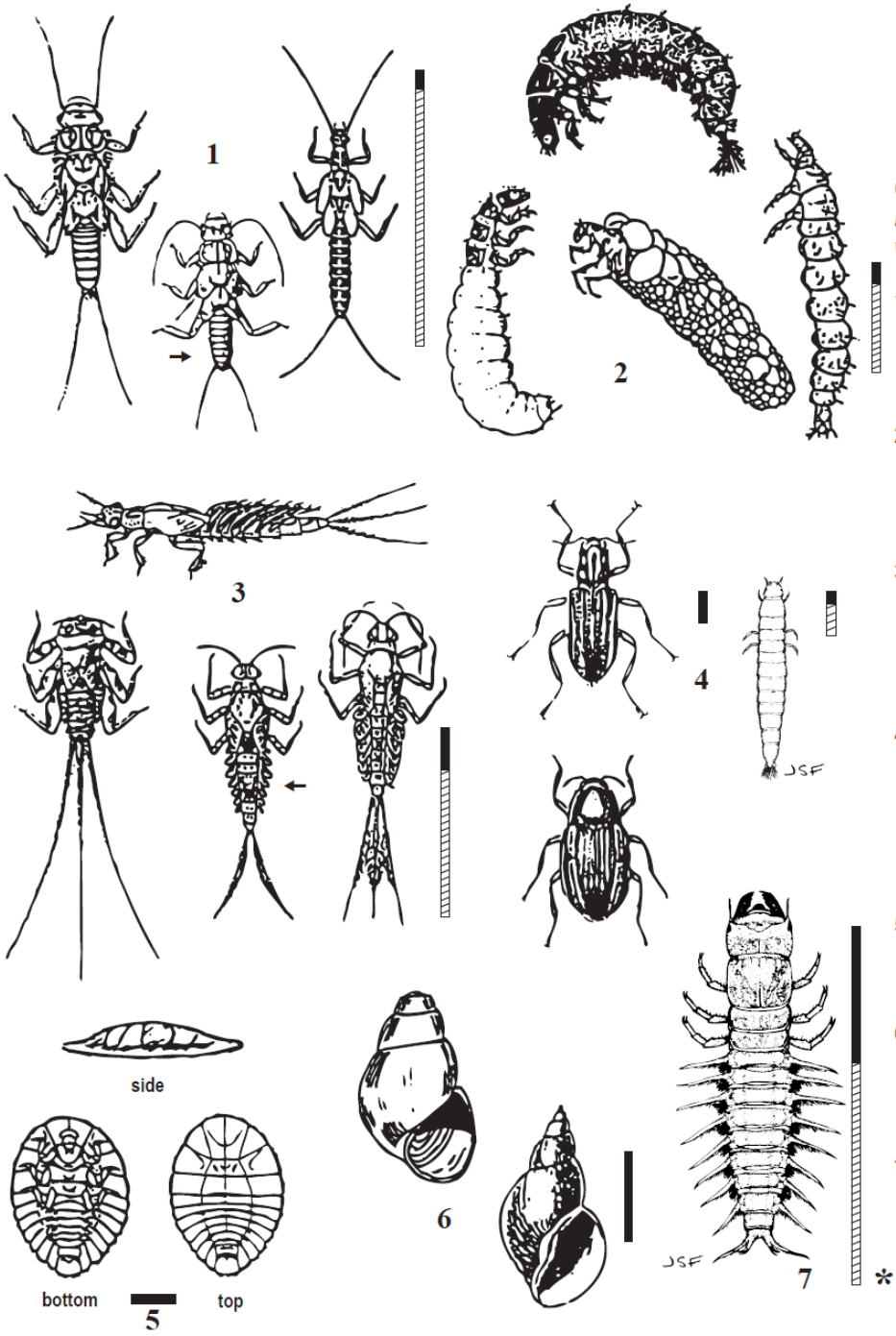


Cards back

• Large mandibles • Hairlike gills under abdominal lateral filaments • Up to 4 inches long	• Gills on abdomen • Six legs • Usually three tails	• Six legs • Two tails • May have gill tuffs under legs (hairy airpits)	• Count both larvae and adults • Six legs • Larvae hard plates covering length of body • Adults tiny six-legged beetles	• Body higher than it is wide • Side swimmer • Resemble small shrimp
• Distinct head • Six legs • Hard plates on the thorax, soft abdomen (cruchy) • May build case from sticks, rocks, or leaves	• Distinct head • Pair of tiny prolegs under the head	• Large eyes • Masklike lower lip • Wide oval-to-round abdomen	• Six legs • Shaped like a small, upside-down saucer • Hard plates conceals head and legs from above	• Seven pairs of legs • Body wider than it is high • Looks similar to a roly-poly bug
• Caterpillar-like segmented body • Fleshy fingerlike extensions at the end of the abdomen • May have turnip-like lobe at end of abdomen	• Shells openings to the right when the spiral is pointing up	• Wide “fat” bottom with suction pad on on • Two fan-like structures on their head	• Lateral filaments on the abdomen • No gill tufts	• Large eyes • Three broad oar-shaped tails (gills) • Six thin legs • Tripod stance
• Two large claws and eight walking legs • Resemble small lobsters	• Flattened muscular bodies • Suction pads on each end	• Lateral filaments • No visible gill tufts • One long hairlike tail resembles the capital letter “A”	• Gills on abdomen • Six legs • Usually three tails	• Distinct head • Six legs • Hard plates on the thorax, soft abdomen (cruchy/cream filled) • May build case from sticks, rocks, or leaves
• Six legs • Two tails • May have gill tuffs under legs (hairy airpits)	• Two-piece (bivalve) shell	• Count both larvae and adults • Six legs • Larvae hard plates covering length of body • Adults tiny six-legged beetles	• Shells openings to the left when the spiral is pointing up	• Resemble terrestrial earthworms

Stream Insects & Crustaceans



GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

1 Stonefly nymph: *Order Plecoptera.* 1/8" - 1 1/2"; 6 legs with hooked tips; 2 hairlike tails. Smooth (no gills) on abdomen (see arrow). May have gills on thorax under the legs.

2 Caddisfly larva: *Order Trichoptera.* Up to 1"; 6 legs on thorax; 2 hooks at end of abdomen. May be in a stick, rock, or leaf case with its head sticking out. May have fluffy gill tufts on lower half.

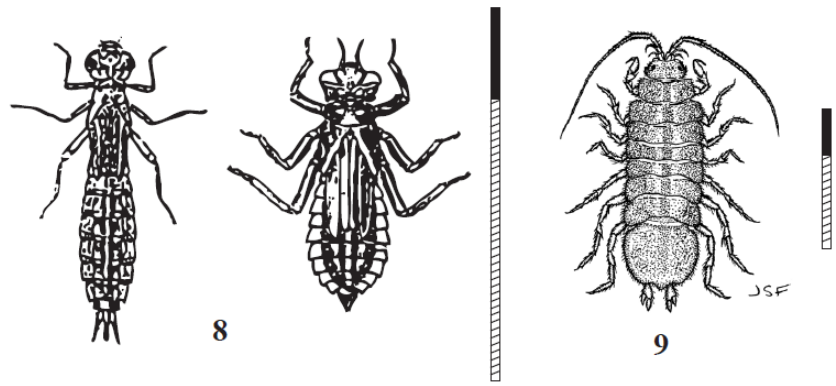
3 Mayfly nymph: *Order Ephemeroptera.* 1/4" - 1"; moving, platelike, or feathery gills on abdomen (see arrow); 6 large hooked legs; antennae; 2 or 3 long, hairlike tails. Tails may be webbed together.

4 Riffle Beetle*: Order Coleoptera.* Adult: Tiny, 6-legged beetle; crawls slowly on the bottom. Larva: Entire length of body covered with hard plates; 6 legs on thorax; uniform brown or black color. Combine number of adults & larvae when reporting total counts.

5 Water Penny larva*: Order Coleoptera.* 1/4"; flat saucer-shaped body, like a penny; segmented with 6 tiny legs underneath. Immature beetle.

6 Gilled Snail: *Class Gastropoda.* Shell opening covered by thin plate called operculum. When pointed up and opening facing you, the shell opens to right. Do not count empty shells.

7 Dobsonfly larva (hellgrammite): *Family Corydalidae.* 3/4" - 4"; dark-colored; 6 legs, large pinching jaws; eight pairs lateral filaments on lower half of body with paired cottonlike gill tufts along underside of lateral filaments; short antennae; 2 pairs of hooks at back end.



GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in good or fair quality water.

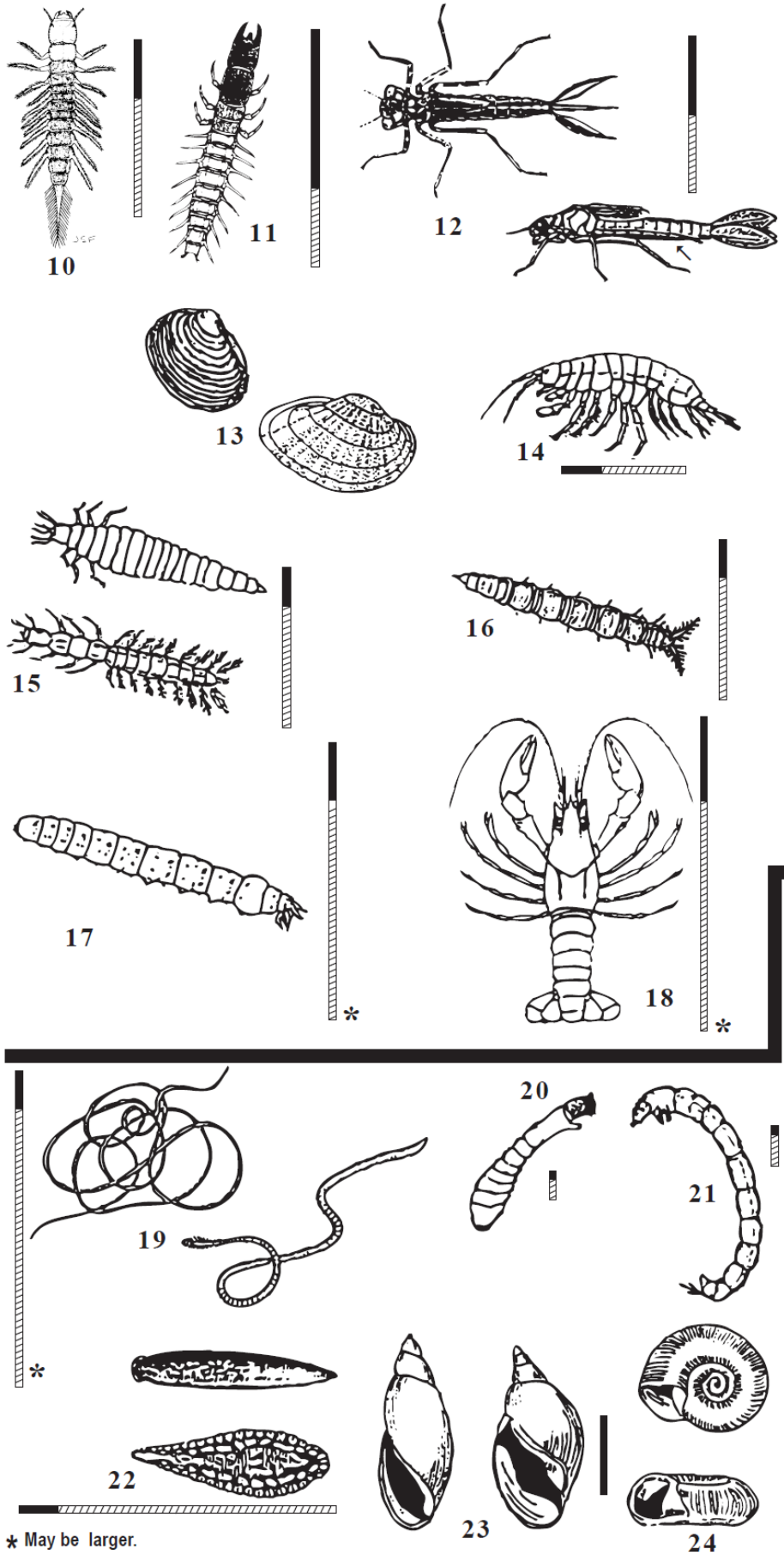
8 Dragonfly nymph: *Suborder Anisoptera.* 1/2" - 2"; large eyes, 6 hooked legs. Wide oval to round abdomen, masklike lower lip.

9 Sowbug: *Order Isopoda.* 1/4" - 3/4"; gray oblong body wider than it is high, more than 6 legs, long antennae, looks like a 'roly poly.'

*** May be larger.**

~Solid bar indicates approx. minimum size. Combined solid and striped bar is approx. maximum size.~

Save Our Streams



GROUP TWO TAXA continued

10 Alderfly larva: *Family Sialidae.* 3/8"- 1"; looks like small hellgrammite but has 1 long, thin, branched tail at end of abdomen (no hooks). No gill tuft underneath the lateral filaments on abdomen.

11 Fishfly larva: *Family Corydalidae.* Up to 1 1/2"; lateral filaments on abdomen. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.

12 Damselfly nymph: *Suborder Zygoptera.* 1/2"- 1"; large eyes; 6 thin hooked legs; 3 broad oar-shaped tails (gills); body positioned like a tripod. Smooth (no gills) on sides of lower half of body (see arrow).

13 Clam/Mussel: *Class Bivalvia.* Do not count empty shells.

14 Scud: *Order Amphipoda.* 1/4"- 3/4"; white to gray, body higher than it is wide; swims sideways; more than 6 legs; resembles small shrimp.

15 Other Beetle larva: *Order Coleoptera.* 1/4" - 1"; light-colored; 6 legs on upper half of body; feelers; antennae; obvious mouthparts. Diverse group.

16 Watersnipe Fly larva: *Family Athericidae (Atherix).* 1/4" - 1"; pale to green; tapered body; many caterpillar-like legs; conical head; two feathery 'horns' at back end.

17 Crane Fly larva: *Suborder Nematocera.* 1/3" - 4"; milky, green, or light brown; plump caterpillar-like segmented body. May have enlarged lobe or fleshy fingerlike extensions at the end of the abdomen.

18 Crayfish: *Order Decapoda.* Up to 6"; 2 large claws, 8 walking legs, resembles small lobster.

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

19 Aquatic Worm/Horsehair Worm: *Class Oligochaeta/ Phylum Nematomorpha.* Aquatic worm: 1/4"- 2"; can be very tiny, thin wormlike body. Horsehair Worm: 4"-27"; slender, can be tangled.

20 Black Fly larva: *Family Simulidae.* 1/8"- 3/8"; one end of body wider. Black head, suction pad on end.

21 Midge Fly larva: *Suborder Nematocera.* Less than 1/4"; distinct head; wormlike segmented body; pair of tiny prolegs under head and tip of abdomen.

22 Leech: *Order Hirudinea.* 1/4" - 6"; flattened muscular body, ends with suction pads.

23 Pouch Snail and Pond Snails: *Class Gastropoda.* No operculum. Breathe air. Shell usually opens on left. Do not count empty shells.

24 Other snails: *Class Gastropoda.* No operculum. Breathe air. Snail shell coils in one plane. Do not count empty shells.

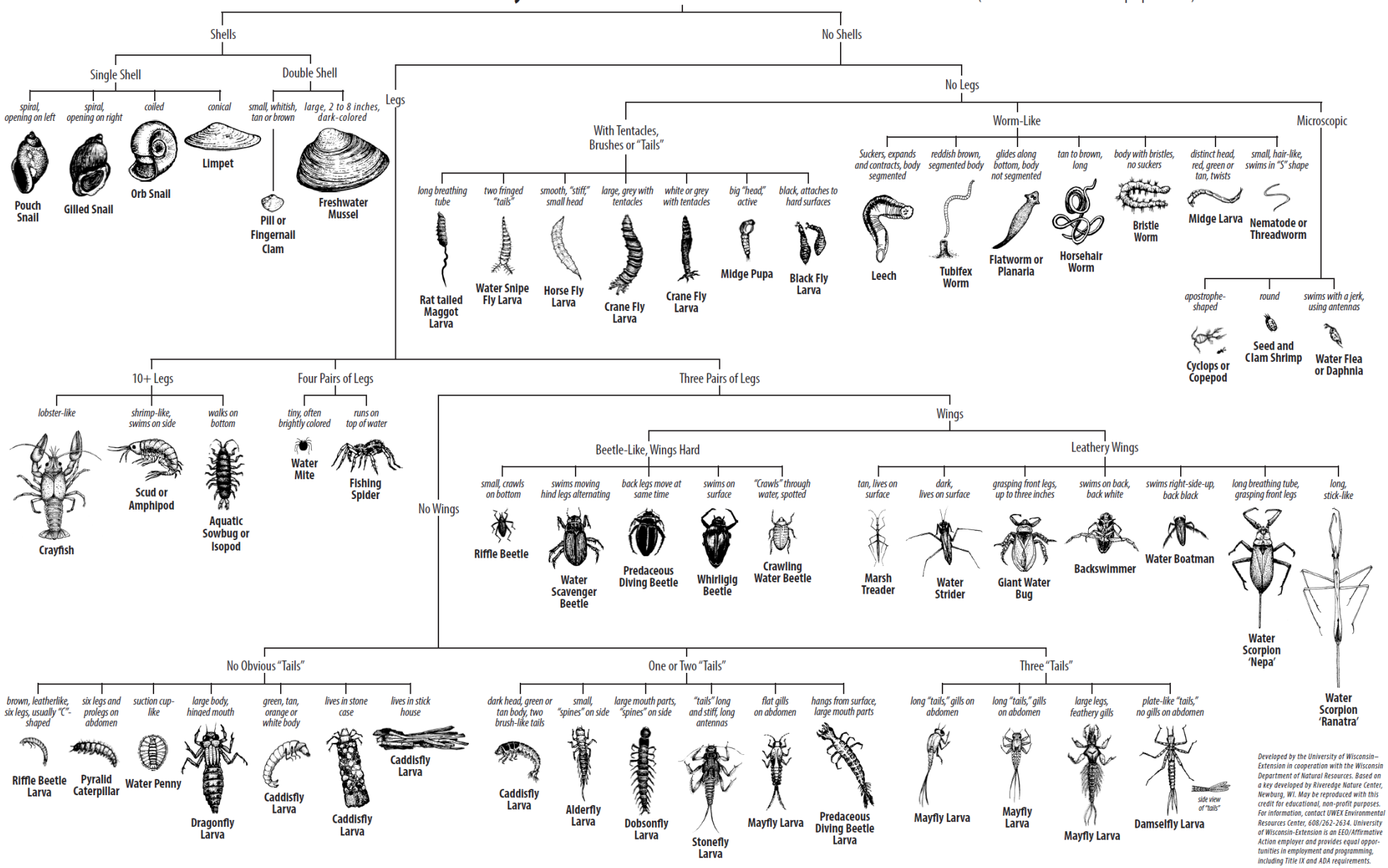
* May be larger.

~Solid bar indicates approx. minimum size. Combined solid and striped bar is approx. maximum size.~

01/10
STR 250

Key to Macroinvertebrate Life in the River

(Sizes of illustrations are not proportional.)



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Riparian Corridor

GRADE LEVEL
K-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Streams

MLS
K.ESS3.B.1
2.ESS2.A.1
6-8.ESS3.C.2
6-8.LS2.C.2
9-12.LS2.B.2

NGSS
K-ESS3-3
2-ESS2-1
MS-ESS3-3
MS-LS2-5
HS-LS2-4

Lesson Summary

The strip of land bordering a stream channel is called the riparian corridor. This corridor is the first 100 feet of the floodplain on each side of the stream and should be well vegetated. The vegetation growing in the corridor provides many benefits and is necessary for creating a healthy stream. Well-managed corridors are accompanied by a general lack of erosion. A diverse plant community including a variety of mixed-aged native trees, shrubs, and grasses provide multiple functions which benefit wildlife: branches, leaves, and bark provide habitat while flowers, nuts and fruit provide food sources. Many animal species use riparian areas in at least one of their life stages.

Objectives

Students will be able to define the function of a riparian corridor by describing the importance and purpose of the flora and fauna within the corridor and how this impacts the water quality and species present within these areas.

Instructional Strategy

Field Portion
Travel to a local stream to expose students to a riparian corridor and to observe the physical characteristics and features within the corridor. Students will complete a Visual Survey Data Sheet to observe any obvious water pollution problems and to characterize the riparian environment through which the stream flows. The students will be dispersed along the corridor from the top of the streambank through the first 100 feet of the floodplain to cover the full riparian corridor.

Procedure
1. Collect samples from trees, grasses, roots, and woody debris for pressing and mounting to share with the class when returned to the classroom.
2. Record and photograph any signs of animal life (tracks, droppings, or scrapes) and human activity.
3. Record and photograph any signs of flooding and the effects the floodwater had on the riparian corridor.

Riparian Corridor

4. Observe and collect samples of leaf litter and soil. (Soil and leaf litter should reflect sediment trapping properties and increased infiltration abilities.)

Evaluation Strategy

A. The students can create a booklet, presentation, or video to share their observations and samples collected at the stream site. They can also discuss how the trees present affect the stream itself. (For example, shade from the trees helps to cool the water, thus increasing the waters ability to hold oxygen.)
   - How do the different soil types affect erosion and the vegetation that is able to grow in the corridor?
   - Discuss what the animals present in the corridor tell you about the health of the corridor and the water quality.
   - How do human activities in the riparian corridor directly affect and disturb stream stability?
   - What types of human activities alter the corridor? (Examples: urbanization and farming)

B. In addition, have the students draw conclusions about the characteristics of a healthy riparian corridor and streambank they assessed. Make sure they note if the site would be considered to have a healthy riparian corridor and if not have the students make recommendations for planning and maintaining a healthy corridor for streams.

Reflection Section

_____

_____

_____

_____

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_____

_____

_____

VOCABULARY

Channelization

Gravel Dredging

Riparian Corridor

Woody debris

Stream Habitats

GRADE LEVEL
3-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Streams

MLS
3.LS3.C.1
6-8.ESS3.C.2
6-8.LS2.A.1
9-12.LS2.C.2

NGSS
3-LS4-3
MS-ESS3-3
MS-LS2-1
HS-LS2-7

Lesson Summary

Aquatic organisms vary in their sensitivity to pollution and alterations to their aquatic ecosystems, riparian corridors, and watershed conditions. A close examination of a stream's habitat can provide information regarding land use practices and other human activities. These factors are important when evaluating the stream's health.

Objectives

Students will understand the concepts of water quality and stream habitats and how these parameters determine the types and abundance of aquatic and terrestrial organisms present in the water source. Students will be able to define and give examples of stream habitats and the organisms living with suitable water quality. In addition, students will be able to make connections between the stream's habitat and land use practices that are occurring in the watershed.

Instructional Strategy

Classroom Activity

1. Provide students with three to five note cards and a marker.
2. Ask students to write down one term or phrase on each card that reflects their knowledge of stream habitats.
3. Ask students to group their like cards with another student, then ask them to team up with another pair and group their cards.
4. Repeat this process until all the cards from the class are grouped together.
5. Go over each group of cards with the class and make connections, corrections, and clarifications as needed.
6. Construct a concept map from the card piles (water, fish, rocks and bugs) showing the "current" knowledge the class just "circulated" and "pooled."
7. Complete multiple rounds and ask the students what they know about stream life, the stream bed, riparian corridor, watershed, and etc.?
8. Have the students sum up the concept map and explain to students that they are going to visit a stream aquatic habitat and observe these components.

Stream Habitats

Field Portion

1. Divide students into pairs and have the students complete the Stream Habitat Observations handout.
2. Allow students to observe shallow underwater environments.
3. Have the students observe and make notes on the variety of different habitats that are present within the stream. (riffles, pools, root mats, gravel bars, riparian corridor, and stream bed composition).
4. Collect different samples of sediment sizes that are found in the habitats observed and have the students compare and contrast the different samples collected. Have them explain their thoughts behind why certain sediments sizes are found in certain stream habitats and not others.

Evaluation Strategy

A. Compare and contrast the flowing aquatic habitat of their stream to other freshwater aquatic habitats such as large rivers, ponds, lakes, and wetlands.
B. Have students compare their Stream Habitat Observations handout with other students in the classroom and combine observations throughout the class with questions on similarities and differences that were found in the stream habitat.
C. Have groups reconstruct their direct observations by drawing on poster board the entire habitat they observed. Make sure the students label the different parts of the habitat, the wildlife and aquatic life present. Note the land uses and make sure connections are made between the aquatic habitat ecosystem health and the surrounding land use practices.
D. Groups will share their observations and posters with the class and will encourage questions and observations from classmates.
E. Have students complete the Stream Habitat Observations handout for a variety of different water bodies.

Reflection Section

_____

_____

_____

VOCABULARY

Aquatic

Ecosystem

Gravel bars

Pool

Riffle

Riparian corridor

Root mat

Stream bed

Watershed

Wetland

Stream Habitat Observations

Directions
Identify each item as either food, water, shelter or space for stream aquatic habitats. Use these symbols: food*, water +, shelter ^ and space #. Some items may serve more than one function.

Make observations about the following items located in or near the stream environment. Record these observations in the provided areas. Use your senses to make observations.

Land use: _____
_____

Vegetation: _____
_____

Ground cover: _____
_____

Soil: _____
_____

Signs of wildlife: _____
_____

Signs of human use: _____
_____

Bottom sediments: _____
_____

Signs of erosion: _____
_____

Gravel bars: _____
_____

Channel width: _____
_____

General depths: _____
_____

Pools: _____
_____

Riffles: _____
_____

Currents: _____
_____

Rootwads: _____
_____

Logs: _____
_____

Boulders: _____
_____

Fish feeding behavior: _____
_____

Stream Habitat Observations

Describe and illustrate the interactions you observed between organisms and their habitat when viewing the underwater environment.

Underwater Observations

Please record any other observations that were made while completing this field activity.

Stream Discharge

GRADE LEVEL
4-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Stream

MLS
4.PS3.A.1
6-8.PS3.A.2
9-12.PS3.A.1
9-12.LS2.B.2

NGSS
4-PS3-1
MS-PS3-2
HS-PS3-1
HS-LS2-4

Lesson Summary

Stream discharge or flow is the volume of water flowing past a given point in a given time. Discharge calculations can be used for flood control information and to determine the requirements for wastewater treatment plants that discharge into streams.

Objectives

Students will be able to calculate stream discharge to determine the beneficial use of a stream and how stream discharge is used for control methods. In addition, students will learn how point source pollutants can be regulated for discharge with permits.

Instructional Strategy

Classroom Activity
Work through the data discharge sheet with students so they understand the calculations and procedures before attending the field trip portion. You can also view the how to measure stream discharge video before going to the field. This can be found at mostreamteam.org/training-materials-and-resources.html

Stream discharge can be measured in four steps:

- Determine Stream Width
- Determine Cross-Sectional Area
- Measure Surface Velocity
- Calculate Stream Discharge

1. The first step in calculating discharge is to determine the width of your stream. Measure width of flowing water. Most streams have an area of non-flowing water at the edges near the bank. We call this “dead” water because it has no measurable surface velocity.
2. The second step is calculating the cross-sectional area is to measure and calculate the average stream depth. For streams less than 20 feet wide, record depth measured at every foot. For streams greater than 20 feet wide, record depth measurements every two feet. The depth must be measured in tenths of a foot.

Stream Discharge

3. We use an average depth measure because the bottom of a stream is not perfectly level. After determining the average depth in feet, multiply this by the stream width to calculate the cross-sectional area.
4. The third step is calculating the surface velocity by determining the average float time. Average float time is equal to the sum of the float times divided by the number of float trials.
5. The next step is to divide the distance floated by the average float time. Choose the correction factor that best describes the bottom of your stream and flow is variable at different depths.
6. The fourth and final calculation for stream discharge: multiply the cross-sectional area by the corrected average stream velocity.

Field Portion

Consider a stream site where the water is not deeper than the knees.
Equipment Needed:

- Two whiffle golf balls
- Tape measure
- Measure stick or dowel rod marked off in 0.1-foot increments with a permanent marker
- Stopwatch
- Calculator
- Writing utensil

VWQM methods used in this lesson plan can be found on the Stream Team website: Standard Operating Procedure - Discharge Measurement in Streams

Evaluation Strategy

A. Have half the students write a paper on the different sizes of water sources and how they are used based on their size (for example, barge travel versus inner tube travel). The rest of the students will write a paper on how water quality is impacted by stream discharge and how it is used as a control method.
B. In addition, have the students create a graph comparing the results from the different stream discharge calculations from the water sources measured. Have them discuss the similarities and differences between the graphs, what surprised them about the graph, and the different stream discharge results.

VOCABULARY

Cross-sectional area

Stream discharge

Stream width

Surface velocity

Wastewater Treatment Plant

Dissolved Oxygen

GRADE LEVEL
5-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Classroom and Stream

MLS
5.PS1.B.2
6-8.PS1.A.2
6-8.PS1.B.1
9-12.PS1.A.2

NGSS
5-PS1-4
MS-PS1-2
MS-PS1-5
HS-PS1-2

Lesson Summary

Dissolved oxygen (DO) readings are essential for assessing the health and quality of a stream. A low or high DO reading can tell you what is going on in the water system. Aquatic organisms need a certain level of oxygen to carry out life functions. Human activities such as removal of vegetation, increasing soil runoff, and algal blooms through eutrophication all impact aquatic DO levels.

Objectives

Students will learn the importance of measuring dissolved oxygen (DO) and how to measure it in the field. Students will understand the different reasons a DO reading may be high or low and will be able to name several sources of DO in a natural setting and how oxygen levels are impacted by the system.

Instructional Strategy

1. Divide the students into groups and have them choose a stream in Missouri that is of interest to them. The groups will answer the questions below and then present their research to the class.
    - Where does the water source originate?
    - What is the size of the watershed?
    - What are the potential point and nonpoint sources?
    - What is the average water temperature?
    - How often does flooding occur?
2. DO questions
    - What is the importance of DO to water quality and why we measure it?
    - What are natural influences on DO?
    - What are human influences on DO?
    - What is Diel (Daily) Fluctuations in DO?
    - How are temperature and DO are related and coincide with one another?
    - What steps can increase or decrease oxygen in a water source?

Field Trip

Remember the time of day is critical when taking samples and making

Dissolved Oxygen

comparisons. Take students to a stream they researched in the first part of the instructional strategy or a stream close to the school. It would be informative to compare the DO readings from the different streams for the classes. The students could upload their data to an online platform so all the students would have access to compare the different DO readings.

If it is not possible to go to the field, have your students find a variety of water sources in the school. Indoor sources can be a bit more challenging due to the aerators installed on the water fountain, sinks in the bathroom and kitchen requiring water to sit for several hours before sampling. Other potential water sources could include the water dish in the reptile cage, a puddle in the parking lot, the water in the fish tank, the deionized water in the science lab, etc.

VWQM methods used in this lesson plan can be found on the Stream Team website: Standard Operating Procedure - Dissolved Oxygen Measurement in Streams

Evaluation Strategy

A. Have the students complete a lab practical by performing the dissolved oxygen test correctly. You can also incorporate the use of DO, water temperature, pH, and transparency in the lesson for understanding.
B. Compare the DO readings from different parts of the stream and think why they are getting different DO readings.
C. Have the students compare their data on the an online platform. Why there are differences in their readings? What factors contribute to these differences in the readings. Have students create graphs on the different readings and have them guess were the readings were taken based on their results.
D. Have students collect DO samples from different sites around town or school throughout the year. Have students compare their DO readings that was collected throughout the year. The results should vary depending on sun exposure, temperature, time of year and day being monitored.

VOCABULARY

Dissolved oxygen

Watershed

Nonpoint source pollution

Point source pollution

pH Readings

GRADE LEVEL
5-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
5.PS1.B.2
6-8.PS1.A.2
6-8.PS1.B.1
9-12.PS1.A.2

NGSS
5-PS1-4
MS-PS1-2
MS-PS1-5
HS-PS1-2

Lesson Summary

The pH (potential hydrogen) reading of a stream or water source tells us how basic or acidic the water. pH measures the H^+ concentration on a scale from 0 to 14 and water that contains equal numbers of H^+ and OH^- is considered neutral (pH 7). Water that contains more H^+ ions than OH^- ions is acidic and has a pH less than 7 and water that contains more OH^- ions than H^+ ions is basic and has a pH greater than 7.

Objectives

Students will be able to define pH and explain the role it has in water quality. Students will be able to measure pH and will conduct in-class experiments on household solutions. Students will understand the function pH plays in a water system, factors that can affect pH and some steps that can be taken to neutralize the water source into a standard range.

Instructional Strategy

1. Divide the students into groups and have the groups choose a stream in Missouri that is of interest to them. Have them complete this background research.
    - Where does the water source originate?
    - What is the size of the watershed?
    - What are the potential point and nonpoint sources?
    - What is the average water temperature?
    - How often does flooding occur?
    - Have the students research pH to find out the importance it has in water quality and why it is important to measure.
    - Have the students research common pH levels in streams around their school and town.
        - Did these levels surprise them?
        - What factors may be contributing to these high or low numbers?
        - What role does pollution have in affecting the pH in the stream?
2. Students will make their own pH indicator solution by boiling red cabbage. Divide the students into groups and assign different tasks

pH Readings

for the making of the indicator. The red cabbage needs to be cut into small pieces and placed into a pan and covered with water. Bring the solution to a boil and remove from heat. Let it cool for half an hour and then strain the cabbage from the solution. The solution is now ready to be tested with the solutions the students brought. A few solution ideas would be laundry detergent, soda, vinegar, baking soda, floor cleaner, and water, etc.

3. Have the students measure pH at a stream at different times of the year and have them record their measurements. Have them compare their findings throughout the year and analyze why the readings may have been higher, lower, or consistent when the readings were taken. In addition, have the students test several different sites or water resources in their town and compare results. Were there certain organisms, plants, factories, sediment loads, ground water runoff, pavement, grass, etc. that could lead to these different readings.
4. Students will present their research to the class in an approved method.

VWQM methods used in this lesson plan can be found on the Stream Team website: Standard Operating Procedure - pH Measurement in Streams

Evaluation Strategy

A. Have the students complete a lab practical by performing the pH test correctly. You can also incorporate the use of DO, water temperature, pH, and transparency in the lesson for understanding. Have the students answer the question of how all these parts correlate with each other and can influence all the parameters?
B. Have students could create a graph comparing the different readings from the streams in the community. Students could also research different streams in the United States and compare the readings from another state to the reading from their stream in the communities. Compare the landscape, climate, temperature, and pollution etc. as to why the conductivity readings could be opposite or relatively close.

VOCABULARY

pH

Ions

Indicator solution

Conductivity

GRADE LEVEL
5-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom

MLS
5.PS1.B.2
6-8.PS1.A.2
6-8.PS1.B.1
9-12.PS1.A.2

NGSS
5-PS1-4
MS-PS1-2
MS-PS1-5
HS-PS1-2

Lesson Summary

Conductivity is a general water quality parameter often used to determine how many dissolved solids are dissolved in the water. Keep in mind that a conductivity measurement does not tell us which dissolved substances are in the water, just how much. Small amounts of certain dissolved solids, such as some metals, can cause substantial changes in conductivity.

Objectives

Students will be able to define conductivity, list the common types of dissolved solids, and learn how to measure conductivity in a stream or water source using a conductivity meter. Students will learn how to calibrate the meter within 12 hours of going into the field and the proper techniques used for measuring. Students will also analyze why different water sources around the state have different conductivity readings and what factors may influence these readings.

Instructional Strategy

1. Divide the students into groups and have the groups choose a stream in Missouri that is of interest to them. This could be a recreational area, a stream they like to float, or a stream close to their home. Have them complete background research on the stream before the chemical tests are completed.
    - Where does the water source originate?
    - What is the size of the watershed?
    - What are the potential point and nonpoint sources?
    - What is the average water temperature?
    - How often does flooding occur?
    - Have the students research conductivity to find out the importance it has in water quality and it is important to measure.
2. Have the students measure conductivity at a stream at different times of the year and have them record their measurements. Have them compare their findings throughout the year and analyze why the readings may have been higher, lower, or consistent when the readings were taken. In addition, have the students test several different sites or water resources in their town and

Conductivity

compare results. Were there certain organisms, plants, factories, sediment loads, ground water runoff, pavement, and grass, etc., that could lead to these different readings?

3. Students will present their research to the class in an approved method. Students are to take notes on the different streams in the region and why conductivity may differ in different parts of the state than others. Students will also choose a stream or a section of a stream in their community that has easy access to measure conductivity.

Students will learn how the conductivity meter works and how to calibrate the meter the day before the readings are going to be taken in the field.

VWQM methods used in this lesson plan can be found on the Stream Team website: Standard Operating Procedure - Specific Conductivity Measurement in Streams

Evaluation Strategy

A. Have the students complete a lab practical by performing the conductivity test correctly. You can also incorporate the use of DO, water temperature, pH, and transparency in the lesson for understanding. Have the students answer the question of how all these parts correlate with each other and can influence all the parameters?
B. Have the students create a graph either by using an online template or creating a graph by hand to show the different readings throughout the year for a stream. In addition, the students could create a graph comparing the different readings from the streams in the community.
C. Students could also research different streams in the United States and compare the readings from another state to the reading from their stream in the communities. Compare the landscape, climate, and temperature, etc., as to why the conductivity readings could be opposite or relatively close.

VOCABULARY

Conductivity

Dissolved solids

Sediment

Nitrate Readings

GRADE LEVEL
5-12

SUBJECT AREAS
Science

DURATION
1 class period

SETTING
Classroom and Stream

MLS
5.PS1.B.2
6-8.PS1.A.2
6-8.PS1.B.1
9-12.PS1.A.2

NGSS
5-PS1-4
MS-PS1-2
MS-PS1-5
HS-PS1-2

Lesson Summary

Nitrogen is an essential plant nutrient required by all living plants and animals for building protein. Nitrate is an indicator of excess nutrient loading, so it is important to understand the role nutrients, including nitrates play in the environment. Nitrate is the most stable form of nitrogen.

Objectives

Students will learn the role nitrogen plays in the environment and what naturally influences nitrate levels. Students will be able to measure nitrate levels in water. They will learn how nitrate levels can affect aquatic organisms and water quality. Students will know the causes of high nitrate levels, the need for monitoring water for nitrates, and the harmful effects of excess nutrients.

Instructional Strategy

During the instructional strategy portion please demonstrate how to use the nitrate test kit correctly and the safety precautions needed when implementing the test. As an extension you could have students research the health risks associated with drinking water with high nitrate levels.

1. Divide the students into groups and have the groups choose a stream in Missouri that is of interest to them. Complete the following questions:
    - Where does the water source originate?
    - What is the size of the watershed?
    - What are the potential point and nonpoint sources?
    - What is the average water temperature?
    - How often does flooding occur?
2. Have the students research nitrate to find out the importance it has in water quality and why it is important to measure.
3. Have several samples of water to be tested for nitrate levels. You can have jars with tap water, creek water, muddy water, and from near a livestock farm, golf course, etc.
4. Divide the students into groups and have them test the water samples. Have the students create a graph comparing results from

Nitrate Readings

the different water sources. Have them discuss the similarities and differences between the graphs, surprising results, and the different nitrate level results.

VWQM methods used in this lesson plan can be found on the Stream Team website: Standard Operating Procedure - Nitrate Measurement in Streams

Evaluation Strategy

A. Have the students complete a lab practical by performing the nitrate test correctly and answer the following questions. The students can also work through the following questionnaire for understanding of nitrates and their influences on water quality. Have the students answer the following questions:
   - Define nitrate
   - Where do nitrates come from?
   - What is the difference between nitrate and nitrite?
   - Have students research how nitrate can have a negative impact on the environment and water quality?
   - Research careers people do to use nitrate test kits
   - Why we should be concerned about nitrates?
   - Why are nitrates important for plants and other organisms?
   - What can be done to reduce excess nitrate levels in a river or stream?

B. You can also coordinate a field trip in the area around the school to have the students collect nitrate samples and to compare the samples from different areas in the community and have the students think about the reason nitrates are higher and lower.

C. The students can also research the ways in which nitrate levels are evaluated around the world and how this information is used in the chemistry field.

Reflection Section

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VOCABULARY

Aquatic

Feedlot

Nitrate

Nitrogen

Questionnaire Nitrate Sheet

1. Which samples contained nitrates?

2. Name the probable source of the nitrate.

3. Describe how human activities may have affected your test result. In your description, note any remedial activities that humans can do to help improve stream water quality.

4. Note how confining livestock can harm water quality. Give some additional ideas as to other watering ideas other than allowing the animals a direct path to the water source.

5. What level of nitrates did you expect at your site? On what factors did you base your prediction? Was your test result better or worse than you expected? Why do you think this is?

6. Explain how the nitrate level at your site might affect the aquatic plant life in or near water.

7. Explain why nitrate levels might vary at your site at different times of the year. Please explain your reasoning.

Microplastics

GRADE LEVEL
1-12

SUBJECT AREAS
Science

DURATION
1-2 class periods

SETTING
Classroom and Stream

MLS
1.LS1.A.1
6-8.LS2.C.1
6-8.ESS3.C.1
6-8.ESS3.C.2
9-12.LS2.C .1

NGSS
1-LS1-1
2-LS4-1
ML-LS2-4
MS-ESS3-4
MS-ESS3-3
HS-LS2-6

Lesson Summary

Plastic materials are used in our life every day. A litter cleanup on a stream or body of water usually contains a variety of plastic that have not been disposed of properly. When people are careless with their pollution, for example, microplastics are often consumed by organisms and other aquatic species that can have detrimental effects on these species.

Objectives

Students will be able to build a microplastic filter and test different materials for plastic content. They will understand the negative consequences plastic litter has on the environment and the different ways we can encourage citizens to dispose of it properly.

Instructional Strategy

Ask your students to look around the classroom and silently identify as many plastic objects as they can in ten seconds. Have your students list a few of the items they found and ask them if they were surprised by the amount of plastic in the classroom. This will hopefully get your students thinking about their use of plastic.

1. Divide your students into groups and have them rotate around the classroom answering questions related to plastic.
    - What is the problem with microplastics?
    - Describe the relationship between microplastics and plastic waste.
    - Can we stop using plastic? Why or why not?
    - Do you think plastics are good or bad?
    - How does plastic affect the waterways?
    - Do you think we can clean up all the plastic in the waterways? Why or why not?
    - What are potential impacts of microplastics on organisms and humans?
    - Have students research how long certain plastic materials stay around or how long it takes them to deteriorate.
2. You can introduce your students to building a basic microplastic filter by watching the following video. The students will work

Microplastics

together in groups to figure out the supplies needed and the steps to build their Microfiber microplastic filter. The students can test their microplastic filters on water sources around the community.
nightsea.com/articles/fluorescence-microplastics/

3. However, not all classrooms are going to have access to marine water and not all teachers have microscopes with fluorescent lightning. Therefore, students could explore the Missouri Water Confluence website to gather information and conduct research on the microplastic monitoring, mapping and research efforts that are taking place here in Missouri. Please check out their website below.
missouriconfluencewaterkeeper.org/microplastics

Evaluation Strategy

A. Student groups can also graph their microplastic pollution results from the various water sources in their community and discuss what factors maybe playing a role in the various levels.
B. Have your students individually respond to the following questions:
    - What is one small thing you could do to reduce microplastic pollution?
    - Do you think regulations need to be set in order to reduce the amount of microplastic pollution?
    - What is one regulation that you would suggest to reduce microplastic pollution?

Reflection Section

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VOCABULARY

Microplastics

Plastic

Microfiber

Glossary

Appendage - A projecting part of an invertebrate or other living organism, with a distinct appearance or function.

Aquatic - Living within the water.

Benthic - Bottom dwelling. Benthic organisms in streams spend their lives in or on the substrate of the streambed.

Best Management Practice - These are activities which mitigate pollution of water and the environment.

Biome - Community of flora and fauna occupying a major habitat.

Bow Caliper - A device used to measure the external size of an object.

Channelization - The process of straightening a stream channel, generally for purposes of navigation, agriculture, or to reduce the flood risk of a site. This practice often seriously damages stream habitats both upstream and downstream of the channelization site.

Conductivity - Measurement of the ability of a substance to conduct electricity. In terms of water quality, conductivity is used to gauge how many solids are dissolved in the water, as water with higher concentrations of dissolved solids is more conductive.

Contour Lines - Lines drawn on a map connecting points of equal elevation. Contour lines show elevation and the shape of the terrain. Closely spaced contour lines signify steeper slopes on a map, whereas widely spaced lines signify more even ground.

Cross-Sectional Area - The area of a two-dimensional shape that is obtained when a three-dimensional object - such as a stream channel - is sliced perpendicular to some specified axis at a point.

Crustacean - Invertebrate within the largely aquatic group Crustacea, including crayfish, scuds, sowbugs, crabs, and lobsters. Like insects and arachnids, crustaceans possess an exoskeleton and many segmented limbs.

Dichotomous Key - A tool that allows the user to determine the identity of items in the natural world, such as trees, wildflowers, mammals, reptiles, rocks, and fish. Keys consist of a series of choices that lead the user to the correct name of a given item.

Glossary

Dissolved Oxygen - The oxygen (O^2) that is in a liquid such as water; measured in milligrams per liter. Aquatic life, such as fish or amphibians, require a certain minimum level of dissolved oxygen to survive.

Dissolved Solid - Substance that is dissolved in a liquid (solvent) to form a solution. The most common dissolved solids in water are calcium, magnesium, bicarbonate, sodium, potassium, and chloride.

Ecosystem - A living community of interacting organisms and their physical environment.

Erosion - The process by which soils and rocks are gradually worn away by wind, water, or other natural agents.

Fauna - The animal species of a given environment.

Feedlot - An area or building where livestock are fed or fattened up.

Fertilizer - A chemical or natural substance added to soil or land to increase its fertility, often containing nitrogen, phosphorus, or potassium.

Floodplain - An area of low-lying ground adjacent to a river that is subject to flooding during high flows.

Food Web - A system of interconnected food chains that represents the flow of energy and nutrients between the many different organisms in an environment.

Geology - The science that deals with the earth's physical structure and substance, its history, and the processes that act on it.

Gravel Bar - An elevated region of gravel within the stream channel that has been deposited by the flow. Gravel bars often stay dry except during high stream flows.

Gravel Dredging - The process of excavating gravel from a stream channel, often to sell or otherwise use for construction projects. Gravel dredging/mining can be very harmful to stream habitats when done incorrectly.

Indicator solution - Substances whose solutions change color due to changes in pH.

Glossary

Intermittent Stream - A stream, or section of a stream, that is below the water table for at least part of the year and obtains its flow from both surface runoff and groundwater discharge.

Invertebrate - Any animal that lack a backbone. Insects, crustaceans, snails, starfish, clams, and jellyfish are all examples of invertebrates.

Ion - An atom or molecule with net electrical charge.

Landscape - Visible features of an area of land.

Macroinvertebrate - Invertebrate animal that is large enough to be visible with the naked eye.

Macroscopic - Visible to the naked eye.

Mammal - Vertebrate animal within the class Mammalia. Mammals are warm-blooded, have hair, and produce milk.

Microfiber - Very fine synthetic material.

Microhabitat - A habitat which is of small or limited extent and which differs in character from some surrounding more extensive habitat. Ex: the spaces between pieces of cobble on the stream bottom of a riffle.

Microplastic - Extremely small piece of plastic debris in the environment resulting from the disposal and breakdown of plastic consumer products and industrial waste.

Monofilament - A type of fishing line using a single strand of man-made fiber.

Nitrate - A molecule containing 1 nitrogen atom and 3 oxygen atoms. Nitrate is the most stable compound of nitrogen and can be an indicator of excess nutrient loading in water.

Nitrogen - The chemical element of atomic number 7. Occurs as a gas in its pure state but is present in many organic molecules.

Nonpoint Source Pollution - An accumulation from multiple pollution sources over a landscape, such as sediment or agriculture chemicals. These pollution sources are often harder to trace and manage for than point sources.

Glossary

pH - Stands for parts hydrogen. It is the ratio of hydrogen (H^+) and hydroxyl (OH^-) ions in water. pH is represented by a scale from 0 to 14, 0 being acidic, with a very high concentration of hydrogen ions; and 14 being basic, with a high concentration of hydroxyl ions. A pH of 7 is called neutral, and represents an equal number of hydrogen and hydroxyl ions. Most streams in Missouri range from a pH of 6.5 to 9.

Plastic- Synthetic material made of a wide range of polymers.

Point Source Pollution - Pollution that can be traced to a single source, such as a pipe.

Pool - A habitat within streams that consists of deeper, slow-moving water.

Riffle - A rocky and or shallow part of a stream or river with rough water.

Riparian Corridor - Is the part of the floodplain closest to the channel and is greatly influenced by the stream. A healthy riparian corridor will be heavily vegetated and have minimal erosion.

Root Mat - A microhabitat within streams that consists of exposed plant roots. Root mats provide important shelter and feeding areas for many stream wildlife.

Runoff - The draining away of water and the substances carried in it from the surface of an area of land, a building or structure. Ex: the water that runs into a storm drain is the runoff from streets and the roofs of buildings.

Sediment - Any particulate matter that can be transported by fluid flow and which eventually is deposited as a layer of solid particles on the bed or bottom of a body of water or other liquid.

Seine - A fishing net which hangs vertically in the water.

Stream Bed - The bottom of a stream channel.

Stream Channel - The path for water and sediment flowing within the stream banks. A stream channel constantly adjusts to changes in streamflow, sediment load, stream slope and vegetation.

Stream Discharge - The volume of water flowing past a given point in a given time. Stream discharge is typically measured in cubic feet per second (cfs).

Stream Width - The width of a stream starting from the flowing water on one side of the bank to the other side.

Glossary

Stewardship - The job of supervising or taking care of something, such as land or the environment.

Substrate - The substance(s) that form the bottom or underlaying layer(s) of an environment. Substrates in a stream bottom generally consist of a mixture of various sized particles, ranging from large boulders and pieces of cobble to gravel, sand, and or mud/silt.

Subsurface Water - Water that lies beneath the planet's surface, aka ground water.

Surface Water - Water that is visible on the planet's surface, such as rivers, lakes, and oceans.

Surface Velocity - The speed at which water is moving at the surface of the stream.

Taxa/Taxon - A taxonomic group of any rank, such as a species, family, or class.

Terrestrial - Living on dry land.

Topographic - The arrangement of the physical features of an area, such as mountains and rivers.

Vegetation - Ground cover provided by plants.

Wastewater Treatment Plant - A facility that treats, filters, or otherwise cleans wastewater (sewage) from a city or municipality before releasing it into water bodies.

Watershed - The portion of land from which all water drains before entering a single water body, such as a river or lake. Watersheds are separated by areas of high elevation, from gentle hills to mountain peaks, and range in scale from small stream valleys to areas covering vast portions of a continent.

Wetland - A distinct ecosystem that is flooded by water, either permanently or seasonally.

Woody Debris - Tree limbs or trunks that have fallen or been washed into the stream channel. Woody debris provides important habitat for many stream animals.

Missouri Stream Team is sponsored by
Missouri Department of Conservation
Missouri Department of Natural Resources
Conservation Federation of Missouri

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