AQUATIC INVASIVE SPECIES

WHAT IS AN ECOSYSTEM?

SKILL LEVEL
6th-8th

KEY TERMS
Species
Population
Community
Ecosystem
Biome
Biosphere
Biotic
Abiotic
Food Chain
Food Web
Fishery
Benthic
Macroinvertebrates
Tolerant
Intolerant

EDUCATION STANDARDS
SD Science: MS-LS2-2
SD Mathematics: 7.SP

TIME NEEDED
50-75 Minutes

MATERIAL LIST
» Strainers, Nets, Kick Nets
» Tubs (for viewing Macroinvertebrates)
» Thermometer
» Benthic Macroinvertebrate ID Sheet (in Appendix)
» Doodle Sheet – Stream Ecology (in Appendix)
» Computer and/or projector
» Stream/Pond Ecology Worksheet

EXPECTED LEARNER OUTCOMES

» **OBJECTIVE 1:** Students will be able to define what an ecosystem is and explain how it differs from a species, population, community, biome, and biosphere.
» **OBJECTIVE 2:** Students will be able to explain and identify abiotic and biotic elements of an ecosystem.
» **OBJECTIVE 3:** Students will understand the unique characteristics of an aquatic ecosystem.

BACKGROUND

Before we jump into understanding Aquatic Invasive Species, it is crucial that we understand aquatic ecosystems. An **ecosystem** or an **ecological system** is all the living and nonliving elements that make up a specific geographic area. The living and nonliving characteristics in an ecosystem are linked together through a variety of systems and cycles. When these systems and cycles are interrupted or altered, they affect the health of the ecosystem.

Here in South Dakota, we have many terrestrial and aquatic ecosystems. For a complete list of these various ecosystems, check out the Wildlife Action Plan - Game, Fish and Parks - South Dakota (*gfp.sd.gov*).

VOCABULARY

Species
A group of living organisms consisting of similar individuals capable of exchanging genes or interbreeding.

Population
A group of individuals of the same species living and interbreeding within a given area.

Community
An interacting group of various species in a common location.

Ecosystem
A system that consists of biotic and abiotic components that function together as a unit.

Biome
A large naturally occurring community of flora and fauna occupying a major habitat.

Biosphere
The regions of the surface, atmosphere, and hydrosphere of the earth occupied by living organisms.

Biotic
Relating to or resulting from living things, especially in their ecological relations.

Abiotic
Physical rather than biological; not derived from living organisms.

Food Chain
A hierarchical series of organisms that depend upon the next as food.

Food Web
All the food chains in a single ecosystem.

Fishery
A fishing ground or area where fish are caught.

Benthic Macroinvertebrates
Invertebrates (e.g., crayfish, mayfly nymphs) that live on the bottom of streams, rivers and lakes and are visible to the naked eye.

Tolerant
Able to endure certain conditions (in the case of macroinvertebrates, this would be tolerance to pollution).

Intolerant
Sensitive or easily affected by adverse conditions (in the case of macroinvertebrates, this would be intolerance to pollution).

ACTIVITY PREPARATION

Begin the lesson by asking what students remember from their class lessons about **species**, **population**, **community**, **ecosystem**, **biome**, and **biosphere**. *Note:* If you have not covered this yet in class, now is the perfect time to introduce students to it with the understanding that the lesson will focus mainly on ecosystems.

Transition: Once you have reviewed species, population, community, ecosystem, biome, and biosphere, inform students you will be digging deeper into ecosystems.

ABIOTIC VS BIOTIC – 5 MINUTES

Break students into groups and take them outside. Have students spend 2 minutes sitting in an area and writing down all that they see. Ask students if they know what **abiotic** and **biotic** mean. To tease this out, ask students to think through "bio-" and further "biology," this will usually lead to discussion about life or living (connect to Latin). Then ask if they know what "a-" means (connect to the Latin). Based on this conversation, have students categorize their findings as abiotic or biotic.

Adaptation: If you are unable to take students outside, you can do the activity inside by having students think of their backyard, putting a picture on the board for them to think through, or showing a YouTube video of a landscape.

Transition: Now that students have had the opportunity to think through abiotic and biotic elements of an ecosystem, it is important to spend a little bit of time discussing food webs. A **food web** is a system of interlocking and interdependent food chains within an ecosystem. An example of this would be a mayfly nymph being eaten by a dragonfly nymph which in turn might be eaten by either a fish or a frog and a fish being eaten by an osprey and a frog being eaten by a snake.

FOOD WEB – 5 MINUTES

To demonstrate a food web, have each student pick an animal or plant that is located near a stream. Take a ball of yarn or a ball of twine and tell students you are going to be demonstrating interactions between species in an ecosystem. Have students stand in a circle and ask someone to start by holding the twine. Have that person say what animal or plant they represent. Then have someone different take the ball of twine from the person who would consume that animal or plant the original twine holder is representing (Note: Each student will be holding a piece of twine as you go through the process. Students should not let go of the twine, but simply pass the remainder of the twine). As the twine gets passed along it should begin to look like a web. Continue until each person is holding a bit of the twine.

Digging Deeper: If you would like to go past simply visualizing what a food web looks like, you can introduce problems to the food web. For example, while everyone is holding the twine in the web, remove a piece of the web, such as remove an animal. Have the students tighten the web, this can show how ecosystems can shift based on what is available. Another adaptation of this would be to have one person begin to lightly tug on the string and have each person tug on the string when they feel the tug. Mention that this tugging indicates the interconnectedness of the food web and how if one species is affected it can affect the whole food web. (*Note: Don't let the students "tugging" get too aggressive, inform students it is a gentle tug only*).

Transition: Inform students that you are now going to be exploring a specific aquatic ecosystem and recording your observations of that ecosystem. Ask students to be cognizant of what biotic and abiotic elements are present when they observe and explore the aquatic ecosystem.

EXTENDED LEARNING

For further learning, consider exploring:

» The South Dakota Wildlife Action Plan (*gfp.sd.gov/wildlife-action-plan*)

» Adding in information about the various cycles present in an ecosystem: Carbon Cycle, Phosphorous Cycle, Hydrologic Cycle, Nitrogen Cycle, Sulfur Cycle

» For more information and a lesson plan for Carrying Capacity see supplemental Lesson Plans.

» During the Stream Ecology, you can add pH and Dissolved Oxygen (DO) to introduce chemical tests to their learning.

STREAM OR POND ECOLOGY – 20 MINUTES

Bring the class to the edge of the water and hand each of them the provided stream/pond ecology worksheet. Have students begin the observation section. Ask them to use their senses to notice everything they can about the given area. Then as a group choose a volunteer to help with taking the aquatic bodies temperature, have students record this data.

Now that we have made observations, we are going to conduct an index to ascertain what types of species are in the water. Note any plants or animals, but also we will pay special attention to **Benthic Macroinvertebrates**. Pass out strainers and identification cards for the benthic macroinvertebrates. Allow students 5-10 minutes to search and then draw the group back together to discuss and count the types of species found. (Utilize the key in the Printables section to help in identification. You can also have the class visit: *waterbugkey.vcsu.edu* for another way to identify the invertebrates).

Adaptation: If you are unable to do this activity outside, you can utilize the indoor adaptation (see appendix A).

Transition: Inform students that you will be returning to the classroom to review your findings.

DOODLE SHEET EXPLANATION – 5 MINUTES

Back at the classroom, give each student a Doodle Sheet (see printable section) and work as a class to define abiotic and biotic. Then have students list out any abiotic or biotic species they noticed in the aquatic ecosystem. Work with students to define an ecosystem and review.

Optional Activity – Carrying Capacity – See Appendix B

REFLECTION

POST-ACTIVITY: DIAGRAMMING

» A good way to wrap up this lesson is to either as a class convert their data to a bar graph based on how many of each invertebrate was found. This could be accomplished on a white board or via an Excel spreadsheet. This will allow for another visualization of the information.

POST-ACTIVITY ALTERNATE: EXIT TICKET

» Prior to class ending, ask students to think of one new thing they learned about ecosystems from today's lesson. Inform students they will "have to" tell you the new piece of information they learned from class prior to exiting the room.

POST-ACTIVITY DISCUSSION QUESTIONS:

» What makes up an ecosystem? How does it differ from a community? How does it differ from a biome?

» What can interfere with the health of ecosystems and food webs?

APPENDICES

APPENDIX A: ACTIVITY PREPARATION - INDOOR ADAPTATION

STREAM OR POND ECOLOGY – 20 MINUTES

Inform students that they will be simulating a bioassessment of a stream utilizing common objects to represent Benthic Macroinvertebrates.

Display a photo of a lake or stream on a television for all to see or print off copies for students to view. Hand each student a stream/pond ecology worksheet and ask students to record in the observation section what they notice.

Note: for the air temperature, say it is 70°F or 21°C. For the smell section, say the area smells "earthy" and the water has no smell.

Now that we have made observations, we are going to conduct an index to ascertain what types of species are in the water. Instruct students that they will go to each station and utilize a strainer to "collect" samples. Student groups should spend a max of 20 seconds sampling the source. *Note, this works best if you have a sampling site per student group.

Setting up the collection site:

» Utilizing a 5-gallon bucket (per group), fill the bucket up about halfway with water.

» Put the following objects in each of the buckets (ie collection sites) so all are sampling the same type of water.

MACROINVERTEBRATE:	REPRESENTED BY:	# OF OBJECT PER COLLECTION SITE:
Mayfly	Yellow Beads	15
Stonefly	Small Paper Clips	35
Dobsonfly	Large Paper Clips	20
Caddisfly	Red Beads	20
Craneflies	White Beads	13
Dragonfly	Green Beads	20
Scuds	Black Beads	15
Midges	Blue Beads	20
Leeches	Thick Rubber Bands	15
Pouch Snails	Pennies	15
Tubifex Worms	Thin Rubber Bands	15

After sampling the source, have the students sit in their groups, categorize their **Benthic Macroinvertebrates** (utilizing the provided correlation chart below) and record their data on the provided sheet.

Allow 5-10 minutes for the index and group discussion. Then draw the group back together to discuss and count the types of species found.

*Adapted from Project Wet.

APPENDICES

APPENDIX B: OPTIONAL LESSON – CARRYING CAPACITY

CARRYING CAPACITY – 20 MINUTES

Introduction: When it comes to ecosystems, it is important to understand that each ecosystem has a certain carrying capacity. Carrying capacity refers to the population of a given species that a habitat can support without environmental degradation. It is the largest population that a unit of habitat can support on a year-round basis. Overpopulation of any particular species can push things out of whack, but underpopulation can be just as detrimental. Carrying capacity can fluctuate often, both seasonally and annually. Some of this can be caused by outside factors, such as natural disasters, rainfall or lack thereof, temperature changes, and human interactions.

CARRYING CAPACITY – 15 MINUTES (ADAPTED FROM PROJECT WILD'S "OH DEER")

In this activity break students into two separate groups: resources and Otters. Have students line up on either end of a field facing each other. Explain to them that half will be resources that otters need: food, water, and shelter and half of them will be osprey. The job of the resource is to choose to be one of the resources: food (represented by hands on their stomach), water (represented by hands on mouth), and shelter (represented by hands over head like a house). The job of the otters is to go and collect a resource. The otters are also to pick one of the resources they would like to collect: food, water, or shelter. To further simulate need not being based on availability of the resource, have otters and resources face away from each other. Both groups choose independent of knowing what the other wants. Each student resource or otter should choose what they want to gather or be individually. Tell students when you say "go" they are to turn around and see what is available. Otters can then go and run (or walk depending on your group) to collect the resource that matches the resource need they identified. (Note: students cannot change their resource or resource choice after seeing what is available). Students are to go down and tag the resource that matches there's and bring it back to their side. This simulates surviving another year, reproducing, and leading to more otters. If an otter cannot find a matching resource, they "die," and become a resource.

Repeat this activity multiple rounds and collect the data from each round. Depending on the way things go, you may end up with all the otters dying (can lead to good discussion on extinction and carrying capacity) or all the resources being used up (can lead to another good discussion on carrying capacity).

When collecting data during the activity, the following is all that is necessary:

YEAR (EACH "ROUND" OF THE ACTIVITY)	# OF OTTERS ALIVE/BORN AT THE END OF THE ROUND
0	_____ otters started out
1	
2	
3	
n	

After running a couple of rounds, go inside and map the results on a graph with the X-Axis being years and the Y-Axis being population. Discuss carrying capacity and what it looks like to overshoot it. Often it will oscillate at the carrying capacity.

This can lead to good discussions on J-Curves and S-Curves with population growth.

There are mathematical equations that resource managers use to determine the carry capacity of an ecosystem, but they can be a bit difficult to understand. Rather, it's more important for the students to understand that anytime a change happens in a population, it can impact the whole ecosystem.

PRINTABLES

1. Field Study
2. Macroinvertebrate Biotic Index
3. Doodle Sheet

FIELD STUDY

Name: _____

OBSERVATIONS

Date: _____ Time: _____
Location: _____
General Weather: _____, Air Temperature: _____

Surrounding area observations: _____
_____

Types of vegetation: _____
Types of animals (not Benthic Macroinvertebrate's):_____
_____
Smell of area: _____ Smell of water: _____

Water Observations:
- Clear/murky: _____
- Moving/still: _____
- Rocky bottom/silty bottom: _____

PHYSICAL TESTS

Water Temperature

What is the temperature of the water? _____

Biotic Survey

INTOLERANT INVERTEBRATES

Species Type						
Number of Species						

FAIRLY INTOLERANT INVERTEBRATES

Species Type						
Number of Species						

TOLERANT INVERTEBRATES

Species Type						
Number of Species						

Which type of invertebrate was there most of? _____

What could be some factors that would influence the findings? _____

Based just on the biotic survey is the water clean? Why or why not? _____
_____

CONCLUSIONS

Based on all our findings, tests, and observations, is the water clean? Why or why not?

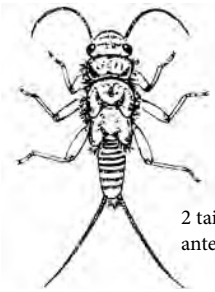
_____
_____
_____

If the stream/lake is polluted, brainstorm some possible sources of this pollution.

_____
_____

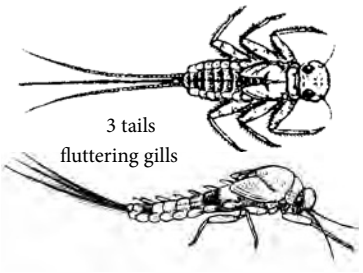
Macroinvertebrate Identification Key

GROUP 1 – Very Intolerant of Pollution



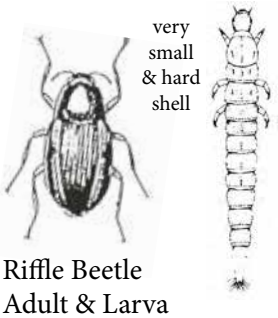
2 tails long antennae

Stonefly Nymph



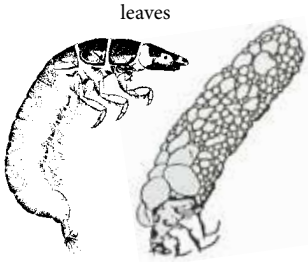
3 tails
fluttering gills

Mayfly Nymph



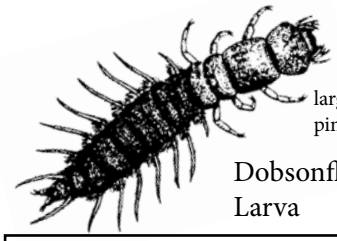
very small & hard shell

Riffle Beetle Adult & Larva



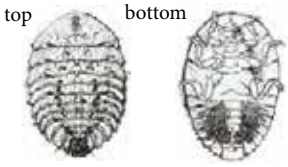
makes a case from twigs, rocks, leaves

Caddisfly Larva



large head & 2 pinchers

Dobsonfly Larva



top

bottom

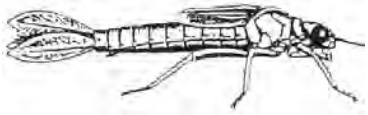
looks like a suction cup

Water Penny Larva

Right-Handed Snail

must be alive to count

GROUP 2 – Moderately Intolerant of Pollution



3 paddle-like (feathery) tails

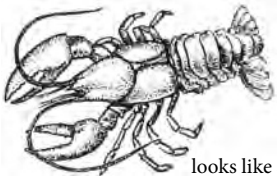
Damselfly Nymph

Dragonfly Nymph

no tails large eyes

flattened side-ways & swims on side

Scud



Crayfish

looks like a mini-lobster

Sowbug

flattened top to bottom (looks like a pill bug)

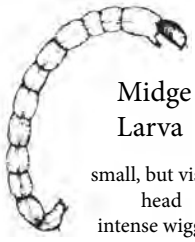
Cranefly

caterpillar-shaped, ringed

must be alive to count

Clam/Mussel

GROUP 3 – Fairly Tolerant of Pollution



Midge Larva

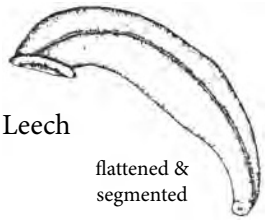
small, but visible head
intense wiggler

Planaria

2 eye spots & very small

one end is swollen

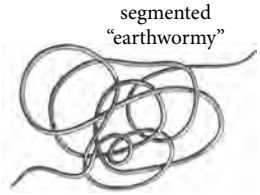
Black Fly Larva



Leech

flattened & segmented

GROUP 4 – Very Tolerant of Pollution

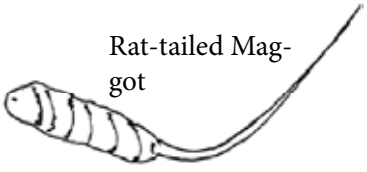


segmented "earthwormy"

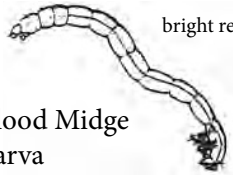
Aquatic Worms

must be alive to count

Left-Handed Snail



Rat-tailed Maggot



bright red

Blood Midge Larva

Abiotic

Examples

Biotic

Examples

"bio" comes from the Greek "bios" meaning living.

Ecosystem

Biosphere	→	Ecosystem	→	Community	→	Population	→	Species