RipCycles & Nutrient Travels

Adapted from: "Water Wonders" in Project Learning Tree produced by The American Forest Foundation, Washington, D.C., 1996.

Grade Level:
Part A: Intermediate to Advanced.
Part B: Basic to Advanced

Duration:
Part A: 40 minutes
Part B: 30 minutes per nutrient cycle

Setting: Classroom

Summary: In Part A, students read information and answer questions about nutrient cycling in riparian ecosystems, particularly the carbon, nitrogen, and phosphorous cycles. In Part B, students follow the travels of these nutrients through a riparian ecosystem.

Objectives: Students will be able to define a cycle, describe the importance of nutrient cycling in ecosystems, describe the carbon, nitrogen, and phosphorous cycles in riparian ecosystems, and identify the abiotic and biotic factors involved in these nutrient cycles.

Vocabulary: riparian, ecosystem, nutrient cycling, biotic, abiotic, producers, consumers, photosynthesis, metabolism, phytoplankton, CPOM, shredders, FPOM, combustion, sedimentation, respiration, excretion, sinks, sources, nitrogen fixation, leguminous, nitrification, assimilation, atmospheric nitrogen fixation, ammonification

Related Module Resources:
- "Riparian Buffer Basics" Fact Sheet

Materials (Included in Module):
- "RipCycles: Nutrient Cycling in Riparian Ecosystems" Info Sheets
- Study Questions & Answer Key
- Nutrient Cycle Diagram overhead transparencies
- Nutrient Travels brown paper bags, cards, and station signs
- Nutrient Travel Logs
- Nutrient Travels Station Cards lists
- Nutrient Travels Card Originals for making your own game pieces

Additional Materials (NOT Included in Module):
- Tape, overhead projector

ACADEMIC STANDARDS: (ENVIRONMENT & ECOLOGY)

GRADE 7

4.3.7.B. Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health.

4.6.7.A. Explain the flows of energy and matter from organism to organism within an ecosystem.
- Identify and explain the characteristics of biotic and abiotic.
- Demonstrate the dependency of living components in the ecosystem on the nonliving components.
- Explain energy flow through a food web.
- Understand limiting factors and predict their effects on an organism.
- Identify the relationship of abiotic and biotic components and explain their interaction in an ecosystem.

4.6.7.B. Explain the concepts of cycles.
- Identify and explain cycles within an ecosystem.
- Analyze the role of different cycles within an ecosystem.

4.6.7.C. Explain how ecosystems change over time.
- Explain a change in an ecosystem that relates to humans.

4.8.7.D. Explain the importance of maintaining the natural resources at the local, state and national levels.
- Explain how human activities and natural events have affected ecosystems.

GRADE 10

4.1.10.C. Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
- Categorize aquatic organisms found in a watershed continuum from headwater to mouth (e. g., shredder, predator, decomposer).

4.1.10.D. Describe the multiple functions of wetlands.
- Describe wetlands in terms of their effects (e. g., habitat, flood, buffer zones, prevention areas, nurseries, food production areas).

4.6.10.A. Explain the biotic and abiotic components of an ecosystem and their interaction.
- Compare and contrast the interactions of biotic and abiotic components in an ecosystem.
- Analyze the effects of abiotic factors on specific ecosystems.
- Describe how the availability of resources affects organisms in an ecosystem.
- Explain trophic levels.
- Examine and explain how organisms modify their environments to sustain their needs.

4.6.10.B. Explain how cycles affect the balance in an ecosystem.
- Describe an element cycle and its role in an ecosystem.
- Explain the consequences of interrupting natural cycles.

4.6.10.C. Analyze how ecosystems change over time.
- Analyze consequences of interrupting natural cycles.

4.8.10.C. Analyze how human activities may cause changes in an ecosystem.
- Analyze and evaluate changes in the environment that are the result of human activities.
- Compare and contrast the environmental effects of different industrial strategies (e. g., energy generation, transportation, logging, mining, agriculture).

GRADE 12

4.1.12.D. Analyze the complex and diverse ecosystems of wetlands.
- Explain the functions of habitat, nutrient production, migration stopover and groundwater recharge as it relates to wetlands.
- Explain the dynamics of a wetland ecosystem.

**NOTE: Riparian areas frequently contain wetlands or are considered to be wetlands.*

4.1.12.E. Evaluate the trade-offs, costs and benefits of conserving watersheds and wetlands.
- Evaluate the effects of human activities on watersheds and wetlands.

4.6.12.A. Analyze the interdependence of an ecosystem.
- Analyze the relationships among components of an ecosyste**m.**
- Analyze the positive or negative impacts of outside influences on an ecosyste**m.**

4.6.12.B. Analyze the impact of cycles on the ecosystem.
- Evaluate the materials necessary for natural cycles.
- Explain the processes involved in the natural cycles.

4.6.12.C. Analyze how human action and natural changes affect the balance within an ecosystem.
- Analyze the effects of substances that move through natural cycles.
- Analyze the effects of natural occurrences and their effects on ecosystems.
- Analyze effects of human action on an ecosystem.
- Compare the stages of succession and how they influence the cycles existing in an ecosystem.

BACKGROUND:

See "RipCycles: Nutrient Cycling in Riparian Ecosystems" for extensive background information.

OVERVIEW:

In Part A, "RipCycles", students read background information and study diagrams on nutrient cycling in riparian ecosystems. They then answer study questions based on the information presented. In Part B, "Nutrient Travels", students trace the pathway of carbon, nitrogen, and/or phosphorous molecules as they cycle through riparian ecosystems.

PROCEDURE:

Teacher Preparation:

Part A: RipCycles

Make copies of "RipCycles: Nutrient Cycling in Riparian Ecosystems" and "Study Questions" for your students.

Part B: Nutrient Travels

1. Make copies of the "Nutrient Travel Log" Data Sheet for each student.

2. Select the carbon, nitrogen, or phosphorous cycle and tape the station brown paper bags corresponding to that nutrient cycle around the classroom. Spread out the stations as much as possible. Verify that the laminated cards in the station brown paper bag are for the appropriate nutrient and that they are thoroughly shuffled.

Student Experiment or Activity:

Part A: RipCycles

1. Pass out "RipCycles: Nutrient Cycling in Riparian Ecosystems" and "Study Questions" to your students.

2. Have them read the background information carefully and study the nutrient cycle diagrams. Have them complete the study questions based on that information.

3. Go over the answers to the questions, clarify points of confusion, and stimulate a discussion about the importance of nutrient cycles and the pathways followed by different nutrients through ecosystems.

Part B: Nutrient Travels

1. Ask students to define "cycle" and brainstorm cycles that they are familiar with.
   A cycle is a series of events that occur over and over again.

2. Ask students to define "nutrient" and brainstorm some common nutrients.
   A nutrient is a material or molecule that is required by living things for maintenance, growth, and reproduction. Examples of nutrients include water, protein (from nitrogen), vitamins, minerals (such as phosphates) and carbohydrates (from carbon).

3. Ask students to define "nutrient cycling" and describe why it is important in ecosystems. *Nutrient cycling is the repeated pathway of particular nutrients or elements from the environment, through one or more organisms, back to the environment. Nutrient cycling is important in ecosystems because there is a fixed quantity of nutrients. If these nutrients weren't cycled, they would run out in some places and build up in others.*

4. Explain to students that they will be doing an activity about the carbon, nitrogen, or phosphorous cycles, depending on the cycle you have selected. They will be following the journey of that nutrient through a riparian ecosystem. Briefly review what a riparian ecosystem is. *A riparian ecosystem is the streamside interface between aquatic and terrestrial ecosystems.*

5. Before starting the activity, ask students to describe why the nutrient they are studying is important to living things. Then have them explain the nutrient cycle they will be following in a paragraph or diagram. Be sure they mention the source of this nutrient in the environment. Review the nutrient cycle using the overhead transparency diagram of that cycle included in the module.

6. Distribute a copy of the "Nutrient Travel Log" Data Sheet to each student.

7. Divide the students into 8 groups if you are doing the carbon cycle or 7 groups if you are doing the nitrogen or phosphorous cycles.

8. Assign each group to one of the stations you have set up around the room. You may want to draw a diagram for the students to refer to indicating the location of the various stations around the room. Ask a member of each group to announce their station name to the rest of the class. Be sure to define and/or give examples of terrestrial, aquatic, producers, consumers and/or biomass if necessary.

9. Have the students record the station name on their "Nutrient Travel Log" Data Sheet under "Station Stop."

10. Have each student take a laminated card out of the station brown paper bag and read it.

11. Have them summarize the card text on their "Nutrient Travel Log" Data Sheet under "What Happens?" (e.g. "The aquatic producer uses you to grow.") and "Destination" (e.g., Aquatic Producer, Soil, Rocks, etc.). Have them put the card back in the brown paper bag.

12. After a few minutes, blow a whistle or otherwise signal to students that it is time to follow the directions on their cards and go to their next destination. (Controlling students' circulation around the room brings order to this activity. Older, more mature students might be able to circulate freely without the teacher signaling when to move, etc.) Students will either proceed to a new station or stay at their current

station for one to three turns. Students who stay at a station for multiple rounds should record that station under "Station Stop" on their Data Sheet for each round they spend there. If their card simply tells them to stay at their station, have them draw another card from that envelope in the next round.

13. Upon arrival at the next station, students should repeat steps 9 through 12.

14. After 5 total rounds have been completed, instruct students to stop what they're doing and look around the classroom. Have them note where groups of students have built up. This will give them grounds upon which to answer the discussion question related to sources and sinks. Then, continue the activity for five more rounds so that ten total rounds have been completed.

DISCUSSION:

Part A: RipCycles

Use "Study Questions" for discussion.

Part B: Nutrient Travels

What does the text on the laminated cards represent? *The text on the laminated cards represents a step in the pathway followed by the nutrient as it is cycled in an ecosystem.*

Some cards at the different stations made you stay at that station for one to three turns. What does this tell us about the length of time of each step in a particular nutrient cycle pathway? *Not all steps in a given nutrient cycle pathway take equal amounts of time. For example, it takes longer for the carbon in biomass to be converted to coal than it does for humans to release carbon back into the atmosphere by burning that coal for electricity.*

Did groups of students build up at any particular station(s)? If so, which stations? What do these stations represent? *Stations where large quantities of a given nutrient are stored are called "sinks." Waterways, soil and the atmosphere are examples of sinks. Cycle processes that release large quantities of a given nutrient back into the water, atmosphere, or soil are referred to as "sources." Respiration, excretion, and decomposition are examples of sources.*

Did any two students go to the exact same 10 station stops? What does this tell about the number of pathways along which a nutrient can be cycled? What were some similarities among the different pathways the students followed? *They are many pathways along which a nutrient can be cycled. All pathways involve biotic and abiotic components and have sinks and sources.*

What are examples of biotic and abiotic components along the nutrient pathway you followed? *Biotic: aquatic and terrestrial producers, consumers, and decomposers. Abiotic: Rocks, soil, the atmosphere, and water.*

How do biotic components of an ecosystem depend on abiotic components of that ecosystem? *For example, plants(biotic) depend on carbon dioxide (abiotic) from the*

atmosphere or dissolved in water for photosynthesis to produce food. Plants also depend on phosphates from rocks and nitrates in the soil to synthesize nucleic acids, cells membranes, proteins, RNA, and DNA.

What is the role of nutrient cycles in ecosystems? *Ecosystems rely on nutrient cycles because the amount of available nutrients in an ecosystem is fixed. Therefore, nutrients must be constantly recycled between biotic and abiotic components to meet the nutrient requirements of living things in the ecosystem.*

What would happen if nutrients weren't cycled? *Nutrients would build up in some places and run out in others.*

Why are carbon, nitrogen, and/or phosphorous important in ecosystems? *Carbon is important because it is a structural component of all organic molecules (e.g., carbohydrates, fats, proteins, nucleic acids, RNA, and DNA). Nitrogen is an essential nutrient because it is used by organisms to synthesize amino acids, proteins, RNA, and DNA. Phosphorous is important in ecosystems because phosphorous containing compounds are involved in energy transfer processes, which affect productivity. Phosphorous is also a component of DNA, nucleic acids, and fats.*

How might humans disrupt this nutrient cycle? How do these disruptions negatively affect the environment? *Humans disrupt the carbon cycle by burning fossil fuels and releasing carbon dioxide back into the atmosphere. This extra carbon dioxide leads to global climate change. Humans disrupt the nitrogen and phosphorous cycles by adding nitrogen and phosphorous rich fertilizers to agricultural lands. These nutrients are eventually washed into waterways in runoff, dramatically increasing nutrient levels in those waterways. Excess nitrogen and phosphorous in waterways lead to algal blooms and eventually eutrophication, which depletes the waterway of oxygen and harms aquatic life. Humans can also disrupt nutrient cycles by removing biomass via agriculture, timbering, construction, etc. When this biomass is removed from its original site, the nutrients contained within its tissues are not returned to the soil. In the case of agriculture, the depletion of soil nutrients by the removal of biomass is compensated for by the application of fertilizers.*

Algal blooms and eutrophication do not frequently occur naturally. They are almost always the result of human disruptions of the nitrogen and phosphorous cycles. Why don't natural algal blooms and eutrophication occur frequently? *Nitrogen and phosphorous are the major factors limiting plant growth in aquatic ecosystems. When these two nutrients are cycled efficiently, they is rarely excess nitrogen or phosphorous that causes algal blooms and eutrophication.*

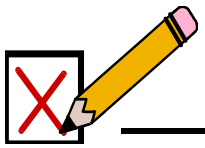
EVALUATION:

- Correctly completed Study Questions.
- Correctly completed Nutrient Travel Log.
- Discussion questions above.

EXTENSIONS AND MODIFICATIONS:

- Divide students into groups to work on the Study Questions or reorganize the questions into shorter nutrient-specific study sheets. Have students work on a specific nutrient cycle and then present their findings to the rest of the class.
- Challenge students to come up with examples of terrestrial and aquatic producers and consumers when they encounter these general terms on the laminated cards in Nutrient Travels. Have them write their example(s) on their Nutrient Travel Logs.
- Use the Nutrient Travels activity to discuss trophic levels or supersaturation and undersaturation.
- Write or have students come up with additional cards for the various Station Stops that bring the idea of nutrient cycle disruption and its consequences into the game. For example, in the Nitrogen Travels game, you might include something like "The Terrestrial Producer (soybean plant) is harvested, taking its nutrients with it and depleting the soil of nitrogen."
- Construct $1m^3$ litter boxes out of wood with window screen stapled to all sides and a lid that opens. In the fall, fill the boxes with leaves and then weigh the leaves. Return to the field site every few weeks and weigh the litter box contents each time. What happens to the leaf litter? Why aren't dead leaves piled high in forests? Discuss how the carbon is recycled back into the ecosystem.

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):



DATA SHEET: NUTRIENT TRAVEL LOG

Name_____Date_____

NUTRIENT: _____

STATION STOP	WHAT HAPPENS?	DESTINATION
EXAMPLE Soil	Taken up by terrestrial producer.	Terrestrial Producer
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		