Summer: Getting the Bugs Out

Middle Level Lesson Plan

Topic
Biodiversity, classification

Grade Levels
7-8

Overview
Expert biologists, eager naturalists, and members of the public of all ages gathered in late June 2004 at the Quechee Gorge in Vermont. They were conducting one of the most comprehensive biological inventories of any site ever done in northern New England. Known as a BioBlitz, it was a 24-hour "marathon," combining science, discovery, education, celebration, competition, and fun. This QUEST episode, *Summer*, tags along with individuals who participated in BioBlitz. The video shows participants scouring diverse habitats (wetlands, meadows, reservoirs, and wooded trails) to collect, inventory, and learn about the incredible diversity of organisms found in this relatively small area.

Introduction
This set of activities is designed to deepen students' understanding and appreciation of the impressive diversity of life found in their local area. Students will learn about a variety of techniques used by scientists to inventory and measure the biological diversity of a particular area. They will also carry out their own study of diversity using weathered pine cones.

At the end of this teaching unit, students will be able to:

- Describe biological diversity.
- Describe several methods of inventorying the biodiversity in a given area.
- Describe the importance of preserving biological diversity.
- Give examples of complex interdependencies among organisms.
- Compare and contrast "invented" classification systems with those used by biologists.

Time Allotment
Seven to eight 45-minute class periods.

QUEST: Investigating Our World is a regional public television series seen on Maine Public Broadcasting Network, Vermont Public Television, and New Hampshire Public Television

Maine Public Broadcasting Network · New Hampshire Public Television · Vermont Public Television · PBS

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Accessing Prior Knowledge

Middle-school students have already been introduced to the variety of plants and animals found in a number of different ecosystems. They will be familiar with organisms typically found in tropical rain forests, deserts, coniferous forests, grasslands, oceans, and so on. This prior knowledge should be used to build upon students' understanding of the complexity of interrelationships within ecological systems.

In addition, middle-school students have had prior experience in sorting and classifying objects, including living things. They should be able to recognize that there are a number of ways to group living things using different features. Remind students that each feature selected for grouping is dependent on the purpose for the grouping, and that systems of classification vary in response to the purpose(s) of the task.

Concepts to Clarify

The series of activities in this unit is best used after students are familiar with the distinguishing characteristics of major taxonomic levels. Students should have familiarity with the traditional five kingdoms of classification used in modern biology: animals, plants, monera, protists, and fungi.

Students should also be familiar with the use of field guides, dichotomous keys, and other reference materials.

Some students may have trouble understanding that classification systems are not part of nature. As stated in the Benchmarks for Science Literacy, classification systems are created by biologists "for describing the vast diversity of organisms, suggesting relationships among living things, and framing research questions." (AAAS, 1993)

Be mindful of misconceptions about various taxonomic groupings. For example, research indicates that individuals commonly have much narrower perceptions of animals – believing, for example, that animals are only those creatures that are four-legged, have fur, and are relatively large.

CONNECTIONS TO THE STANDARDS

National Science Education Standards	Benchmarks for Science Literacy	Maine Learning Results	New Hampshire Curriculum Framework	Vermont Learning Standards
Life Science (5-8) Diversity and Adaptations of Organisms 1. Millions of species of animals, plants, and microorganisms are alive today. Although different species might look dissimilar, the unity among organisms becomes apparent from an analysis of internal structures, the similarity of their chemical processes, and the evidence of common ancestry.	Chapter 5A: Diversity of Life (6-8) 3. Similarities among organisms are found in internal anatomical features, which can be used to infer the degree of relatedness among organisms. In classifying organisms, biologists consider details of internal and external structures to be more important than behavior or general appearance.	A. Classifying Life Forms (5-8) – Compare systems of classifying organisms, including systems used by scientists. – Decipher the system for assigning a scientific name to every living thing. – Describe some structural and behavioral adaptations that allow organisms to survive in a changing environment. J. Inquiry and Problem Solving – Design and conduct scientific investigations which include controlled experiments and systematic observations. Collect and analyze data, and draw conclusions fairly.	Life Science 3a. Curriculum Standard 1 (Grade 6) – Classify a variety of organisms based on their characteristics, and use this scheme as a tool to organize information about the diversity of life forms. Standard 1 (Grade 10) – Identify and give examples of representative life forms in the five kingdoms of living things. 3b. Curriculum Standard 5 (Grade 6) – Identify and describe examples of New Hampshire animals and plants that live together in one ecosystem, e.g., forest, seashore, lake, river, stream.	The Living World (5-8) 7.13.dd: Describe evolution in terms of diversity and adaptation, variation, extinction, and natural selection.

Materials Needed

- TV with VCR
- QUEST *Summer* video
- Computers with Internet access
- Two sheets of lined note paper
- One sheet of 8-1/2" x 11" plain paper for drawing
- Graph paper or access to computer graphing program
- Chart paper and markers
- One copy per student of each of the following reproducible handouts:
  - Student Handout 1: First Word, Last Word
  - Student Handout 2: QUEST: Summer Video Viewing Guide
  - Student Handout 3: Examining Biodiversity in Your Own Backyard Using Insect "Pitfall" Traps
- For each team of students:
  - Large paper grocery bag for cone collecting (if students will be collecting the pine cones themselves)
  - Access to enough pine cones to fill a 2-liter plastic bottle
  - 2-liter plastic bottle
  - Cheesecloth (approximately 1/2 yard)
  - Ring stand with ring (same diameter as that of 2-liter bottle)
  - Small clamp-on lamp
  - Baby-food-size jar
  - Duct tape
  - 70% ethanol or rubbing alcohol
  - Petri dish or other small flat tray for sorting organisms
  - Forceps
  - Medicine dropper
  - Hand lenses
- For the classroom:
  - Dissecting microscopes (if available)
  - Field guides and/or access to Internet field guides
  - Access to an "expert" entomologist or other knowledgeable volunteer (optional)

1. Introducing the Concepts

The initial activities engage students around the concept of biodiversity, initiating students' thinking about what biodiversity means. How is it quantified? How do scientists know what living things are out there? Why do we need to know? Why are biologically diverse ecosystems important? What would be the value of knowing the variety of species in a particular area? What does it tell us?

Activity 1: Biodiversity

Step 1

Begin the lesson by asking students if they have ever thought about how many different kinds of living things inhabit a natural place. Use an example that is familiar to them – their backyards, the schoolyard, a pond site, a forested area, or their state. Ask students to consider the following questions:

- Why might it be biologically important to know what types of living things exist in a particular area?
- What might be the value in knowing the types of organisms that can be found in a particular area?
- How could we find out which types of organisms are in a given area?
- How do scientists collect this kind of information?

The point of this conversation is to get students to start thinking about and sharing their initial conceptions of biodiversity.

Step 2

Provide each student with a copy of Student Handout 1: First Word, Last Word. Explain that this activity is called First Word, Last Word because students will first be doing some writing; then, later in the lesson, they will be revisiting what they have written to see if their ideas have changed.

Instruct students to use each of the letters in the word BIODIVERSITY to start a phrase or sentence that captures something they know now about that concept. For example, B might begin the sentence, "Biological diversity is different in different places." Assure students that it is fine to put down whatever thoughts they have at this point; they should not be wondering whether their ideas are right or wrong. This activity will give students a chance to reflect on their current knowledge base and will enable you to scan through the papers quickly, getting a sense of students' prior knowledge and depth of understanding.

Collect and save these papers to hand back to students near the close of the lesson.

Step 3 (optional)

On the reverse side of Student Handout 1 (or on a separate sheet of paper), instruct students to make a drawing (or list) of the types of organisms they think they would find in a designated familiar natural area (perhaps one of the sites mentioned in Step 1 above). Assure students that these drawings are simply meant to capture their initial thoughts, and that they will not be judged on their artistic abilities and/or lists. This activity will encourage students to think about the variety of life that might be in a particular area; it also reveals their current thinking about the diversity of organisms. (Note: People of all ages tend to have a very narrow sense and appreciation of how diverse any particular area can be.)

Collect and post students' drawings. Discuss the similarities and differences in their sketches. Ask, "Would your drawings look different if they had been created at a different time of the year? Would the same living things be present in this natural area?"

Step 4

Hang a piece of chart paper in a central location in the classroom. Make available a set of colored markers. Write the phrase "What Is Biodiversity?" in a circle at the center of the chart paper.

Have students visit the World Wildlife Fund's Web links at *http://www.biodiversity911.org/default.html* (You may also have them visit an alternative Web site of your choice.) As students visit these biodiversity-related links and explore the material, have them create a collective biodiversity concept map. As they come across pertinent information on the Internet, students should record their ideas on the chart paper posted in the room. Encourage them to link their ideas with arrows and other graphics, and to show accurate relationships among the concepts they have recorded.

When students have finished their Web research, lead a brief discussion to allow them to summarize their findings. Leave the concept map posted for students to reflect on for the duration of this teaching unit.

2. Exploring the Concepts

In the next activity, students will view the QUEST *Summer* video to learn about a large-scale BioBlitz held in Vermont. They will use information from the video to further develop their understanding of the importance of biological diversity.

Activity 2: BioBlitz and Biodiversity

Step 1

Introduce the idea of a BioBlitz by asking if anyone in the class has ever heard of or participated in a BioBliz event. Students may be more familiar with similar volunteer projects that monitor numbers of specific types of organisms in particular areas, such as the Audubon Society's annual Christmas Day bird count, loon counts, or vernal pool monitoring done by local watershed conservation groups. Perhaps some students have participated in such activities or know someone who has. Ask students if they can think of other ways for us to get information about the diversity of species in a particular place.

Step 2

Provide each student with a copy of Student Handout 2: QUEST *Summer* Video Viewing Guide. Go over the directions with the class. Remind students to be on the lookout for evidence that will support their ideas for the final paragraph described at the bottom of the handout.

Step 3

Show the QUEST *Summer* episode. This may take two class periods, depending on your individual class schedule.

Step 4

After watching the video, allow adequate time for students to complete their notes and paragraphs. Then

divide students into groups of three or four. Have them share their viewing-guide notes and paragraphs with other group members.

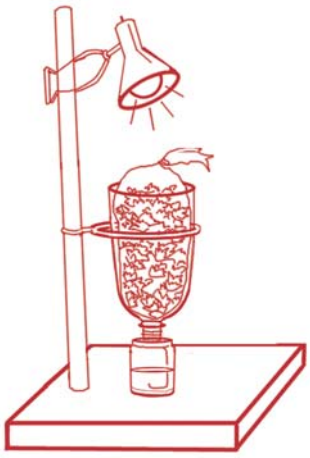
Finally, reconvene the class, and ask individual students to share some of the ideas generated by their teammates.

3. Developing the Concepts

In the next activity, teams of students will use collections of weathered pine cones to gain an appreciation for the diversity of life in a relatively small area. Students will examine, sort, and classify the biodiversity of life found in the pine cones, and they will create their own system of classifying the organisms they find. Students' working ("invented") systems will then be compared to those used by scientists.

Activity 3: Biodiversity of a Pine Cone

Note: Before introducing this activity to students, follow the procedure described below to prepare the classroom appropriately.



- Gather the materials needed to set up a Berlese separator for each team of students.
- You may wish to set up these devices ahead of time, or you may prefer to have students assemble them using a preassembled model and/or demonstration.
- Consider whether or not students are able to collect pine cones easily around the school site. If a good supply of pine cones is not available in the area, consider assigning the cone collection as "homework," or gather cones yourself ahead of time to use for the activity.
- Think about where students will be able to leave their Berlese separators so that they are safe and undisturbed for a number of days. Be conscious of fire hazards; check students' setups and placement of their finished devices.
- **Note:** It typically takes three to seven days for organisms to collect in the specimen jar at the base of each apparatus. You may consider starting this activity before a long weekend or school break.

Step 1

Introduce students to the activity by explaining that they will be using "homemade" Berlese separators to help collect a variety of organisms. Tell them that the organisms they will be collecting actually live in or near the weathered pine cones they will be using in the activity. Ask students to speculate on some of the interactions among these organisms and the cones (pine cones might serve as food, shelter, etc.). Now have each student take out a piece of paper. Direct students to predict individually the number and types of organisms they think the class will find living in or near the cones. Have them keep these notes for later use.

Step 2

Arrange the class in small teams of three students. If student teams are setting up their own apparatus, walk the class through the procedure at this time. If the materials have been preassembled, distribute an apparatus to each team and explain how the device works. Have each team write their group name or group number on their collection jar with a permanent marker. (As the cones dry, the organisms will migrate down to the collection jar, where they will be collected and preserved for examination later.)

Step 3

Supervise students as they half-fill the small collection jar at the bottom of their apparatus with the alcohol solution. (You may also choose to prefill the jars yourself.) Explain that the alcohol level must be checked often and replenished as needed, since alcohol evaporates quickly. Direct each team to secure the neck of their collection jar to the neck of the bottle with wide duct tape. Tell them that this will help prevent both rapid evaporation of the solution and the escape of the critters!

Step 4

Have student teams wrap enough weathered pine cones in a cheesecloth "bag" to fill their 2-liter bottle. Then direct them to place the bag gently inside the bottle. Finally, tell each team to turn on their clip-on light.

Step 5

Help each team to secure their bottle in the ring stand. Then have them place their apparatus in a designated area, exposed to the lamp light, for three to seven days.

Step 6

Set up dissecting microscopes for teams to use. Then distribute forceps, a petri dish, a medicine dropper, and hand lenses to each team. Supervise as they carefully remove the collection jar from their apparatus. Direct teams to pour the contents of their collection jar into a petri dish (or other suitable shallow pan) for examination and sorting of organisms.

Step 7

Instruct teams to separate the organisms from any "litter" (sticks, needles, grass, etc.) that may have accumulated in the jars. Then have them take an inventory of what remains in their jars. Direct teams to sort their specimens according to type. (Typical finds include arthropods, such as mites, spiders,millipedes, centipedes, flies, beetles, etc.) Encourage students to make annotated sketches of the organisms they find, highlighting key characteristics and descriptive words that will help them later in the activity. Also have teams count the number of individuals (abundance) within each type of organism they find.

Step 8

Ask students to locate their original notes indicating their predictions about the number and types of species they thought they would find. Now have every team create a data table in which they list each of the different types of organisms they found and the total number of each type.

Step 9

Have students compare and contrast their data tables with those of other teams. Lead a discussion about patterns, similarities, and differences in the teams' findings.

Students will probably notice that each team identified their organisms in slightly different ways. Question them about how scientists remedy this problem. Ask, "How would scientists sort these organisms?" Be certain to emphasize that the scientific system of classification serves a different purpose than the students' working system. Discuss the criteria scientists use to classify organisms. (Biological classification moves away from sorting based on external features and behaviors exclusively to examination of internal structures and processes – ultimately to cellular activity and molecular structure.)

Step 10

Make field guides, dichotomous keys, and other reference materials available to students at this time. (**Note**: You may also choose to make use of an Arthropod/Conifer Checklist, which can be found at *http://www.amnh.org/learn/biodiversity_counts*. Click on Resources, then scroll down the page to the midway point.)

As you introduce these reference materials to the class, review the characteristics used by scientists to classify organisms into major taxonomic groupings. If possible, arrange for an expert to visit the classroom at this point to help students with this phase of the activity. Then direct student teams to re-sort their specimens using the new resources. Have each team create a new tally based on the traditional taxonomic groupings.

At this point, it is important to emphasize the diversity of species rather than to be overly concerned with students' identifying organisms with 100 percent accuracy. Reassure students that it is acceptable not to know the complete scientific name (genus and species names) of every organism they have found; sorting the organisms to the nearest order is probably sufficient. Remind students that it takes many years of training – and much more time observing behaviors, external and internal anatomical features, and so on – to become experts at inventorying an area.

Step 11

Consolidate the revised information from all teams' data tables into one class data set. This data set should be entered and saved on a classroom computer, since it will need to be printed out for use in the next activity.

4. Synthesizing and Applying the Concepts

In the activity that follows, students will graphically represent the diversity of organisms that they found during Activity 3. They will then engage in a discussion of their findings, relating their ideas to biological diversity in general.

Activity 4: Biodiversity

Step 1

Make available to each student a copy of the class data set compiled at the end of Activity 3. Guide students in making individual graphs (either by hand or on a computer) that show the relative abundance of species found in the pine cones. You might suggest that students approach this assignment by calculating the percentage of the sample represented by each taxonomic grouping. You might also prefer to brainstorm with students other possible ways to show the biodiversity found in their cone samplings.

Step 2

When students have completed their graphs, discuss the following ideas with the whole class:

- Why do you think the animal communities found in the pine cones are so diverse? Why are there so many different types of organisms living there – wouldn't just a few organisms living in the cones be diverse enough?
- If this survey were done at a different time of year, do you think the results would be different? What other factors might influence our findings?
- One of the key themes in ecology is that every organism has a particular "niche," or role, which is uniquely its own. How can so many different types of creatures live in such a relatively small place?
- If we were to construct a food web of this ecosystem, what might it look like? What could the number of individuals present tell us about the trophic level (place in the food chain) that a particular organism occupies?
- Different ecosystems have differing biological diversity. For example, rain forests are extremely diverse. What factors are most important in terms of how they affect diversity? What role do humans play in biodiversity?

Step 3

Hand back the students' original copies of Student Handout 1: First Word, Last Word. Then distribute a clean copy of Student Handout 1 to each student. Ask students to look back at their original ideas and expand, revise, and/or rewrite their ideas, based on what they have learned during the course of this unit. They should use this final version of the handout to communicate, as accurately as possible, the knowledge they have gained from these activities.

5. Extending the Concepts

In the following take-home activity, students will use pitfall insect traps to survey the diversity of organisms in their own backyards.

Activity 5: *QUEST* at Home: Backyard Biodiversity

Insect traps are another low-tech way for students, with their family and friends, to survey the diversity of insects found in their own backyards. Later, they can compare their findings to the findings of their classmates.

Step 1

Tell students that now you will be introducing them to another method of surveying the diversity of organisms – but that this time they will be examining organisms (mainly insects) in their own backyards.

Distribute copies of Student Handout 3: QUEST at Home – Examining Biodiversity in Your Own Backyard. Go over the directions with the class, and set a due date for project completion.

Note: You will need to decide ahead of time if students will bring their completed collections to school to sort or if this work will be done at home. Consider whether students have the resources available to do this work at home; also consider how students would be able to transport their specimens to school. Keep in mind that many school buses do not allow students to transport living things. Check your school policy (and check with bus drivers!) before giving students their final instructions. Ideally, you should encourage students to practice catch-and-release methods. You should also advise them not to use glass to contain their collections. Glass can easily be broken, and many schools do not allow students to transport glass containers on buses.

Step 2

When students return to class with their completed projects, have them compare their findings with those of their classmates. Ask them which types of organisms were most prevalent. Also have them speculate on the differences in the variety of organisms found in various backyard habitats. Focus the discussion on the importance of biodiversity and how periodic monitoring can serve to inform us of a particular area's biodiversity "status."

Community Connections

■ Perhaps you have students who are budding biologists, or who simply have an interest in learning more about the living things found in their local area. Virtually every community has active naturalists, conservation groups, watershed associations, land trust organizations, and the like for individuals to get involved at many levels. Encourage your students to explore the possibilities in their community.

■ Help students explore the possibility of taking part in a biological inventory. Local conservation groups often sponsor song bird counts, vernal pool monitoring, macroinvertebrate surveys, loon counts, or invasive species monitoring. These groups are frequently looking for volunteers and typically provide hands-on training.

Career Opportunities

There are a number of career opportunities related to biodiversity. Careers in the biological sciences abound. Challenge students to brainstorm a list of the "specialists" who are profiled in this QUEST episode, and have them come up with definitions for each specialty based on what they have learned during this teaching unit. For instance, students should be able to state that entomologists study insects, or that taxonomists specialize in the classification of organisms based on their structure, origin, and behavior.

Resources

Printed Material

Slesnick, I., et al. Global Environmental Change: Biodiversity. Arlington, VA: National Science Teachers Association, 1997.

Web Sites

Biodiversity Counts!
http://www.amnh.org/learn/biodiversity_counts
This project, developed by the American Museum of Natural History, gets middle-school students to examine natural areas around their schools. The site contains an outstanding resource section for teachers, including a teacher guide, lists of specialists, field trip guidelines and information, on-line field guides, lists of print resources and related literature, and biodiversity Web links.

Biodiversity Dilemmas
http://www.centerforplantconservation.org/peril/peril8.html
Scenarios at this site were developed by the Center for Plant Conservation. Dilemmas can be modified and used in an extension activity.

Discovery School – Biodiversity of Plants Lesson (6-8)
http://school.discovery.com/lessonplans/programs/yosemite/index.html
This site offers a simplistic way for students to gain appreciation for the biodiversity of plant life through collecting and identifying leaf samples from trees.

Life in a Pine Cone
http://pubpages.unh.edu/~pcj/pinecone.html
A detailed description of, and more formal protocol for, the activity used in this teaching unit can be found here.

U.S. Biodiversity Month
http://www.nrel.colostate.edu/IBOY/biomonth/backbioblitz.html
This site describes Biodiversity month, held annually in May. The site has information and materials for conducting a local Backyard BioBlitz. There is also a wealth of material for educators, including a teaching guide, posters, and suggestions for participating in the event.

The University of Michigan's Museum of Zoology – Animal Diversity Web Site
http://animaldiversity.ummz.umich.edu/site/index.html
This site contains information, pictures, classification schemes, and sounds of a number of different animals. It is pleasingly arranged, engaging, and searchable.

The Vermont BioBlitz

http://www.vinsweb.org/BioBlitz/

This is the home page of the 2004 BioBlitz. The site provides information on the number and types of species identified during the event. It also contains a description of the collection area and the methods that were used, as well as a rationale for the project. A sample collection sheet is included.

"Volunteers brave rain to collect species for BioBlitz"

http://www.seacoastonline.com/news/09192004/news/38380.htm

A newspaper article by the Portsmouth Herald describes the 2004 BioBlitz at Odiorne Point State Park.

What is entomology?

http://www.entsoc.org/education/elem_mid/what_is.htm

This site, sponsored by the Entomological Society of America, provides excellent background material on what entomology is. Basic insect facts are included.

U.S. Fish and Wildlife Service: Division of Human Resources

Wildlife managers, foresters, and park rangers have a vested interest in the biodiversity of natural areas. Find out more at *http://hr.fws.gov/HR/Careers_FWS.htm*

First Word, Last Word

Directions: Use each of the letters in the word **BIODIVERSITY** as the beginning of a sentence or phrase that tells something you know about biodiversity.

B _____

I _____

O _____

D _____

I _____

V _____

E _____

R _____

S _____

I _____

T _____

Y _____

QUEST *Summer*
Video Viewing Guide

Directions: As you watch the QUEST *Summer* video, answer the questions below. They will guide you to note down the most important details about the BioBlitz featured in the film.

When was the BioBlitz held? How long was the event? _____

What was the purpose of this event? _____

What kinds of people attended the BioBlitz? _____

What types of organisms were identified? How were they identified? _____

How was data collected? How was data shared with others? _____

What tools were used during the BioBlitz? _____

What safety issues needed to be considered during the BioBlitz? _____

On the back of this sheet, write a paragraph describing how the information gathered during an event like a BioBlitz can be used to inform scientists of the biodiversity in a particular area. Be sure to explain why this is useful. Use specific examples to support your ideas.

Examining Biodiversity in Your Own Backyard

You're on a Quest!

Go on a biodiversity hunt in your backyard! With family and friends, follow the steps listed below to gain greater understanding of the wide variety of organisms that can be found just outside your door.

A Gather the following materials:

- 1 clean empty yogurt cup (8 oz size) with lid
- 8 1/2" x 11" sheet of cardboard (recycled cereal boxes work well)
- Bait of your choice (corn syrup, small bits of meat or cheese, fruit, small pieces of baked potato, etc.)
- (optional) Small digging tool, such as a trowel or spade

B Follow these procedures to collect your specimens:

1. Select an area in your yard where your trap will be undisturbed by humans or pets.

2. Add approximately 1 tablespoon-sized amount of the "bait" you have decided to use in the bottom of the yogurt container. Snap the lid back on.

3. Dig a hole big enough to bury the container so that its top is level with the ground.

4. Place the yogurt cup in the hole. Pack the surrounding dirt tightly around the edges of the container. Carefully remove the container's lid. Try not to knock dirt and debris into the cup! Save the lid for later.

5. Place the cardboard loosely over the opening of the trap. Anchor the cardboard by placing small stones gently around the edges. This will serve as a "roof," keeping out rain and larger animals.

6. Return to the trap 24 hours later.

7. Secure your collection of "found" organisms by snapping the lid back on the yogurt container. Fill in the hole; place the stones and cardboard back in their appropriate locations.

8. Identify the organisms that have found their way into the container. Use library and online resources to help you during this process.

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