

Grades 9-12 Version (created by Becky Schnekser)

TEACHER NOTES (pages 1-8) STUDENT PAGES (pages 9-16) Optional extension activities (pages 17+)

Teacher Background Knowledge: (this is also included as nonfiction text with comprehension questions for students, pages 17-20)

What Is the Boiling River?

The **Boiling River** (*Shanay-Timpishka*) is a real river located deep in the Peruvian Amazon that gets hot enough to boil—reaching temperatures up to **200°F (93°C)**. What makes this river so unusual is that it is **not near any active volcanoes**, which is where boiling water sources are typically found. Instead, the water is heated by geothermal energy from deep within the Earth, independent of volcanic activity.

The river is sacred to local Indigenous communities and has long been part of their cultural stories and practices. It gained global attention when **geoscientist Andrés Ruzo** began studying it scientifically and working with locals to understand and protect these unique natural features and the surrounding ecosystem. Each year, Andrés brings scientists from all disciplines to study the area to better understand the ecosystem, what lives here, and what doesn't. They also compare the ecology to other parts of the Amazon to better understand how this area is similar and different to other regions.

The Boiling River is an incredible example of how science, geography, culture, and conservation come together—and it's a powerful reminder that there are still natural mysteries to explore on our planet.

Projeto Mantis, a team of Brazilian Entomologists working with the Boiling River Team, seek to study and understand insects of all types, but specifically the praying mantis. Their field practices are different from most while they capture live specimen, keep until natural death, studying their behaviors, and once they die of a natural death, then prepare typical box pinning as you would see in museum displays. Oftentimes, scientists collect specimen in the field and immediately immerse in formaldehyde or isopropyl alcohol to bring back to their laboratories to study. Using the techniques by Projeto Mantis requires special containers for collecting and maintaining specimen. Containers must allow the creature inside space to thrive, breathe, and live a comfortable life that mimics their natural environment but also be portable, collapsible, and sturdy for handling in the field. It is also important that the container be lightweight to keep costs of transport as low as possible.

The Projeto Mantis team needs YOUR help. Design, create, and test a 3-dimensional container to carry specimens collected in the field to the laboratory.

This lesson plan allows students to connect to how a team of scientists seeks to answer these questions: What insects live in the Boiling River area? How is this similar to and different from other parts of the Amazon?

Boiling River Entomology Design Challenge Brief:

Projeto Mantis, a team of Brazilian Entomologists working with the Boiling River Team, seeks to study and understand insects of all types, but specifically the praying mantis. Their field practices are different from most while they capture live specimens, keep them until natural death, study their behaviors, and once they die of a natural death, then prepare typical box pinning as you would see in

museum displays. Oftentimes, scientists collect specimens in the field and immediately immerse them in formaldehyde or isopropyl alcohol to bring them back to their laboratories to study. Using the techniques by Projeto Mantis requires special containers for collecting and maintaining specimens. Containers must allow the creature inside space to thrive, breathe, and live a comfortable life that mimics their natural environment, but also be portable, collapsible, and sturdy for handling in the field. It is also important that the container be lightweight to keep the costs of transport as low as possible. Don't forget, these scientists must carry all of their equipment while out collecting specimen.

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Teacher Notes: This project leads students through a 6 phase project. That sounds like a lot, but it is intentionally broken down this way to help support students completion and success with the project.

Phase 1: Students plan their project in this phase beginning with the selection of what insect they will create a container for. Students do not have to design their container for praying mantises—rather, an insect of their choice. In phase 1 of the activity, they will need to choose the specimen for which they are designing, which will inform the size of the container they design and build. There is also a place for students to record the resources they used to determine the size of the container needed—ideally, students will research their chosen insect to determine this information and then record the source(s). This is great practice for simple research and source citing. This phase also includes time for students to brainstorm how they will test their creation to ensure it meets project criteria, sketch their design, and list materials they would like to use. As the teacher, you can decide how to handle materials—do you have set materials for each team? Can they bring things from home? Will they have to budget and “pay” for certain materials (this is great way to integrate more math practice)?

Phase 2: In this phase, students are creating their prototypes. It is a good idea to provide a time limit for this phase while it tends to be when groups use a vastly different amount of time to be productive.

Phase 3: Phase three is all about testing the prototypes. After creating them, teams should make sure that it passes all the criteria for the project.

Phase 4: This phase allows students to modify their projects to better meet the criteria. This is another phase that benefits from time parameters to keep students motivated and engaged in the project. They should also record any modifications they make in the recording sheets.

Phase 5: Phase five requires students to devise a communication plan to “pitch” their project idea to the team of entomologists. Essentially, they want their design “chosen.” This can be facilitated in many different ways depending on your capacity and time limits. Students can present to you, to the class, or even to invited guests to your classroom. You can also determine whether a “winner” is selected or whether this is just a great way to practice public speaking and persuasive writing.

Phase 6: This phase is for reflection. Students are given several reflection questions to think about the project process and how their team faced challenges throughout.

Learning Standards:

Next Generation Science Standards (NGSS)

HS-ETS1-1: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants

HS-ETS1-2: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering

HS-ETS1-3: Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

HS-ETS1-4: Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Sustainable Development Goals:

15- Life on Land: Protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Common Core

HSG.GMD.A.3	Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.
HSG.MG.A.3	Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).

Advanced Preparation:

- Collect materials for students to build models and have them readily available
- Decide whether you would like students to work alone or with a collaborative team
- Decide on protocols for students or teams to record progress along the way
 - For example, will they keep a journal or sketchbook daily?
- Consider preparing students to identify insects, best practices to locate them, and connect specifically to praying mantises
- Consider introducing students to the Projecto Mantis Team that worked at the Boiling River
 - [Website of the Boiling River Expedition](#)
 - Extension activity about the team on page 21
 - [Team Bios](#)
 - This is the main team that consists of two scientists

Materials:

- Items for prototype construction
- Journal or way to track progress along the way
- Student recording sheets

Specimen container requirements:

- able to lie flat when not in use
- lightweight
- allow for the specimen to move around comfortably within the container
- rigid to withstand movement in the field and storage between the field and the lab

Potential Grading Rubrics

Written Response Rubric (numerical, developmental scale 1, developmental scale 2)

- Can be used to evaluate written pieces such as reflection phase

Project Rubric

- Can be used to assess the project completion

Student Name: _____

Written Response Rubric

1	2	3	4
Response may or may not answer all questions OR contain a large amount of grammatical errors	Response may or may not answer all questions OR contain several grammatical errors	Responses answer all questions, but might have minor grammatic errors	Responses answer all questions, use complete sentences, and show thinking about learning.

Comments:

Student Name: _____

Written Response Rubric

insightful	thorough	basic	marginal	inadequate
The response shows deep thought, reflection, and connection to learning with elaboration	The response shows thought, reflection, and connection to learning with elaboration.	The response answers the questions but does not elaborate or show deep reflection or connection to learning	The response shows minimal thought, reflection, or connection to learning	The response does not show thoughtful reflection or connection to learning

Comments:

Student Name: _____

Written Response Rubric

emerging	developing	proficient
Response does not answer all questions, contains many grammatical errors or inconsistencies	Response might not answer all questions, contain grammatical errors or inconsistencies	Response answers all questions in complete sentences, free from grammatical error

Comments:

Entomology Project Rubric

	0	1	2	Comments
Able to lay flat when not in use	Creation is unable to lie flat	Creation can be made smaller, but does not completely flatten	Creation is able to completely flatten/	
lightweight	Creation has a noticeable weight to it. It might be a pound or heavier.	Creation has noticeable weight but does not approach 1 pound.	The creation is lightweight, and barely noticeable in terms of weight. Might not register on a scale.	
allow for the specimen to move around comfortably within the container	Specimen would not have space to move around comfortably. It might not even fit in the container.	Specimen fits in container, but would not have ample space to move.	Container has adequate space for the specimen to be inside and move around freely.	
rigid to withstand movement in the field and storage in between the field and lab	Construction does not appear strong enough to withstand rigidity test OR Project fails to withstand rigidity test	Construction seems to be able to withstand some movement or storage but may contain questionable wobble or strength integrity OR Project partially withstands rigidity test, may contain minor damage	Construction seems sturdy enough to withstand rigidity test. OR Project successfully withstands rigidity test.	
Project Documentation	Documentation is missing altogether or contains very little project progress	Documentation is present although some details of the project may be missing	Documentation thoroughly shows the progression of project	
Communication	Engineer or team of engineers does not explain project or many or major details are unclear	Engineer or team of engineers is able to explain project and answer questions, some details may be unclear	Engineer or team of engineers is able to thoroughly explain project and answer questions	

Points earned _____ / 14 points possible

Name: _____

date: _____

Entomology Design Challenge

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Specimen container requirements:

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Part 1: Planning Phase

Specimen Type (what will be collected?):

How much space will your specimen need?

What resources did you use to find this answer?

How will you test your model?

This image shows a completely blank white rectangular area enclosed within a thin black border. There are no markings, text, or illustrations present on the page.

List the Materials you will need to create your model

Sketch the design of your model here. Be sure to draw and label each part.

Part 2: Create

Build your model based on your design. If you have to modify your design while building, you must record changes here.

Part 3: Test

You must now test your model to ensure it meets the requirements. Record below the steps for testing, protocols, as well as the results.

Testing Protocols

Results (what happened during testing?)

Step 4: Modify

Based on your test and results, what changes will you make? How can you improve your model? Make a plan, record below, and get started!

Step 5: Communicate

How will you communicate your project to the team of entomologists?

Let's get started! Begin and complete your communication piece!

Step 6: Reflection

What parts of this challenge were difficult for you? How did you overcome the difficult parts?

What parts of this challenge were easy for you? What made them easy for you?

In what ways did you use observation during this project? How did using this skill help you complete the project?

In what ways did you use collaboration during this project? How did using this skill help you complete the project?

In what ways did you use communication during this project? How did using this skill help you complete the project?

If you could change one thing about this project, what would you change and why?

Compared to other projects presented, which is the best solution for Projeto Mantis' problem? Explain.

The Boiling River & Projeto Mantis

The **Boiling River** (*Shanay-Timpishka*) is a real river located deep in the Peruvian Amazon that gets hot enough to boil—reaching temperatures up to **200°F (93°C)**. What makes this river so unusual is that it is **not near any active volcanoes**, which is where boiling water sources are typically found. Instead, the water is heated by geothermal energy from deep within the Earth, independent of volcanic activity.

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Comprehension Questions – The Boiling River & Projeto Mantis

Comprehension Questions – The Boiling River

Recall & Understanding

1. Where is the Boiling River located, and what is its maximum recorded temperature?
2. What makes the Boiling River unusual compared to other sources of boiling water?
3. Who is Andrés Ruzo, and what role has he played in studying the Boiling River?
4. What is Projeto Mantis, and what type of insect do they focus on?
5. How does Projeto Mantis' method of specimen collection differ from more common practices?

Interpretation & Connection

6. Why might the Boiling River be considered culturally significant to local Indigenous communities?
7. What is geothermal energy, and how does it apply to the Boiling River?
8. How might studying this ecosystem help scientists understand the Amazon as a whole?
9. Why might Projeto Mantis' approach to studying insects be considered more ethical or conservation-friendly compared to traditional methods?

Critical Thinking & Application

How could the research conducted at the Boiling River contribute to global conservation efforts?

If you were designing a new field container for Projeto Mantis, what features would you prioritize and why?

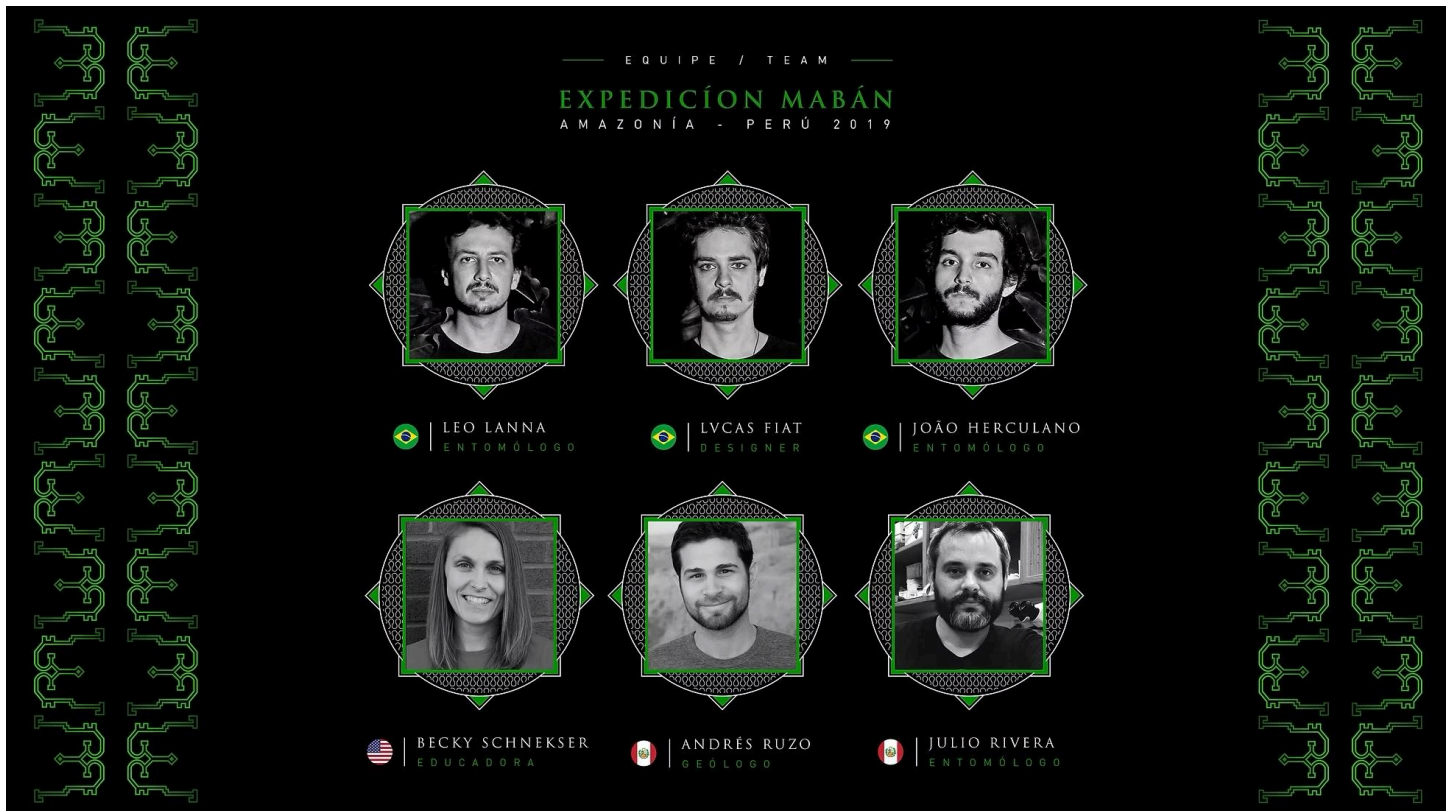
What are some possible challenges scientists might face when conducting research in such a remote and extreme environment?

Do you think preserving the Boiling River is more important for scientific research or cultural heritage? Explain your reasoning.

How does this case study illustrate the intersection of science, culture, and conservation? Provide examples from the text.

What's in a Team?

Teams and teammates matter whether you are playing a sport, board game, or heading out on a scientific expedition. In 2019, the team pictured below was created to complete a scientific expedition in the Peruvian Amazon about insects, and more specifically, praying mantises. Take a few moments to observe the team photo. What do you notice about this team?



Observations about the Expedition Maban Team

Now that you have made observations, what has sparked your curiosity? What questions do you have about this team?

[illegible]

If you were building a team to go on a scientific expedition about insects, who would you want on your team? Why would you invite them?

Team Member	Justification (why)

With your small group, share about your teammate choices. Based on what others have shared, would you change any of your choices? Why or why not?