# Boiling River STEM Challenge Specimen Container Grades 9-12

created by Becky Schnekser

# STEM Challenge
# Specimen Container
# grades 9-12


Thank you for using this resource. It was created based on my expeditions to the Boiling River which began in 2018.

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**TEACHER NOTES** (pages 1-12)

**STUDENT PAGES** (pages 13-20)

**Optional extension activities** (pages 21+)

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# STEM Challenge: Specimen Container

**Teacher Background Knowledge:**
(this is also included as nonfiction text with comprehension questions for students, pages 21-26)

**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?

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**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.

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.

**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.

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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.

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## 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

o 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 Projeto Mantis Team that worked at the Boiling River
  - Website of the Boiling River Expedition
    - Extension activity about the team on page 27
  - Team Bios
    - This is the main team that consists of two scientists

# STEM Challenge: Specimen Container

## 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

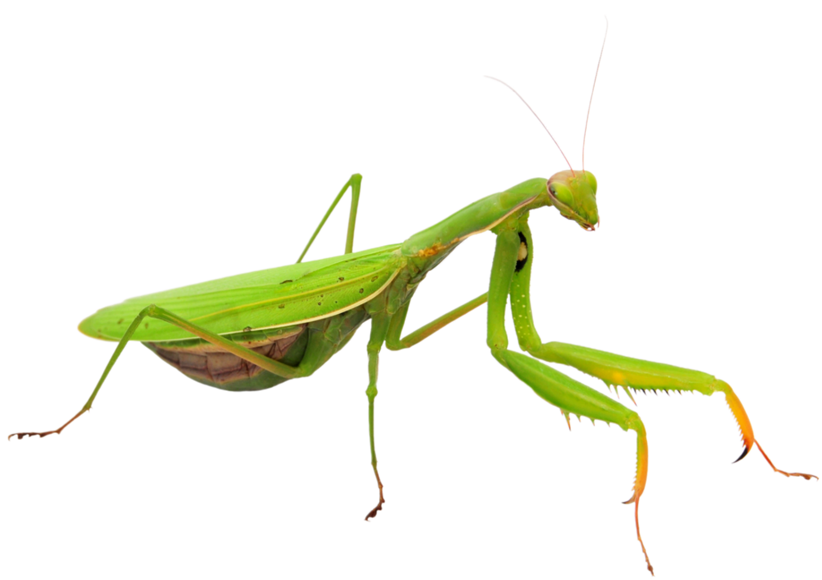
## Potential Grading Rubrics

**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



# STEM Challenge: Specimen Container

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: |
| --- |
| |

# STEM Challenge: Specimen Container

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: |
|---|
| |

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: |
|---|
| |

## 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<br><br>OR<br><br>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<br><br>OR<br><br>Project partially withstands rigidity test, may contain minor damage | Construction seems sturdy enough to withstand rigidity test.<br><br>OR<br><br>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

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**Design:**

- 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

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## Phase 1: Planning

## Determine specimen to be collected

- Investigate insects near you.
- How large do they grow?
- How large will your container need to be?
- What do they eat?
- What kind of insect will you plan your project around?
- How will you make sure what you create will meet the project requirements?
- What insect will you choose and why?

| | |
|---|---|
| Specimen chosen (insect) | |
| How much space will your specimen need? | |
| Resources (what helped you make your decision) | |
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| How will you test your model? |
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| List the Materials you will need to create your model | |
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## Design the storage device

Create a detailed and labeled sketch of your design idea.

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|---|---|
| Justification<br><br>Describe the design elements used and why you chose them | |

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## Phase 2: Create the prototype/model
## Phase 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** |
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| **Results (what happened during testing?)** |
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## Phase 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! |
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## Phase 5: Communicate

This is your opportunity to convince the entomologists to choose your design!

| How will you communicate your project to the team of entomologists? |
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**Let's get started! Begin and complete your communication piece!**

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## Phase 6: Reflection

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

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## Phase 6: Reflection

| 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?** |
| |

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

# The Boiling River and Projeto Mantis

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**Comprehension Questions – The Boiling River**

Where is the Boiling River located, and what is its maximum recorded temperature?

What makes the Boiling River unusual compared to other sources of boiling water?

Who is Andrés Ruzo, and what role has he played in studying the Boiling River?

What is Projeto Mantis, and what type of insect do they focus on?

How does Projeto Mantis' method of specimen collection differ from more common practices?

## Interpretation & Connection

Why might the Boiling River be considered culturally significant to local Indigenous communities?

What is geothermal energy, and how does it apply to the Boiling River?

How might studying this ecosystem help scientists understand the Amazon as a whole?

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?

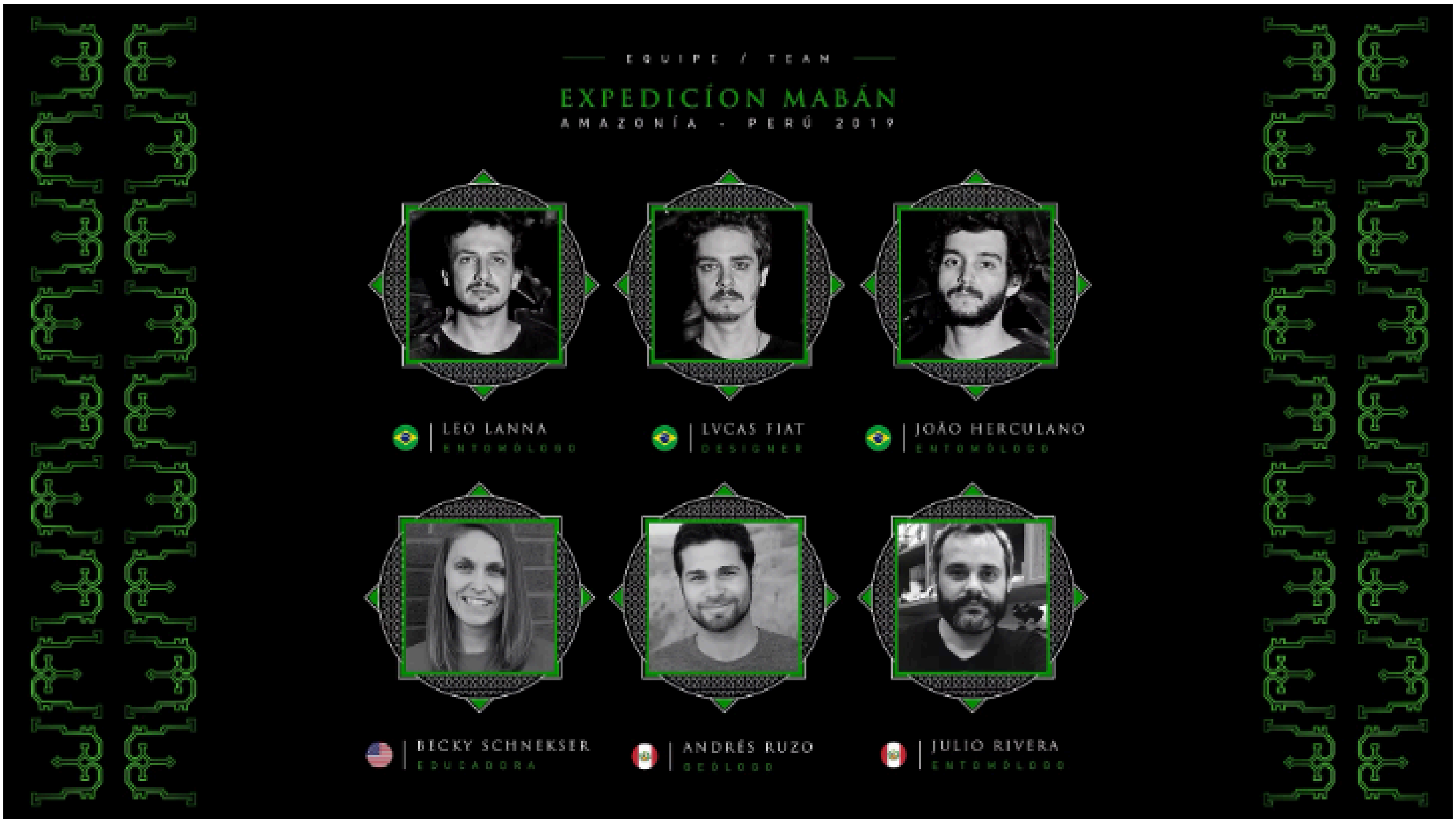
What are some possible challenges scientists might face when conducting research in such a remote and extreme environment?

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

| Questions about the Expedition Maban Team |
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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)** |
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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?

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