

VIRTUAL FIELD TRIP TEACHER'S GUIDE

Borneo: The Symphony of the Rainforest

Grades: 3-8

Subjects: Science

Purpose: This guide contains a variety of student materials, which can be used before, during, or after the virtual field trip. It also contains links to Nature Lab resources and other relevant resources.

Description of Virtual Field Trip: What does sound tell us about the world's wildest places? To find out, join science writer Justine Hausheer as we embark on a Virtual Field Trip to Borneo, the third largest island in the world. We'll explore a compelling question: How can we use science and acoustic technology to care for the land and protect the plants and animals in one of the world's most biodiverse regions?

On this journey, we'll learn how experts are using cutting-edge science to find out how healthy the rainforest is—and to discover where it needs some help! Scientists at The Nature Conservancy have developed ways to record and listen to the sounds of the forest to determine how many different animal species live there.

Join us on this virtual field trip to see the amazing wildlife of the Indonesian rainforest, explore places many people never go, and learn about innovative scientific methods that are helping protect nature.

Materials:

Elementary School

- **Borneo Nature Spy Handout**

This handout includes images of animals and other items that students will **hear** during the field trip. Print it off and have students use it to match the sounds to the animals.

- **Borneo Virtual Field Trip Log**

This one-page handout can be printed and used before, during, and after the field trip for students to think about what they hope to see, what they learned, what they want to know more about.

- **Borneo Vocabulary Graphic Organizer**

This handout includes vocabulary words used during the virtual field trip and provides a structure for students to define and use them in a sentence.



Justine Hausheer
Science Writer
The Nature Conservancy

Elementary and Middle School

• Borneo Virtual Field Trip Discussion Questions

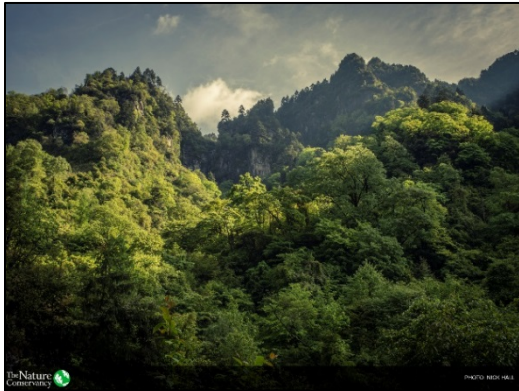
This handout can be used during and after the virtual field trip. Modify the questions as needed or use them as discussion prompts after the trip. The answer key is located at the end of this teacher's guide. Includes a false-color spectrogram for analysis.

Standards:

Next Generation Science Standards Disciplinary Core Ideas

- ESS3.A Natural Resources
- ESS3.C Human Impacts on Earth Systems
- LS2.C Ecosystem Dynamics, Functioning, and Resilience
- LS4.D Biodiversity and Humans

Nature Lab Resources: The following lesson plan and video can be used for additional learning related to concepts presented in the virtual field trip.



Reforestation: Impact on Climate

Grade Levels: 6-8

In this lesson, students learn the value of large-scale forest landscapes and their role in the carbon cycle. Tools such as infographics and carbon calculators help students investigate deforestation and its impact on climate. Reforestation also impacts climate change. Students explore how reforestation can help decrease carbon dioxide and greenhouse gases in the atmosphere, thereby minimizing climate change and improving air quality.

Other Related Resources:

- Orangutan's Forest
www.nature.org/ourinitiatives/regions/asiaandthepacific/indonesia/the-orangutans-forest/index.htm
Website with information about TNC's work in Indonesia and the Wehea Protected Forest as well as stories about the people and animals that call this place their home.
- Regrowing Borneo's Rainforest—Tree by Tree
www.scientificamerican.com/article/regrowing-borneo/
An article about reforestation efforts in Borneo and the Samboja Lestari forest and orangutan sanctuary.

Follow our Hosts:

Justine Hausheer, The Nature Conservancy (TNC)

- Justine Hausheer writes for TNC's Cool Green Science conservation science blog (blog.nature.org/science/). You can learn more about her and find direct links to her articles here: blog.nature.org/science/profiles/justine-e-hausheer/
- *Eavesdropping on the Sounds of the Rainforest* – An article by Justine about TNC's acoustic studies in Papua New Guinea <http://blog.nature.org/science/2015/09/14/eavesdropping-on-the-sounds-of-the-rainforest/>

Jacqueline Howard, CNN

- Jacqueline Howard is a feature write for CNN (CNN.com). To learn more about Jacqueline, visit her website www.jacqueline-howard.com and watch for her upcoming appearances on CNN's morning show "New Day".
- You can also find her articles on health and science at www.cnn.com/health

Discussion Question Answer Key: You can use or adapt these questions for a follow-up discussion with your students after viewing the virtual field trip. Older students may be able to follow along and answer the questions while viewing.

1. What is an ecosystem?

Answer: An ecosystem is a community of interacting organisms and the physical environment in which they live—including biotic (living) and abiotic (nonliving) factors.

2. What is biodiversity and why is it important for an ecosystem?

Answer: Biodiversity is the variety of life in a particular habitat or ecosystem. It is important for several reasons including:

- *A variety of plants provides food for insects and other animals and those organisms can provide food for organisms higher up the food chain.*
- *A larger number of plant species means more food variety for all organisms, especially if one were to get diseased and/or die out.*
- *Many medical discoveries have been the result of research into plants and animals and every time an animal or plant goes extinct, we may have lost crucial insight into new medicines for human diseases.*
- *Healthy, biodiverse ecosystems provide services to humans like clean air, clean water, tourism, food, etc.*

3. Why are scientists using acoustic surveys to learn about rainforest biodiversity?

Answer: It is very costly and difficult to send a trained crew of researchers into the rainforests to catalogue everything that lives there. Acoustic recorders can be left in place for days to capture all of the sounds of the area and scientists can process those sounds and quickly learn about the animals that live there.

4. Why are rainforests in Borneo being cut down?

Answer: The island of Borneo is extensively covered with rainforests, which are being cut down to make way for food production, timber harvesting, and palm oil production—these are all valuable things to the economy and to the people that live there.

5. Rainforests are often called the lungs of the planet. How much oxygen do rainforests produce globally?

Answer: Rainforests produce over 20% of Earth's oxygen.

6. What does audio (or sound) frequency mean?

Answer: Frequency means how often an event repeats over an amount of time. Frequencies can be high (a lot of events per unit time) or low (few events per unit time).

Teachers: The concept of frequency is a great extension for this virtual field trip. The unit of frequency is the Hertz (Hz). Frequency is the property of sound that determines pitch. Humans can hear between 20-20,000 Hz. You can use this online tone generator with your students to test their ability to hear high frequencies -

<http://onlinetonegenerator.com/hearingtest.html>. See also:

<http://www.qrg.northwestern.edu/projects/vss/docs/communications/1-what-is-frequency.html> and

<http://www.physicsclassroom.com/class/waves/Lesson-2/Frequency-and-Period-of-a-Wave>

7. Why do animals communicate at different frequencies?

Answer: Animals have evolved to communicate at different frequencies so they can hear each other amongst all of the other sounds.

8. What is a false-color spectrogram?

Answer: A false-color spectrogram is a graph of different sound frequencies across time. The sounds can be animal, human, or environmental, like the sound of rain. The false-color spectrograms used for the Borneo study only show the frequencies within the range of human hearing, though there are animals that communicate with sounds outside of the range of human hearing.

9. Describe how a healthy forest might sound different than an unhealthy forest.

Answer: A healthy forest should have a lot of organisms all making sounds at different frequencies. So it might sound more like a symphony with a lot of different instruments. An unhealthy forest will have fewer animals making sounds, occupying fewer frequencies. It would be like a symphony that is missing all of the instruments except violins.

10. How can the acoustic data collected now be useful in the future?

Answer: Acoustic data can be used to examine biodiversity across time. In other words, we can take recordings today and then compare them to recordings 10 years from now and see if there has been any change in the organisms are living in an area.

11. What percent of their DNA do orangutans share with humans?

Answer: Orangutans share 97% of human DNA. They are one of our closest living relatives.

12. Describe two ways that orangutans help the forest.

Answer: Orangutans eat fruits and disperse seeds through their feces as they move throughout the forest. They also nest by folding in tree branches at least two times a day, which helps to open up the forest and let light in to the forest floor where it can reach seedlings.

13. Why is orangutan habitat in Borneo under threat and how can the acoustic survey data support conservation of their habitat?

Answer: Orangutan habitat is under threat by some of the logging activities associated with palm oil plantations and tree harvesting. Acoustic survey data can help inform scientists about the locations of the rainforest with the highest biodiversity. They can then use this information to manage land-use to maximize biodiversity. By working with these companies, The Nature Conservancy can help inform them of where they might try to create wildlife corridors or connected habitats on their lands. They can also help the companies decide what methods of logging are more beneficial for conservation than others.

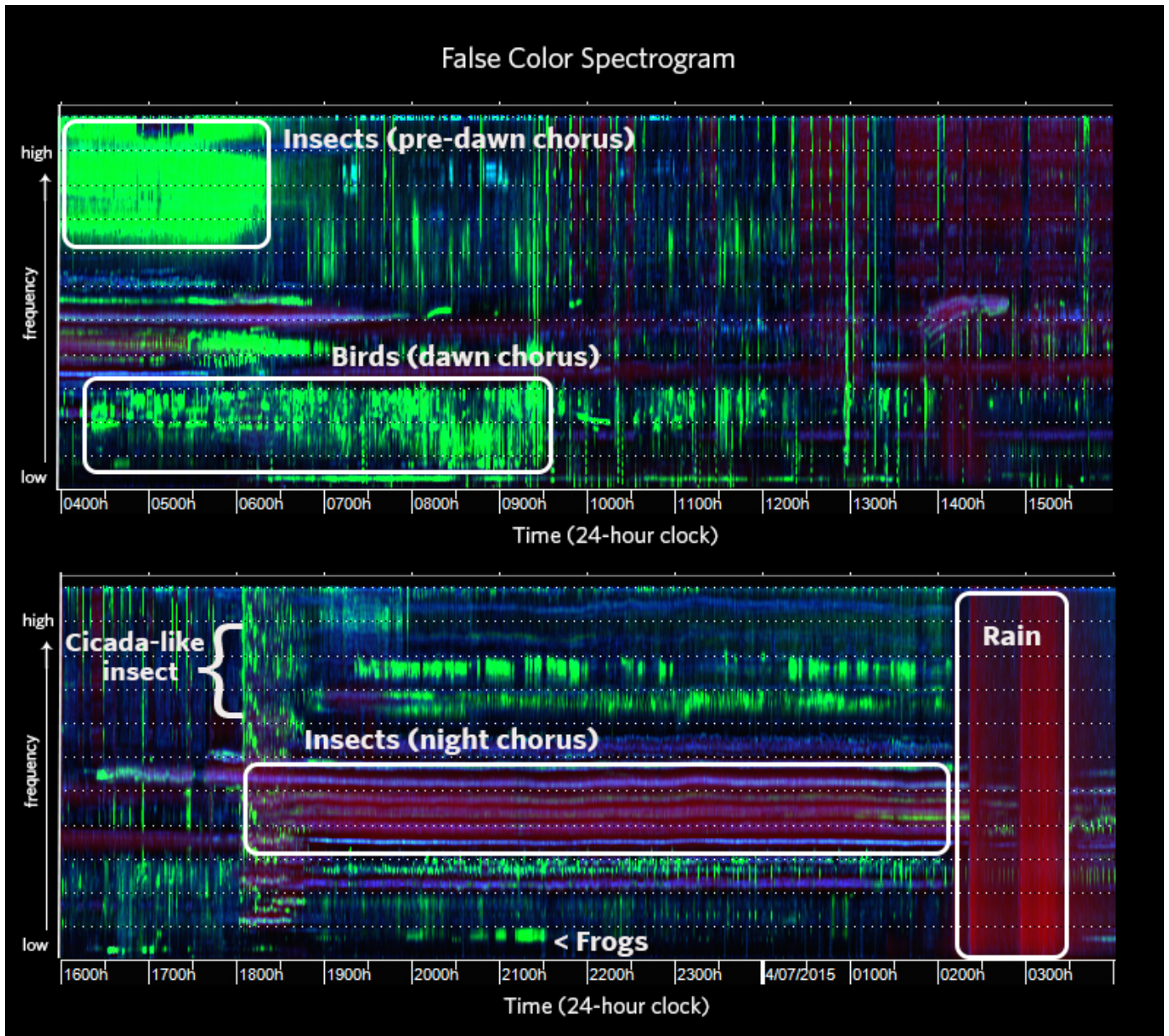
14. Describe at least two things you can do to help protect rainforests and their inhabitants.

Answer: You can become a responsible consumer by looking for and purchasing paper products with the FSC logo. This stands for Forest Stewardship Council and it means that the product is made from wood that has been harvested in a sustainable way. You can also learn more about palm oil and research which products contain it. You can look for the Certified Sustainable Palm Oil (CSPO) logo on everyday products. As always, reduce, reuse, and recycle are good mottos to live by. You can also learn more about supporting orangutans by looking into the work that is being done by organizations like the Borneo Orangutan Survival Foundation (orangutan.or.id/).

15. Look at the false color spectrogram provided by your teacher (see page 7) and answer the following questions. The time scale is written using 24-hour time instead of 12-hour time (where AM and PM is used). This is a more accurate method for scientists since it's harder to confuse the time of day if someone forgets to write AM or PM in their notes. In your answers below, you can write the 24-hour clock time and then convert it to 12-hour time.
- What time of day is the loudest with almost all frequencies (low to high) filled with sound?
Answer: The early morning hours between 400 h (4:00 AM) and 630h (6:30 AM) appear to have the most frequencies filled with sound – the insects are especially active.
 - What time of day are the birds making the most sound?
Answer: The birds are really active from about 415h (4:15 AM) until 930h (9:30 AM).
 - When did the rainstorm happen?
Answer: It was raining from just after 200h (2:00 AM) to 330h (3:30 AM).
 - What makes the rainstorm sound different from the animal sounds?
Answer: The sound of the rain fills all of the frequencies on the spectrogram, whereas the animal sounds are restricted to bands of frequencies ranging from low to high.
 - Which organisms make sounds for the longest period of time?
Answer: The insects communicating at the middle frequencies go from 1800h (6:00 PM) to 200h (2:00 AM) the next day. They seem to stop when the rain starts but were making sound for the longest period.
 - What is the quietest time of day?
Answer: From 1400h (2:00 PM) to 1630h (4:30 PM) there are fewer frequencies occupied with sound.
 - Indicate which animals communicate at the highest and lowest frequencies.
Answer: Frogs communicate at the lowest frequencies on this spectrogram, birds are a little higher than frogs, and insects communicate at the middle to high frequency levels. The insects that are active in the morning communicate at the highest frequency level on this spectrogram whereas the night-chorus of insects communicates at the middle level.
 - The location where this audio recording was taken is near the equator. Because of this, the sun rises and sets close to the same time every day, all year long. On the day this acoustic recording was made, the sun rose around 600h (6:00 AM) and the sun set around 1800h (6:00 PM). Do the increases and decreases in sound correspond with the sunrise and sunset?
Answer: The pre-dawn chorus of insects is aptly named because they stop quite abruptly around 630h (6:30 AM) just after the sun has risen. At the same time, the birds really pick up and are the most active after sunrise. Lastly, the insects—called the night chorus—start to be very active right around sunset at 1800h (6:00 PM).
 - What factors might contribute to the quiet afternoons on this spectrogram?
Answer: It could be because it is hottest during the afternoon and animals aren't as active. It could also be because some animals are most active in the morning and then there's a lull in activity before the nocturnal animals come out.

- j. Name one thing you would like to learn more about with regard to the sounds of the forest – or the sound of any landscape?

Answers: May vary.



False-color spectrogram adapted from spectrogram by © Michael Towsey and Anthony Trusking (Queensland University of Technology) pictured on [The Nature Conservancy's Cool Green Science blog](#).

Borneo: The Symphony of the Rainforest

Discussion Questions

16. What is an ecosystem?

17. What is biodiversity and why is it important for an ecosystem?

18. Why are scientists using acoustic surveys to learn about rainforest biodiversity?

19. Why are rainforests in Borneo being cut down?

20. Rainforests are often called the lungs of the planet. How much oxygen do rainforests produce globally?

21. What does audio (or sound) frequency mean?

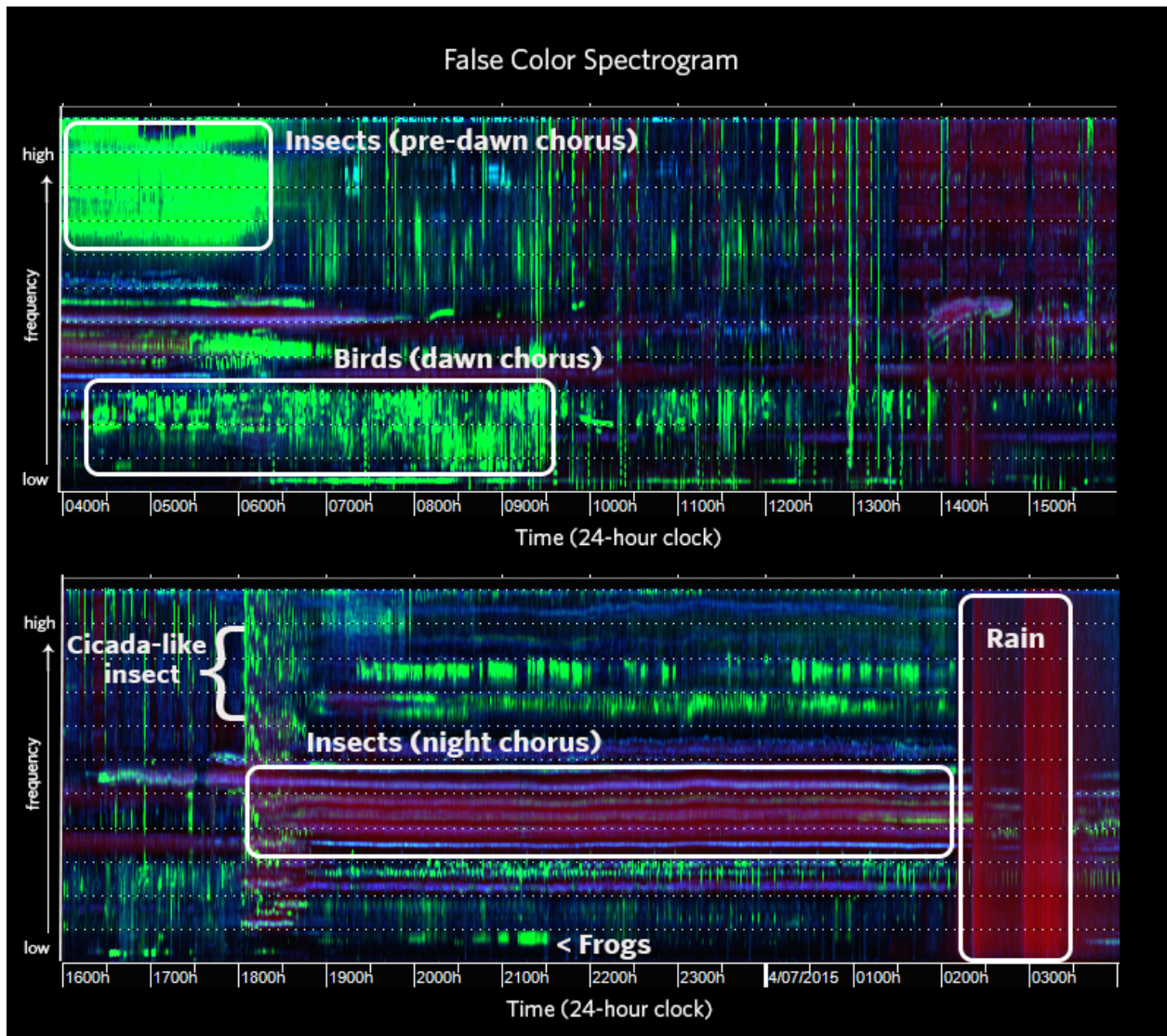
22. Why do animals communicate at different frequencies?

23. What is a false-color spectrogram?

24. Describe how a healthy forest might sound different than an unhealthy forest.

25. How can the acoustic data collected now be useful in the future?
26. What percent of their DNA do orangutans share with humans?
27. Describe two ways that orangutans help the forest.
28. Why is orangutan habitat in Borneo under threat and how can the acoustic survey data support conservation of their habitat?
29. Describe at least two things you can do to help protect rainforests and their inhabitants.
30. Look at the false color spectrogram provided by your teacher and answer the following questions. The time scale is written using 24-hour time instead of 12-hour time (where AM and PM is used). This is a more accurate method for scientists since it's harder to confuse the time of day if someone forgets to write AM or PM in their notes. In your answers below, you can write the 24-hour clock time and then convert it to 12-hour time.
- k. What time of day is the loudest with almost all frequencies (low to high) filled with sound?
 - l. What time of day are the birds making the most sound?
 - m. When did the rainstorm happen?
 - n. What makes the rainstorm sound different from the animal sounds?
 - o. Which organisms make sounds for the longest period of time?
 - p. What is the quietest time of day?

- q. Indicate which animals communicate at the highest and lowest frequencies.
- r. The location where this audio recording was taken is near the equator. Because of this, the sun rises and sets close to the same time every day, all year long. On the day this acoustic recording was made, the sun rose around 600h (6:00 AM) and the sun set around 1800h (6:00 PM). Do the increases and decreases in sound correspond with the sunrise and sunset?
- s. What factors might contribute to the quiet afternoons on this spectrogram?
- t. Name one thing you would like to learn more about with regard to the sounds of the forest or the sound of any landscape?



False-color spectrogram adapted from spectrogram by © Michael Towsey and Anthony Truskinger (Queensland University of Technology) pictured on [The Nature Conservancy's Cool Green Science blog](#).

Borneo Virtual Field Trip Log

BEFORE

I know that... _____

I wonder if... _____

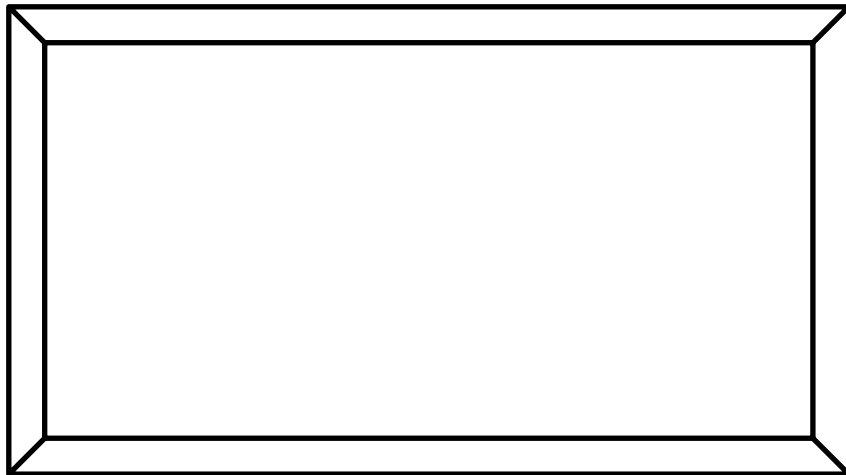
I hope that... _____

AFTER

I want to know more about... _____

My favorite part was ... _____

I learned that... _____



Imagine you are in the rainforests of Borneo—what would you be doing? On the left, draw a “selfie” of yourself on your trip.

Rate this virtual field trip by coloring in the number of stars you would give it!

What does it mean?

Word: **Ecosystem**

Definition:

Part of speech:

- Noun
- Verb
- Adjective
- Adverb

Sentence:

Word: **Biodiversity**

Definition:

Part of speech:

- Noun
- Verb
- Adjective
- Adverb

Sentence:

Word: **Acoustic**

Definition:

Part of speech:

- Noun
- Verb
- Adjective
- Adverb

Sentence:

Word: **Frequency**

Definition:

Part of speech:

- Noun
- Verb
- Adjective
- Adverb

Sentence:

Word: **Spectrogram**

Definition:

Part of speech:

- Noun
- Verb
- Adjective
- Adverb

Sentence:

Word: **Proboscis**

Definition:

Part of speech:

- Noun
- Verb
- Adjective
- Adverb

Sentence: