LESSON 7: Why do orangutans need so much forest space?

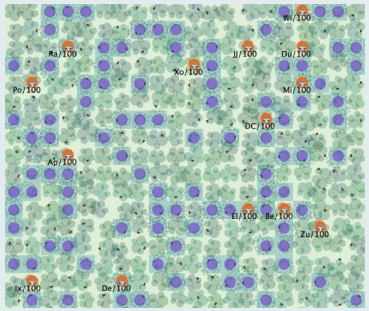
PREVIOUS LESSON

We examined a StoryMap with data about orangutan populations in four parks and noticed that larger areas had larger populations. We calculated ratios of orangutans per area and realized that only 1-3 orangutans can live in 1 km2. We wondered if that is because of food limitations and considered what we would need in a simulation to test this idea.

THIS LESSON

INVESTIGATION

2 days



We gather data from a whole-group computer simulation in which individual orangutans compete with each other for two different food sources (figs and termites). We test the simulation in a variety of environmental conditions (independent variable) including: (1) plentiful figs and termites, (2) plentiful figs but few termites, (3) few figs but plentiful termites, and (4) few figs and few termites. After constructing class histograms using data from each simulation, we examine how well individual orangutans and the orangutan population overall responded (dependent variables) by analyzing measures of central tendency and ranges for each environmental condition. We make claims about food sources and competition between individuals within species.

NEXT LESSON

We will conduct investigations in a simulation, manipulating the amount of resources (IV) over longer periods of time to observe how populations increase or decrease (DV). We will notice that population sizes increase when resources are plentiful and decrease when resources are limited. We will also notice that all populations have natural fluctuations in size. We will connect our findings to the differences in population density in the different ecosystems from Lesson 6.

BUILDING TOWARD NGSS

MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-LS2-5

WHAT STUDENTS WILL DO

Carry out a series of investigations using a simplified computer simulation (system model) in which individual orangutans compete with each other for two different food sources in a variety of environmental conditions.

Analyze measures of central tendency and range in class-constructed histograms to make claims about how populations of orangutans responded to a variety of environmental conditions and the ways in which the environmental conditions contributed to the stability of the population or changes in the population.

WHAT STUDENTS WILL FIGURE OUT

- Organisms in the same population compete with each other for food.
- Competition between individuals within a population increases when availability of resources is limited.
- Populations of organisms like food sources that give them more energy, but can eat things with less energy to survive.
- If an organism cannot meet its needs, it may not grow and survive.

Lesson 7 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	3 min	**NAVIGATION** Set the purpose for the lesson by reviewing our ideas about why orangutans need so much space and how we might test our ideas in a computer simulation.	A	Class chart from Lesson 6 outlining class ideas for a computer simulation
2	10 min	**ORIENT TO THE COMPUTER SIMULATION** Orient students to the computer simulation by introducing the various components in the simulation and the interactions between the components.	B-D	computer and projector, Orangutan Forest Model 1 simulation, Orangutan Forest Model Orientation: Interactions video, Orangutan Forest Model Orientation: Aesthetics video
3	7 min	**COMPARE THE SIMULATION TO A REAL ECOSYSTEM** Have students compare the simulation to a real ecosystem and consider how the simulation will be useful in helping us make sense of what is happening in a real ecosystem and what the limitations might be.	E-F	chart paper, markers
4	7 min	**PREPARE FOR INVESTIGATION A** Gather the class around the projected simulation, assign each student to an orangutan to track, and make predictions.	G-H	*Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, computer and projector, Orangutan Forest Model 1 simulation, *Orangutan Name Cards* (cut-out prior to the lesson)
5	18 min	**CONDUCT INVESTIGATION A** Run the simulation and create a class histogram based on the results. Draw conclusions based on the data from the simulation.	I-L	*Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, 1 sticky note, marker, computer and projector, Orangutan Forest Model 1 simulation, class whiteboard or chart paper, markers
				End of day 1
6	15 min	**CONDUCT INVESTIGATION B** Test the question, "What happens to the orangutans if there are fewer fruit trees?" Make predictions, run the simulation, and create a class histogram based on the results. Draw conclusions based on the data from the simulation.	M-N	*Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, 1 sticky note, marker, computer and projector, Orangutan Forest Model 1 simulation, class whiteboard or chart paper, markers
7	15 min	**CONDUCT INVESTIGATION C** Test the question, "What happens to the orangutans if there are more fruit trees?" Make predictions, run the simulation and create a class histogram based on the results. Draw conclusions based on the data from the simulation.	O-P	*Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, 1 sticky note, marker, computer and projector, Orangutan Forest Model 1 simulation, class whiteboard or chart paper, markers
8	12 min	**BUILDING UNDERSTANDINGS DISCUSSION** Make sense of patterns in the data to draw conclusions about why orangutans need so much space to survive.	Q-R	
9	3 min	**NAVIGATION** Predict what might happen to the orangutan population if we add births and deaths to the simulation.	S	
				End of day 2

Lesson 7 • Materials List

	per student	per group	per class
Lesson materials	• science notebook • *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*	• 1 sticky note • marker	• Class chart from Lesson 6 outlining class ideas for a computer simulation • computer and projector • Orangutan Forest Model 1 simulation • Orangutan Forest Model Orientation: Interactions video • Orangutan Forest Model Orientation: Aesthetics video • chart paper • markers • *Orangutan Name Cards* (cut-out prior to the lesson) • class whiteboard or chart paper

Materials preparation (45 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Print and cut out *Orangutan Name Cards*. Prepare enough sets of *Orangutan Name Cards* for every student to receive 1 card. There are 15 name cards, so if you have a class of 30 students, you will need 2 sets of cards. You may wish to laminate name cards for future use.

Make sure you can open the *Orangutan Forest Model 1* simulation from https://tinyurl.com/forestmodel1 and can project it on a large enough screen so that everyone in the class can see it. Alternatively, you can download the sim code file and run it directly from your computer. Instructions for different methods to access the Netlogo simulations are located at the field test website: https://www.teachersopensciedfieldtest.org/palmoil.

Make space around the screen so that students can form a semi-circle to view the simulation.

Watch the *Orangutan Forest Model Orientation: Interactions* and *Orangutan Forest Model Orientation: Aesthetic* videos from https://www.teachersopensciedfieldtest.org/palmoil prior to day 1. These videos introduce the simulation on **slide C** and will be viewed by your students. You can download the videos from the field test website and play directly from your computer.

Spend some time familiarizing yourself with the simulation and the controls. Run each investigation outlined in the lesson on your own prior to running the investigations with the class.

Make the data chart on your whiteboard or chart paper for the class to build the histogram using sticky notes. Make sure to space your units on the X-axis every 100 energy units and use a sticky note to space each unit far enough apart so that when students build the histogram, the sticky notes within a certain 100-block range (e.g., 100-200) do not overlap with neighboring ones (e.g,, 0-100 and 200-300).

If using composition notebooks, print 1 copy of *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?* for each student. Trim the edges so that the handout can be glued or taped in students' science notebooks. You will only pass out the *Investigation A* pages on day 1 and will need the *Investigation B* and *C* pages on day 2. Have glue or tape readily available for students to attach to handouts to their notebooks.

Lesson 7 • Where We Are Going and NOT Going

Where We Are Going

In Lesson 6, students figured out that populations of orangutans refer to groups of orangutans that live in a certain area. They also figured out that larger areas of intact forest support larger populations of orangutans, but that orangutans generally have a density of 1-3 per km^2. Students were left wondering whether the need for available food is the reason for orangutans requiring so much space. This lesson allows students to test their ideas about food availability by manipulating the amount of food in a given area to see how it impacts orangutans' energy levels (a sign of health).

This lesson builds from previous lessons to specifically target these important DCIs:

- Competition exists within a population for resources, primarily for food.
- Individual organisms have preferred food resources, but can survive on different food resources if necessary.
- Resource availability affects an individual organism's growth and survival.

These science ideas are part of LS2.A Interdependent Relationships in Ecosystems. The lesson focuses on figuring out important aspects of these DCIs with respect to competition within populations and individual organism survival. Students will connect organism survival to population growth and decline in the next lesson.

This lesson builds on the 5th grade DCI, *Organisms can survive only in environments in which their particular needs are met*. This lesson extends students' understanding by connecting organism survival to resource availability in the ecosystem.

Where We Are NOT Going

You may be tempted to make connections between individual organism energy levels and survival to population growth and decline. Avoid making these connections for students in this lesson, as that is the focus of Lesson 8. If students make these connections in this lesson, use their ideas to motivate wanting to test the survival of individual organisms as it relates to population growth and decline, which they will do in another simulation.

In terms of resource availability, the focus of this lesson and Lesson 8 is food resources. Students will layer on other resources, such as shelter, safety, and hunting and other relationships between organisms and resources in Lesson 10.

LEARNING PLAN for LESSON 7

1 · NAVIGATION

3 min

MATERIALS: Class chart from Lesson 6 outlining class ideas for a computer simulation

Set the purpose for the lesson by reviewing our ideas about why orangutans need so much space. Have the class chart created at the end of Lesson 6, which outlined class ideas for a computer simulation, visible to students. Project **slide A** and say, *Yesterday we shared some of our ideas about why we think orangutans need so much forest space. We also brainstormed some ideas about what we would want to see in a simulation that could help us test why orangutans need so much forest space. Let's review some of our ideas.*

As a whole group, have students share out some of their thinking about both questions. Start with the first question on **slide A**, *What were some of our ideas about why we think orangutans need so much forest space?* When students are ready, progress to the second question on **slide A**, *What were some of our ideas about what we would want to see in a simulation that could help us test why orangutans need so much forest space?* ✱

Suggested prompt	Sample student response
1-3 orangutans in a 1 km^2 area is a really big area for only a few individuals. That's only 1-3 orangutans in a space that is 186 football fields. Why do we think orangutans need so much forest space?	*Maybe they need a lot of food, there's only so many homes they can live in, or they fight with each other.*
If we were going to test the idea that orangutans need so much space to get the food they need using a simulation, what would we need to have in the simulation?	*Different types of food that orangutans eat—figs and termites.* *A set amount of space.* *Orangutans.* *A way to spread out the food in the space.*

Tell students, *I have a simulation that may have some of the components that we wanted in it. Now that we have specified what we think such a simulation should include, we can think critically about how the simulation will be useful in helping us make sense of what is happening in a real ecosystem.*

✱ ATTENDING TO EQUITY

This is an important opportunity for students who might need more processing time to go public with their ideas in a whole-class setting. At the end of Lesson 6, students were asked to share their ideas about the two questions posed on **slide A.** After hearing from a few students at the end of Lesson 6, you may wish to seed the idea that you will ask these questions again at the beginning of the next lesson. This will allow time for students to think through and prepare their ideas and may provide time to help you support and encourage students who don't normally share their ideas to go public. When you ask the questions again at the beginning of this lesson, make a point of calling on students who may not normally share their ideas in whole-group settings.

2 · ORIENT TO THE COMPUTER SIMULATION

10 min

MATERIALS: computer and projector, Orangutan Forest Model 1 simulation, Orangutan Forest Model Orientation: Interactions video, Orangutan Forest Model Orientation: Aesthetics video

Orient students to the computer simulation by introducing the various components in the simulation. Direct students' attention to the center image on **slide B.** This image is a screenshot taken from the computer simulation. The simulation includes four main components: (1) orangutans, (2) fruit trees, (3) termites, and (4) rainforest trees. The images show how the icons used in the simulation map to their counterparts in a real ecosystem. Prompt students to consider the ways in which orangutans interact with the other components in the ecosystem (termites, rainforest trees, and fruit trees).

✱ SUPPORTING STUDENTS IN ENGAGING IN PLANNING AND CARRYING OUT INVESTIGATIONS

Use this orientation to review and reinforce what students know about independent variables as a way to run tests in a system. There are 4 possible independent variables

Suggested prompt	Sample student response
How do you think orangutans and fruit trees interact?	*Orangutans probably eat the fruit from the fruit trees.* *Fruit trees probably lose fruit when orangutans eat the fruit. We think the fruit should be able to grow back.*
How do you think orangutans and termites interact?	*Orangutans probably eat the termites, but termites probably don't give orangutans as much energy as the fruit on fruit trees.* *Termites probably die when orangutans eat them.*
How do you think orangutans and rainforest trees interact?	*Orangutans can probably swing through the rainforest trees, but can't eat anything off of them.*

Say, *Those are really interesting ideas! Let's check to see if our ideas are consistent with how this model actually works.*

Orient students to the computer simulation by demonstrating the interactions between components. Project **slide C** and play the *Orangutan Forest Model Orientation: Interactions* from https://www.teachersopensciedfieldtest.org/palmoil . The video introduces students to the ways in which the various components of the ecosystem interact with one another. The key rules are outlined below:

- Orangutans wander around the ecosystem randomly
- When an orangutan runs into a fruit tree, the orangutan eats fruit and gains 2 units of energy and the tree loses some of its fruit
- When an orangutan runs into a termite, the orangutan eats the termite and gains 0.1 unit of energy and the termite dies
- To swing from one rainforest tree to the next, an orangutan loses 1 unit of energy
- Fruit grows back and termites reproduce at a set time interval
- The simulation lasts for about 5.5 years

Demonstrate how to control variables in the ecosystem.✱ Project the simulation and demonstrate how to control different variables related to orangutans, fruit trees, rainforest trees, and termites.

- Orangutans: Move the "initial-orangutans" slider to change the initial number of orangutans in an ecosystem
- Fruit Trees: Move the "%-fruit-trees" slider to change the percentage of fruit trees in the forest
- Rainforest Trees: Move the "area-of-forest" slider to change the amount of forest in the ecosystem. Move the "forest-distribution" slider to change how the forest is distributed around the screen.
- Termites: Move the "% termites" slider to change the initial number of termites in the ecosystem.

The video also shows students that they can change the visualization of the trees and orangutans using the aesthetic controls. Present **slide D** and play the *Orangutan Forest Model Orientation: Aesthetics* video located at https://www.teachersopensciedfieldtest.org/palmoil . You may wish to skip this step if you are short on time.

Remind students that changes in the sliders are only applied after pressing "SETUP/RESET" and the simulation runs after pressing "GO".

ADDITIONAL GUIDANCE	In this lesson, the teacher will be manipulating the controls for the simulation. The introduction to the controls will help students manipulate the simulation in Lesson 8. Emphasize to students that in order for us to collect reliable data from the simulations to pool together and draw conclusions from as a class, everyone needs to work with the same data, with the variables manipulated in similar ways. This can only be accomplished if everyone has a good understanding of the variables and how to manipulate them.

in this computer model, and it's important to manipulate only 1 independent variable at a time.

3 · COMPARE THE SIMULATION TO A REAL ECOSYSTEM

7 min

MATERIALS: science notebook, chart paper, markers

Compare the components and interactions in the simulation to a real ecosystem. Present **slide E** and say, *Computer simulations are one way of helping us think about what is happening in real ecosystems. Simulations allow us to speed up time and eliminate some complicating variables, but they also have limitations. Identifying the strengths and limitations of our simulation will help us think about how this simulation will be useful in helping us make sense of what is happening in a real ecosystem. Let's start by considering how our simulation is similar to or different from a real ecosystem.*

Prompt students to recreate the table on **slide E** in their science notebooks. Then, give students time to individually jot down their ideas about how the simulation is similar to or different from a real ecosystem.

After jotting their ideas in their notebooks, have students share their ideas with the whole class. Prompt students to record additional ideas in their notebooks based on their classmates' contributions.

Suggested prompt	Sample student response
How is this simulation similar to a real ecosystem?	*The simulation includes many of the key components of the ecosystem - orangutans, fruit trees, rainforest trees, and termites.* *When orangutans eat food, they get more energy. Orangutans get more energy from fruit than from termites.* *When orangutans eat termites, the termites die. When orangutans eat fruit, the fruit tree loses fruit.* *It takes energy for orangutans to move.*
How is this simulation different from a real ecosystem?	*The simulation is missing many of the other living and nonliving things in the ecosystem.* *Orangutans eat more than just fruit and termites.* *Orangutans don't just wander about aimlessly.* *Orangutans can reproduce and die - we haven't seen that in the simulation.* *Termites also depend on food sources.* *Rainforests and fruit trees depend on water and sunlight availability, which aren't included in the simulation.* *Orangutans spend more energy walking on the ground than swinging through trees. We don't see a difference in the simulation.*

✱ SUPPORTING STUDENTS IN ENGAGING IN PLANNING AND CARRYING OUT INVESTIGATIONS

Students carry out investigations in a simulated space and may not view these as "lab investigations". Use this opportunity to broaden students' understanding of different ways that scientists investigate the world, particularly through the use of computer simulations that allow multiple scenarios and trials to be run. It's important to also share that computer simulations are based on estimates from field data, so at some point research on orangutans in their real environment was used to create the computer model.

✱ SUPPORTING STUDENTS IN DEVELOPING AND USING SYSTEMS AND SYSTEM MODELS

During this discussion, students uncover the idea that the simulation is limited in that it only represents certain aspects of the ecosystem. The simulation focuses specifically on the orangutans, so it doesn't account for all of the variables related to the other components in the ecosystem. It is important to help students understand that there are both advantages and limitations to using simulations to model a system.

Prompt students to consider the advantages and limitations of using the simulation to help us understand what is going on in the ecosystem. ✱ Present **slide F** and say, *It sounds like our simulation is a very simplified model of the actual ecosystem. There can be some advantages to using a simulation like this. There can also be some limitations. Let's keep track of the advantages and limitations so that we can keep them in mind as we use the simulation.*

Suggested prompt	Sample student response
What are the advantages of using a simulation to study this ecosystem?	*By simplifying our ecosystem, we can think more clearly about the interactions in the ecosystem and how they might lead to particular outcomes.* *We are able to focus closely on the orangutans without getting distracted by too many other interactions in the ecosystem.* *We are able to speed up time and repeat trials without actually harming the ecosystem.*
What are the limitations of using a simulation to study this ecosystem?	*The simulation doesn't account for all of the various interactions taking place in the ecosystem (e.g. termites eating food, trees getting enough water, etc.), so we need to be careful about drawing conclusions without considering how our results might change if the other components in the ecosystem change.* *Our simulation shows only one small part of a much larger ecosystem, so we need to be careful about generalizing to a larger ecosystem.*

As students share their ideas, keep track of the advantages and limitations of using a computer simulation by constructing a T-chart on chart paper. ✱

Summarize by saying, *Even though we know that there are some limitations to using a simulation, it sounds like there are many advantages. Let's do some investigating with this simulation to help us focus closely on what is happening with the orangutans in the ecosystem.*

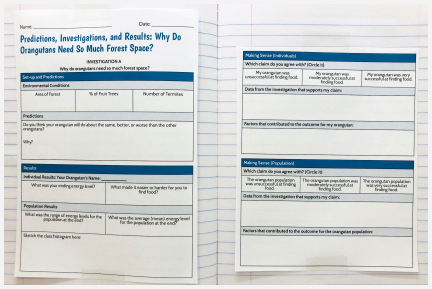
4 · PREPARE FOR INVESTIGATION A

7 min

MATERIALS: science notebook, *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, computer and projector, Orangutan Forest Model 1 simulation, *Orangutan Name Cards* (cut-out prior to the lesson)

Orient to the investigation by reminding students that our goal is to figure out why orangutans need so much forest space. To figure this out, we are going to conduct a series of investigations using the computer simulation. For each investigation, we will need to record the environmental conditions (forest area, % fruit trees, number of termites), make predictions, record our findings, and make sense of our findings.

Handout 1 copy of *Investigation A* from *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?* to each student. Keep the *Investigation B* and *C* pages for later use on day 2. Use **slide G** to prompt students to paste each page of the handout into their science notebooks.


Name: _____ Date: _____

Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?

INVESTIGATION A

Why do orangutans need so much forest space?

Set-up and Predictions

Environmental Conditions

Area of Forest	% of Fruit Trees	Number of Termites

Predictions

Do you think your orangutan will do about the same, better, or worse than the other orangutans?

Why?

Results

Individual Results: Your Orangutan's Name: _____

What was your ending energy level?	What made it easier or harder for you to find food?

Population Results

What was the range of energy levels for the population at the end?	What was the average (mean) energy level for the population at the end?

Sketch the class histogram here.

Making Sense (Individual)

Which claim do you agree with? (Circle 1)

My orangutan was consistently successful at finding food.	My orangutan was moderately successful at finding food.	My orangutan was very successful at finding food.

Data from the investigation that supports my claim:

Factors that contributed to the outcome for my orangutan:

Making Sense (Population)

Which claim do you agree with? (Circle 1)

The orangutan population was very successful at finding food.	The orangutan population was moderately successful at finding food.	The orangutan population was very unsuccessful at finding food.

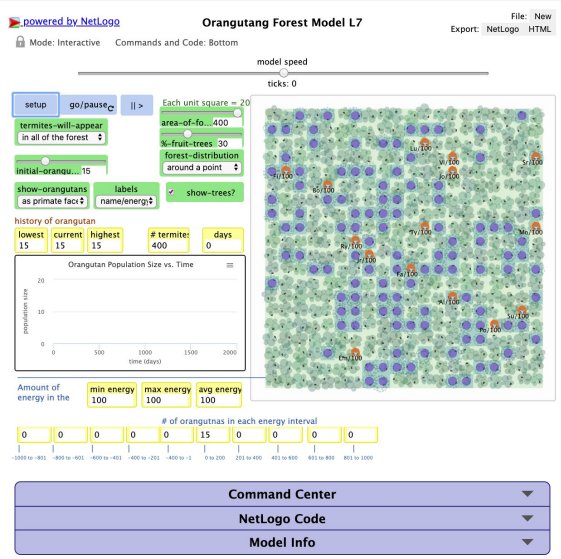
Data from the investigation that supports my claim:

Factors that contributed to the outcome for the orangutan populations:

Project the *Orangutan Forest Model 1* simulation on a larger screen and gather students in a semi-circle around the screen. Make sure to press "setup" so that students can see the orangutans on the screen. Use the default values for the first investigation. Double check your set-up for *Investigation A* using the image below.

Pass out one *Orangutan Name Cards* to each student and have students locate their orangutan on the screen. When assigning more than one student to an orangutan, have students with the same orangutan stand or sit next to each other. Say, *In the wild, scientists gather data on orangutan individuals and populations by carefully observing them in their natural habitat. We are going to do the same in our simulation. Each of you will be assigned one orangutan to carefully monitor throughout the simulation. It is your job to pay close attention to what your orangutan eats, which other orangutans your orangutan comes into contact with, and the energy level of your orangutan.*

Record environmental conditions and make predictions. Before running the simulation, explain that it is important to record the environmental conditions for the investigation and make predictions. Project **slide H** and, using the prompts on *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, have students record the environmental conditions and predictions for *Investigation A*. The values for the environmental conditions can be found on the sliders in the simulation.



30%fruit trees

5 · CONDUCT INVESTIGATION A

18 min

MATERIALS: science notebook, *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, 1 sticky note, marker, computer and projector, Orangutan Forest Model 1 simulation, class whiteboard or chart paper, markers

Conduct *Investigation A*. Project the *Orangutan Forest Model 1* simulation from https://tinyurl.com/forestmodel1 large enough for all students to see it. You may wish to orient students to the steps needed to conduct the investigation using **slide I.** Before pressing "Go/Pause" remind students that it is their responsibility to carefully watch their assigned orangutan. When students are ready, press "Go/Pause" and run the simulation. The simulation will automatically end after 2000 ticks (noted at the top of the simulation as "model speed"). This will take about 2-3 minutes.

Record data from the simulation. At the end of the simulation, have students record their individual results on the "Results" section of *Investigation A*. Students can find the ending energy level of their orangutan by checking the number next to their orangutan's name. Next, have students record the population results. Students can find the range and mean energy levels on the simulation interface. You may wish to orient students to the steps in recording data using **slide J**.

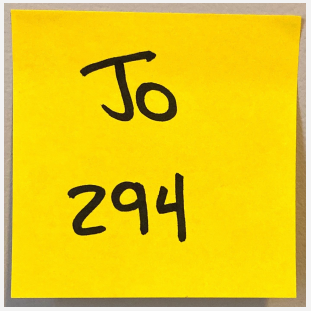
ADDITIONAL GUIDANCE

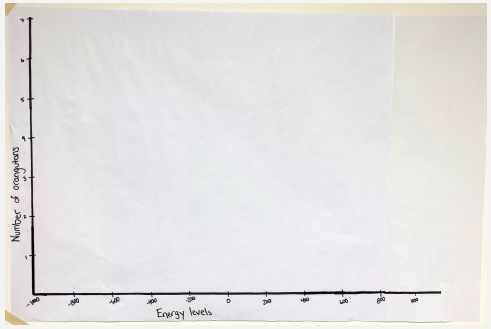
The simulation automatically ends at 2000 ticks. As you near the end of the simulation, prompt students to pay very close attention to the energy levels of their orangutans. Occasionally, the names/energy levels of the orangutans overlap when the simulation ends, so it is difficult for students to see the ending energy level of their orangutan. If students pay close attention to the energy level of their orangutan as the simulation nears its end, they can use the most recent value that they were able to see.

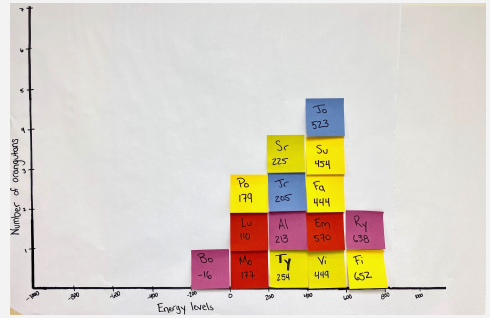
Create a class histogram. Pass out one sticky note per orangutan (for a total of 15 sticky notes). If more than one student is watching the same orangutan, the students should share one sticky note between them. Instruct students to write the name and energy level of their orangutan on the sticky note.

While students are recording the name and energy levels of their orangutan on sticky notes, create an axis for a class histogram on the class whiteboard or on chart paper. Label the y-axis as "Number of orangutans" and add numbers approximately every three inches (the size of a standard sticky note) as illustrated below. Label the x-axis as "Energy levels" and indicate energy ranges in increments of 200 every three inches (the size of a standard sticky note), as illustrated in the image provided.

Have students add their sticky notes to the histogram according to the energy levels of their orangutans. It may help to demonstrate how to do this by adding the first sticky note as a class.

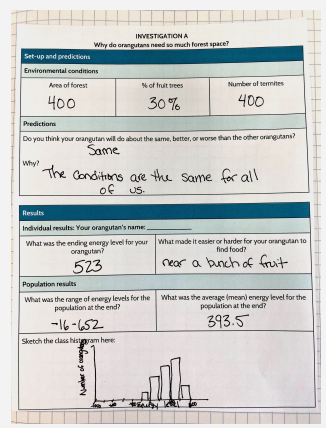






ADDITIONAL GUIDANCE	To easily compare histograms across investigations, you may want to consider creating histograms using the same scale rather than the maximum and minimum energy levels for each investigation. We recommend using a -1000 to 1000 scale across all three investigations.

After generating the class histogram, prompt students to sketch the histogram in their science notebooks in the space indicated on *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*.


INVESTIGATION A
Why do orangutans need so much forest space?

Set-up and predictions

Environmental conditions

Area of forest	% of fruit trees	Number of termites
400	30%	400

Predictions

Do you think your orangutan will do about the same, better, or worse than the other orangutans?
Same

Why?
The conditions are the same for all of us.

Results

Individual results: Your orangutan's name: _____

What was the ending energy level for your orangutan?	What made it easier or harder for your orangutan to find food?
523	near a bunch of fruit

Population results

What was the range of energy levels for the population at the end?	What was the average (mean) energy level for the population at the end?
-16 - 652	393.5

Sketch the class histogram here:

Lead a class discussion to reflect on the findings. Project the discussion prompts on **slide K.** Start by focusing on the extremes - orangutans that were very successful getting food and orangutans that were not very successful at getting food. Select one student watching an orangutan in each category to share out their observations. Then, progress to the orangutans who were moderately successful at getting food.

Suggested prompt	Sample student response
How do orangutans gain energy? How do they lose energy?	*Orangutans gain energy by eating food. They gain lots of energy by eating fruit and only a little bit of energy by eating termites.* *Orangutans lose energy by swinging through the trees.*
What does it mean if an orangutan has negative energy?	*It means that the orangutans energy level fell below 0. This can't actually happen with real orangutans! In our simulation, orangutans can't die, but we think they should die at 0.* *We want to see a revision to the simulation that would show orangutans dying at 0 energy level.*
Which orangutans were most successful at finding food? What made it so they could get a lot of food?	*There were many fruit trees around my orangutan, so my orangutan could easily move back and forth between fruit trees.* *There weren't many other orangutans around my orangutan, so my orangutan wasn't competing with anyone to get food.*
Which orangutans were least successful at finding food? What prevented your orangutan from finding food?	*There weren't many fruit trees around my orangutan, so my orangutan had to eat termites,.* *There were a lot of other orangutans around my orangutan who kept stealing my orangutan's food!*
Which orangutans were moderately successful at finding food? What made is so that your orangutan could get food when your orangutan needed it?	*There were fruit trees around my orangutan, but my orangutan sometimes had to travel longer distances to get to other fruit trees.* *There were lots of fruit trees around my orangutan, but there were also some other orangutans around my orangutan, so my orangutan couldn't eat all of the fruit.* *My orangutan ate a mixture of termites and fruit.*

Summarize by saying, *It sounds like the orangutans that did really well had better access to food because there were either more fruit trees around them or fewer orangutans. Orangutans that were the least successful either had access to fewer fruit trees or had to compete with many other orangutans for the fruit.*

Make sense of individual and population data. In the space provided on , prompt students to make sense of the data from *Investigation A*. Project **slide L** to guide student work. Students should circle the claim that they most agree with, provide data from the investigation to support their claim, and then list factors that may have contributed to the outcomes that they observed. Be sure to prompt students to make sense of data for both their individual orangutan and the orangutan population as a whole.

End of day 1

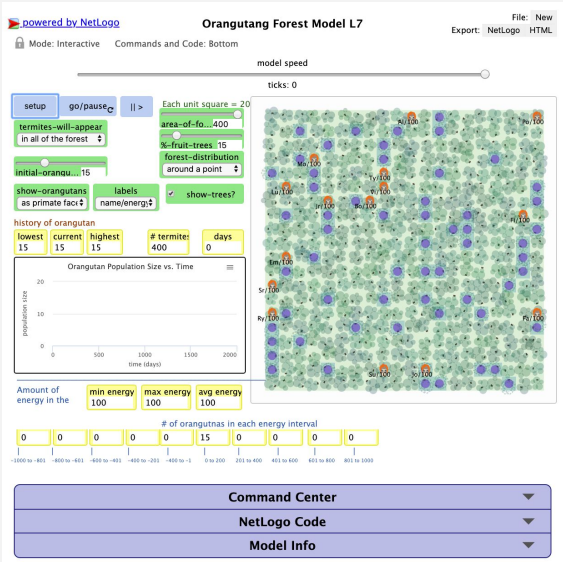
6 · CONDUCT INVESTIGATION B

15 min

MATERIALS: science notebook, *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, 1 sticky note, marker, computer and projector, Orangutan Forest Model 1 simulation, class whiteboard or chart paper, markers

Pass out the *Investigation B* handouts to students (from *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*). Have students attach the handouts to their notebooks.

Orient to the investigation by reminding students that fruit trees in rainforests were cut down to make space for oil palm trees. You may wish to outline the steps in the investigation by projecting **slide M.** Show students that we can partially mimic this scenario by reducing the number of fruit trees in the simulation. Project the simulation on the screen and change the "% of fruit trees" slider to 15. Make sure to press "setup" so that students can see the changes reflected on the screen. Double check your set-up for *Investigation B* using the image below.
Remind students that it is their job to closely track one orangutan in the simulation. Students should continue tracking the same orangutan that they tracked in *Investigation A*.



15% fruit trees

Record environmental conditions and make predictions. Before running the simulation, have students record the environmental conditions and predictions for *Investigation B* on their handout.

Conduct *Investigation B*. When students are ready, press "Go/Pause" and run the simulation. The simulation will automatically end after 2000 ticks (noted at the top of the simulation as "model speed"). This will take about 2-3 minutes. You may wish to increase the model speed to save time.

Record data from the simulation. At the end of the simulation, have students record their individual results on the *Investigation B* handouts. Students can find the ending energy level for their orangutans by checking the number next to their orangutans' names. Next, have students record the population results. Students can find the range and mean energy levels on the simulation interface.

Create a class histogram. Use the same process to create a class histogram that you used in *Investigation A.* Pass out one sticky note per orangutan (for a total of 15 sticky notes). If more than one student is watching the same orangutan, the students should share one sticky note between them. Instruct students to write the names and energy levels of their orangutans on their sticky notes.

While students are recording the names and energy levels of their orangutans on sticky notes, create an axis for a class histogram on the board or on chart paper. Label the y-axis as "Number of orangutans" and add numbers approximately every three inches (the size of a standard sticky note). Label the x-axis as "Energy levels" and indicate energy ranges in increments of 200 for every three inches (the size of a standard sticky note). Note that the energy ranges will be significantly lower than in *Investigation A*.

Have students add their sticky notes to the histogram according to the energy levels of their orangutans. It may help to demonstrate how to do this by adding the first sticky note as a class. After generating the class histogram, prompt students to sketch the histogram in their science notebooks in the space indicated under "Results" for *Investigation B*.

Lead a class discussion to reflect on the findings. Project the discussion prompts on **slide N.** Prompt students to consider the ways in which the orangutans' diet changes when there are fewer fruit trees and how that might be related to the orangutans' chance for survival.

Suggested prompt	Sample student response
Compared to Investigation A, did orangutans eat fewer or more termites? Why?	*Orangutans ate more termites because they didn't have as much fruit available to them.*
When there were fewer fruit trees, what happened to the energy levels of individuals? The population?	*The energy levels of individual orangutans and the orangutan population as a whole went down drastically. This is because orangutans don't get much energy from termites.* *When there were fewer fruit trees, there were more orangutans competing for the same resources. This increased competition between orangutans for the fruit trees.*
How might the energy levels of orangutans in this investigation relate to their chance for survival?	*The energy levels of the orangutans decreased below 0. We think that this means that the orangutans should die. So, when there are fewer fruit trees available, orangutans run out of available food and are more likely to die.*

Summarize by saying, *It sounds like reducing the number of fruit trees caused increased competition between orangutans, even though orangutans could get some energy from the termites. This meant that orangutans were less likely to gain energy and we think that this could ultimately lead to the death of individual orangutans.*

Make sense of individual and population data. In the space provided under "Making sense", prompt students to make sense of the data from *Investigation B*. Students should circle the claim that they most agree with, provide data from the investigation to support their claim, and then list factors that may have contributed to the outcomes that they observed. Be sure to prompt students to make sense of data for both their individual orangutan and the orangutan population as a whole.

7 · CONDUCT INVESTIGATION C

15 min

MATERIALS: science notebook, *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*, 1 sticky note, marker, computer and projector, Orangutan Forest Model 1 simulation, class whiteboard or chart paper, markers

Pass out *Investigation C* handouts to students (from *Predictions, Investigations, and Results: Why Do Orangutans Need So Much Forest Space?*). Have students attach the handouts to their notebooks.

Orient to the investigation. Summarize the previous investigations by saying, *In our first investigation, we figured out that orangutans need a lot of space because they compete for food resources. In our second investigation, we figured out that when there are fewer fruit trees, orangutans struggle to find food even though they can eat termites. This increases competition between orangutans in the population. Now, let's investigate what might happen if we increase the number of fruit trees in the environment.*

You may wish to outline the steps in the investigation by projecting **slide O.** Project the simulation on the screen and change the "% of fruit trees" slider to 45. Make sure to press "setup" so that students can see the changes reflected on the screen. Double check your set-up for *Investigation C* using the image below.

Remind students that it is their job to closely track one orangutan in the simulation. Students should continue tracking the same orangutan that they tracked in *Investigations A* and *B*.

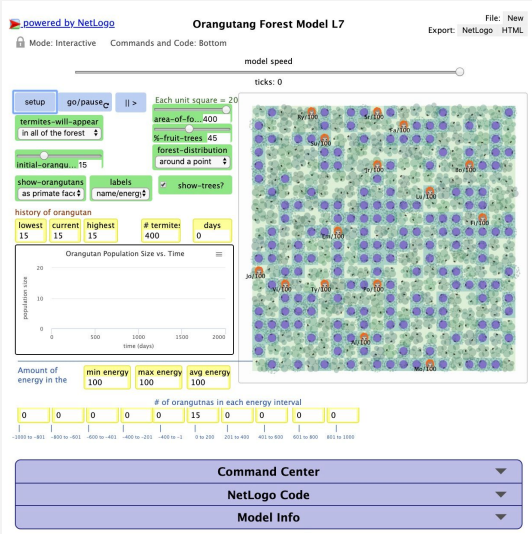
Record environmental conditions and make predictions. Before running the simulation, have students record the environmental conditions and predictions for *Investigation C*.

Conduct *Investigation C*. When students are ready, press "Go/Pause" and run the simulation. The simulation will automatically end after 2000 ticks (noted at the top of the simulation as "model speed"). This will take about 2-3 minutes. You may wish to increase the model speed to save time.

Record data from the simulation. At the end of the simulation, have students record their individual results under "Results". Students can find the ending energy level of their orangutans by checking the numbers next to their orangutans' names. Have students record the population results. Students can find the range and mean energy levels on the simulation.

Create a class histogram. Use the same process to create a class histogram that you used in *Investigation A*. Pass out one sticky note per orangutan (for a total of 15 sticky notes). If more than one student is watching the same orangutan, the students should share one sticky note between them. Instruct students to write the names and energy levels of their orangutans on the sticky notes.

While students are recording the name and energy levels of their orangutans on sticky notes, create an axis for a class histogram on the board or on chart paper. Label the y-axis as "Number of orangutans" and add numbers approximately every three inches (the size of a standard sticky note) as illustrated below. Label the x-axis as "Energy levels" and indicate energy ranges in increments of 200 for every three inches (the size of a standard sticky note), as illustrated below. Note that the energy ranges will be significantly higher than in *Investigation A*.



45% fruit trees

Have students add their sticky notes to the histogram according to the energy levels of their orangutans. After generating the class histogram, prompt students to sketch the histogram in their science notebooks in the space indicated under "Results".

Lead a class discussion to reflect on the findings. Project the discussion prompts on **slide P.** Prompt students to consider the ways in which the orangutans' diet changes when there are more fruit trees and how that might be related to the orangutans' chance for survival.

Suggested prompt	Sample student response
When there were more fruit trees, what happened to the energy levels of individuals? The population?	*The energy levels of individual orangutans and the orangutan population as a whole went up drastically. This is because orangutans were easily able to access fruit trees and didn't have to compete with one another for limited resources.*
How might the energy levels of orangutans in this investigation relate to their chance for survival?	*The energy levels of the orangutans increased significantly. This could increase their chance for growth and survival, and potentially reproduction.*

Summarize by saying, *It sounds like increasing the number of fruit trees reduced competition between orangutans, which allowed the overall energy levels of the population to increase.*

Make sense of individual and population data. In the space provided under "Making sense", prompt students to make sense of the data from *Investigation C*. Students should circle the claim that they most agree with, provide data from the investigation to support their claim, and then list factors that may have contributed to the outcomes that they observed. Be sure to prompt students to make sense of data for both their individual orangutans and the orangutan population as a whole.

8 · BUILDING UNDERSTANDINGS DISCUSSION

12 min

MATERIALS: science notebook

Make sense of the patterns in the data. Project **slide Q.** Facilitate a Building Understandings Discussion in which students share their interpretations of the simulation data and make claims about why orangutans need so much forest space and how changing environment conditions (independent variable) affected individual orangutan energy levels and the energy level of the orangutan population as a whole (dependent variable). This discussion can piggyback off of the making sense discussion after each investigation.

KEY IDEAS

Purpose of the discussion: To help students recognize that organisms in the same population compete with each other for food and that competition for resources increases when availability of resources is limited.

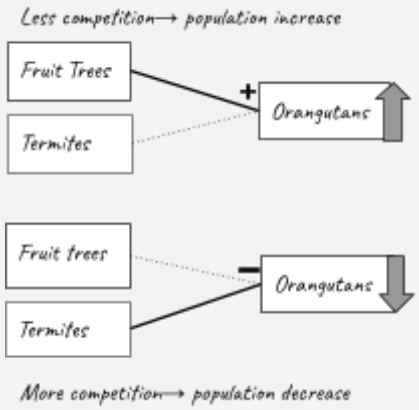
Listen for:

- Organisms in the same population compete with each other for food.
- Competition between individuals within a population increases when availability of resources is limited.
- Populations of organisms like food sources that give them energy, but can eat things with less energy to survive.
- If an organisms cannot meet its needs, it may not grow and survive.

Suggested prompt	Sample student response
What claim can you now make about why orangutans need so much forest space?	*Orangutans need so much forest space because individual orangutans within the population compete for limited food resources (fruit trees and termites). In order for an orangutan to access the energy it needs, there needs to be enough fruit trees per orangutan for the orangutan to get fruit. Otherwise, the orangutan will lose energy by moving around, which could make the orangutan slower and could potentially cause the orangutan to die.*
What claim can you now make about how changing environment conditions (IV) affected individual orangutan energy levels and the energy levels of the orangutan population as a whole (DV)?	*When there are more food resources (e.g. more fruit trees) available, orangutans compete less for resources and end up with higher energy levels.* *When there are fewer food resources available, orangutans compete more for resources and end up with lower energy levels.* *When there are fewer food resources available, orangutans eat more termites than fruit.*

During the discussion, generate a shared class representation to represent competition between individuals within a species and the different food sources. An example representation has been provided. The dashed lines represent weaker interactions. At this point, the plus sign represents increased energy. In Lesson 8, the plus sign will represent increased population size.

Summarize by saying, *We have figured out some really important ideas about how individual orangutans compete with each other in a population! Competition increases when food resources are limited. In our simulation, though, we noticed that energy levels of orangutans could get really high or could fall below 0. We identified this as a potential issue in our simulation and wondered if the high and low energy levels might be related to birth and death rates.*



Give students 3–5 minutes to quietly update their Progress Trackers using words and drawings to show what they have figured out. Project **slide R** to guide student work. Ask students to draw a line underneath their responses when they are done.

9 · NAVIGATION

3 min

MATERIALS: None

Lead a whole-class discussion to predict how our results might change if we add births and deaths into the simulation. Project **slide S** and say, *Imagine that orangutans with enough energy could reproduce (by splitting in half) and that orangutans whose energy levels fall below 0 would die. How might this change the results of our investigations?*

Suggested prompt	Sample student response
What do you predict will happen to the orangutan population when there are many fruit trees available?	*We think that the overall size of the orangutan population would increase and stay high because there are more resources available.*
What do you predict will happen to the orangutan population when there are NOT many fruit trees available?	*We think that the overall size of the orangutan population would decrease and stay low because there are fewer resources available.* *It is possible that the orangutan population might disappear completely!*

Summarize by saying, *It sounds like we should do some investigating to focus more specifically in the* population *of orangutans when we add in the opportunity for orangutans to reproduce and die. Let's start there tomorrow!*

Additional Lesson 7 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN MATH

CCSS.Math.Content.6.SP.A.2 Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

CCSS.Math.Content.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

CCSS.Math.Content.6.SP.B.5.c Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

CCSS.Math.Content.7.SP.A.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population.

In this lesson, students dive deeply into the mathematical concepts of central tendency and range. Students primarily engage with math concepts they developed in Grade 6. Students use data from simulations to identify ranges and means for the orangutan populations with respect to the energy they obtain from their environment. Use this opportunity to help students understand that measurements such as mean and range are useful measurements when looking at larger groups of things (e.g. populations of orangutans). This will push your students into 7th grade statistical math concepts.

Students also construct class histograms. By constructing the histogram, students are building mathematical ideas related to graphing data, in this case, how data from individuals will map to graphs for populations. The transition between individual outcomes and population outcomes is a focus of students making sense questions. Students learn that this transition also influences the kinds of conclusions we can draw from graphs.