LESSON 9: Why is planting oil palm trees making the number of orangutans go down?

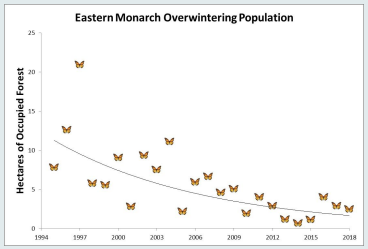
PREVIOUS LESSON

We conducted investigations in a simulation, manipulating the amount of resources (IV) over longer periods of time to observe how populations increased or decreased (DV). We noticed that population sizes increased when resources were plentiful and decreased when resources were limited. We also noticed that all populations have natural fluctuations in size. We connected our findings to the differences in population density in the different ecosystems from Lesson 6.

THIS LESSON

PUTTING PIECES TOGETHER

2 days



In this lesson, we build a Gotta-Have-It Checklist and engage in consensus modeling to show what we figured out so far about how changes to an ecosystem impact the population of organisms that live there. Afterwards, we apply these understandings towards an assessment in which we explain why the loss of short and tallgrass prairies has caused monarch butterfly populations to decrease.

NEXT LESSON

We will brainstorm different kinds of interactions between populations and develop system models for the rainforest and oil palm farm. We will compare the two systems, looking for similarities and differences. We will figure out that the rainforest system has more components and interactions than the oil palm system, but there are similar types of interactions in both ecosystems. We will use our models to brainstorm ideas to make the oil palm system more like the rainforest system.

BUILDING TOWARD NGSS

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

WHAT STUDENTS WILL DO

Develop a model based on evidence from investigations to explain how changes to resource availability in the ecosystem in which orangutans live affect the size of the population living there.

Apply mathematical concepts and processes to explain how the loss of short and tallgrass prairies to soybean oil production has caused a decline in the size of monarch butterfly populations.

WHAT STUDENTS WILL FIGURE OUT

- Organisms, and populations of organisms, are dependent on their environmental interactions.
- Organisms with similar requirements for food compete with each other for limited resources, lack of access to which consequently constrains their growth and reproduction.
- Growth of organisms and population increases are limited by access to resources.
- It is normal for populations to fluctuate depending on resource availability from year to year. Drastic changes to resource availability can cause unusual and unstable changes to populations.

Lesson 9 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	5 min	**NAVIGATION** Students review the phenomenon and question we are trying to answer about it, "Why is planting oil palm trees making the number of orangutans go down?"	A-B	highlighter
2	15 min	**BUILD THE GOTTA-HAVE-IT CHECKLIST** Students work in groups to review their artifacts from Lessons 5-8. They decide on which ideas to include in their new models to answer the lesson question.	C	*Gotta-Have-It Checklist: Healthy Orangutan Populations*, *Key for Gotta-Have-It Checklist: Healthy Orangutan Populations*
3	10 min	**DEVELOP A MODEL FOR WHY ORANGUTAN POPULATIONS ARE DECREASING** Allow students time to work on their own or with a partner to revise their models for explaining why orangutan populations are decreasing, using their Gotta-Have-It Checklist.	D	*Gotta-Have-It Checklist: Healthy Orangutan Populations*, colored pencils
4	15 min	**FACILITATE A CONSENSUS DISCUSSION TO EXPLAIN WHY ORANGUTAN POPULATIONS ARE DECREASING** Facilitate a Consensus Discussion to explain why orangutan populations are decreasing. Record a shared representation of our ideas.	E	*Gotta-Have-It Checklist: Healthy Orangutan Populations*, Communicating in Scientific Ways poster, chart paper, markers
				End of day 1
5	3 min	**NAVIGATION** Brainstorm where our model from day 1 could be useful in explaining other systems.	F	
6	15 min	**REVISE THE MODEL FOR THE MONARCH BUTTERFLY AND PRAIRIE** Work together to draw parallels between palm oil farming and soybean farming. Revise the model from day 1 to explain the monarch butterfly decline.	G-J	chart paper, markers
7	23 min	**INDIVIDUAL ASSESSMENT: BUTTERFLIES ON THE SHORTGRASS PRAIRIE** Have students individually complete an assessment to demonstrate their learning about resource availability, competition, and population size change.	K-L	*Monarch Butterflies on the Shortgrass Prairie*, *Scoring Guidance: Monarch Butterflies on the Shortgrass Prairie*
8	4 min	**NAVIGATION** Students wonder if the design solutions they have identified would also support other animals in the rainforests besides orangutans, like tigers, and decide to investigate how those animals are affected when more oil palm trees are planted.	M	
				End of day 2

Lesson 9 • Materials List

	per student	per group	per class
Lesson materials	• science notebook • highlighter • *Gotta-Have-It Checklist: Healthy Orangutan Populations* • colored pencils • *Monarch Butterflies on the Shortgrass Prairie*		• *Key for Gotta-Have-It Checklist: Healthy Orangutan Populations* • Communicating in Scientific Ways poster • chart paper • markers • *Scoring Guidance: Monarch Butterflies on the Shortgrass Prairie*

Materials preparation (20 minutes)

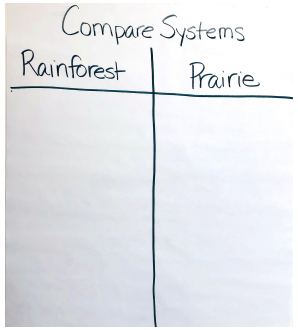
Review teacher guide, slides, and teacher references or keys (if applicable).

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

Make a space for a Scientists Circle on day 1. Have previous class models from day 1 and any agreed-upon modeling conventions displayed near this circle.

Have a copy of the Communicating in Scientific Ways poster near your Scientists Circle or previously taped into your students' science notebooks.

Before day 2, prepare a chart paper to compare the rainforest system to the prairie system as shown to the right.



Lesson 9 • Where We Are Going and NOT Going

Where We Are Going

In Lesson 8, students figured out that resource availability affects population size and that there is a normal fluctuation in population size based on resource availability and death and birth rates, but drastic changes in resource availability can cause unusual and unstable changes in populations. This lesson has students apply these ideas to explain population changes in orangutans (the anchor) and to think about palm farm designs given what students have learned about resource availability. Students also extend these ideas to a related phenomenon of monarch butterflies and milkweed availability on the prairie.

By the end of this lesson students should solidify their understanding about the following:

- "Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors" (MS-LS2-1).
- "In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction" (MS-LS2-1).
- "Growth of organisms and population increases are limited by access to resources" (MS-LS2-1).

Lesson 10 will layer on additional environmental interactions and competition between populations to fully satisfy these DCIs, but students should have figured out most of the science ideas with respect to food resource availability, within population competition, and population growth and decline.

This lesson builds on 5th grade DCIs: *Organisms can survive only in environments in which their particular needs are met. A healthy ecosystem is one in which multiple species of different types are each able to meet their needs.* This lesson extends students' understanding by connecting resource availability to healthy population sizes and normal and unusual fluctuation in populations based on resources.

Where We Are NOT Going

This lesson focuses on normal and unusual fluctuation in populations due to fluctuations in resource availability. This lesson introduces students to the idea that an extreme change in resource availability can greatly impact populations but does not yet connect this to human-caused disruptions. This will happen in Lesson 10 as students build out ecosystem webs for the tropical rainforest and palm farms. Disruptions and ecosystem health will also be the focus of Lesson 12.

LEARNING PLAN for LESSON 9

1 · NAVIGATION

5 min

MATERIALS: science notebook, highlighter

Take stock of where we are in our thinking about how changing an ecosystem affects the organisms that live there. Project **slide A**. Ask students to recap what the class has been investigating and what they have figured out so far about our Driving Question: "How does changing an ecosystem affect what lives there?"

Quickly review the challenge to design a better palm farm introduced in Lesson 5 and what we figured out during investigations in Lessons 6-8 and take stock of what has been figured out through those investigations. Don't spend too long here, as students will revisit their Progress Trackers next to create a Gotta-Have-It Checklist. Sample prompts are included below.

Suggested prompt	Sample student response
What did we decide our better palm farm needed to do? What were our criteria and constraints?	*Our farm needs to still make enough palm oil for people to use for products.* *Farmers still need to make money for their families and for the people living in these areas.* *Our palm farm can't hurt the animals and other living things in the area, though. They still need to have a healthy population, so they don't go extinct.*
What did we figure out about what makes a healthy population of orangutans?	*We learned that only a certain number can live in an area.* *They need a certain amount of space, and they need other things like food and shelter.*
Why did we say that the orangutans need a certain amount of space to keep a healthy population?	*If there isn't enough space or if there aren't enough resources, more of the orangutans will die, and the population will decrease.* *They need food and other resources, like water. If there isn't enough food for all the orangutans, some of them won't survive.* *If there isn't enough space, they have to compete with each other, and the orangutans that lose don't get the stuff they need to survive.*

Introduce the lesson question. Have students summarize some of the big questions we have been working on in the previous lessons before presenting the new lesson question. Then show **slide B** and introduce students to the question, "Why is planting oil palm trees making the number of orangutans go down?"

Establish the mission for the class. Say, *We know a lot more about what's changing in the rainforests when they get destroyed to make palm farms. But, we've been trying to figure out how these changes cause orangutan populations to decrease so that we can plan a better palm farm. We think we have enough information to explain this now, and that's what we're going to focus on today.*

2 · BUILD THE GOTTA-HAVE-IT CHECKLIST

15 min

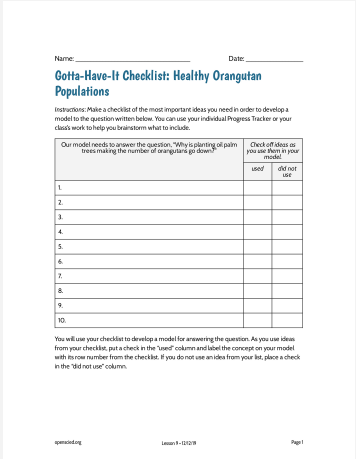
MATERIALS: science notebook, *Gotta-Have-It Checklist: Healthy Orangutan Populations*, *Key for Gotta-Have-It Checklist: Healthy Orangutan Populations*

ADDITIONAL GUIDANCE

Key for Gotta-Have-It Checklist: Healthy Orangutan Populations is provided to you as an example of the different science ideas that students have developed from Lessons 5-8. These ideas are color-coded to help you easily reference them as students share their Gotta-Have-It Checklist. Students' ideas do not need to match the key we have provided to you but should be expressed in their own words and reflect the ideas that the class developed together during Lessons 5-8.

Preview the Gotta-Have-It Checklist.✱ Explain to students that they will create a Gotta-Have-It Checklist where they decide on which ideas from their Progress Tracker and investigations they believe are most important for explaining why planting oil palm trees is causing the number of orangutans to go down.

Preview the Gotta-Have-It Checklist. Pass out a copy of *Gotta-Have-It Checklist: Healthy Orangutan Populations* to each student. This will be taped or glued into students' science notebooks when complete. Use **slide C** to preview how to build the checklist. Students will complete only the left column right now. They should leave the right columns blank. Direct students to first consult their Progress Trackers in their notebooks. Tell students that these are important ideas they have figured out over the past lessons and that some of them may be more critical than others for explaining why planting oil palm trees is causing the number of orangutans to go down.



Name: _____ Date: _____

Gotta-Have-It Checklist: Healthy Orangutan Populations

Instructions: Make a checklist of the most important ideas you need in order to develop a model to the question written below. You can use your individual Progress Tracker or your class's work to help you brainstorm what to include.

Our model needs to answer the question, "Why is planting oil palm trees making the number of orangutans go down?"	Check off ideas as you use them in your model.	
	used	*did not use*
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

You will use your checklist to develop a model for answering the question. As you use ideas from your checklist, put a check in the "used" column and label the concept on your model with its row number from the checklist. If you do not use an idea from your list, place a check in the "did not use" column.

Have students work with a partner to develop their checklist. They will note the ideas from their Progress Trackers that may help them explain the lesson question, "Why is planting oil palm trees making the number of orangutans go down?" They do not need to record all of ideas from previous lessons—only the ones they want to include to answer the lesson question. Students should spend about 8-10 minutes working with their partner.

Facilitate a sharing of ideas. Facilitate a brief sharing of ideas from the groups. Ask students to briefly mention an idea they included on the checklist and why it is important. You can also ask which ideas they did not include and why those ideas are less important. The example student responses below are not a comprehensive list of all of the ideas but may give you an idea of what students will include or not include.

✱ SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS

An alternative to doing the Gotta-Have-It Checklist in partners is to construct the checklist together as a class with a public representation of the ideas the class agrees should be part of the consensus model. If you make a modification to the current activity, keep in mind the following important components to make this activity a productive one:

- The process should be collaborative and involve students arguing from evidence for their ideas.
- There should be a public record, or artifact, of the ideas that students agree to include in their models.

Suggested prompt	Sample student responses
Can someone suggest an idea from a previous lesson that can help explain why planting oil palm trees is making the number of orangutans go down?	*Farmers and companies are cutting down rainforests to plant oil palm plants and to use resources from the trees (like wood).* *All the orangutans living in the same area are called a population, and there can only be so many in an area.* *Orangutans eat parts of trees and use trees for other resources they need, like shelter.* *Orangutans need a certain amount of space, food, and other resources to survive.* *Orangutans have to compete for resources if there aren't enough of them in an area.* *If orangutans get enough of what they need, they'll survive and reproduce.* *If an organism cannot meet its needs, it may not reproduce. Over years this could affect the total population number.*
Can someone suggest an idea we do NOT think will be helpful for explaining why planting oil palm trees is making the number of orangutans go down?	*We don't need to include the products that palm oil is used for, like candy and makeup.* *We don't need to include all the other kinds of oils there are and how they're similar and different to palm oil.* *We also shouldn't include all that we learned about what the plants need and why they're grown by the equator.* *We don't have to include why people cut down rainforest trees, even though their reasons are important for our overall question.* *We don't need to include that population sizes sometimes go up and down even in healthy populations.*

3 · DEVELOP A MODEL FOR WHY ORANGUTAN POPULATIONS ARE DECREASING

10 min

MATERIALS: science notebook, *Gotta-Have-It Checklist: Healthy Orangutan Populations*, colored pencils

ADDITIONAL GUIDANCE

Students should use 2 pages in the Progress Tracker section of their notebook to complete the model. Have students tape the Gotta-Have-It Checklist on one side and use the three-box Progress Tracker on the other side (i.e., question, evidence, what we figured out in words and pictures, example shown further down in the teacher guide).

Set a purpose for model building. Use **slide D** to orient students to the task and remind students about the lesson question we want our model to explain: "Why is planting oil palm trees making the number of orangutans go down?" Students can work on their own or with a thought partner. Remind students that the purpose of building individual models is to gather their thinking.✱ Direct students to

✱ SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS

Individual time gives students an opportunity to synthesize evidence and formulate their ideas. This is important so that students are prepared to defend their ideas and evaluate others' ideas when they share with the whole class. As students

develop their model on a new page in their science notebooks, near where they attached their Gotta-Have-It Checklist.

Give students time to develop their models. Students should then use their Gotta-Have-It Checklist to add to their model (words and pictures) different ideas that help them explain their thinking about the lesson question. Remind students that, as they use an idea from their checklist, they should check the appropriate column on their list. If they decide not to include an idea from their list, they can check that on their list as well.

work, circulate among them prompting them to defend their model (or part of their model) using evidence collected during investigations in Lessons 5-8. This can help students think through where their model may have a hole prior to the collaborative whole-class sharing.

4 · FACILITATE A CONSENSUS DISCUSSION TO EXPLAIN WHY ORANGUTAN POPULATIONS ARE DECREASING

15 min

MATERIALS: science notebook, *Gotta-Have-It Checklist: Healthy Orangutan Populations*, Communicating in Scientific Ways poster, chart paper, markers

Form a Scientists Circle for a Consensus Discussion. Have students bring their individual models in their science notebooks to the discussion circle.

Remind students of discussion norms for a Consensus Discussion.✱ Show students the Communicating in Scientific Ways chart and remind students of the discussion norms and sentence frames to use when having scientific discussions. Emphasize the importance of having a safe space in which students can share their ideas and push each other's thinking. Remind students:

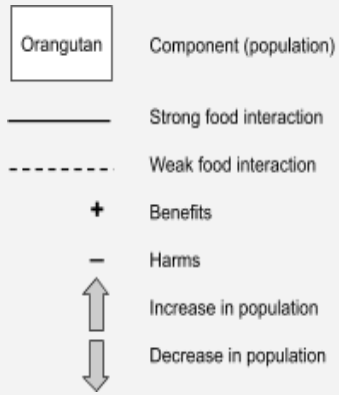
- how to agree or disagree respectfully,
- how to push for justification,
- that it's OK to share an idea they're not sure about, and
- that it's OK to disagree with someone's or a group's idea but to back up their thinking with evidence.

Display **slide E**. Say, *We're going to take stock of the ideas in everyone's models and try to build a classroom consensus model that everyone agrees upon to explain why planting oil palm trees is making the number of orangutans go down.*

Facilitate the Consensus Discussion and record a classroom consensus model. Start by having students offer proposals for what should go in the model. It may be helpful to focus on having students identify the components that need to be included on the model, followed by the relationships between them. After that, students can discuss how changing one component of this model, the rainforest trees, impacts the orangutans in such a way as to cause the population of orangutans to decrease.

As the class discusses each component and relationship that students want to add to the consensus model, encourage students to support or challenge proposals based on evidence. Students can also suggest modification to another student's proposal.

On the chart paper create a public representation of agreed-upon ideas as the class puts them together. Generate a list of modeling conventions (i.e., a "key") that explains what symbols in the model represent (shown to the right).



✱ STRATEGIES FOR THIS CONSENSUS DISCUSSION

The purpose of the Consensus Discussion on day 1 is to build a common, class-level model to explain why orangutan populations are decreasing, drawing on all of the ideas learned in Lessons 5-8. The teacher's role is to prompt students to share what needs to be in the model, evidence they have to support their ideas, and how to represent it. The students' role is to offer proposals for ideas to include in the model and how to represent those ideas, to support or challenge proposed ideas from peers, and to come to a consensus about what should be included in the model.

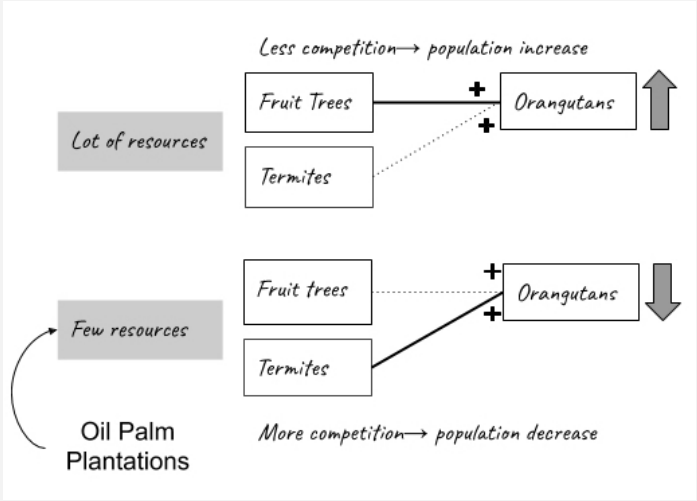
✱ ATTENDING TO EQUITY

The key ideas shared are suggestions for important ideas that the model could include. Several of these ideas are also located on *Key for Gotta-Have-It Checklist: Healthy Orangutan Populations*. Your class's list of key ideas could be articulated differently and may include other ideas not listed here. It is important, however, to appropriate the words and ideas that your students use during this discussion. Actively look for different ways that students share and represent their ideas as an opportunity to communicate to your students that different ways of representing our thinking is valuable. These differences give the group an opportunity to think more deeply about their evidence and what the evidence supports or does not support.

Question	Source of Evidence
Why is planting oil palm trees making the number of orangutans go down?	Orangutan simulation data, maps of orangutan populations in Borneo and Sumatra, and images of the rainforest.

What we figured out in words and pictures:

- Orangutans use the rainforest trees for resources, like food and shelter.
- When farmers and companies plant oil palms, they destroy the rainforest trees.
- When there aren't enough resources, orangutans have to compete for them and some orangutans don't get what they need to survive.
- If an orangutan can't get what it needs, it may not reproduce. Over the years, that means that the population goes down as orangutans die and not enough are born to keep the population stable.



Not all students are comfortable being the "only one" who voices a disagreement or a potentially wrong idea. Ask students to think about what they heard their partner or group members saying, and ask the room if their partner's or group members' ideas are represented in the class discussion. This supports all students to share, to listen, to be heard, and to be represented.

KEY IDEAS

Purpose of the discussion: to agree, based on evidence, of why planting oil palm trees is making the population of orangutans decrease.

Listen for students' ideas:✱

- Orangutans use the rainforest trees for resources, like food and shelter.
- When farmers and companies plant oil palms, they destroy the rainforest trees.
- When there aren't enough resources, orangutans have to compete for them, and some orangutans don't get what they need to survive.
- If an orangutan can't get what it needs, it may not reproduce.
- Over the years, that means that the population goes down as orangutans die and not enough are born to keep the population stable.

Suggested prompts	Sample student responses	Follow-up questions
What are all the components or factors that we think we should include on our model?	*Rainforest trees, oil palm trees, orangutans, other animals (like termites), other plants, humans.*	*What factors did we see in our pictures of the rainforest?* *What about in our simulations?*

Suggested prompts	Sample student responses	Follow-up questions
How could we connect these components? *How are these components connected in this system?*	*Orangutans use the rainforest trees for food and shelter.* *Oil palm trees replace the rainforest trees.* *Orangutans eat termites and other plants.* *Other animals eat parts of the rainforest trees.* *Humans use parts of the rainforest trees and parts of the oil palm trees.*	*Who is this interaction beneficial for?* *Who is this interaction bad for?* *How can we represent these interactions on our classroom consensus model?* *Which of these interactions are important for determining whether or not the orangutan population goes up or down?*
When the farmers plant oil palms, what changes in this model? *What happens that explains why the population of orangutans is decreasing?*	*When farmers and companies plant oil palms, they destroy the rainforest trees.* *When there aren't enough resources, orangutans have to compete for them, and some orangutans don't get what they need to survive.* *If an orangutan can't get what it needs, it may not reproduce.* *That means the population goes down, since orangutans die and not enough are born to keep the population the same.*	*How can we show this change on our consensus model?* *How does this change cause a change in the population of orangutans?*

ASSESSMENT OPPORTUNITY

Listen for students to suggest ideas, including (1) orangutans use the rainforest trees for food and shelter, (2) farmers destroy these rainforest trees to plant oil palms, (3) with fewer trees, orangutans have to compete more for resources and more don't get what they need to survive and reproduce, and (4) this means that the population goes down over time as orangutans die and not enough are born to keep the population stable.

If students struggle to piece the ideas together, ask them to tell the story beginning with the growth of oil palm farming into areas previously occupied by rainforests. Encourage students to make use of the incremental models the class has constructed, asking students to start with actors and factors the class has identified and to consider what relationships they can map between these factors. Then, prompt students to use these relationships to reason through what changes cause orangutan populations to decrease.

Motivate applying this model to other cases. Say, *Now we've developed a model for explaining the decline in orangutan populations due to palm oil farming.* Recall with students the related phenomena that they explored in Lessons 2 and 5 and come to an agreement that the class could use what they have figured out to explain these phenomena, too.

End of day 1

5 · NAVIGATION

3 min

MATERIALS: None

Taking stock of important ideas. Display **slide F**. Remind students of the model they developed on day 1 for explaining the decline in orangutan populations. Give students a minute to turn and talk, focusing on the prompt on the slide: "Where else can we use this model (or a similar model) to explain changes in populations?"

Elicit 3-5 ideas from students but keep this sharing brief. Example student ideas could include:

- other farming cases, such as soybean, corn, or canola,
- other land use changes, such as changing a forest to rangeland or urban areas, and
- the local land use change case study.✱

Say, *Let's apply our model to a new case to see where it's similar or different. Some ideas may be very similar, and other ideas may need to change for the new system.*

✱ ATTENDING TO EQUITY

Have students think about the previous cases that could be explained using a similar model as the palm oil model. The orangutan decline and palm oil farming may still feel faraway for some students, so use this opportunity to bring it closer to home. In today's activity, students will develop a new model to explain butterfly population decline and loss of prairie to soybean and corn farms, but this same model could be applied to the local case you shared with students in Lesson 5.

6 · REVISE THE MODEL FOR THE MONARCH BUTTERFLY AND PRAIRIE

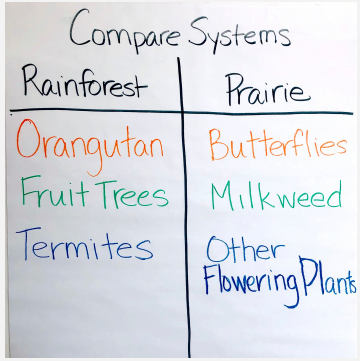
15 min

MATERIALS: science notebook, chart paper, markers

Introduce the purpose of revising the model for a new case. Say, *One way to test our model for the orangutan population decline and palm oil farming is to see if there are similar components and interactions in another ecosystem experiencing a problem we think could be similar to the palm oil problem.*

Introduce the monarch butterfly and prairie ecosystem. Display **slide G**. Introduce students to the pattern of migration for the monarch butterfly between the United States and Mexico. Display **slide H** then **slide I** and have students read aloud to the class the information on each slide about the butterflies' interaction with the milkweed plant and the range of this milkweed plant in the Midwest of the United States.

Record a list of analogical components in each system. Have the classroom consensus model from day 1 displayed. Make a T-chart on the whiteboard or chart paper near this consensus model. Draw parallels between the components of the orangutan-rainforest model from day 1 and the new components introduced in the monarch butterfly scenario.

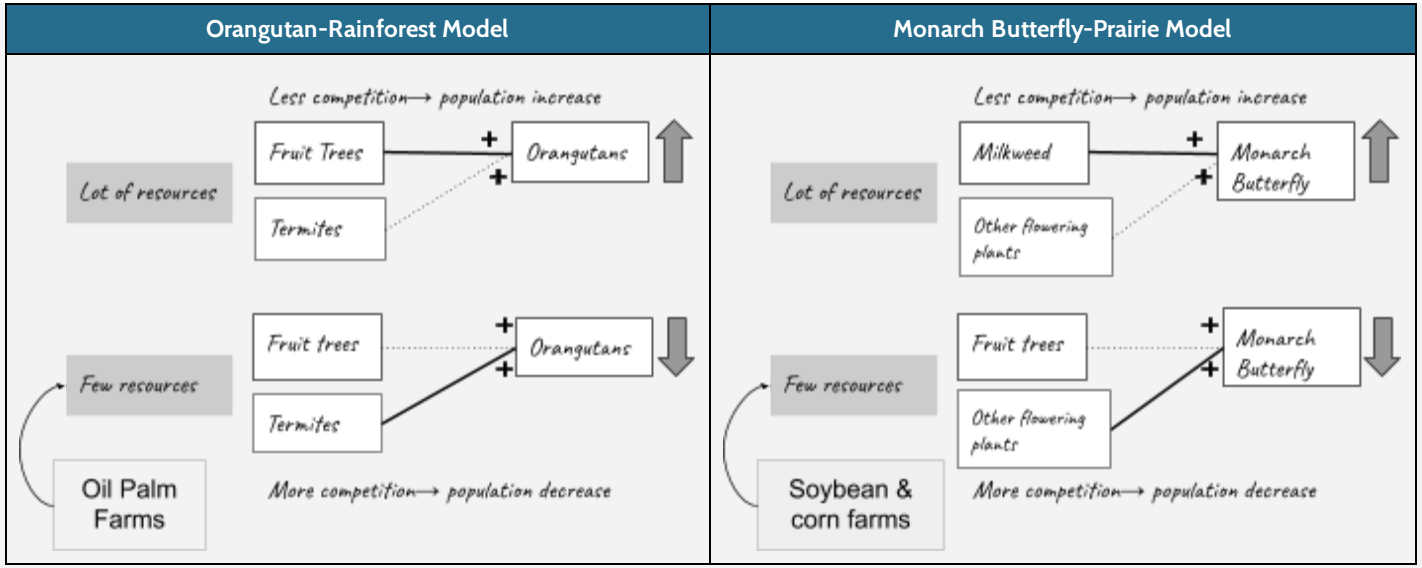


Record a classroom consensus model for how the butterflies interact with the prairie ecosystem following the orangutan-rainforest structure. Display **slide J**. Start by having students offer proposals for what should go in the model. It may be helpful to focus on having students identify the components that need to be included on the model, followed by the relationships between them. Make reference as needed to the classroom consensus model that students made on day 1 for the rainforest system, if students need help thinking of how to structure their model or what components to include.

As the class discusses each component and relationship that students want to add to the consensus model, encourage students to support or challenge proposals based on evidence. Students can also suggest modification to another student's proposal.✱

✱ SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS

Students should use the model that they and the class created for orangutan population decline to co-construct this model for the relationship between monarch butterflies and milkweed inside the prairie ecosystem. This model will be used in students' individual explanations for why the population of the monarch butterfly has decreased in these ecosystems as the presence of milkweed has declined, due to increased use of the land for soybean farming.



Suggested prompts	Sample student responses	Follow-up questions
What are all the components or factors that we think we should include on our model?	*Monarch butterflies (and caterpillars), milkweed, humans (like farmers), predators (like birds), other plants.*	*What information do we have about what the butterflies eat?* *What do we know about where these butterflies lay their eggs?*
How could we connect these components? *How are these components connected in this system?*	*The butterflies eat milkweed and other plants.* *The butterflies can only lay their eggs on milkweed plants.* *Humans destroy the milkweed plants to make room for farms.*	*Who is this interaction beneficial for?* *Who is this interaction bad for?* *How can we represent these interactions on our classroom consensus model?* *Which of these interactions could impact the population of butterflies in these areas?*

Keep the new monarch butterfly-prairie model posted for students to use in their individual assessments.

7 · INDIVIDUAL ASSESSMENT: BUTTERFLIES ON THE SHORTGRASS PRAIRIE

23 min

MATERIALS: *Monarch Butterflies on the Shortgrass Prairie*, science notebook, *Scoring Guidance: Monarch Butterflies on the Shortgrass Prairie*

Introduce the individual assessment. Display **slide K**. Pass out 1 copy of *Monarch Butterflies on the Shortgrass Prairie* to each student. Say, *Scientists have been studying these populations of butterflies because they need protection. On this assessment, you're going to show what you've learned throughout this unit by explaining, based on our class model, why the population of monarch butterflies in prairie ecosystems is decreasing.*

Depending on your students' comfort with the monarch butterfly-prairie system, consider reading through the introductory components of the assessment together, which are located just prior to question 1 and again prior to questions 4 and 5.✱ You may want to pause the class after question 3 and take a moment to read page 3 from the assessment together, then have students continue with questions 4 and 5.

Slide L is an optional slide. This graph corresponds to the histogram on question 5 and could be a useful visual to help your students as they complete item 5. Consider displaying it, if necessary.

Ask students to complete the assessment.✱ Have students individually complete *Monarch Butterflies on the Shortgrass Prairie*.

✱ ATTENDING TO EQUITY

This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far through multiple modalities, including writing to explain and drawing models. Some students may benefit from using multiple modalities to show their thinking for any or all of the questions on this assessment. You may consider allowing some students to present their answers verbally with you or with another student acting as a scribe to record their thinking on paper. Some students may benefit from using gestures, images, or manipulatives to support their explanations as opposed to written text. In each case, encouraging students to use multiple modalities to show their thinking creates a clear, accessible, equitable pathway for all students to demonstrate proficiency.

✱ ATTENDING TO EQUITY

For some students, particularly students with learning differences, below grade-level reading, or students who are emergent multilingual learners, this assessment may require more time than that which is provided for this lesson because there is a heavy reading component. Consider allowing students to finish this assessment as home learning or providing extra time for these students to demonstrate their full understanding. These students would benefit from reading the introductory text and item prompts together and allowing them to ask clarifying questions.

8 · NAVIGATION

4 min

MATERIALS: None

Navigate investigating other animals in the rainforest system besides orangutans. Display **slide M**. Remind students that one solution to our design challenge to make a better palm farm was to plant more fruit trees. Recall that other populations in the rainforest were impacted besides orangutans, including tigers, rats, and snakes.

Ask students if they think that these populations would be supported if we planted more fruit trees, and what they think the class needs to do to know for sure.

Suggested prompt	Sample student responses
Do you think that the other animals we identified, like tigers, would be supported if we planted more fig trees?	*I'm not sure about the tigers. I think they eat meat, not figs or other kinds of fruits.* *The rats' and snakes' populations were going up when more oil palms were being planted, so I don't know how they would change if we planted more fig trees.*
How could we figure out more to tell how these other animals would be affected by planting more fig trees?	*We could see if there's data on the population of these animals, like we had for orangutans.* *Maybe there's a simulation that would include these other animals, too.* *We could add these animals to our model and see how they relate to the rainforest trees.*

Come to a consensus that the class needs to investigate more about how these animals are affected when the number of rainforest trees changes, and how other animals fit into the ecosystem model the class made on day 1 of this lesson.

Additional Lesson 9 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA

In this unit, students will frequently engage in speaking, listening, and responding to others as part of their participation in scientific and engineering practices. In this instance, students engage in peer-to-peer discussion to share, express, and refine their thinking. As they do this, they must develop, present, and defend their ideas to one another verbally in a focused, coherent manner with relevant evidence; sound, valid reasoning; and well-chosen details (CCSS.ELA-Literacy.SL.8.1). Using the Communicating in Scientific Ways sentence starters can help facilitate the discussion between and among students.

As students work on their individual assessments on day 2 they are working toward the following:

- CCSS.ELA-LITERACY.W.7.2. Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
- CCSS.ELA-LITERACY.W.7.2.A. Introduce a topic; organize ideas, concepts, and information, using strategies, such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.
- CCSS.ELA-LITERACY.W.7.2.B. Develop the topic with relevant facts, definitions, concrete details, quotations, or other information and examples.
- CCSS.ELA-LITERACY.W.7.2.D. Use precise language and domain-specific vocabulary to inform about or explain the topic.

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN MATH

CCSS.Math.Content.6.RP.A.1 Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

In their individual responses on their assessments, students apply grade-appropriate mathematical concepts, namely rate and ratio reasoning, to describe and explain phenomena. For example, students parse descriptions of quantities that use rate language (like "plants per acre") and understand how relating these two quantities as a ratio helps us to analyze changes to plant populations in specific areas. In each case, the rate and ratio reasoning supports students in making sense of how resource availability changes and how resources are allocated between changing numbers of individuals in populations.

CCSS.Math.Content.6.RP.A.3 Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

In addition to explaining, using key science concepts from across the unit, why populations change in response to changes to ecosystem factors, students represent these changes in population mathematically using rate and ratio concepts. For example, on their individual assessments, students have to draw a line on a graph of population over time to represent what they think would be happening in a population that remains stable over time compared to a population that has been unstable. In doing so, students have to translate their content understanding of how stable populations change over time to a grade-appropriate mathematical representation.

If students need extra support with rate and ratio reasoning or representations, consider offering math supports, like targeted questioning or anchor charts on ratio language or graphing on the coordinate plane, so that students can demonstrate their understanding of key science concepts through mathematical language and representations. Support may focus on helping students to identify ratio language like "per" or two quantities separated by the word "to" and translating these ratios to make sense of how one quantity is compared to another (for example, making sense of "milkweed plants per acre" to mean how many of these plants there are in an area of 1 acre).