LESSON 10: How is planting palm oil affecting other populations?

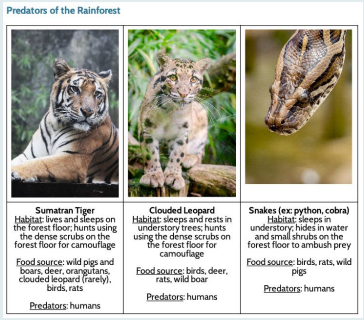
PREVIOUS LESSON

We engaged in consensus modeling to show what we had figured out about how changes to an ecosystem impact the population of organisms that live there. Afterwards, we applied these understandings on an assessment to explain why the loss of short and tallgrass prairies has caused monarch butterfly populations to decrease.

THIS LESSON

INVESTIGATION

2 days



We brainstorm different kinds of interactions between populations and add to our modeling conventions. We develop system models for the rainforest and oil palm farm and provide feedback to each other on these models. We do a gallery walk to look for similarities and differences between the two systems. We decide that the rainforest system has more components and interactions than the oil palm system, but there are some similar types of interactions in both ecosystems. We use our models to brainstorm ideas to make the oil palm system more like the rainforest system.

NEXT LESSON

We will investigate two cases of diversified oil palm farming and realize that these are like a rainforest because there are more different kinds of plants. We will explore two related cases through StoryMaps and notice that those cases also have much more plant biodiversity.

BUILDING TOWARD NGSS

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

WHAT STUDENTS WILL DO

Develop two system models to compare the components and interactions that are similar and different in the two ecosystems.

WHAT STUDENTS WILL FIGURE OUT

- Populations depend on other populations for shelter.
- There is competition between populations of organisms that need the same resource.
- Predators depend on prey populations for food.
- There are patterns in the way that populations interact across ecosystems.
- Some populations can meet their needs in different systems, while other populations are dependent on one system or one component in the system.
- There are more components and interactions in the rainforest system compared with the oil palm system.

Lesson 10 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	5 min	**NAVIGATION** Revisit ideas about resource availability and population growth. Discuss how palm oil farms are affecting other populations.	A	*Reading: Growing Oil Palm in Indonesia* (in science notebook)
2	10 min	**BRAINSTORM RELATIONSHIPS BETWEEN POPULATIONS** Engage students in an Initial Ideas Discussion about the causes of the growth and decline of populations and the different kinds of relationships between populations in the ecosystems.	B	Impacts of Palm Oil chart (made prior to day 1), markers, agreed-upon modeling conventions (from Lesson 9)
3	22 min	**DEVELOP RAINFOREST AND OIL PALM SYSTEM MODELS** Arrange students into small groups to develop rainforest and oil palm system models that show components and interactions in these two systems.	C-D	*Tropical Rainforest Plants and Animals*, *Oil Palm Farm Plants and Animals*, colored pencils, chart paper, markers
4	8 min	**GIVE PEER FEEDBACK ON SYSTEM MODELS** Provide students an opportunity to give feedback to another group using the Sticky Note Peer Feedback protocol.	E	sticky notes, markers
				End of day 1
5	8 min	**REFLECT ON FEEDBACK ABOUT THE MODELS** Arrange students in their small groups to reflect on the feedback they received and to revise their system model in their notebooks.	F	sticky note feedback (from day 1), Group Rainforest System Model (from day 1), Group Oil Palm System Model (from day 1)
6	10 min	**COMPARE MODELS THROUGH A GALLERY WALK** Have students complete a Notice and Wonder chart as they do a gallery walk of the different system models.	G	Group Rainforest System Model (from day 1), Group Oil Palm System Model (from day 1)
7	18 min	**COMPARE SYSTEMS IN A BUILDING UNDERSTANDINGS DISCUSSION** Facilitate a Building Understandings Discussion about the two-system model to identify different kinds of interactions between populations and patterns of interactions across the systems.	H	
8	6 min	**UPDATE PROGRESS TRACKER** Add an entry to students' individual Progress Trackers in their science notebooks.	I	
9	3 min	**NAVIGATION** Have students complete an exit ticket, choosing from one of two prompts on the slide.	J	notecard
				End of day 2

Lesson 10 • Materials List

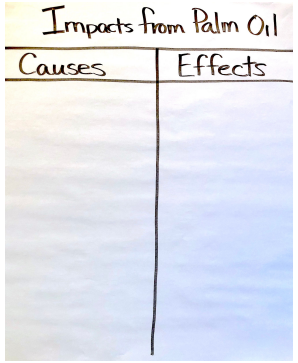
	per student	per group	per class
Lesson materials	• science notebook • *Reading: Growing Oil Palm in Indonesia* (in science notebook) • *Tropical Rainforest Plants and Animals* • *Oil Palm Farm Plants and Animals* • colored pencils • sticky notes • markers • notecard	• chart paper • markers • sticky note feedback (from day 1) • Group Rainforest System Model (from day 1) • Group Oil Palm System Model (from day 1)	• Impacts of Palm Oil chart (made prior to day 1) • markers • agreed-upon modeling conventions (from Lesson 9)

Materials preparation (25 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.

Prior to day 1, prepare a chart with the title "Impacts from Palm Oil" with one column titled "Causes" and the other column titled "Effects."



Prior to day 1, tear blank chart paper (roughly 24" x 36") for groups to use to develop their models.

Lesson 10 • Where We Are Going and NOT Going

Where We Are Going

In Lesson 9, students figured out that resource availability affects population sizes and that there is competition for resources within populations. There is normal fluctuation in population sizes based on normal changes to resources available, but unusually large changes to resources can cause unusually large population growth or decline. This lesson has students pick back up with the anchoring phenomenon to investigate how changes to resource availability (converting rainforest to oil palm farms) affects other populations in the system.

Students are working toward (1) ideas about competition between populations, (2) different interactions within the ecosystem, and (3) patterns in interactions across ecosystems. Furthermore, a main takeaway science idea is that rainforests have more components and more interactions between components compared with oil palm farms.

Students should solidify their understanding of the following:

- Populations are dependent on their environmental interactions for survival.
- In any ecosystem, populations with similar requirements for food and shelter may compete with each other.
- Similarly, predatory interactions may reduce the number of organisms or eliminate whole populations of organisms. Although the populations involved in these competitive, and predatory interactions vary across ecosystems, the patterns of interactions of organisms with their environments are shared.

This lesson builds on 5th grade DCIs, "Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants." Organisms can survive only in environments in which their particular needs are met. This lesson extends students' understanding by moving beyond food webs to add other interactions between populations and to compare the components and interactions of two different systems. Students also extend their understanding that some populations can survive in different ecosystems, while other populations are more dependent on one system or one component of the system and, therefore, cannot flexibly move between systems.

Where We Are NOT Going

The field-test version of the unit does not include mutually beneficial relationships. The final version of the unit will include these kinds of relationships in the context of orangutans and hornbills propagating seeds for figs and other fruit populations.

The ecosystem web does not include abiotic interactions, but these could be added, particularly for the plant populations, if time permits.

Students will recognize that the rainforest has more components or populations than the oil palm farm (more boxes). It is intentional that they only identify this difference in this lesson. In the next lesson, students will figure out that the number of components refers to a system's biodiversity, and they will build on these ideas in Lesson 12, looking at why biodiversity is important.

LEARNING PLAN for LESSON 10

1 · NAVIGATION

5 min

MATERIALS: science notebook, *Reading: Growing Oil Palm in Indonesia* (in science notebook)

Give students time to review their resources. Display **slide A**. Have your students spend about 2-3 minutes looking through their science notebooks to find evidence about how palm oil is affecting other populations. One particular resource shared in Lesson 1, *Reading: Growing Oil Palm in Indonesia*, is helpful information that identifies population changes in tigers, rats, pigs, and snakes. This should be attached in students' science notebooks.

Using the prompts on the slide, facilitate a whole-group discussion to elicit from students a list of other populations that are impacted, and how these populations have been impacted.

Suggested prompt	Sample student response
What other populations live in the rainforest and palm oil farm areas?	*Tigers, rats, snakes, pigs, termites, fig trees, rainforest plants, and oil palm plants.*
How is the change from rainforest to palm oil farm affecting these populations?	*Tigers decreasing.* *Rats increasing.* *Snakes increasing.* *Pigs increasing.* *Figs (or other fruit trees) decreasing.* *Termites staying the same.* *Oil palm plants increasing.* *Rainforest plants decreasing.*

2 · BRAINSTORM RELATIONSHIPS BETWEEN POPULATIONS

10 min

MATERIALS: Impacts of Palm Oil chart (made prior to day 1), markers, agreed-upon modeling conventions (from Lesson 9)

Facilitate an Initial Ideas Discussion about the causes of the growth or decline in populations. Display the Impacts of Palm Oil chart. Explain to students that cause and effect can be a useful lens for thinking about why certain populations are increasing or decreasing.✱ Say, *We know that other populations are decreasing or increasing when there is a change from rainforest to palm oil farms, but we aren't sure about the causes of these changes. It could be the same cause as we saw with the orangutan, or it could be something different. Let's list a few of our ideas about things that could cause each of our populations to go up or down.*

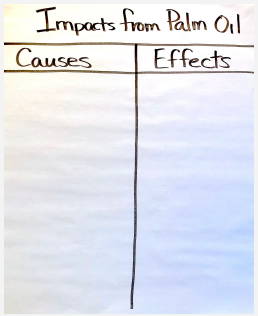
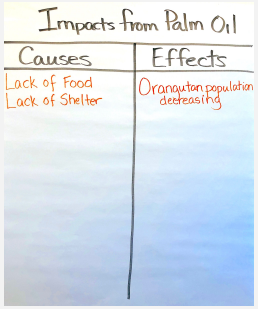


Chart orangutans first as an example. Add the orangutan population first as a way to model for students how to use cause and effect as a lens to guide thinking. Think aloud as you add "orangutan population decline" to the effect column and then list "lack of food" to the cause column. Then ask, *Are there any other causes of orangutan decline that we know about?*

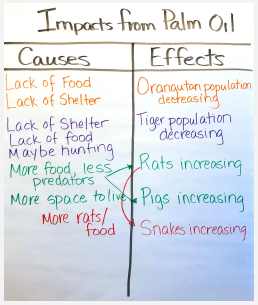
Listen for students to suggest a lack of canopy trees (or tall trees) for their shelter and safety. Add this to the list.



Repeat the cause-and-effect charting for different populations. As students share their thinking, write down their different ideas about the causes of the population increase or decrease. Emphasize that each population growth or decline could be caused by different things, so it can be challenging to identify any single cause without systematic testing.

As you start repeating causes on the list, elicit from students whether they notice any patterns.

You do not need to continue to rewrite each cause and can use arrows if this makes the charting process easier and faster.



✱ SUPPORTING STUDENTS IN DEVELOPING AND USING CAUSE AND EFFECT

As students share their initial ideas, they are encouraged to brainstorm different causes that could lead to the decline or growth of each population in the system. Explain to students that, in complex systems, such as the rainforest ecosystem, there could be multiple causes to investigate or a number of causes that, when combined, lead to a given effect.

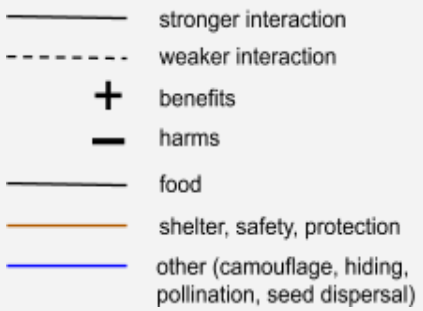
✱ ATTENDING TO EQUITY

When you decide on representation conventions, (1) choose a colorblind friendly palette, such as blue and orange or blue and brown, and avoid red and green together and/or (2) add labels to the lines (e.g., food, shelter, safety).

Identify different kinds of relationships between the populations. Say, *In our model we developed in the previous class periods, we were mostly focused on how populations, like orangutans, figs, and termites, are connected by food. It looks like there are other kinds of interactions happening other than food. Let's think about the different ways populations interact or depend on each other.* Use the prompts on **slide B** to facilitate a brief brainstorm. The prompts include:

- What ways do populations interact or depend on each other in an ecosystem?
- How can we represent these different interactions in our models?

Facilitate a whole-class sharing of ideas. As students discuss the second question, review the class's modeling conventions from Lesson 9 (shown in black font in the example to the right). Decide how the class wants to represent new interactions beyond food (shown in brown and blue font). Your class may have a slightly different version of the key that represents their own decisions about modeling conventions agreed upon in previous lessons.✱



3 · DEVELOP RAINFOREST AND OIL PALM SYSTEM MODELS

22 min

MATERIALS: *Tropical Rainforest Plants and Animals*, *Oil Palm Farm Plants and Animals*, colored pencils, chart paper, markers

Motivate the need for a system model for the rainforest. Display **slide C**. Say, *It looks like we think the tiger may be declining for the same reasons as the orangutan population. We think planting more fruit trees will help orangutans, but will planting more fruit trees help tigers, too?*

Use this prompt to puzzle students and get them thinking about (1) other interactions that populations may be dependent on and (2) where tigers fit in the food chain.

Set the purpose of the rainforest ecosystem model. Say, *So far our model has been fairly simple, focusing on orangutans, fruit trees, and termites, but there are a lot of other things in this system that we aren't accounting for. For example, we don't know how to support other populations, like tigers, if we decide to plant fruit trees. Let's set up a system model for the rainforest and for the oil palm farm to help us understand how the different populations interact so that we know what they depend on in each system.*

Arrange students into groups of 3-4 students. Assign each group one system to model—either the rainforest system or oil palm system.✱ Pass out 1 copy of *Tropical Rainforest Plants and Animals* or *Oil Palm Farm Plants and Animals* to each student, which appears in color in the *Student Edition* behind the Reference section or can be printed using *Reference: Tropical Rainforest Plants and Animals* or *Reference: Oil Palm Farm Plants and Animals*.

Give instructions and model how to place plants at the base of the ecosystem web. Display **slide D** to provide instructions to students. Students should read through the materials and individually develop a model for the ecosystem in their science notebooks. They should focus on food interactions first (using a black pencil, for example), then add safety, shelter, or protection using the designated color, and finish any other connections in the designated color. Their models in their notebooks may be messy as they add different components and interactions, which is OK, because these should be considered a "sandbox" space for student thinking.

After 10 minutes of working in their notebooks, direct students to create a group consensus model on a piece of chart paper using markers. Refer to these as the "Group Rainforest System Model" or "Group Oil Palm Farm Model." This will provide groups an opportunity to discuss how they want to organize their models to share with others. Encourage students to revise their individual notebook models if they realize they have missed an important component of interaction in the system.

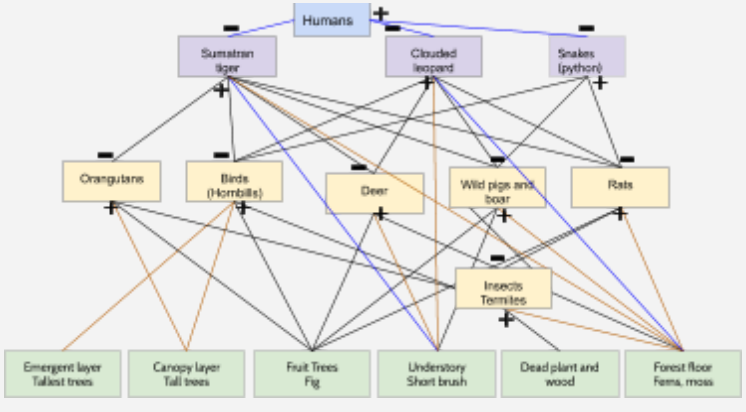
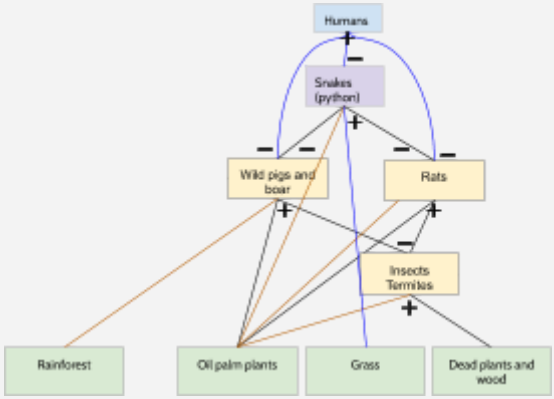
✱ ATTENDING TO EQUITY

The rainforest system is a more complicated modeling task compared with the oil palm system. Developing the model to show components and interactions for the rainforest will likely take longer for groups assigned this system. Be strategic in assigning students to this task and be particularly mindful that students who need more of a challenge are assigned to the rainforest system model.

ADDITIONAL GUIDANCE

Dead plants and wood are not explicitly called out as components of the systems. However, students will encounter that insects, such as termites, use this as a food source. Encourage students to add these components to their system as shown in the models below.

Sample models:

Rainforest system model	Oil palm system model
	

ADDITIONAL GUIDANCE

The rainforest system model will likely look disorganized—much more disorganized than the example above. Avoid focusing students on getting the model neat and orderly. Rather, use the "messiness" of their models to emphasize the complex nature of the ecosystem and the fact that they are only accounting for a few populations in a system that has millions of different species. It is OK if groups miss a few interactions because the overall goal is for them to see that there are more components and more interactions in the rainforest system compared with the oil palm system.

4 · GIVE PEER FEEDBACK ON SYSTEM MODELS

8 min

MATERIALS: sticky notes, markers

Have students give feedback to another group. Post the Group Rainforest System Model or Group Oil Palm System Model in a location that is visible to other groups. Review the Sticky Note Peer Feedback protocol using **slide E**. Assign each group to review another group's model. Groups should provide feedback to another group that developed a model of the same system. Give students sticky notes and markers and allow them 6 minutes to review the other group's model.

ADDITIONAL GUIDANCE

Consult the Assessment System Overview and *Peer Feedback Facilitation: A Guide* to learn more about the Sticky Note Peer Feedback protocol—which comes from *Tools for Ambitious Science Teaching*. Students use sticky notes to leave questions and comments posted on other students' work. There is time built in at the start of day 2 for students to respond to the feedback. Source: https://ambitiousscienceteaching.org/sticky-note-student-feedback/

End of day 1

5 · REFLECT ON FEEDBACK ABOUT THE MODELS

8 min

MATERIALS: science notebook, sticky note feedback (from day 1), Group Rainforest System Model (from day 1), Group Oil Palm System Model (from day 1)

Give students time to reflect on their feedback. Arrange students into their small groups from day 1. Display **slide F** with directions for how to respond to the feedback. Allow students time to read their feedback and discuss it as a group. Groups should (1) make changes to their system model on their chart paper and (2) answer questions or respond to feedback on the sticky notes. Prompt students to record any changes to their group models on their individual models in their science notebooks.

ASSESSMENT OPPORTUNITY

At the end of this lesson, or for home learning, is a good opportunity for students to self-assess using *Self-Assessment for Classroom Discussions*. Helping students reflect on their progress in giving and receiving feedback will help build their skills in this important area.

6 · COMPARE MODELS THROUGH A GALLERY WALK

10 min

MATERIALS: science notebook, Group Rainforest System Model (from day 1), Group Oil Palm System Model (from day 1)

Set up for a gallery walk of the system models. Arrange the Group Oil Palm System Models in a similar space in the classroom. Arrange the Group Rainforest System Models in a different space in the classroom.

Display **slide G** to help students set up their notebooks for observations. Use the prompts on the slide to guide student observations as they view the models during the gallery walk.

- What do you see that is similar about the two systems?
- What do you see that is different about the two systems?

Allow students time to view both sets of models and return to each set as needed to make comparisons.

7 · COMPARE SYSTEMS IN A BUILDING UNDERSTANDINGS DISCUSSION

18 min

MATERIALS: science notebook

Facilitate a Building Understandings Discussion to compare the system models. Display **slide H**, which includes some initial discussion prompts, though, more are suggested below. Make certain you have at least one example model for each system visible to students during the discussion.

ADDITIONAL GUIDANCE

In 5th grade, students developed the idea of an "ecosystem" (LS2.A: "A healthy ecosystem is one in which multiple species of different types are each able to meet their needs in a relatively stable web of life."). During this Building Understandings Discussion, you may want to reinforce what it means to be an ecosystem and add it to your word wall. It is recommended to do this after students have developed models for each system. You may need to remind students that ecosystems also include the abiotic components, which may or may not be represented in their models.

✱ SUPPORTING STUDENTS IN ENGAGING IN DEVELOPING AND USING MODELS

Ask students to think about how a change in one variable in the system (orangutans) could affect other parts of the system. Emphasize to students that, once you have a model developed for a system, you can use the model to make predictions.

✱ SUPPORTING STUDENTS IN DEVELOPING AND USING SYSTEMS AND SYSTEM MODELS

Use this opportunity to discuss the limitations of the two system models. Both models are overly simplified compared to

KEY IDEAS

Purpose of the discussion: to establish the different kinds of relationships between populations, particularly predation and competition, and to identify similar patterns between the two systems but notable differences in the number of components and interactions.

Listen for:

- Populations depend on other populations for shelter (e.g., orangutans need canopy).
- There is competition between populations of organisms that need the same resource (e.g., competing for fruit trees).
- Predators depend on prey populations for food.
- There are patterns in the way populations interact across ecosystems (e.g., competition for food in both systems, predators in both systems).
- Some populations (e.g., rats, pigs) can meet their needs in both systems. Some populations are dependent on the rainforest system or one component in the system (e.g., orangutans and canopy trees).
- There are more components and interactions in a rainforest compared to an oil palm farm.

Suggested prompts	Sample student responses	Follow-up questions
What do you notice is similar?	*Both have plants, animals that eat plants, and predators.* *Both have animals competing for food.*	*Would we expect to see the same patterns in another ecosystem?*
What do you notice is different?	*There are a lot more components and interactions in the rainforest compared with the oil palm system.*	*How do you think a rainforest can support more animals compared with the oil palm farm?*
Which populations compete with each other?	*Orangutans, birds, deer, pigs, and rats.* *Pythons, tigers, clouded leopards.*	*What are they competing for?*
How do plant populations affect predators?	*The plants are eaten by animals in the middle, and the predators need those animals for prey (food).*	*How do predators depend on plants directly?*
How could a decline in orangutans affect the predators?✱	*If there are fewer prey, there would be fewer predators.*	*How does this impact competition between populations?*
If we increase the orangutan population, how would that impact the tigers?	*There would be more tigers.*	*How does this impact competition between populations?*
What populations can go between the systems? Which ones can't?	*Rats, pigs, and snakes can go between.* *Orangutans, leopards, and hornbills can't.*	*Why do we think some populations are able to live in both systems, while other populations can only live in one system?*
How is this model limited compared to the real system?✱	*We only have a few things living in it, but in the real world, there are a lot more plants and animals.*	

the real systems, which is especially true for the rainforest system model. Yet the rainforest system model is still complicated to represent on paper even with only 15 populations.

8 · UPDATE PROGRESS TRACKER

6 min

MATERIALS: science notebook

Update individual Progress Trackers for an individual reflection. Explain to students that we want to take some individual time to capture what we have figured out about our question: "How is planting palm oil affecting other populations?"

Have students turn to the Progress Tracker section in their notebooks. Use **slide I** to guide students in drawing a line before the last entry from Lesson 9 and to complete the 2 columns, filling in both lesson questions and their responses.

Give students 3-5 minutes to quietly update their Progress Trackers using words and drawings to show what they have figured out. Ask students to draw a line underneath their responses when they are done. Prompt students to use evidence from the readings.

ASSESSMENT OPPORTUNITY	Use the Building Understandings Discussion and Progress Tracker entry for formative assessment. Students share ideas about the rainforest, including more numbers/types of populations and more interactions between populations, compared with the oil palm system in which there are fewer numbers/types of populations and fewer interactions. If students are struggling to understand these concepts, count the number of populations in each system and the number of interacting lines between the populations. Revisit photos of the rainforest and oil palm farm to observe the variety of populations in the rainforest system compared with the oil palm system.

9 · NAVIGATION

3 min

MATERIALS: notecard

Have students complete an exit ticket. Display **slide J** and read the exit ticket prompt.

- Do you know of any farming that happens that is more like the rainforest than the oil palm farm?
- What is one thing you would like to change about the oil palm farm to make it more like the rainforest system?

Have students spend the last 1-2 minutes of class completing their exit ticket. Ask students to give you their exit ticket before leaving class.

Additional Lesson 10 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA	**CCSS.ELA-Literacy.RST.6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).** In order for students to develop their ecosystem models, they must decipher technical information from a text that describes populations in each system and how those populations interact. Students transfer that information to a graphical representation, or model, using the agreed-upon modeling conventions to show components and interactions in the system.