Lesson 5: How Do Sizes of Populations Change Over Time? (part 2)

Overview:

Purpose:

The purpose of this activity is to describe how a sustained change to the environmental conditions of an ecosystem often leads to a different stable state (different carrying capacities).

Connection to previous activities:

Students have analyzed population level graphs for fluctuation and stability in the computer model. They have described the carrying capacity of a population in an ecosystem as the average population level over time. And they have discussed why changing the amount of a limited resource necessary for one population could have a delayed effect on the size of this population. They used an index card model as a class to account for the cyclical pattern of population size changes in terms of delayed effects between the average amount of grass available per bug, and death rates and birth rates in the bug population.

Learning Performances

- Use mathematical and computational representations from investigations to support explanations of factors that affect carrying capacity of ecosystems. NGSS HS-LS2-1

Scientific Principles (re)Discovered in this Activity

- More sustained changes in environmental conditions (e.g. loss of habitat) tend to change the stability of ecosystems and often result in new carrying capacities.

Description

In this activity, students make predictions about how different initial conditions affecting amount of resources available in the ecosystem will affect the stability of the bug population size. From their model runs, students record observations about fluctuations in population size and stable states (equilibrium levels) for each population to test their predictions.

Through discussion, the teacher helps build consensus about some of ways that populations sizes change in ecosystems – exhibiting minor fluctuations, cyclical fluctuations, while remaining relatively stable under certain environmental conditions. They discuss how sustained environmental changes lead to new stable states for the ecosystem.

In their homework students brainstorm other types of environmental changes and read about the sources of evidence scientists use to figure out how the environment changed in the distant past. They read about some of the type of climate changes and biological changes that have occurred on earth over the past 3.5 billion years.

Lesson Details:

Time 90 minutes

Materials

Per Student

- 1 computer with Java 7 and Firefox installed.
- A student WISE account for the class period was already created.
- One large post-it note
- In-class handout 5.0: Case Study Update #2

Per Pair of Students

- 4 or more different colored pencils

For Teacher

- 1 computer with Java 7 and Firefox installed and projector or large display screen for the teacher to display the computer model.
- The driving question board
- 1 piece of butcher paper or poster paper or space on the wall for students to stick the post it notes on.
- An empty cereal box from the last activity (reuse it for each class or keep one new empty one for every class)
- A couple handful of coins from last activity
- Tape

Lesson Outline and Timing

Launch

- Introduce today's lesson question, brainstorming and share responses (step 5.1) – (5 min.)

Explore

- Test different environmental conditions (step 5.1-5.6)– (20 min.)

Summarize

- Presentations and Class Consensus Building Discussion – (35 min.)

Exploring the Case Study

- Review graph from Homework 2.1 – Case Study Update #1; use the graph to make predictions about the years between 1972 and 2009 (5-10 min).
- Work on In-class Handout 5.0 – Case Study Update #2 (20-25 min.)

Lesson Enactment Details

Launch:

Remind students of the discoveries they made related to their driving question. Tell students that they will continue using models today explore and discover more ideas to help answer the driving question. Tell students that they are going to be investigating the 3rd lesson question today and tomorrow, "How Do Sizes of Populations Change Over Time?"

Ask students to think of pond or lake as an ecosystem like they did in activity 1. Ask students if the size of a population of fish in the pond would remain the same or would change from day to day? Week to week? Year to year? *Students will likely say it would change at some point due to deaths and/or births.*

Put these two ideas onto the driving question board in the green section:

- Reproduction increases the size of a population
- Deaths decrease the size of population

Ask students to think back to the last activity and make some predictions regarding the individuals in that ecosystem. Which bugs would be more likely to die and which ones would be more likely to reproduce.

Have students log into WISE and resume work on the Population Biology Unit

- **Instruct students to go to step 5.1 and complete the questions on that step.**

Have students share their responses. Remind students that yesterday they discovered that the ecosystem model they explored tended to remain stable in spite of encountering different temporary disturbances. Ask students to explain what in the model results provided evidence of that stability?

- **Instruct students to complete steps 5.2 through 5.6 and that if they don't see their model run results in the experiment gallery on step 5.6 to go back to step 5.5 and make sure to follow all the instructions there again.**

Summarize:

With 20 minutes left have all students stop the simulations and join a discussion about how the stability of an ecosystem is affected by a sustained environmental change and how the outcomes different than the effects of temporary disturbance.

Ask for student volunteers who can show two model results in the gallery step (5.6) that give us evidence for helping us answer this question: "Do different environmental conditions lead to different carrying capacities". Have them present these to class.

Ask for student volunteers who can show a model results in the gallery step (5.6) that led to the collapse of the entire bug population, even though there was some grass available. Have them present these to class.

Ask students for reasons why some little amount of grass may not be enough to sustain any size of bug population. *Accept all answers. One useful way to think about why a bug population can't survive in such an ecosystem is that the rate of energy loss from foraging for food exceeds the average rate of energy intake. Simply put, the food is too far and too sparse to make the journey from one food source to another without dying.*

Ask students to go back to their answers in step 5.1 and to discuss these with a partner next to them, identifying one of the changes they agree is a more sustained environmental change than the others. The one they choose is one they think would be affecting the carrying capacity of that ecosystem. Have different students share their example with class and the reasoning behind their choice

Remind students that similar environmental conditions yielded similar stable states, different environmental conditions sometimes yielded different stable states, and sometimes made the system unstable (so that the population collapsed completely). These changes environmental conditions were different than the temporary disturbances we gave the system before, because they changed the conditions of the entire ecosystem for a sustained amount of time.

Show the cereal box again with the coins in the bottom. Using a big piece of duct tape, tape the coins to the bottom of the cereal box. Now turn the box upside down. Explain to the students how the coins now at the top of the box. Ask the students what will happen if the box was pushed the same amount as before? Ask them to explain whether this kind of change to the box is this a good model for a temporary disturbance or a more sustained environmental change? Help students to see that this could be a good model for representing a sustained change in the environmental conditions, similar to setting the amount of grassland very low for the entire model run.

In such a new environment once some bugs are introduced into the system, or grass is burned down for a bit, or a disease wipes out half of the bugs, that would be similar to the push/tilt you gave the box, but instead of returning to the same state as before, it may move to a very different state (fall over) due to these new environmental conditions. Changing the box now to sit on its long side might represent another type of sustained environmental change, as would be adding more coins or taking away more coins.

Summarize the big ideas from the day's lesson. The non-bold italics statements are possible student ideas. The bold italics statement can serve as another way to summarize what is common amongst the student ideas and each underlined category.

Conclusions & Big Ideas:

As a class: : How do sizes of populations change over time?

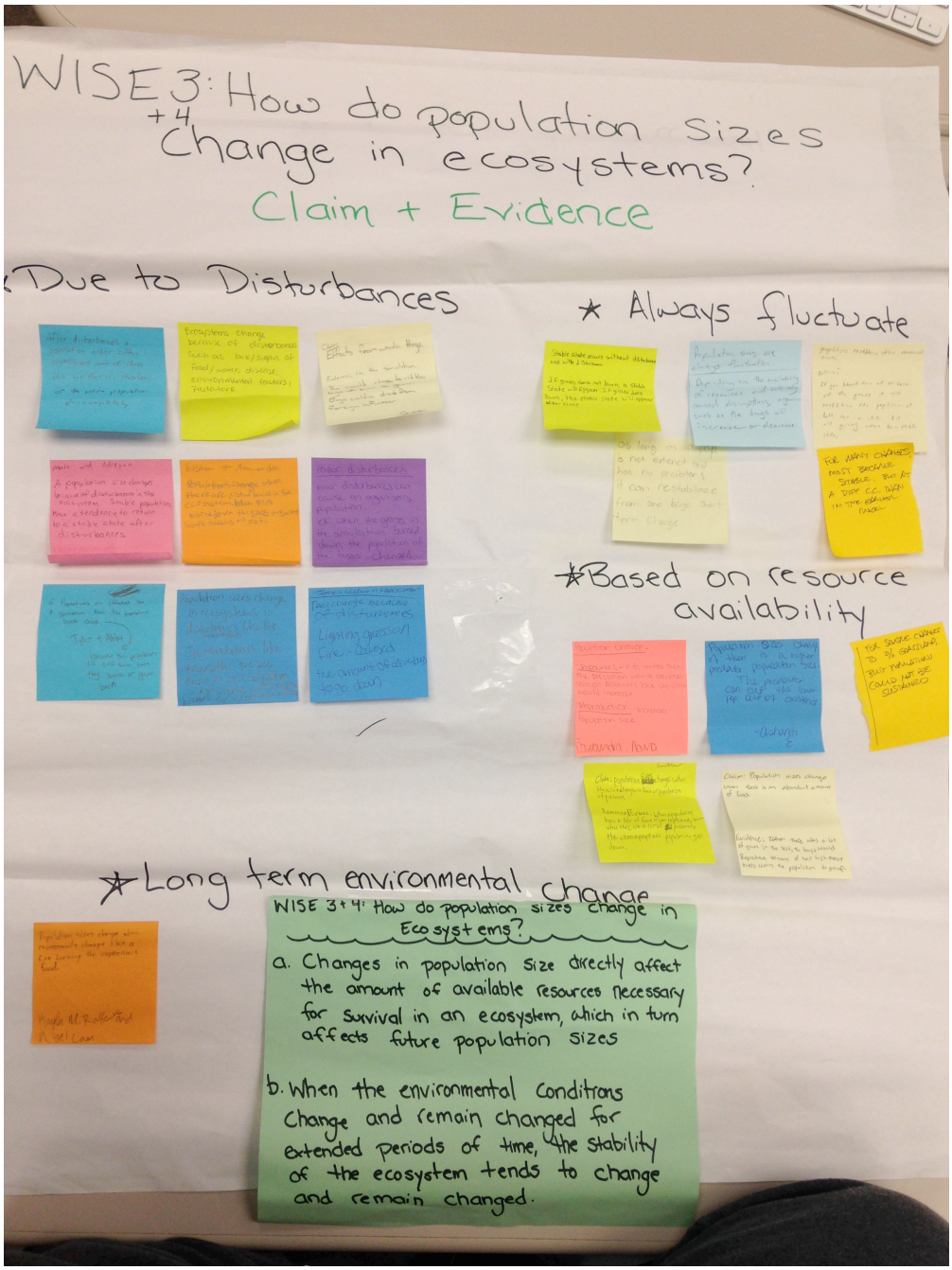
Due to amount of habitat

- *Example student idea: Changing the amount of grassland had a different effect than temporarily burning down the grass, because after the burn, the grass could grow back.*
- *Example student idea: The population had a different carrying capacity when we changed the amount of grassland each time.*
- *Example student idea: When there was a different amount of grassland there was a different amount of fluctuation.*
- *Example student idea: Too little grassland and the bugs all died off.*
- *Example student idea: If there isn't enough grass, no bugs can survive for long.*
- ***Summarize with these one idea:***
  - **More sustained changes in environmental conditions that affect the amount of resources available in the ecosystem tend to change carrying capacities.**

Add only this one scientific principle to the driving question board:

- More sustained changes in environmental conditions (e.g. loss of habitat) tend to change the stability of ecosystems and often result in new carrying capacities.

Once these ideas in the bold have been agreed upon by the class make sure they have been added to the question board. Here are example student post-its from 9th grade regular biology classroom from this lesson and the last. (special thanks to the first pilot teacher: Kate Cook in Dayton, OH):



Notice that the big ideas on the green sheet can take a very different syntax and focus than the ones suggested in the teacher manual. This teacher used her own student's ideas and language to craft summaries of their discoveries as they converged on trying to express the scientific principles suggested in the teacher guide

Exploring the Case Study

Ask students take out an assignment they completed on a previous night: Homework 2.1 – Case Study Update #1. Discuss the answers they gave on the last page with students. Ask them to share questions they had written down. Ask students if there are any of those questions that they now think we can answer based on the work they've done in their investigations.

Ask students to predict what they think the graph will look like between 1972 and 2009. You may want them to make a sketch of their prediction on the last page of Homework 2.1. Tell students to compare predictions with classmates and give reasons for their predictions.

Now pass out the In-class Handout 5.0 – Case Study Update #2. Tell student that this case study update will help them understand how to annotate graphs, which they will need to do as part of their final assessment for the unit.

Have students do page 1 individually and then share out their answers.

Pass out colored pencils to partners and have each person use these to share and label the regions corresponding to events A, B, C, D. Events might be only 1 year long, or many years long, and so the width of the region shaded may vary.

When students have completed this have them finish the remainder of the pages.

If time permits have students share their answers to these questions:

- "What ideas from the computer modeling activities and class discussion are you suing to predict this outcome?"
- "What additional data would like to be able to see form the case study site, to help you better understand what is causing the changes in the population sizes of the moose and wolves?"

Homework: **Assign Reading 5.2 that can be assigned tonight.** PDFs of the homework is available on the teacher resource page for the unit. Simply click on the blue link for each activity under the student assignments section to download the pdf of the homework.

Teacher Guides | ScreenCast Videos | Student Work Viewer | Student Assignments

Student Assignments for the ModelSim Population Biology Unit

In-class Activity	In-class Steps or handout	Estimated Time	Out of class assignment based on this activity
1: Modeling Interactions In Ecosystems	1.1 to 1.8	60 min.	Reading 1.1 – Interactions In Ecosystems
2: Case Study – Isle Royale	In-class Handout 2.0: Case Study Introduction	60 min.	Homework 2.1 – Case Study Update #1
3: Competition Between Individuals	3.1 to 3.11	60 min.	Reading 3.1 – Competition for Limited Resources
4: Fluctuation and Stability (part 1)	4.1 to 4.11	60-90 min.	Reading 4.1 – Fluctuation and Stability
5: Fluctuation and Stability (part 2)	5.1 to 5.7	40-60 min.	Homework 5.1 – Case Study Update #2 – AND – Reading 5.2 – Environmental Change
6: Competition Between Populations	6.1 to 6.12	60 min.	Reading 6.1 – Competition Between Populations
7: Design a Population	7.1 to 7.9	60-90 min.	Homework 7.1 – Case Study Update #3 – AND – Reading 7.2 – Unchanging vs. Changing Designs
8: Scientific Explanation	In-class Handout 8.0: Case Study Preparing Your Explanation	60 min.	Final Explanation