Lesson 3: What Causes Competition Between Individuals in an Ecosystem?

Overview:

Purpose:

The purpose of this activity is for students to describe how consumer/producer interactions for limited resources necessary for survival leads to the emergence of a competition for those resources, even when there is no intentional effort being made by individuals to outcompete each other.

Connection to previous activities:

In previous activities, students have described types of interactions between organisms and their environment. They have described predator/prey interactions and direct consumer/producer interactions in food webs they observe. And they have described how indirect and delayed effects between consumers and predators can occur between populations through intermediate interactions with abiotic factors and between other populations in the ecosystem. They have identified some of the abiotic resources that are necessary for survival for different types of organisms (food, space, water, air, and shelter) and factors that influence the distribution of resources.

Learning Performances

- Use mathematical thinking to 1) compare an individual's success at gathering resources from an ecosystem to other individuals in the population and 2) compare the performance of different populations in a participatory simulation.

- Use mathematical thinking to determine the average amount of food available in an ecosystem per individual consumer as the size of the consumer population changes.

Scientific Principles (re) Discovered in this Activity

- All ecosystems have a limited resources necessary for survival (e.g. water, habitat, sunlight, food).
- Competition emerges when individuals consume resources that other individuals need.

Description of the Lesson

In this lesson, students are introduced to a participatory computer simulation where each student takes the role of an individual consumer (a bug) in an ecosystem. Students make predictions about various model runs and compare their predictions to the outcomes they observe. In one exploration they control the direction of movement of a bug, trying to gather as much food (grass) as possible in a variety of conditions. In another exploration they observe the outcome when many bugs move randomly and blindly around an ecosystem consuming food without any intentional control. Students recreate a physical representation of a histogram graph (of energy levels of bugs) from NetLogo and analyze characteristics of the population in the graph to draw comparisons between populations and individuals.

Through discussion, the teacher helps build consensus about what they discovered: Competition is an emergent outcome that results from 1) limited resources necessary for survival, 2) and unequal distribution of those resources throughout the ecosystem, 3) and from interactions (intentional or unintentional) that always are occurring between each individual and their environment.

In their homework students address the difference between intentional and unintentional competition further. They critique the modeling assumptions used in the computer simulation. They describe the variation in local resource availability for individuals in the computer model. They calculate how changes in the amount of grass or amount of bugs in would change the average amount of grass per bug in the ecosystem and they identify that ecosystems with lower average grass per bug would have higher levels of competition than those with higher average amounts of grass per bug.

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 small post-it note and one large post-it note.

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.

Lesson Outline and Timing

Launch

- Review the driving question board and introduce today's lesson question– (2 min.)

Explore – Exploration 1

- Screencast - Demonstrating the interface and model rules (step 3.1 to 3.2) – (5 min.)
- Students join the simulation (step 3.3) and run the first competition – (5 to 10 min).
- Build the class histogram and (step 3.4) - (10 min)
- Sketch the graph and discuss the distribution (step 3.4 to step 3.6) - (10 to 15 min.)

Explore – Exploration 3

- Make a prediction and discuss (step 3.7) – (5 min).
- Record data, sketch the graph, answer follow-up questions (step 3.8 to 3.10) - (10 to 15 min.)

Summarize

- Student Discoveries and Big ideas – (5 min.)
- Class Consensus Building Discussion – (15 to 20 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 2nd lesson question today, "What Causes Competition Between Individuals?"

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

- **Instruct students to complete step 3.1 and then wait a minute before continuing.**

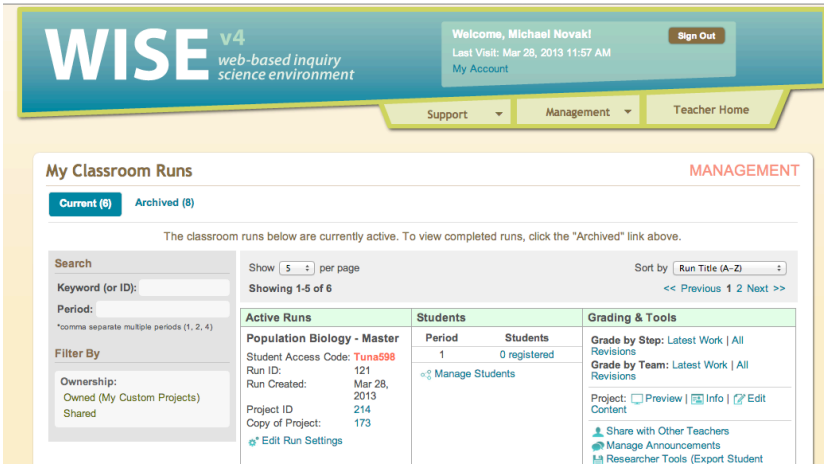
Tell the class that they will be using a computer model to run a simulation today. In this simulation each student will be given an individual bug to control the movement of. Every student's bug will appear in the same ecosystem, as the computers will be networked together. In this way all members of the class will be playing in the same simulation. The goal of every player is to move a bug around such that it eats as much food as possible before the end of the competition. Everyone's goal is to outcompete other players by gathering more food. Tell students that you will provide a brief introduction on how to the interact with the controls of the simulation and then they will join the simulation and play it multiple times, each time learning new information about how the model works as well as analyzing the results from the entire class. Tell students that they will have to summarize some notes about what you are demonstrating in the next step on WISE.

Explore:

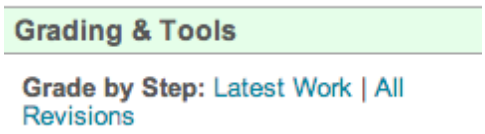
Directions for teacher: Model Introduction & Exploration #1

These directions explain in detail how to launch run a HubNet based Participatory Simulation from WISE. Remember to have Java 7 downloaded and log into WISE using a 64-bit browser (Safari or Firefox). You will not be able to run Java content in Chrome. Do the following steps to launch the model before class starts.

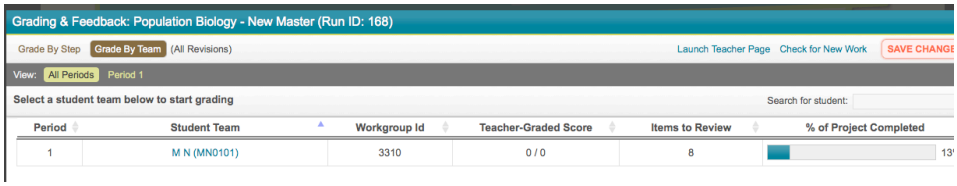
1. After logging into WISE, click on the Teacher Home tab. You will see a list of all the active runs you have started for each class period. For the current class that you are teaching. In the example below, the first row show the Student Activity for this Teacher's Period 1 class.



2. Look for the Grading & Tools Column to the right. Under that look for the Grade by Step heading. Next to that you will click on the link that says All Revisions.

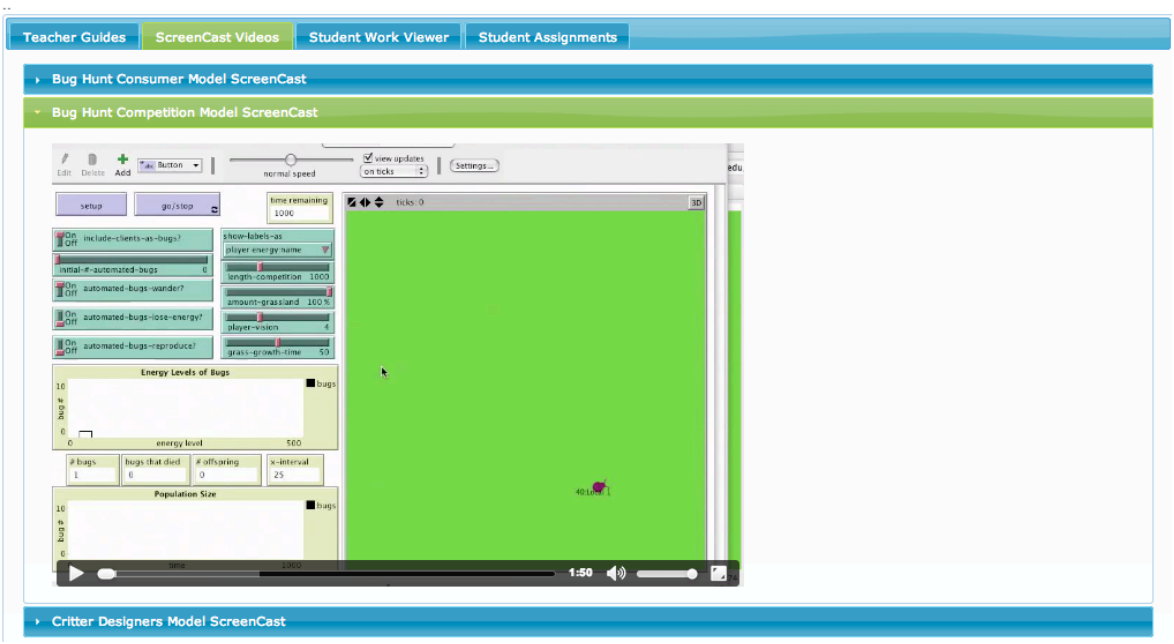


3. A new window will pop up like the one shown below. Click on Launch Teacher Page on the top right of the page.



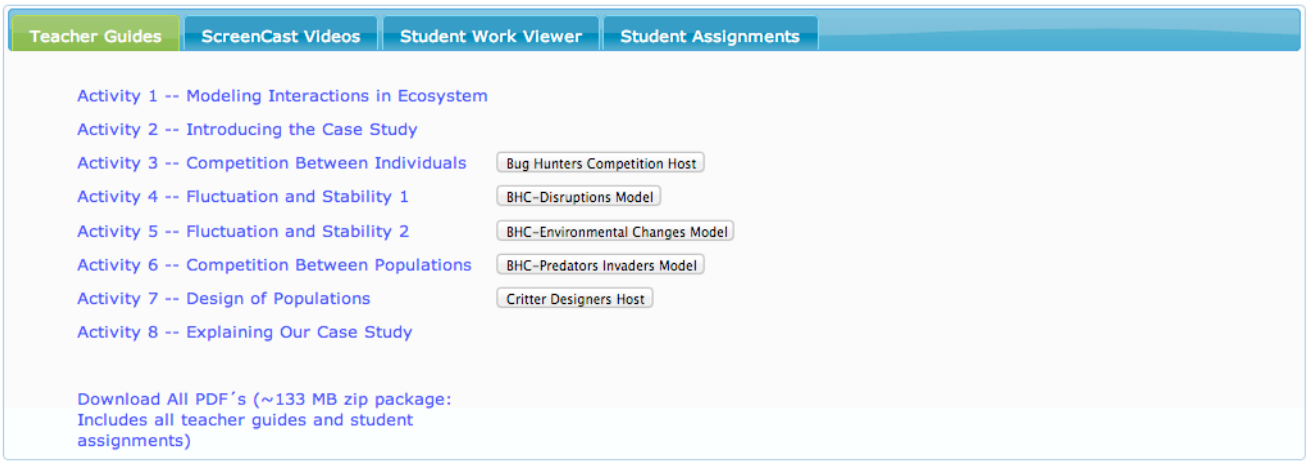
4. The teacher Grading & Feedback page will come up. Click on Launch Teacher Page on the top right of the page.

5. Play a screencast of a sample model run, by clicking on the ScreenCast Videos tab.



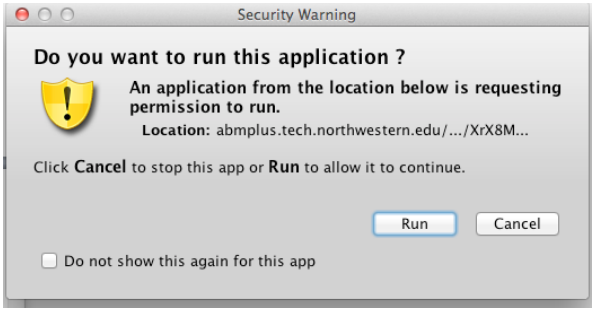
6. Click on the Bug Hunt Competition Model ScreenCast menu item. Press the play button. Audio narration is provided

7. Now you will launch the model yourself. Click on Launch Teacher Guides tab on the top right of the page.

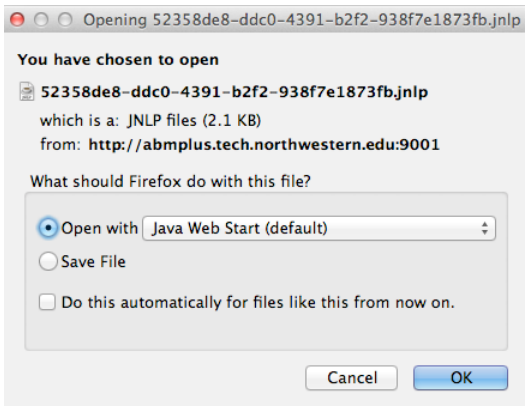


8. Press the Bug Hunters Competition Host button to launch the model to demo for the class and that they will join in to.

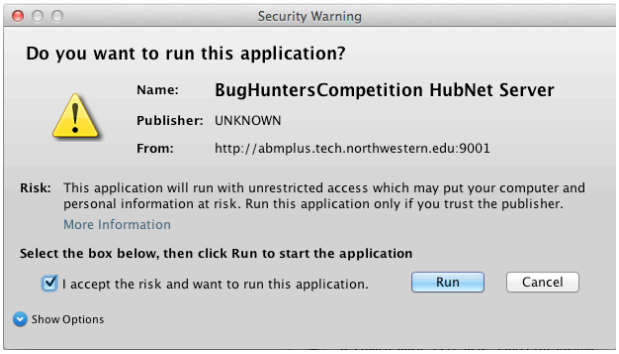
9. You will see a Security Warning dialog box appear. Click on Run to run the program



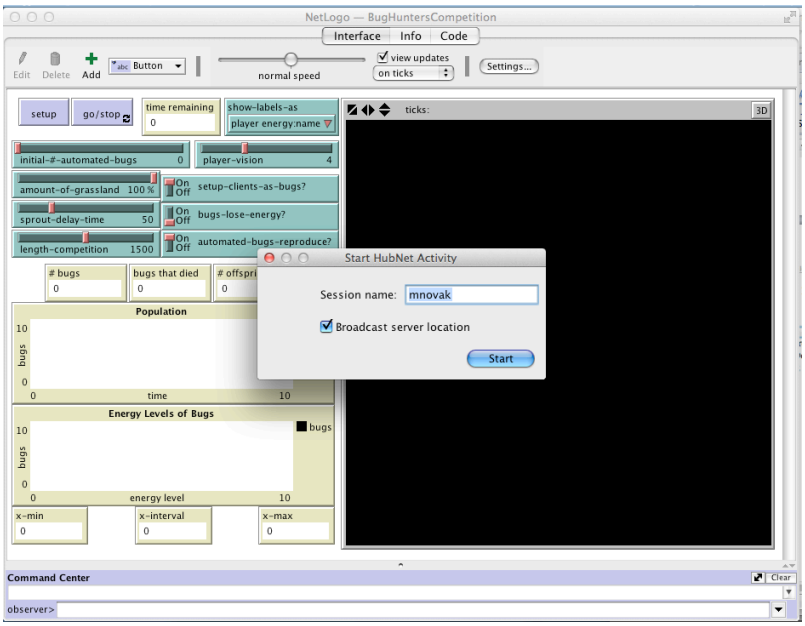
10. A Java Web Start file dialog box will now open. Press the **OK** button.



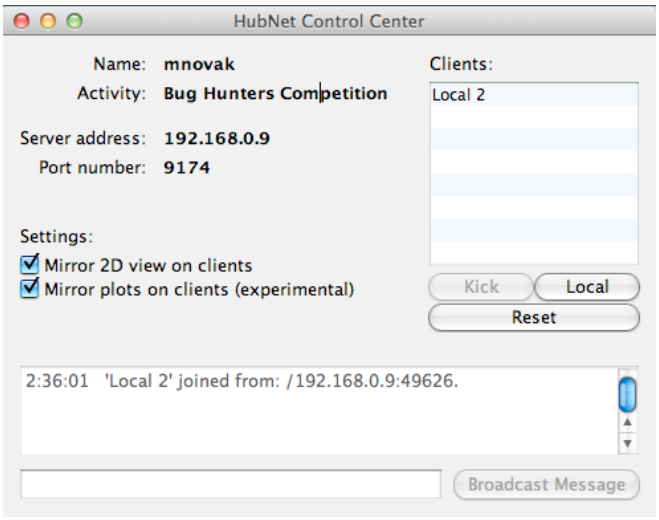
11. A 2nd Security Warning dialog window will open. Select the box that says **I accept the risk and want to run this application,** and then click **Run** to start the supplication.



12. A NetLogo – BugHunters Competition Window will now open. When it does press the **Start** button on the Start HubNet Activity dialog box.

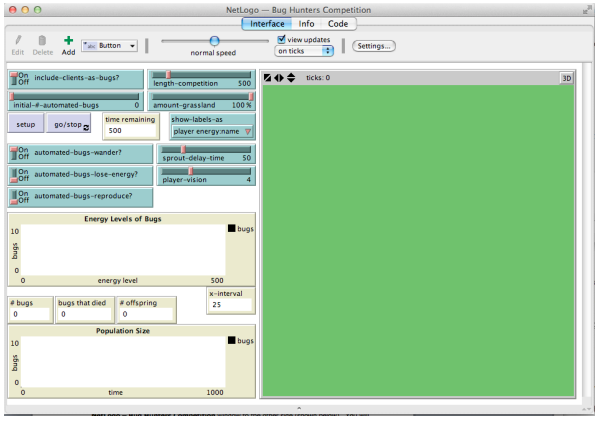
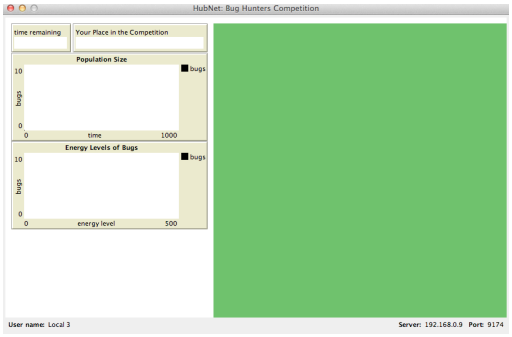


13. A HubNet Control Center window will now open. Check both the **Mirror 2D view on clients** box and check the **Mirror plots on clients (experimental)** box too.



14. Then Press the LOCAL button to launch a student interface window.

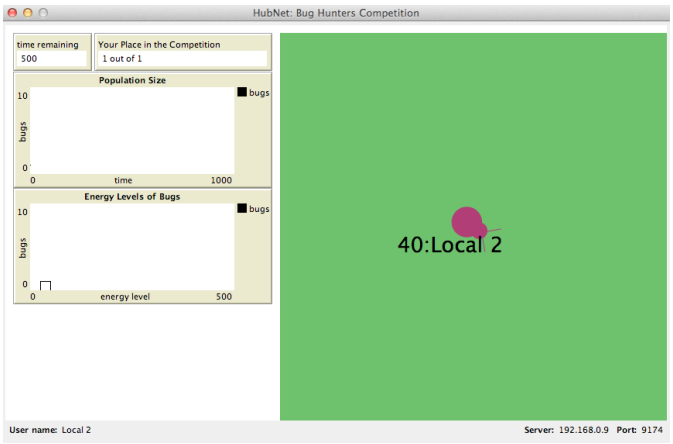
15. After pressing that LOCAL button, a **HubNet: Bug Hunters Competition** window will appear.

NetLogo – Bug Hunters Competition Window	**HubNet: Bug Hunters Competition window**
	

16. Move the window to one side of the screen and **NetLogo – Bug Hunters Competition** window to the other side (shown below). You will need to interact with both these windows in

this demonstration.

17. Press SETUP in the **NetLogo – Bug Hunters Competition** window. In both windows, the world will turn green and a bug will appear on the screen. This is the bug you will be controlling in the demo.



The model is now ready to run and demo to the students. You can keep the model in this state for the coming class period before the class starts. But you can only run one HubNet model at a time, so if you have back to back classes, you will have to close each HubNet window you launched between classes and launch a new one, by going back to the 1st instruction 1 picking a run from another class period.

18. Tell students that what they see on the left is the entire ecosystem that the bug can move in. What they see in the **HubNet– Bug Hunters Competition** window is a small view of the world around the bug. This is what the bug can see. Tell students that they will each get a bug to control in a class wide ecosystem in today's computer activities.

19. Tell students to watch how the bug moves and what happens to the grass when you press GO/PAUSE. Press GO/PAUSE and let the model run a bit. Then Press GO/PAUSE again to pause the model. Ask students to explain what they saw happen. Students should note the following observation in italics. With each observation explain the underlined rules in the model that lead to that outcome:

    - *The bug appears to move forward on its own. Tell students that all bugs that added to the model will move forward on their own.*

    - *The green grass under the bug turns lighter (and sometimes all white) as the bug moves over it. Tell students that a bit of the grass that the bug moves over will be eaten automatically by the bug and the longer the bug travels over a spot a grass the more of it that will be eaten (until there is none left – which then appears white).*

    - *The number next to the bug is increasing. Tell students that this number represents the amount of energy this bug has gained from eating grass. The larger the number, the more grass it has eaten and stored in its body for later use. When the students enter into the*

model, they will see their name next to that number as well.

- *Spots of white that used to be green eventually turn back to green. Tell students that grass grows back after a short delay.*

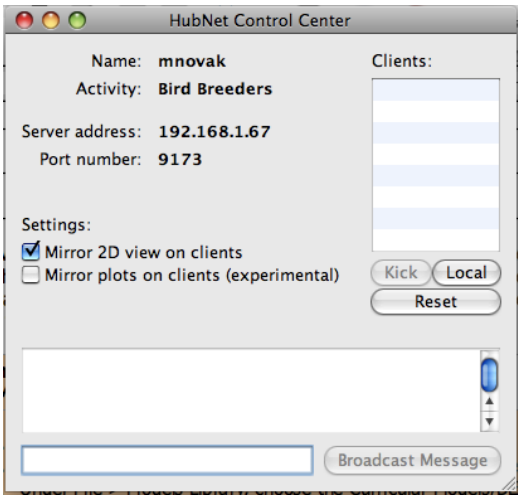
- *When the bug reaches the edge of the **NetLogo – Bug Hunters Competition** window it appears on the other side. (Students may not notice this effect. If not point it out to them) Tell students that this window is like a world map, where east and west edges wrap around – but is a bit different in that north and south edges wrap around too.*

20. Now show students how to steer the bug. Again press GO/PAUSE to resume the model. Use the mouse cursor in the **HubNet: Bug Hunters Competition** window to click on different spots around the bug. The bug will move toward the spot you clicked on.

21. Tell students that this is how they will also steer their own bugs in the model when everyone in the class joins into the ecosystem. Remind them that, "Your own bug will automatically keep moving forward throughout the game. It is your job to steer the direction of movement so that your bug moves eats the grass they move across. Clicking on locations you want to the bug to head towards does this. It is your goal in the first few explorations to "drive" your bug so that it eats more grass than any other player within about a two-minute time limit. Ask if there are any questions.

22. **Now have the students complete the MODEL RULES and the MAKE A PREDICITION sections of step 3.2.** While students are doing this, make sure you have passed out a small post it note to each of them to transfer data to at the end of this exploration.

23. **Have students follow the directions on step 3.3.** As they do so, you will see their names pop up on the client list in the **HubNet Control Center** window.



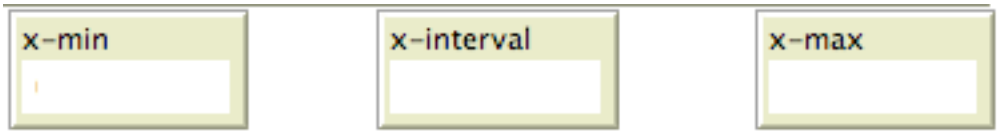
24. Once you have checked the Client List to make sure all students have joined the game. Press the SETUP button again. After you do so, ask students if they all see a bug at the center of their screen with their name on it. (If not, make sure students have joined the simulation in the CLIENT list. If they are not in the list, repeat their directions with them on the student activity sheet) and then repeat the press SETUP button step again.

25. When all students have a bug to control, tell them that this steering will begin when you say go (press the GO/PAUSE button in the model when you say go). The model will automatically stop two minutes.

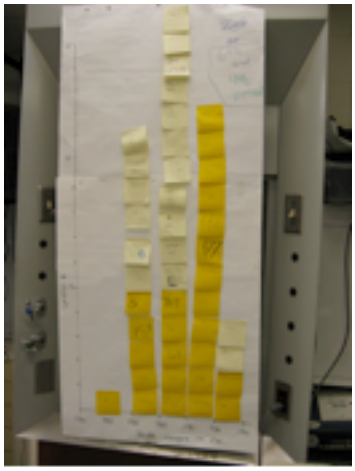
26. When the model stops ask the students to do four things*:*

    (1) ***Have them complete the step 3.4.***

    (2) While students are doing this setup the class Histogram on a piece of butcher paper or on a white board so that its x-axis starts at X-MIN and ends at X-MAX and increases by an interval of X-INTERVAL. The width of each interval should be the width of the post it notes you gave the students to record their data on. These values will be displayed in the following monitors in the model window:



*(3) Direct students to put their post-it note on the class histogram. Model where the first students post it note would go for the class, using the energy level of your bug (you will see your [the teacher's] bug energy in the **HubNet: Bug Hunters Competition**. An example class histogram of the energy of the bugs built from post-it notes is shown here:*



(4) Once all post-its are on the histogram point out to students that the shape of the histogram they built matches the shape of the histogram in the model. Use your mouse button to hover over the histogram at various points to show that the x and y values also match what is shown in the histogram built in class. Point out that though students can't read the individual energy values for each bug in the histogram in NetLogo, like they can on the post it notes in class, they can still tell how many bugs are in each energy interval.

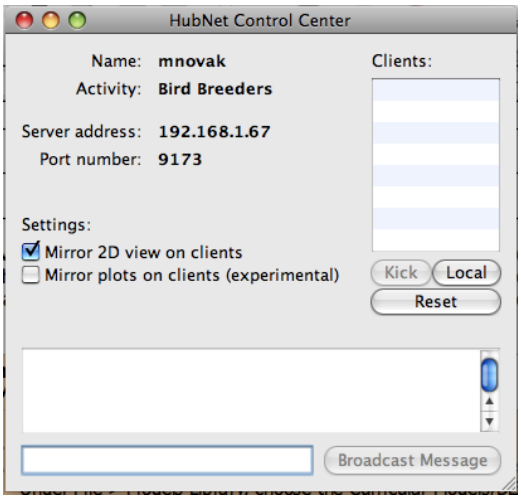
- **Tell students to make a sketch of this graph in Step 3.5 and complete Step 3.6.**

Directions for teacher: Exploration #2

1. **Have students go to step 3.7.** Have a student read the question out loud for this exploration. Describe to students how the model will change in this last exploration: Instead of student driven bugs, the computer will control all the bugs in the model, steering the randomly back and forth as they move forward. The bugs therefore will be moving blindly through the ecosystem. Tell students, "I wonder how the outcome of this competition will compare to the previous one. Will there be any noticeable differences in the histogram?"

2. Have students complete their prediction question on this step. Have student share some of their predictions.

3. All the students should still be connected to the model. You should still see their names the **HubNet Control Center** window.



4. *In the **NetLogo – Bug Hunt Competition window** make the following changes:*

Setting	Value
INITIAL-AUTOMATED-BUGS	30
SETUP-CLIENTS-AS-BUGS	Off
PLAYER-VISION	10
SHOW-LABELS-AS	Energy ranges
ALL-BUGS-LOSE-ENERGY?	On

5. Press the SETUP button again. Tell students that they can either watch the **NetLogo – Bug Hunt Competition** window or the **HubNet: Bug Hunt Competition** window during the simulation. At the end of the simulation, however, they will need to sketch the shape of the graph

6. Press GO/STOP to run the model.

7. **When the model stops have students complete 3.8 through 3.10**

Summarize:

Remind students that the main question for the unit of study that they are studying is "How do Populations Change?"

Ask students what we discovered today that helps us both the lesson question and the unit question. Have students write their ideas down in the DISCOVERIES AND INSIGHTS section of the activity sheet.

- **Then have students talk with a partner and select one idea they discovered today related to "What causes competition between individuals in ecosystems?" (Step 3.11)**

Have students write this idea on a large piece of paper or a large post it note in dark pen/marker. Have one student from each pair of students bring their papers/post-its to the front of the room and stick them up on the board.

Also have students bring up any questions they came up with too to post (the last question on step 1.6 encourages this). Have students post those questions along the side of the driving question board that they think it most related to.

With the papers/post-its displayed for the class to look at together, lead a consensus building discussion. Facilitate the movement and reorganization/clustering of the ideas students brought up, under the 4 headings listed below. This consensus building discussion and reorganization of the student descriptions of their discoveries will help students condense and summarize the big ideas from the day's lesson. If an idea that students suggest doesn't fit under these 4 areas, don't leave it out. Rather, emphasize that the idea shared is another interesting discovery and that the main ideas that the students are responsible for knowing and reusing in future explorations are the ones organized under the 4 areas listed. Try to write the 4 categories in the student's own words, and using their own papers if possible. You may want to consider posting these big ideas in class, having students summarize these ideas now (or later) in their notes. Either way, try to use the students own words and the way the class expresses the ideas listed below, without feeling it is necessary to use this exact wording. Examples of possible student responses they might contribute on their sheet or post it note are shown in italics. Ask students whether they agree or disagree with how the ideas or organized and whether this summary helps pull out the main points they discovered.

The underlined statement is the suggested category. 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 & Insights: What Causes Competition Between Individuals In Ecosystems?

- Limited Resources Necessary for Survival
  - *Example student idea: There is limited space for plants to grow in a pond.*
  - *Example student idea: An area can run out of food.*
  - ***Summarize with this idea: All ecosystems have a limited amount of resources available that are needed for survival (food, water, space, air, sunlight, shelter, etc.)***

- Variation in Resource Distribution
  - *Example student idea: Some creatures are lucky to find food before others*
  - *Example student idea: If a seed lands near where there is water it will grow quicker and use up more water than one that does not.*
  - *Example student idea: The soil is different in different parts of an ecosystem, so trees would grow better in some parts than others.*
  - ***Summarize with this idea: Because resources aren't always equally distributed near every individual all the time, sometimes some individuals will be able to get more***

resources than others.

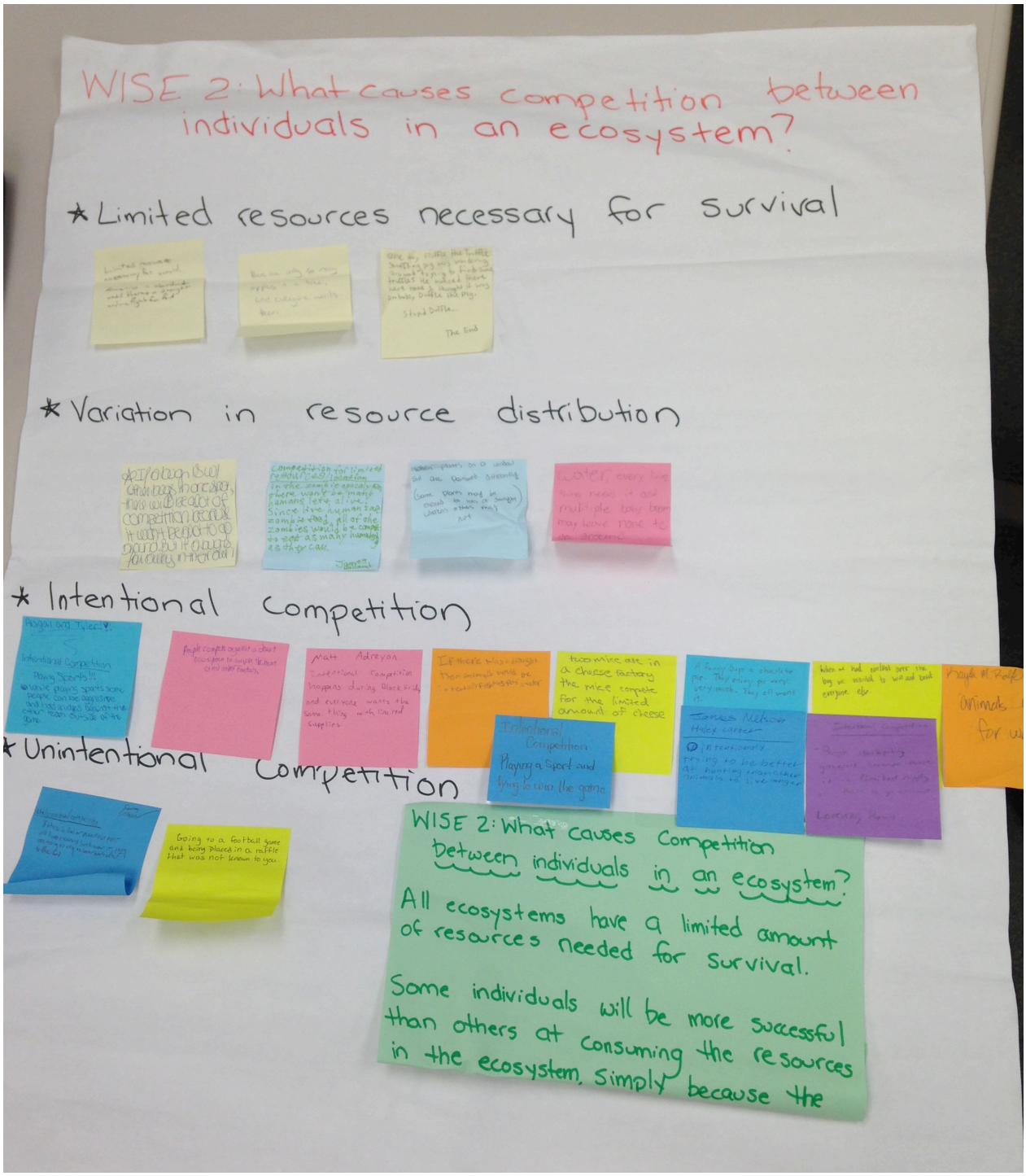
- Intentional Competition
  - *Example student idea: Humans can try to outcompete others.*
  - *Example student idea: Some animals may learn and think about how to outwit or beat their competition*
  - *Example student idea: Birds fight other birds who try to take their food away from them*
  - *Example student idea: Plants growing together in a container might automatically try to choke out or over shade neighboring plants when they sense they have competition.*
  - ***Summarize with this idea: Some organisms sometimes make an effort to intentional compete. (Example: instincts, ability to learn and plan, etc.).***

- *Unintentional competition*
  - *Example student idea: There are winners and losers in a population even when the organisms aren't intentionally competing for resources.*
  - *Example student idea: Not every organism is equally successful at getting what they need to survive, even when they aren't trying.*
  - *Example student idea: Some bugs win, even when they aren't trying.*
  - ***Summarize with this idea: Competition emerges, when organisms interact with and deplete the same resource pool, even if there is no intentional effort between individuals to compete.***

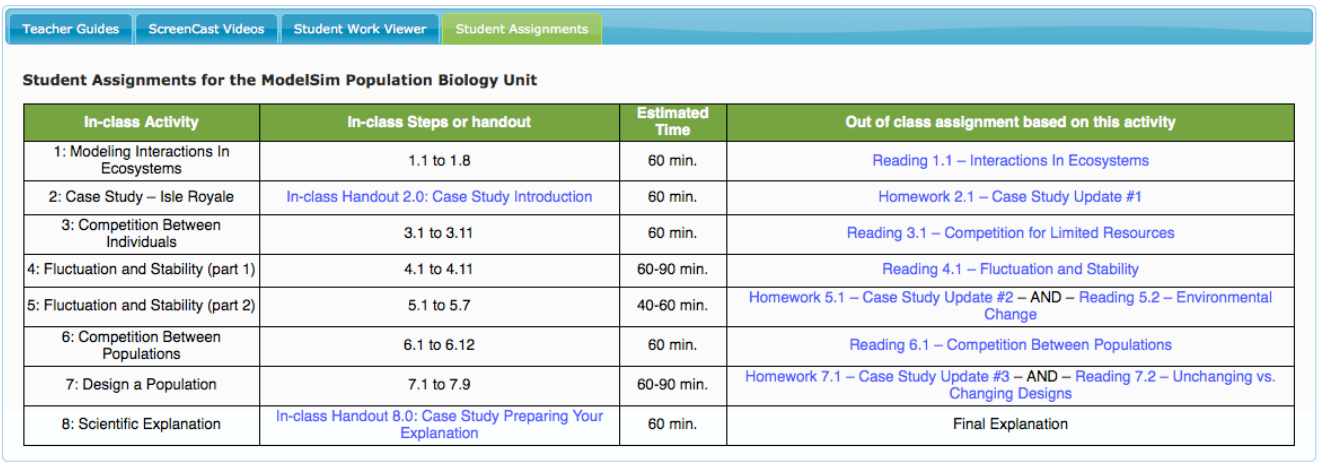
Add only these two scientific principles to the driving question board:

- All ecosystems have a limited amount of resources necessary for survival (e.g. water, habitat, sunlight, food).
- Competition emerges when individuals consume resources that other individuals need.

Once these ideas in the bold have been agreed upon by the class make sure they have been added to the orange section of your driving question board. Add them either in the abbreviated form (e.g. "limited resources necessary for survival" or the fuller form of the idea "All ecosystems have a limited amount of resources necessary for survival for living things"). One easy way to do this is to move the butcher paper or poster paper that you had been using to keep track of the ideas and tape it under the lesson question for today. An example of this is shown below. Special thanks to Katahdin Cook Whitt at Dayton STEM School, Dayton OH.



Homework: **Assign the homework (reading 3.1) for 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