



A KBS K-12 Partnership
Activity

Survivor: Who Will Be The Best Competitor?

The effect of environmental change on competition between species

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OVERVIEW

Students explore the effects of the environment on competition between species. Students play a game where two different species forage for prey. Species differ in vision, simulated by light-filtering goggles, which affects their ability to forage on particular food items that differ in color. Students gather data, make tables and graphs, and make comparisons between outcomes for different species and in different environments. Students develop new questions to test within the framework of the game. They make predictions, develop methods, gather data and interpret results from their questions. Connections to evolution, competition, predator-prey dynamics and food webs can be made.

OBJECTIVES

At the conclusion of the lesson, students will be able to:

- Understand that organisms require resources from their environment.
- Understand that organisms compete for resources in their environment.
- Become familiar with examples of competition between species.
- Understand that changes to the environment change competition between species through a game.
- Become familiar with examples of change in environments that cause change in competition between species.
- Make applications to real world situations of environmental change and competition (including applications to bioenergy plots).
- Make tables and graphs of data collected.
- Interpret data from graphs and make comparisons between graphs from different scenarios and species.
- Develop new questions, make predictions, design methods, test question, collect and interpret data.

LENGTH OF LESSON

One 90-minute class period or two 45-minute class periods. Notes for where to break the lesson down into 45-minute periods are included in the lesson plan.

GRADE LEVELS

3rd – 12th grade. Lesson is written at the 4th – 6th grade level. Ideas for simplifying or adding complexity are discussed in the “Modification and Extensions” section at the end of the lesson plan.

STANDARDS COVERED

Grade 3:

S.IP.03.16 Construct simple charts and graphs from data and observations.

S.IA.03.11 Summarize information from charts and graphs to answer scientific questions.

L.OL.E.03.32 Identify and compare structures in animals used for controlling body temperature, support, movement, food-getting, and protection.

**STANDARDS COVERED
(CONTINUED)**

L.EV.03.12 Relate characteristics and functions of observable body parts to the ability of animals to live in their environment.

Grade 4

S.IP.04.16 Construct simple charts and graphs from data and observations.

S.IA.04.11 Summarize information from charts and graphs to answer scientific questions.

L.OL.04.16 Determine that animals require air, water, and a source of energy and building material for growth and repair.

L.EV.04.22 Identify how variations in physical characteristics of individual organisms give them an advantage for survival and reproduction.

L.EC.04.21 Explain how environmental changes can produce a change in the food web.

Grade 5

S.IP.05.15 Construct charts and graphs from data and observations.

S.IP.05.16 Identify patterns in data.

L.EV.05.11 Explains how behavioral characteristics (adaptation, instinct, learning, habit) of animals help them to survive in their environment.

L.EV.05.12 Describe the physical characteristics (traits) of organisms that help them survive in their environment.

Grade 6

S.IP.06.15 Construct charts and graphs from data and observations.

S.IP.06.16 Identify patterns in data.

L.EC.06.21 Describe common patterns of relationships between and among populations (competition, parasitism, symbiosis, predator/prey).

Grades 8-12

B.1.1D Identify patterns in data and relate them to theoretical models.

B1.1f Predict what would happen if the variables, methods, or timing of an investigation were changed.

B2.4B Describe how various organisms have developed different specializations to accomplish a particular function and yet the end result is the same (e.g., excreting nitrogenous wastes in animals, obtaining oxygen for respiration).

B3.2C: Draw the flow of energy through an ecosystem. Predict changes in the food web when one or more organisms are removed.

MATERIALS

PowerPoint of background information and examples of competition (included).

Worksheet for (1) generating charts and graphs for the game, (2) brainstorming student-generated questions to test in the framework of the game, (3) making predictions, and (4) recording data from the student-generated question (included).

Different colored objects to serve as “food items.” We used yellow, green and red pre-cut foam pieces from a variety foam container.

Two (or more) different colors of cellophane found at craft stores or in gift wrap sections of general stores. We used blue and red cellophane.

MATERIALS (CONTINUED)

Goggles. Tape double-layered cellophane to the outside or inside of the goggles. (A class set is available for check-out from the Kellogg Biological Station. You can also make a simple classroom set using cardstock with eye holes cut out or by using toilet paper tubes attached to make binoculars and then adding colored transparency to the cardstock glasses or tubes. If you make your own, you will need to experiment with how many layers of cellophane are needed to get the desired result.)

BACKGROUND

(Text to accompany PowerPoint)

Imagine a rainforest full of different species (or kinds) of plants. These plants are all competing for the resource of light, which is necessary for growth, survival and reproduction.

We will focus on competition between species, which is called interspecific competition. [Note: Competition also occurs within species, which is called intraspecific competition.] Species compete for resources (food, living space, mating space) in their environments.

In our rainforest example, taller trees absorb light before it reaches shorter trees.

(Show video in PowerPoint of clover plants sprouting. Competition occurs above ground for light and below ground for nutrients and water.)

Another example is in the case of cheetahs and lions. These two species both eat the same prey items. So, if lions are better at capturing food, then there will be fewer prey available for cheetahs. Thus, lions have the competitive advantage and cheetahs are negatively affected by the presence of lions.

(Show video in PowerPoint of damselfish (dark colored) defend territories in corals. They are defending a food resource. Other fish (light colored) also feed on the algae on the corals. These fish overpower the territory defense of damselfish by schooling – their high numbers overpower the defense of individual damselfish.)

(Discuss the following after the game.)

Competition is costly. If members of one species are poor competitors, they will get less of the resource (food, territory). This lowers the chance that members of this species can survive or reproduce. Thus, there is a benefit to reducing competition.

One mechanism to reduce competition between species is if they use different resources. It is common in nature for two species to become specialists on different species instead of using a common resource. (*See PowerPoint for examples.*)

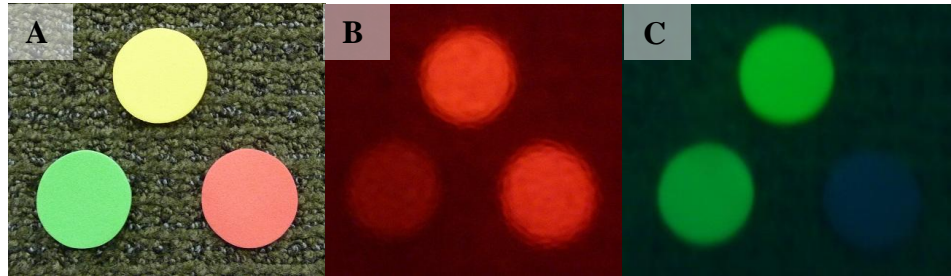
Understanding competition is important for predicting whether species can coexist and predicting outcomes when species are lost or introduced to an environment. This is useful in conserving endangered species and when introducing biological controls (e.g., lady bird beetles (biological control) that eat aphids (plant pest) off of crop plants.)

ACTIVITIES OF THE SESSION

- Present the introduction in the PowerPoint (included) having students provide examples of competition. This should help the lesson connect to students' previous knowledge.

**ACTIVITIES OF THE
SESSION
(CONTINUED)**

- Describe the underlying concept of the game: Students model two different species that are foraging for food. The species are distinguished by their differences in vision, which is accomplished by wearing either red- or blue-tinted goggles. There are multiple prey items, represented by red, yellow and green foam pieces. The red goggles allow one to see yellow and red, but not green. The blue goggles allow one to see yellow and green, but not red. We are simulating the differences in the species' ability to forage for food based on their vision capabilities.



Unfiltered (A), red-filtered (B) and blue-filtered (C) vision of yellow, green and red prey items.

- Play the game (Part I).

General rules for all simulations:

- There will be 60 seconds allotted to gathering your food.
- Each student must pick up only one piece of prey at a time and take it back to their cup (stomach) location.

Scenario 1

- The amount of preferred food is limited, but there is plenty of the “common” food. Competition exists between the two species as they are both preying on a lot of common food.
- Set up: Randomly place “prey” around the classroom:
10 red/60 yellow/10 green
- Data collection: Students will be asked to collect as many prey as they can within the allotted time. Have students record on their worksheet how many of each prey they collected.

Scenario 2

- The amount of “common” food becomes scarce, allowing the preferred food to become more abundant. This promotes more competition between organisms within a species. In the real world, this could happen if the “common” food item experienced a disease or was eaten preferentially over other food sources.
- Set up: Randomly place “prey” around the classroom:
35 red/10 yellow/35 green
- Data collection: Again, students are asked to collect as many prey as they can within the allotted time. Have students record on their worksheet how many of each prey they collected.

**ACTIVITIES OF THE
SESSION
(CONTINUED)**

(Could break here for two 45-minute class periods.)

• Data analysis

Have students work collaboratively to tabulate total prey collected by all members of their species. Select a student in each species group to chart data and report out to the whole class. Individual students record species totals and draw bar graphs of species totals on their worksheet.

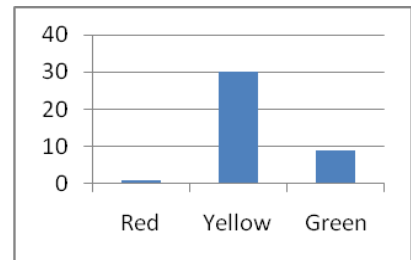
Students should explain how their results differed between Scenario 1 and Scenario 2. Why do they think these differences occurred?

Expected Outcomes

Scenario 1: 10 red / 60 yellow / 10 green

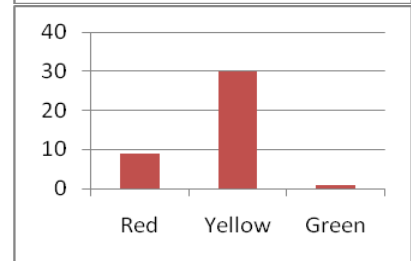
“Blue” species

<i>Prey Color</i>	<i># captured</i>
<i>Red</i>	<i>1</i>
<i>Yellow</i>	<i>30</i>
<i>Green</i>	<i>9</i>



“Red” species

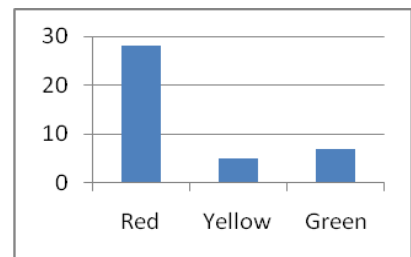
<i>Prey Color</i>	<i># captured</i>
<i>Red</i>	<i>9</i>
<i>Yellow</i>	<i>30</i>
<i>Green</i>	<i>1</i>



Scenario 2: 10 red / 60 yellow / 10 green

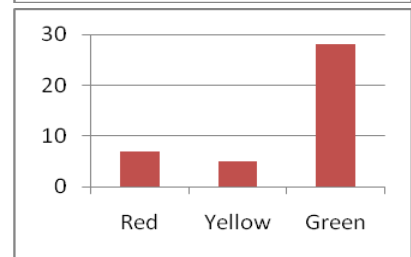
“Blue” species

<i>Prey Color</i>	<i># captured</i>
<i>Red</i>	<i>28</i>
<i>Yellow</i>	<i>5</i>
<i>Green</i>	<i>7</i>



“Red” species

<i>Prey Color</i>	<i># captured</i>
<i>Red</i>	<i>7</i>
<i>Yellow</i>	<i>5</i>
<i>Green</i>	<i>28</i>



Actual results may vary, but you can expect that totals for each species should be approximately equal for yellow as both species can see yellow equally well. Members of the “Blue” species should be able to capture more green and members of the “Red” species should be able to capture more red.

**ACTIVITIES OF THE
SESSION
(CONTINUED)**

- Discussion (Part I)

How do results vary between the “Blue” species and the “Red” species?

Why do we see these differences?

How was competition affected by the change in the prey distributions between Scenario 1 and Scenario 2? (*Answer: Because the “common” prey (=yellow) became more rare, individuals were competing less with members of the other species, instead they used the prey item they could see best that was now more common (=red for “Red” species or green for “Blue” species).*)

What kinds of environmental change might cause changes in the predator-prey or species competition dynamics?

- Assessment / Play the game (Part II)

Have students come up with their own scenario to model an environmental change. Students make predictions and modify the model to test their prediction.

In their species teams or in smaller groups, have students brainstorm new scenarios to try. Students may come up with many different ideas, but here are some possibilities we have considered: vary the colors or numbers of the prey items, add new colored items (who can see it better?), change the color filter (perhaps a new “purple” mutation enters the predator population, how does it compete with the “red” and “blue”?), change the size of the objects, change the total number of objects available, or change the spatial distribution of prey items (perhaps some prey colors clump together or are far from each other, perhaps some prey items hide in difficult to reach spots).

- Discussion (Part II)

Facilitate a discussion of how the results from the students’ chosen variation differed from the previous scenarios. Why did they see this difference? What other things could impact differences between scenarios, between multiple runs of one scenario or between individuals? How does individual variation play a role in affecting individual or species outcomes? How does learning affect foraging / searching for prey items?

Discuss with students the connection between their results and how it a real world example in stickleback fish. (See PowerPoint for background on Stickleback story).

RESOURCES

PowerPoint of examples and background information.

Student worksheets.

EXTENSIONS & MODIFICATIONS

- Add survival component.
Students must capture a certain number of prey items to survive. When we tested this lesson, we said each person must capture 5 food units to survive – red & green items were 2 food units and yellow items counted as 1 food unit. Students will see that more individuals survive in Scenario 2 than Scenario 1 (because there are more of the “2 food unit” items available and because competition for the “common” food item is reduced.) We allowed students to participate in all scenarios regardless of whether they survived the previous scenario to make data more comparable and to keep everyone involved. However, one variation to the game could involve tracking changes in the predator population over time by running multiple runs of the game and only letting survivors play in subsequent rounds.

Note: When adding this component, don't reveal the food item requirements until after running the second scenario. Otherwise, individuals may change their capturing strategies and affect data outcomes.

- Add a reproductive component.
Similar to the survival component, assign the number of food items an individual must capture to reproduce. Perhaps 2 food items are needed to survive and every subsequent 2 food items captured allows the individual to produce 1 offspring. (Relevant for 7th grade and above.)
- Model evolutionary processes.
Using the survival and reproductive requirements, you can run multiple rounds of each scenario and track how many individuals of each species survive and reproduce. Track total population sizes over time.
You might also model geological isolation by putting barriers between predator populations or develop variations to model Hardy-Weinberg. (Relevant for 8th grade and above.)
- Tracking prey populations.
In 60 seconds, 20 people were able to collect all 70 food items. We still saw the competition patterns we were hoping to demonstrate, but if you wanted to track prey populations over time, you could have a 30 second time limit or put out more food items per person. Otherwise, there will be no prey left to reproduce.

You could also have the prey populations reproduce and run multiple generations of each scenario. For example, if the yellow pieces are eaten the most, then over time you should see more green and red individuals in the prey populations. This will continue until green and red are too common and yellow has an advantage again. This is called frequency dependent selection, discussion of which would be appropriate for advanced high school students, but the pattern is simple enough to work for any grade level.

**EXTENSIONS &
MODIFICATIONS
(CONTINUED)**

You could also relate this to predator-prey interactions. As the more profitable green and red (“2 food unit”) food items increase in the population, more of the predator individuals (=students) should survive.

- Vary the profitability of each food item depending on the species.
If green food items are hardest to see for “Red” species, then these items could be worth the most food units. Thus, it might benefit “Red” species individuals to spend longer searching for these hard-to-find but profitable prey. Depending on how many prey items of each color are available it may be more beneficial to pick the easy-to-find and less profitable prey. You might discuss with your students which strategy would be best in different scenarios.
- Vocabulary.
“Kinds” or “types” may be more accessible for 3rd graders while “species” may be more appropriate for 6th grade and above. Similarly, “groups” may be more accessible for elementary students while “populations” may be more appropriate for middle and high school students.
- Non-vision related modifications.
Students with color-blindness or other vision impairments may have difficulty seeing food items or wearing the safety goggles. You may choose to alter the activity so that the two predator species differ in other ways.
Example 1: Each species could have different ways of capturing their prey (e.g., tweezers, chopsticks, spoons, forks, or toothpicks).
Example 2: One species could be larger than the other. Students wear nametags or hold cards that represent if they are a member of the smaller or larger species. Because of this size difference, members of the different species have different food requirements to survive and/or reproduce (e.g., members of the bigger species need 10 food items; members of the smaller species need 5 food items).
- Model food web or food chain dynamics using some of above suggestions.
- Use for exploring properties of color and light (Relevant for 3rd grade.)
- You may choose to set up the activity on tabletops or in small groups if you do not have a large open space for this activity or want to minimize classroom chaos.

Scenario 1

*Graph the total number of food items collected of each color for all members of **your** species.*



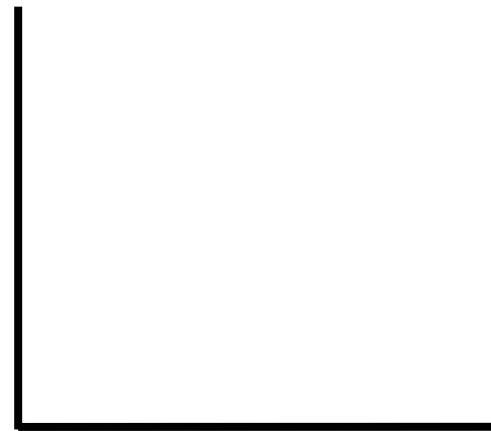
Scenario 2

*Graph the total number of food items collected of each color for all members of **your** species.*



Scenario 1

*Graph the total number of food items collected of each color for all members of **the other** species.*



Scenario 2

*Graph the total number of food items collected of each color for all members of **the other** species.*



How do your results differ between Scenario 1 and Scenario 2? Why do you think you see this difference?

How do results differ between species? Why do you think you see this difference?

Brainstorming:

In your group, develop new ideas to test. How might you change the prey, predators or the environment?

Testing the New Scenario:

Record the class' pick for the new scenario.

Methods: How will you set up the game to model this scenario (give exact numbers, locations, colors, etc.)?

Prediction: What do you think the results for the "red" species and the "blue" species will look like? (Describe in sentences, make a table or draw a graph.)

Will these results differ from those in Scenario 1 and/or Scenario 2? Why or why not?

Scenario 3

*Graph the total number of food items collected of each color for all members of **your** species.*



Scenario 3

*Graph the total number of food items collected of each color for all members of **the other** species.*



Do these results match your predictions for Scenario 3? Why or why not?

How do results of Scenario 3 compare to those of Scenario 1 and Scenario 2? Are they different or similar? Explain.

How does Scenario 3 affect competition between the species?

What other thoughts do you have about Scenario 3? (You might address some or all of these questions: Did you forage for prey differently? Did other predators change their behavior? Do you think you have learned how to forage better over time? Do you have new questions or ideas now that you have finished Scenario 3?)