Lesson 4: Natural Selection Simulation

Introduction

In this lesson, you will use a simulation to decide if natural selection was the process that changed the stickleback population in Loberg Lake. In this simulation you will collect and analyze data from a simulation about a snail population in order to determine the importance of each factor of natural selection and the effect that the interaction of the four factors has on a population of organisms.

Process and Procedure

The focus question for today's lesson is, **"Which of the four factors of natural selection is necessary to explain the changes we see in populations in nature over time?"** You will respond to this question at the end of today's lesson.

The Snail Phenomenon

Nucella lapillus is the scientific name for Dog Wharf snails that live on the rocky shores of oceans. These snails reproduce approximately 1000 offspring annually. The snails eat barnacles and mussels. Scientists have found that snails in areas with a lot of waves have thinner shells and snails living in areas with no waves, like tidal pools, tend to have thicker shells. In the tidal pools, crabs are the main predator of the snails. Recently, scientists have discovered an area where a change in sea current has reduced wave action and created a new tidal pool. They want to investigate the population of snails living in this new tidal pool.

1. To help us make connections from previous lessons, compare the snail phenomenon described above to the stickleback phenomenon that we've been learning about by completing the chart below.

	Stickleback	**Snails**
Habitat		
Variation in traits		
Predator(s)		
Reproductive Habits		
Food Source(s)		

Snail Simulation Part 1

2. Follow your teacher's directions to set up the snail simulation. Keep in mind that a simulation is one type of model. Complete the analogy map below based on the materials you will use in the simulation.

Analogy Map

Part of the Model		Part of the Natural World
The raisins	Represent(s)…	
The M&Ms		
The forceps/tweezers		
The tall cup or pail		
Raisins or M&Ms placed in the discard container		
Rolling the die		

3. Record the number of each variation of snail **at the beginning of each generation** in the table below. Determine the percentages of each variation **after** you complete the simulation. Record the percentages in the last two columns of the table.

Generation	Number of Thin-Shelled Snails	Number of Thick-Shelled Snails	Total number of snails in population	Percentage of Thin-Shelled Snails	Percentage of Thick-Shelled Snails
1	15	5	20	75%	25%
2					
3					
4					
5					

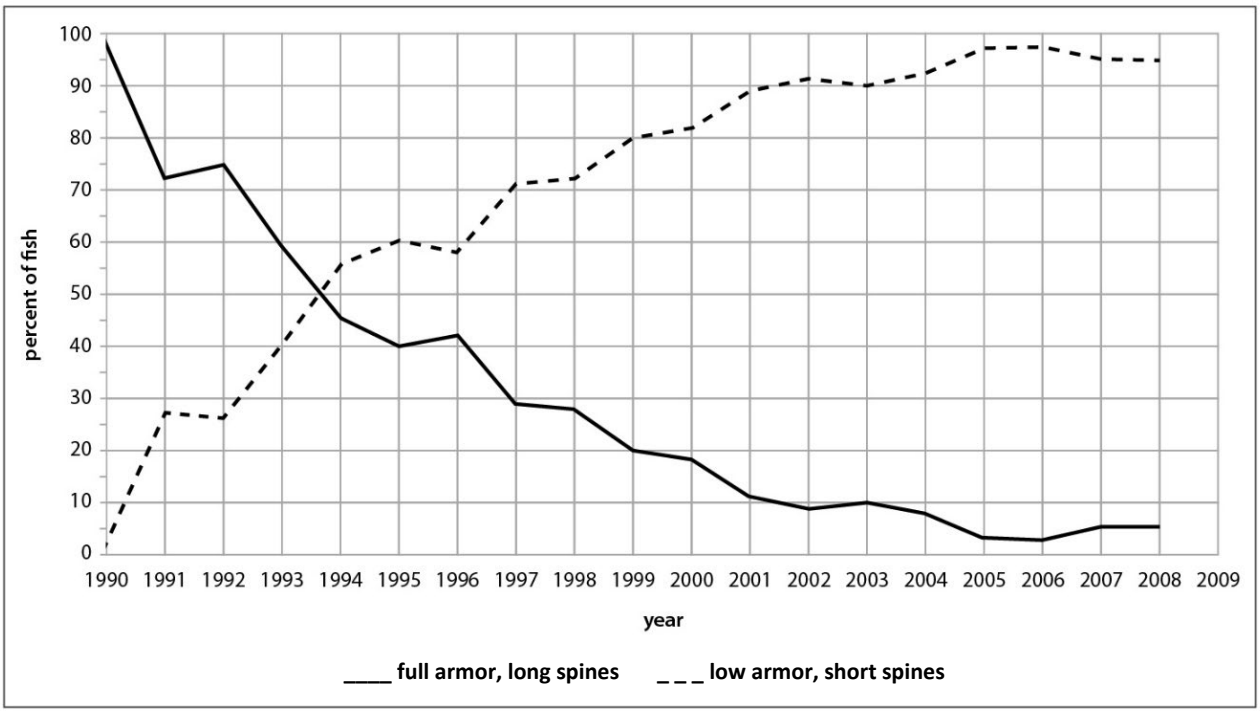
4. Use the percentages of each variation to create a graph showing the changes in the thick-shelled and thin-shelled snail population over 5 generations. Be sure to title your graph, label the axes, and provide a legend.

Graph 1:

5. Use Identify and Interpret (I^2) on the graph you completed above by writing "What I see" and "What it means" statements. Be sure to draw an arrow from the "What I see statement" to the trend, pattern, high-point, or low-point on the graph.

6. Compare the trends you found in the graph that you completed on the previous page about your snail population with the trends that you found in the graph below from the Loberg Lake Graph. Discuss with your team any similarities or differences. Record your ideas in the space below.

Percent of Fish in Population Sample with Full and Low Body Armor



7. A scientific study completed by Sonia Pascoal, Gary Carvalho, Simon Creer, Sonia Mendo, and Roger Hughes (2012) resulted in the following findings:

   The intertidal snail Nucella lapillus *generally has thicker shells at sites sheltered from wave action than at exposed sites. Crabs are abundant and pose a high risk of predation at sheltered sites, but they are rare at exposed sites.*

   Compare the scientific findings of Pascoal and others explained above with the results from your snail simulation. How do your results compare to the changes found in nature?

8. Which factors of natural selection do you think influenced the findings of the snail study? Explain your thinking.

Snail Simulation Part 2

To learn about how each variable affects a population, we will conduct a second snail simulation in which we remove one of the four factors of natural selection and analyze the effect it has on the population of snails.

9. Before completing the second part of the simulation, you will need to think about the different variables that relate to each of the four factors of natural selection. Draw an arrow from the factor listed on the left to a variable listed on the right that best matches with it. Some factors have more than one matching variable.

Factor 1: More individuals are born than can survive and reproduce.	a. Different variations of traits, like a thin shell or thick shell.
	b. The amount of available food
	c. The number of individual organisms competing for food or habitat
Factor 2: Individuals within a population inherit traits from their parents. These traits show variation.	d. The number of organisms that reproduce over a certain period of time
	e. The number of trait variations within a population of organisms
Factor 3: Individuals in a population compete for limited resources (e.g., food, habitat, or mates).	f. The number of organisms that survive to adulthood
	g. The amount of habitat available to the population
Factor 4: Some offspring inherit variations of traits that help them better survive and reproduce in their environment.	h. The number of organisms that are born over a certain period of time

10. With your partner or group, decide what you will need to change for each factor and predict how the change will affect the population. Make a prediction about what will happen to the percentage of each trait (e.g., shell thickness) present in the population when you remove each factor. Record your prediction in the space below.

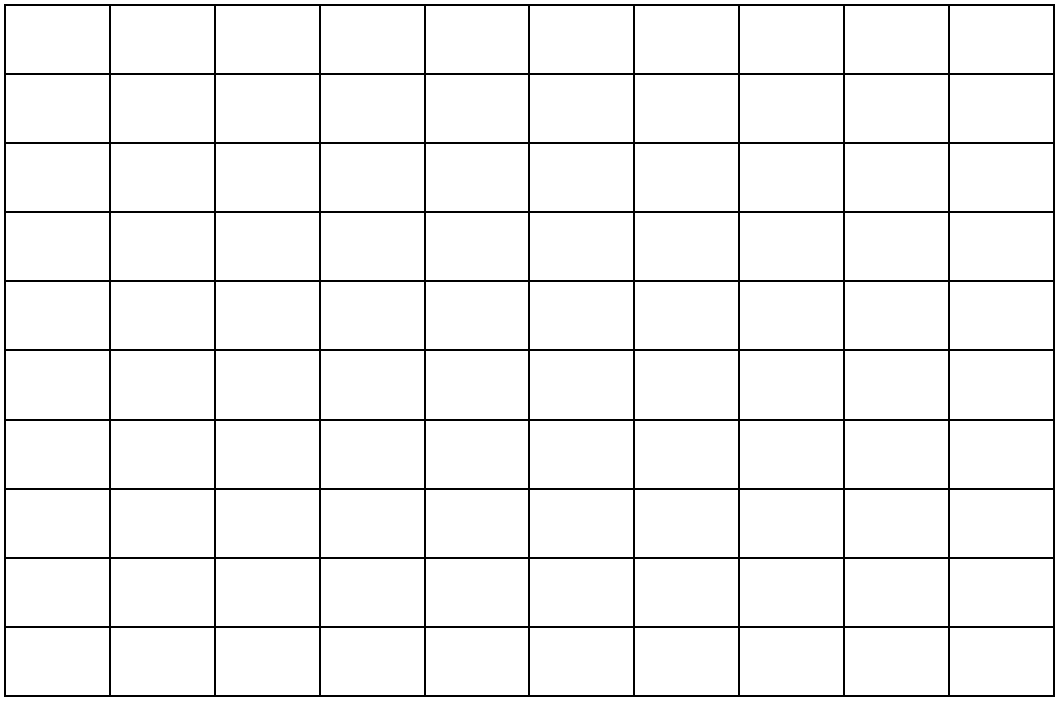
Cause	*Change to* the Simulation
Factor 1: More individuals are born than can survive and reproduce. To eliminate Factor 1 from the population, we need to…	
Factor 2: Individuals within a population inherit traits from their parents. These traits show variation. To eliminate Factor 2 from the population, we need to…	
Factor 3: Individuals in a population compete for limited resources (e.g., food, habitat, or mates). To eliminate Factor 3 from the population, we need to…	
Factor 4: Some offspring inherit variations of traits that help them better survive and reproduce in their environment. To eliminate Factor 4 from the population, we need to…	

11. Follow your teacher's directions and circle the variable that you and your partner or group will remove from your simulation.

Group A = Remove Factor 1	Group B = Remove Factor 2
Group C = Remove Factor 3	Group D = Remove Factor 4

You were asked to remove one of the four natural selection factors and to predict how the snail simulation would be affected. Use the graph below to illustrate what your prediction would look like. Assume that you again start with a snail population that has 75% thin shells and 25% thick shells. You don't need to include a number scale on the y-axis. We are just concerned with the shape of the data line(s).

Graph 2.



Compare Graph 2 (Snail Simulation Part 2) showing one factor of natural selection removed to Graph 1 (Snail Simulation Part 1) with all four factors included. Discuss the similarities and differences you notice with your group.

12. Are the patterns you see in graph 2 consistent with what we see in nature? Explain your answer.

13. With your group discuss the following question: What effect did removing this factor have on the change you observed in the population of snails? Record your response in the space below according to your teacher's directions.

14. Share your findings from part 2 with other classmates that removed different factors from their simulation. Your discussions will be documented in the cause and effect chart below.

Cause	Effect
Factor 1: More individuals are born than can survive and reproduce. **If** Factor 1 is NOT present in the population…	
Factor 2: Individuals within a population inherit traits from their parents. These traits show variation. **If** Factor 2 is NOT present in the population…	
Factor 3: Individuals in a population compete for limited resources (e.g., food, habitat, or mates). **If** Factor 3 is NOT present in the population…	
Factor 4: Some offspring inherit variations of traits that help them better survive and reproduce in their environment. **If** Factor 4 is NOT present in the population…	

Summarize and Synthesize Ideas

The focus question for this lesson is, **"How do the four factors of natural selection explain the changes we see happening in populations?"**

15. Based on your cause and effect chart on page L4-12, decide which factor or factors of natural selection are necessary to explain the changes that we see in populations in nature. Circle the factors below.

    Factor 1: *More individuals are born than can survive and reproduce.*

    Factor 2: *Individuals within a population inherit traits from their parents. These traits show variation.*

    Factor 3: *Individuals in a population compete for limited resources (e.g., food, habitat, or mates).*

    Factor 4: *Some offspring inherit variations of traits that help them better survive and reproduce in their environment.*

16. Use evidence from our stickleback and snail studies along with the ideas in your cause and effect chart to explain your answer to #15.

References

Pascoal, S., Carvalho, G., Creer, S., Mendo, S., & Hughes, R. (2012, December 13). Plastic and Heritable Variation in Shell Thickness of the Intertidal Gastropod Nucella lapillus Associated with Risks of Crab Predation and Wave Action, and Sexual Maturation. Retrieved January 17, 2019, from https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0052134