

Survival or Extinction?

The Evolution of Bay Animals and their Limiting Factors



Overview

The success of a population is dependent on the limiting factors impacting its environment. This activity is designed to help students understand how limiting factors may have directed evolutionary pathways, and applies this understanding to current environmental problems. Students work in groups to evolve into a present day species by playing a board game as a class. They then have to find solutions to present day problems facing their species in order to survive.

Estimated Time

one class period and homework assignment

Objectives

Students will be able to:

- Explain the relationship between limiting factors and evolution
- Hypothesize possible evolutionary pathways for modern day organisms
- Apply what they have learned to current environmental problems
- Construct a phylogenic tree
- Identify limiting factors affecting species that use the San Francisco Bay.

Materials

- Transparency copy of Evolution Game Board,
- Dry erase markers in 6 different colors,
- Scenario Cards (Photocopy cards, cut up, and put into a bag labeled Round 1).
- Role Cards (Photocopy and cut up)

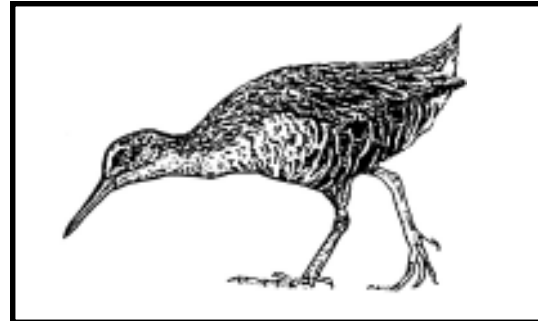
Vocabulary

limiting factor, evolution, phylogenic tree, common descent, divergent, convergent

California's Science Content Standards

Grade 7

Standard Set 3.a: both genetic variation and environmental factors are causes of evolution and diversity of organisms.



Standard Set 3.b: the reasoning used by Darwin in making his conclusion that natural selection is the mechanism of evolution.

Standard Set 3.d: how to construct a simple branching diagram to classify living groups of organisms by shared derived characteristics, and expand the diagram to include fossil organisms.

Standard Set 3.e: extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient for its survival.

Grades 9-12

Biology/Life Sciences Standard Set 8.a: how natural selection determines the differential survival of groups of organisms.

Biology/Life Sciences Standard Set 8.b: a great diversity of species increases the chance that at least some organisms survive large changes in the environment.

Biology/Life Sciences Standard Set 8.d: reproductive or geographic isolation affects speciation.

Additional Resources/Activities

Evolution Activity: <http://www.nap.edu/readingroom/books/evolution98/evol6-c.html>

Limiting Factors-Migration: http://www.expeditionnorthamerica.com/Education/migration_act_01.htm

Teacher Procedure

1. Divide the students into 6 groups. Explain that all groups will start out at the beginning of the phylogenetic tree, and can choose their own paths as they evolve. All paths have the same number of steps; the cards they draw will determine how quickly they move on the board. (Two groups cannot evolve into the same species, so there are limits to the routes each group can take on the phylogenetic tree.)
2. The scenario cards describe historical events that have changed the earth's environment. Evolution is the result of genetic changes that occur in constantly changing environments. Natural selection determines the differential survival of groups of organisms. Organisms that were adapted to a particular change survived, while others died or failed to reproduce. Make sure the students realize that these scenario cards are not in correct historical order, as they are drawing them from the bag randomly. Also, not all of the scenario cards truly affected the species they are evolving into, but they demonstrate the limiting factors that have occurred over the history of life on Earth. Emphasize that this is a simulation.
3. Now is your chance to evolve! Have each group take turns drawing scenario cards from the bag (roll dice to see who goes first). Their group needs to choose together which forks to take on the phylogenetic tree. As they evolve, mark their spaces on the overhead with six differently colored dry-erase markers. Used cards go back in the bag.
4. The game ends once each group reaches the end of the board. At this point, hand out the cards describing the species that they have evolved into: Human, Winter Run Chinook Salmon, California Clapper Rail, Brown Pelican, Salt Marsh Harvest Mouse, Harbor Seal
5. Everyone has now evolved to become a present-day species that depends upon the San Francisco Bay to survive. Hundreds of thousands of years have been spent adapting to the environmental conditions that exist on Earth and thousands of years have been spent adapting specifically to the San Francisco Bay. Over the last 150 years, beginning with the Gold Rush, new limiting factors have appeared, primarily caused by a human population explosion around the Bay. Is survival or extinction next for these species? It's in the cards. In order for your species not to go extinct, you have to come up with a reasonable solution to one of your limiting factors. Hand each group the description of their limiting factor and allow them time to discuss solutions as a group. Each group should then present their solutions to the rest of the class, and either you or the class should vote – Survival or Extinction. (Choose the fairest voting method for your class).
6. After the solutions are discussed, hold a group discussion about evolution and limiting factors. Some of the following questions could be used:
 - Is evolution happening today?
 - Are the extinctions of large numbers of species occurring presently “natural”?
 - How does a high diversity of species help an ecosystem?
 - Why would we want to save species from extinction?

Adapted from Limiting Factors/Evolution Game by Amy Quillen and Gail Corey, as part of the Woodrow Wilson Leadership Program in Biology

Congratulations! You have evolved to the point where you have lungs! Evolve 2 spaces.	Your species is contributing to biodiversity of the land mammal population. Evolve 2 spaces.
An increase in atmospheric CO2 causes an increase in phytoplankton in the ocean, increasing the fish population (your food supply). Evolve 1 space.	An abundance of food in the ocean has increased the biotic potential of your species. Evolve 1 space.
A meteor has created a nuclear winter. The added insulation provided by your fur has increased your chance for survival. Evolve 2 spaces.	You are a winner in the Darwin gene pool. Evolve 3 spaces.
As a result of tectonic movement desert habitat has become a redwood forest. Other species fail to adapt and you thrive. Evolve 2 spaces.	An increase in the population of krill has brought different species into your area of the ocean. Your ability to compete allows you to evolve to the next level. Evolve 1 space.
Increased CO2 in the atmosphere has melted the polar ice caps, decreasing the ocean's salinity and upsetting the osmotic balance of plankton, your food supply. Regress 2 spaces.	Your forelimbs have broadened, making you a much better swimmer. Evolve 2 spaces.
A volcanic eruption has distributed ash on all land vegetation. Regress 2 spaces.	The loss of your legs over many generations has made you more streamlined. This increases your swimming speed and hence your success as a species. Evolve 2 spaces.
You have the ability to give birth to live young. Since you need not worry about egg snatchers, Evolve 1 space.	Volcanoes are erupting all over earth's surface, but you are relatively unaffected due to the buffering effect of your ocean. Evolve 2 spaces.
A decrease in temperatures has caused freezing of the polar ice caps. Land mass has increased. Evolve 3 spaces.	Your food supply is successful and provides you with a stable food supply for a long period of time. Evolve 3 spaces.
The Ice Age ends and the San Francisco Bay is formed as water levels rise. This provides you with habitat. Evolve two spaces.	Your ability to filter feed on krill using your baleen allows you to eat lower on the food chain (a helpful adaptation). Evolve 3 spaces.
An increase in Carbon dioxide has contributed to an increase in land vegetation. Evolve 1 space.	Your water environment filters out much of the solar radiation before it gets to you. Evolve 3 spaces.
The salinity in your ocean increased due to a long period of increased temperature. These stresses reduce reproductive capacity. Regress 1 space.	Sedimentation from rivers flow into the San Francisco Bay, increasing your wetland habitat. Evolve 2 spaces.
	A small population becomes geographically separated from the species, due to a newly formed mountain range. Evolve 2 spaces.

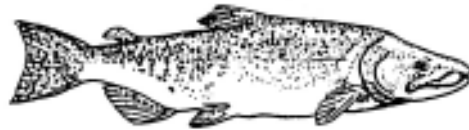
Humans

Emissions from cars are causing greenhouse gasses to build up. Global warming may threaten your ability to grow food.



Winter Run Chinook Salmon

Limiting Factor: Dams have been built on nearly every California river, and you are unable to return to your breeding grounds in order to reproduce.



California Clapper Rail

Limiting Factor: Red foxes have been accidentally introduced by humans to California and are eating you and your young. Only 700 California clapper rails remain and the future is grim.



Brown Pelican

Limiting Factor: DDT, a pesticide, weakens your egg shells, causing them to crack. You are unable to successfully reproduce.



Harbor Seals:

Limiting Factor: Pollution from streets, yards, farms, and industries flows into the Bay each day. Polluted plankton are eaten by fish and you eat the fish. Ultimately, pollution builds up in you, and you are unable to reproduce.



Salt Marsh Harvest Mouse

Limiting Factor: Your salt marsh habitat is disappearing. Only 10% is left and it's threatened by development.



Evolution Board

