A KBS K-12 Partnership Activity

Effects of fishing on fish populations

Who wants to fish for bass that won't take the bait?

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OVERVIEW

Students explore the effects of fishing on fish populations. Students simulate fishing pressure, gather data from the simulation, analyze it by making figures, and draw conclusions about how fishing could cause quick evolutionary change in only a few generations of the population being fished.

OBJECTIVES

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

- List the three requirements for evolution by natural selection
    1. Phenotypic variation in a trait exists within a population
    2. The phenotypes must be heritable
    3. Some phenotypes have higher fitness than others
- Determine whether evolution happened in a given situation
- Explain potential ecological and evolutionary effects of not using natural resources in a sustainable manner

LENGTH OF LESSON

Two hour-long class periods (one to collect data and run initial simulation, one to plot data, discuss, and run other versions of the simulation)

-Could be done in one class period if simulate behavioral data instead of collecting it and only run basic fishing simulation

GRADE LEVELS

8-12

STANDARDS COVERED

B3.5: Populations. Populations of living things increase and decrease in size as they interact with other populations and with the environment. The rate of change is dependent upon relative birth and death rates.
B3.5A: Graph changes in population growth, given a data table
B3.5B: Explain the influences that affect population growth.
L5.p1A: Define a species and give examples
B3.4C: Examine the negative impact of human activities.
L5.p1D Explain the importance of the fossil record.
B5.1 Theory of Evolution. The theory of evolution provides a scientific explanation for the history of life on Earth as depicted in the fossil record and in the similarities evident within the diversity of existing organisms.
B5.1: A Summarize the major concepts of natural selection (differential survival and reproduction of chance inherited variants, depending on environmental conditions).
B5.1B: Describe how natural selection provides a mechanism for evolution
B5.3: Natural Selection. Evolution is the consequence of natural selection, the interactions of (1) the potential for a population to increase its numbers, (2)

the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection from environmental pressure of those organisms better able to survive and leave offspring.
B5.3A: Explain how natural selection acts on individuals, but it is populations that evolve. Relate genetic mutations and genetic variety produced by sexual reproduction to diversity within a given population.
B5.3B: Describe the role of geographic isolation in speciation.
B5.3C: Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.

Standards Linked:
L3.p3: Factors influencing Ecosystems**.** The number of organisms and populations an ecosystem can support depends on the biotic resources available and abiotic factors, such as quantity of light and water, ranges of temperatures, and soil composition.
L3.**p3A:** Identify the factors in an ecosystems that influence fluctuations in population size.
L3.**p3B:** Distinguish between the living (biotic) and nonliving (abiotic) components of an ecosystem.

Prerequisite Standards:
L4.p2: Heredity and Environment. The characteristics of organisms are influenced by heredity and environment. For some characteristics, inheritance is more important. For other characteristics, interactions with the environment are more important.
L4.p2A: Explain that the traits of an individual are influenced by both the environment and the genetics of the individual. Acquired traits are not inherited; only genetic traits are inherited.
L5.p1: Survival and Extinction. Individual organisms with certain traits in particular environments are more likely than other to survive and have offspring. When an environment changes, the advantage or disadvantage of characteristics can change. Extinction of a species occurs when the environment changes and the characteristics of a species are insufficient to allow survival. Fossils indicate that many organisms that lived long ago are extinct. Extinction of species is common; most of the species that have lived on the Earth no longer exits.
L5.p1B: Define a population and identify local populations
L5.p1C: Explain how extinction removes genes from the gene pool
L5.p1B: Define a population and identify local populations.
L5.p1C: Explain how extinction removes genes from the gene pool.
L5.p2A: Explain, with examples, that ecology studies the varieties and interactions of living things across space while evolution studies the varieties and interaction of living things across time.

MATERIALS

Small magnets
Fish cut outs
Small pieces of wire
Paper clips
Fishing pole (stick to attach string and magnet to)
5 Gallon buckets
Tape
PowerPoint
Graph paper
5-10 Aquaria (not required)
30 fish to observe (not required)
Stopwatches (not required)

BACKGROUND

Phenotype: Observable traits that result from a combination of genes and environment (G x E)
Genotype: Genetic makeup of an organism
Inherited: The trait or phenotype is passed on from parent to offspring
Fitness: Survival and reproduction
Evolution: The change in a population's genotype (gene frequency) over time
Natural selection: Something in an organism's habitat (either biotic or abiotic) causes some phenotypes to have higher fitness than others
Population: A group of the same species that live in the same area.

Over the last several decades, society has begun to realize that our actions can have drastic, long-term effects on natural communities. One such impact that has received a great deal of attention recently is the effects of fishing on the populations being fished. In addition to the fact that recreational fishing can decrease the overall abundance of a population through over harvesting, scientists have become aware that it also has the potential to cause evolutionary changes in the fished population if certain types of individuals in the population are selected against (which can occur even if we our not intentionally targeting those types).

The primary goal of this lab is to investigate how fishing can act as an agent of selection and the adaptive effects that might take place in a population.

Within populations of largemouth bass, some individual bass are consistently more aggressive than others, so there is phenotypic variation in the trait. This trait (aggression) is likely heritable, meaning that more aggressive bass have more aggressive offspring and less aggressive bass have less aggressive offspring. Fishing acts as a selective pressure on this trait, creating a relationship between a bass's ability to survive (and future reproductive success) by selectively targeting the aggressive individuals. Thus, the three requirements for evolution (heritable trait, phenotypic variation in the trait, relationship between trait and fitness) are met, which means fish populations can evolve in response to fishing pressure.

Evolution is a change in the mean (average) trait value in a population over time. Evolution does not happen to an individual; it happens to a population. It cannot happen in less than a single generation, because traits must be passed on to the offspring. Evolution can happen rapidly; "rapid evolution" happens in tens or hundreds of years (relative to the life span of the organism), instead of thousands of years or longer. In this exercise, you may see evolution (change in the frequency of boldness in a population) in 1-3 generations.

ACTIVITIES OF THE SESSION

1. Present the introduction in the PowerPoint and explain the situation as described above and briefly in the PowerPoint.
2. Divide the students into groups of three students.
3. Pass out the student worksheet **(included)** and have students volunteer to present definitions of the terms. This should allow you to find out their misconceptions.
4. Part I- Data collection: Students observe aggression levels in bass (explained in more detail on activity handout). This data can be simulated if access to needed materials is not possible. A video will also be made available to show examples of aggressive and non-aggressive fish.
5. Part II- Fishing Simulation: Divide into groups of 3. Each group will be given materials to create a bass population of aggressive (paper clip on back) and docile (small piece of wire on back) bass that they can fish. (Details of fishing simulation are on activity handout).
6. Compile all the groups' data, filling out the tables in the student worksheet.
7. Ask the students to make graphs of the data using graph paper for each of the scenarios.
8. Discuss your results and answer questions in student worksheet. Depending on your class, you might decide to have students answer some questions in groups and others with the class as a whole.
11. Collect the student worksheets and use them to assess student learning.

Variations to the simulation that can also be run:

- Differences in vulnerability to angling between aggressive and docile fish (changing these will impact the strength of selection)
- Change initial population distribution that students start with
- Change the percent of depletion from 50% to something else (allows for incorporation of over-harvesting/exploitation issues and sustainability)
- Change reproductive success so not equal (speed of evolution)
    - Not always one fish produced by every survivor
    - Aggressive fish may not always produce aggressive fish
- Could run simulation for more/ less than three generations

RESOURCES

A student worksheet is included with this lesson.