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# K-12 Partnership Lesson Plan

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# *Why is there variation in personality type?*

# *Does fishing impact the variation?*

## Overview

Students simulate bass populations with and without fishing pressure, gather data from the simulation, analyze it by making graphs, and draw conclusions about what maintains variation in personality type and how fishing could cause evolutionary change in personality in populations that are 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 and how it happened.
* Explain potential ecological and evolutionary effects of not using natural resources in a sustainable manner

**Length of Lesson**

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

**Grade Levels**

8-12

**Standards covered**

Disciplinary Core Ideas:

*Middle School*

* **MS-LS1-4**: use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively
* **MS-LS1-5**: construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms
* **MS-LS4-5**: gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms
* **MS-LS4-4**: construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals probability of surviving and reproducing in a specific environment
* **MS-LS4-6**: use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time

*High School*

* **HS-LS4-2:** construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment
* **HS-LS4-4**: construct an explanation based on evidence for how natural selection leads to adaptation of populations

Cross Cutting Concepts:

* Patterns
* Cause and effect
* Structure and function
* Stability and change of systems

Science and Engineering Practices

* Planning and carrying out investigations
* Analyzing and interpreting data
* Engaging in argument from evidence

***Previous Michigan Standards Met:***

* **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
* **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.
* **B5.1A**: 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.
* **B5.3C**: Give examples of ways in which genetic variation and environmental factors are causes of evolution and the diversity of organisms.

**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 and worksheet (located on “Why is there variation in fish personality type” lesson page on the KBS GK-12 website)

**Background**

*Evolution*: The change in a population’s genotype (gene frequency) over time

*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

*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.

Human actions can have drastic evolutionary effects on populations of organisms. Sometimes we intend to have such impacts, as in the case of many artificial selection programs. However, we also often unintentionally select for traits of a species when we interact with natural populations (either directly or indirectly). 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 are not intentionally targeting those types).

The primary goal of this lab is to investigate how phenotypic variation in a trait (personality type) can be maintained and how fishing can act as an agent of selection to cause evolutionary change in a population.

Within populations of largemouth bass, some individual bass are consistently bolder than others, so there is phenotypic variation in personality. This trait (boldness) is heritable, meaning that bolder bass have bolder offspring and less bold bass have less bold offspring. Fishing acts as a selective pressure on this trait by selectively targeting the bolder 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 1-5 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. 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.
3. Simulation:Divide into groups of 3. Each group will be given materials to create a bass population of bold (paper clip on back) and shy (small piece of wire on back) bass that they can fish. (Details of simulation are on activity handout).
4. Compile all the groups’ data, filling out the tables in the student worksheet.
5. Ask the students to make graphs of the data using graph paper.
6. Answer the questions on the worksheet. Depending on your class, you might decide to have students answer some questions in groups and others as a class.
7. Collect the student worksheets and use them to assess student learning.

**Resources**

* A student worksheet and powerpoint can be found on the “Why is there variation in fish personality type” lesson page on the KBS GK-12 website

**Extensions and Modifications**

* Differences in vulnerability to angling between bold and shy fish (changing these will impact the strength of selection)
* Change initial population distribution that students start with
* Change the juvenile mortality parameter for bold and shy fish.
* Change reproductive success parameter for bold and shy fish
* Change number of fish caught each generation
* Bold fish may not always produce bold fish
* Could run simulation for more/ less than five generations

**Assessment**

Wrap up questions included on the student worksheet.