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# K-12 Partnership Lesson Plan

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# *To Fish or Not to Fish*

# *Sustainability of Seafood Consumption*

## Overview

Students explore sustainability of seafood consumption through modeling harvest rates in an Excel file and debating the relative costs and benefits of farmed vs. wild-caught fish. Provided with information on the various direct and indirect human impacts of both fishing and fish farming and assigned a position, teams of students will construct argument for their position and use data to support their conclusions.

**Objectives**

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

* Understand that there are costs and benefits of human impacts and to provide examples of each
* Understand and be able to describe the magnitude of human disturbances
* Define environmental sustainability and make an argument from whether it should be an important consideration in our behavior

**Length of Lesson**

1-2 60 minute periods, depending on the amount of student worktime and time spent preparing out of the classroom.

**Grade Levels**

High school

**Standards covered**

Disciplinary Core Ideas:

* **HS-LS2-4**: use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem
* **HS-LS2-1**: use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales
* **HS**-**LS2-6**: evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem
* **HS**-**LS2-7**: design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity

Cross Cutting Concepts:

* Cause and effect
* Scale, proportion, and quantity
* Energy and matter in systems

Science and Engineering Practices

* Analyzing and interpreting data
* Using mathematics and computational thinking
* Engaging in argument from evidence
* Obtaining, evaluating, and communicating information

***Previous Michigan Standards Met:***

* **B1.1E**: Describe a reason for a given conclusion using evidence from an investigation.
* **B1.2A:** Critique whether or not specific questions can be answered through scientific investigations.
* **B1.2B**: Identify and critique arguments about personal or societal issues based on scientific evidence.
* **B1.2C**: Develop an understanding of a scientific concept by accessing information from multiple sources. Evaluate the scientific accuracy and significance of the information
* **B1.2D**: Evaluate scientific explanations in peer review process or discussion format
* **B1.2f**: Critique solutions to problems, given criteria and scientific constraints.
* **B1.2k**: Analyze how science and society interact from a historical, political, economic, or social perspective.
* **L3.p2A**: Describe common relationships among organisms and provide examples of producer/consumer, predator/prey, or parasite/host relationship.
* **L3.p3D**: Predict how changes in one population might affect other populations based upon their relationships in a food web.
* **L3.p4A**: Recognize that, and describe how, human beings are part of Earth’s ecosystems. Note that human activities can deliberately or inadvertently alter the equilibrium in ecosystems.
* **B3.2C**: Draw the flow of energy through an ecosystem. Predict changes in the food web when one or more organisms are removed.
* **B3.3A**: Use a food web to identify and distinguish producers, consumers, and decomposers and explain the transfer of energy through trophic levels.
* **B3.4C**: Examine the negative impact of human activities.
* **B3.5B**: Explain the influences that affect population growth.

**Materials**

* Excel spreadsheet of population size and harvest rate
* Student worksheet (1 per student)
* Debate Ammunition powerpoint (printed and copied, 1 per group)
* Debaters Positions powerpoint (printed as handout, 6 slides per page and cut into cards, 1 per class)
* Student evaluation (optional) (all materials available on “To Fish or Not to Fish” lesson page on the KBS GK-12 website)

**Background**

Fish is a yummy and nutritious food, but obtaining fish has lots of impacts on the environment. We will explore the many human impacts of the fishing industry and its alternative, industrial fish farming. Both activities have direct and indirect effects on fish populations and aquatic ecosystems. Direct effects are sometimes the most obvious (for example, harvesting a fish can reduce its population). However, indirect effects can be just as important and hard to predict (for example, harvesting a top predator can increase the size of herbivorous prey populations and therefore decrease the populations of whatever the prey eats). Distinguishing between direct and indirect human impacts is not important, but it is essential to realize that both happen and that it can be very difficult to predict or prevent human impacts on the environment.

Trophic cascades are one example of indirect effects. These exist when doing something to one population affects other organisms in the food web through increasing or decreasing populations of predators or prey. An example of a tropic cascade involving sea otters, killer whales, pollock, and kelp forests is explained in the introductory powerpoint.

The debate between fish farming and wild-caught fish is complicated because the human impacts of each depend on the fish species. The trophic level (predator, herbivore, etc) of a fish often can tell a lot about the human impacts of farming or catching that fish. The trophic level can be summarized in a number: 1=primary producer (plant), 2=primary consumer (herbivore), 3=secondary consumer (eats herbivores), 4=eats predators (tertiary consumer), and so on. A species could have a trophic level of 2.5 by eating some plants and some animals. Generally, it is more efficient to eat lower on the food pyramid because of conversion efficiencies (explained in powerpoints). Some fish or shellfish are filter feeders so they may actually have a beneficial effect on water quality. A fish species’ tolerance of nutrient rich or polluted water, dense populations, and other factors can also affect how hard it is to farm the species.

Science can measure the human impacts of fishing and fish farming, such as effects on water quality, reducing population sizes, changing food webs, habitat loss, the spread of disease in farmed and wild populations, and others, but can science tell us how to balance these considerations to make decisions about how we should produce our food? This may be a largely personal decision, but students should be able to point to data to support the position they are assigned in this debate.

### Activities of the session

1. Ask the class for preconceptions about what “sustainability” is. Lead this into a discussion of human impacts in general (what are they, are they always bad, etc).
2. Present introductory powerpoint (Human impact in aquatic systems.ppt)
3. Play with Excel model of fish population sizes by altering the harvest rate (values between 0 and 1 make sense) and observing what happens to the population size, whether population is stable, and the total number of fish caught over 10 years. Have students suggest values of harvest rate and then record population sizes on their student worksheets. You may be able to find two harvest rates that produce stable populations, one at a large and one at a smaller population size. (Stable populations are those that do not go extinct and appear to have about the same number of fish each year, after some time to adjust to a new harvest rate*.)* What might be a benefit of having a high harvest rate and a low standing population (i.e. more food and jobs for people)? What could be a benefit of having a low harvest rate and a high standing population (i.e. a more intact ecosystem, and more food for predators)? Talk about how sustainability can mean different things depending on the goal we are trying to achieve.
4. Split the class into groups of 4-5 and assign each group positions (using the Debate Positions powerpoint). Hand each group a printed copy of the Debate Ammunition powerpoint.
5. Give the groups work time to read and assimilate the Debate Ammunition information, decide on their answer to the question (What should we eat?), and prepare evidence to support their answer. This may be slightly overwhelming to students because there is a lot of information and each species is a little different, but teachers can ask students to make generalizations based on what they know about ecology and food webs (e.g., trophic level or growth rates), or to discuss specific example species (e.g., tilapia or salmon).
6. Each group gives a brief (2-3 min) presentation where they first read their assigned position to the class and then summarize their argument, referring to specific data or figures in the Debate Ammunition ppt. Each group’s presentation is followed by questions and debate from other students or the teacher.
7. After all groups have presented, the teacher should attempt to summarize the important points learned from the debate. The teacher can also point out web resources for making sustainable eating decisions, listed at the bottom of the student worksheet.

**Resources**

* All materials available on the “To Fish or Not to Fish” lesson page on the KBS GK-12 website

**Assessment**

A student evaluation is provided for students to reflect on what they learned during the debate.