Title: Walleye Pollock in the Gulf of Alaska

Subject: International Baccalaureate Biology

Grade Level: Public High School, grade 12

Average Learning Time: Two 90 minute class periods

Lesson Summary: Students will examine real-world fish data that is used in the calculation of biomass of Walleye Pollock in the Gulf of Alaska.

Overall Concept: Students will investigate and understand the procedures that Real World Scientists perform to estimate the biomass of the Walleye Pollock, and why this is important.

Specific Concepts: 1) Procedures involved in estimating biomass, including a) charting the course, b) finding the fish – acoustics, c) trawling, d) collecting and examining data. 2) Creativity and technology used in designing a fish measuring board. 3) Calculate several means from a large data set. 4) Correlation of otolith length with fish mass and length. 5) Prediction of the effect of the removal of the Walleye Pollock on the food web of the North Pacific Ocean.

Focus Questions: 1) What are the steps that scientists perform to estimate the biomass of a fish population? 2) How is a fish measuring board designed? 3) How can a mean be calculated from real world fish data? 4) What information can temperature-depth profiles provide? 5) Can otolith length be used to estimate biomass? 6) How does the Walleye Pollock affect the North Pacific Ocean food web?

Objectives/Learning Goals: 1) Students will list and describe the 4 steps required to estimate the biomass of Walleye Pollock after viewing a powerpoint. 2) Students will describe two points each for creativity and technology required to design a measuring board when given a rubber fish model to handle. 3) Students will calculate fish mass and length means from the given data set and deduce if there are relationships between depth, gender, mass, and length. 4) Students will draw 3 conclusions from depth-temperature profiles about how temperature is related to depth. 5) Students will correlate otolith length with fish length, and biomass. 6) Students will design and illustrate a food web of the North Pacific Ocean with 15 organisms, including scientific names and common names with access to a laptop computer.

Background Information: Students should understand the basic principles of the niche concept (what role an organism plays in its environment), food webs and trophic levels, and international fishing, including the consequences of overfishing.

Common Misconceptions/Preconceptions: 1) Fish are found everywhere in the ocean, 2) Fish are unlimited and cannot be overfished, 3) Man cannot possibly influence something as large as the ocean.

Materials:

1) rubber fish
2) photograph of fish measuring board
3) Pollock Survey data from the Oscar Dyson
4) haul profile graphics
5) otolith kit with 7 pairs of otoliths and fish data

Technical Requirements: Excel and Internet on classroom laptops, calculator

Teacher Preparation:
Gather laptops, calculators, fish data, otoliths (collected on board the Oscar Dyson, paper substitutes could be used), and rulers

Key Words: biomass, otolith, quota, acoustics, trawling, haul profile, food web

Pre-Assessment Strategy/Anticipatory Set: Review principles of fishing and overfishing with students, including fish stock, bycatch, and the need for quotas, based on biomass.
Students will begin lab report which will include: 1) need for quotas, 2) steps of estimating biomass, 3) design to measure fish length and mass, 4) features of a fish measuring board, 5) procedure and results of examining fish data, 6) conclusions about haul profile graphics, 7) otolith measurements and calculations, 8) food web for Pollock in the Gulf of Alaska; to be completed by the end of the second class period.

Lesson Procedure:

1. Discuss the steps in estimating the biomass of Walleye Pollock in Gulf of Alaska, including: a) charting the course, b) finding the fish – acoustics, c) trawling, d) collecting and examining data.
2. Working in small groups, students will design a way to measure length and mass of fish, using a large rubber fish as an example, considering working aboard a moving ship, and thousands of fish to measure.
3. Each group will report on their design.
4. Show students a picture of a fish measuring board. Discuss how imagination, creativity, and technology are needed to design such a board. Ask students if they have any suggestions for improvements.
5. Students will examine length, mass, sex, and depth data for 4 different hauls that were processed during Leg II of the Walleye Pollock Survey, Oscar Dyson, July, 2011. Students will determine if depth or sex has an influence on length, and mass, by calculating a mean for each group, using an Excel spreadsheet on a classroom laptop.

6. Students will interpret and draw conclusions from haul profile graphics that contain depth and temperature information.
7. Students will measure the length of each otolith in the otolith kit (contains 7 pairs of otoliths). Length and Mass data for each fish that the otoliths came from will be examined. Students will calculate what percent of total fish length that the otolith is, and determine if this percent is reliable for every fish in the kit. Students will answer the question: Can otolith length be used to estimate biomass of the fish?
8. Students will research, write, label and illustrate a food web (including trophic levels) containing at least 15 organisms for the Walleye Pollock in the Gulf of Alaska. Students will write conclusions about a hypothetical situation where the Pollock are removed from the food web due to overfishing.

Assessment and Evaluation: Teacher will monitor student progress, assisting when necessary. Lab Report will be graded for participation, and accuracy. Students will lose points for not answering any of the questions. Reasoning and thinking are more important for this lab activity, and most of the questions do not have a right or wrong answer.

Standards:
National Science Education Standards:

Life Science Content Standard C

INTERDEPENDENCE OF ORGANISMS

- Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.
- Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite. This fundamental tension has profound effects on the interactions between organisms.
- Human beings live within the world's ecosystems. Increasingly, humans modify ecosystems as a result of population growth, technology, and consumption. Human destruction of habitats through direct harvesting, pollution, atmospheric changes, and other factors is threatening current global stability, and if not addressed, ecosystems will be irreversibly affected.

MATTER, ENERGY, AND ORGANIZATION IN LIVING SYSTEMS

The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.

Science and Technology

Content Standard E

UNDERSTANDINGS ABOUT SCIENCE AND TECHNOLOGY

Creativity, imagination, and a good knowledge base are all required in the work of science and engineering.

Science in Personal and Social Perspectives Content Standard F

NATURAL RESOURCES

- Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.

The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed.

ENVIRONMENTAL QUALITY

- Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.
- Materials from human societies affect both physical and chemical cycles of the earth.

Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth.

Ocean Literacy Principles:

5 The ocean supports a great diversity of life and ecosystems.

d Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.

f Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

6 The ocean and humans are inextricably interconnected.

b From the ocean we get foods, medicines, and mineral and energy resources. In addition, it provides jobs, supports our nation's economy, serves as a highway for transportation of goods and people, and plays a role in national security.

e Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

g Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

State Science Standards: N/A

Other National or State Standards: International Baccalaureate Organization, IB Biology for the Diploma Program
Topic 1: Statistical Analysis. Calculate the mean and standard deviation of a set of values.

Topic 5: Ecology and evolution. Define species, habitat, population, community, ecosystem and ecology. Describe what is meant by a food web. Deduce the trophic level of organisms in a food chain and a food web. Construct a food web containing up to 10 organisms, using appropriate information.

Option G: Ecology and conservation. Explain the factors that affect the distribution of animal species, including temperature, water, breeding sites, food supply and territory. Explain what is meant by the niche concept, including an organism's spatial habitat, its feeding activities and its interactions with other species. Define biomass. Describe one method for the measurement of biomass of different trophic levels in an ecosystem. Discuss the role of active management techniques in conservation. Use a local example wherever possible to illustrate this. Describe the methods used to estimate the size of commercial fish stocks. Outline the concept of maximum sustainable yield in the conservation of fish stocks. Discuss international measures that would promote the conservation of fish.

Additional Resources:
Otolith Research Laboratory
http://www.marinebiodiversity.ca/otolith/english/home.htm

Midwater Assessment Conservation and Engineering (MACE) (conduct Pollock Survey in the North Pacific)
http://www.afsc.noaa.gov/RACE/midwater/default_mw.php

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