NOAA Teacher at Sea Program
Lesson Plan #2

Unit Plan: Sustainable Harvesting of Chinook Salmon; A Fisheries Management Decision
Activity Title: Bering Sea Food Web
Subject (Focus/Topic): Life science: marine ecology /fisheries
Grade Level: 9th – 12th Grade
Average Learning Time: 90 minutes
Lesson Summary (Overview/Purpose): Students will work in teams to create a poster of a Food Web that incorporate a given set of Arctic animals. Posters will be displayed around the room to allow students to participate in a Gallery Walk to discover similarities and differences between food webs.

Overall Concept (Big Idea/Essential Question): This activity is designed to acquaint students with some of the less familiar aquatic animals in the Bering Sea and Alaskan ecosystems. More importantly, this activity will help students describe the complicated ecological connections between the Chinook salmon and other marine and terrestrial life.

Specific Concepts (Key Concepts)
- The Bering Sea is a unique ecological environment that supports a very large food web.
- Chinook Salmon have unique life histories that are inextricably linked to humans.
- Fishery management must take into consideration various aspects of ecological relationships between marine and terrestrial life.

Focus Questions
7) What is an ecosystem and how can we study one?
8) How do the biotic components of an ecosystem impact each other?
9) How can/do abiotic components impact the biology of a marine ecosystem?
10) In what ways is the Chinook salmon connected to marine and terrestrial life?

Objectives/Learning Goals
- Students will be able to use predator/prey information to create a food web that describes the energy transfer between trophic levels of marine and aquatic life in the Bering Sea and Alaskan ecosystems.
- Students will be able to describe ways in which the biotic components of these ecosystems rely on each other.
- Students will be able to explain what different ecological roles the Chinook salmon plays depending on which part of its' life history it is in.
- Students will be able to use their food web to describe why the Chinook salmon is considered a keystone species.
- Students will be able to describe how abiotic factors can impact the biological relationships in an arctic marine ecosystem

Background Information
The Bering Sea is an extremely biologically productive region that is home to many variety of marine life. This marine life is inextricably linked to terrestrial life in the

region. A food web is essentially a diagram that describes the interconnecting feeding patterns between species that are a part of complex interrelationships. A food web represents the pathway followed by nutrients and food energy as they move through trophic levels. The overall efficiency of energy transfer up each trophic layer of an open-ocean system is about ten percent. That means in order to add 1kg of weight; a person would need to each 10kg of salmon. The 90% loss of energy between trophic levels is due to the metabolic requirements of the consumer. The initial source of energy of the food web is the sun, which fuels primary production in the surface layers of the ocean. The primary production relies on a source of nutrients either from upwelling, melting sea ice or terrestrial inputs.

The relative abundance of organism decreases as you go up the trophic levels of a food web; however, the average size of organisms increases. Humans harvest from both high trophic levels (salmon and pacific cod) as well as lower levels (herring and shellfish). Overharvesting any level endangers levels both above and below it by removing food resources from high levels and preventing recycling of nutrients from higher to lower trophic levels. Care is required to conserve the stock for future harvest and for the requirements of other organisms.

Web Resources
Arctic Marine Life
http://www.windows2universe.org/earth/polar/arctic_marine_life.html
Arctic Ocean Diversity
http://www.arcodiv.org/index.html
About Arctic Animals
http://www.arctic.noaa.gov/animals.html
Marine Food Web Game
http://www.coolclassroom.org/cool_windows/home.html

Common Misconceptions/Preconceptions
- All the energy and nutrients of the lower trophic levels are transferred to high trophic levels.
- Species are only interconnected by simple predator and prey relationships.
- Human impact on terrestrial land will not influence ocean ecosystems

Materials
Handout with Five Expert Topics titled in boxes for Pre-Assessment
Poster paper if student groups will be coordinating information on a poster.
Team Building Exercise requires scraps of recycled paper and an empty envelope for each team.

Technical Requirements
- Access to the Internet for student research on Arctic organisms

Teacher Preparation
This lesson has students working in their ***Fisheries Management Teams*** to create a Food Web that explores and graphically shows how Arctic species are interconnected. Each

team member of the ***Fisheries Management Teams*** must choose one of three roles for this assignment. Each role must be filled by at least one team member.

1) Researcher – gathers data/information to help teammates build food web.
2) Artist – lays out and draws the food web designed by the group.
3) Reporter – reports findings of team to members of other teams.

Each team needs poster paper, colored markers, a printed set of Food Web cards.

Keywords: food web, food chain, trophic level, primary producers, herbivorous consumers, carnivorous consumers, decomposers

Pre-assessment Strategy/Anticipatory Set (Optional)
Students must be familiar with how to construct a food web and also how it differs from a food chain. Allow students the opportunity to use the Marine Food Web Game http://www.coolclassroom.org/cool_windows/home.html either as a class demonstration or individually to become familiar with marine food webs.

Giving teams a chance to come up with a unique and applicable team name will allow students to participate in a simple team-building exercise. Each student must each come up with two names that they write on individual scraps of paper, fold up and place in the center of the team table. Team members one by one open papers and categorize each name into a category "Keep" or "Discard". They must have at least three names in the "Keep" pile. The pile remains on the table while students teams visit the other desks and write on a paper which name they would collectively choose for the team from that team's "Keep" pile and place it in an envelope on the desk. When the team returns, to their team table, they open the envelope and the name with the most selections from the other teams is their official team name. In case of a tie, the team may choose between the two.

Lesson Procedure
Student research
1. Hand out a set of Food Web Cards Allow individual students in the ***Fisheries Management Teams*** to choose the topic for which they wish to become an expert.
2. Student teams should cut out Food Web Cards to help them organize their poster. All students should begin investigating how each of these animals is ecologically linked. Provide students a time limit that is provided for each team to complete this task.
3. Post "*Poster Requirements*" for all teams to refer to during activity:

Student teams will create a Food Web that correctly demonstrates the ecological connections between species in the Alaskan terrestrial and Bering Sea Ecosystems. The web must include all species provided on the Food Web Cards and three additional species from at least two different trophic levels. Your poster must follow the following guidelines:

- **Must have appropriate title**
- **Must contain more pictures than words**
- **Must use at least five colors**
- **All writing must be legible 30 feet away from poster.**

- **Trophic levels must be easily distinguished.**
- **Poster must include three additional species that are not on Food Web cards. (from at least 2 separate trophic levels)**
- **Team name must be placed on the poster to attribute work.**

4. When students have completed their posters, hang them is different parts of the room for a Gallery Walk.
5. As a group, the ***Fisheries Management Teams*** walk around the room to observe the work of their peers. A specific time is allotted for viewing each poster. At each site the Team discusses what two things they like and one thing we would add or change about the poster. The reporter of the group records these comments to later give to the team that created the poster.
6. Student teams return to their team poster and reporters hand out comments.
7. Three questions are now asked of the team regarding changes or stresses on their food web. Teams are given a chance to discuss their answer, but answers to the questions will be individually written and submitted for evaluation. A suggestion is to not inform students that a written response is required until they have had a chance to discuss the questions.

- How does your food web help demonstrate that the Chinook salmon is a keystone species?
- Besides over-harvesting the marine ecosystem, how can humans impact your food web? What are the consequences of that impact?
- Explain how it is possible to learn information about a species in your food web with directly studying it.

Assessment and Evaluation
For the purpose of this lesson, evaluate students based on both their individual work as well as their ability to work as part of an team. The content of the food web should include clear distinctions between trophic levels and clearly labeled connections between species with arrow pointing from lower trophic levels to higher ones.

A more formal assessment is employed to ensure that each student understands the extent of the connections of the food web and ramifications of placing stresses on the ecological system.

Standards

National Science Education Standard(s) Addressed:
• NSES A: Unifying Concepts and Processes
Sub-categories 1, 2, 3 and 4
• NSES B: Science as Inquiry
Sub-category 2
• NSES D: Physical Science
Sub-category 6
• NSES D: Life Science
Sub-categories 4, 5 and 6
• NSES E: Earth and Space Science

Sub-categories 1 and 2
- NSES G: Personal and Social Perspectives
Sub-categories 2, 3, 4, 5 and 6
- NSES H: History and Nature of Science
Sub-categories 1 and 2

Ocean Literacy Principles Addressed:
- Principle 1: The Earth has one big ocean with many features.
Fundamental Concepts: g and h
- Principle 3: The ocean is a major influence on weather and climate.
Fundamental Concept: e
- Principle 5: The ocean supports a great diversity of life and ecosystems.
Fundamental Concepts: a, b, c, d, e, and f
- Principle 6: The ocean and humans are inextricably interconnected
Fundamental Concepts: e and g
- Principle 7: The ocean is largely unexplored.
Fundamental Concept: b, c, d, e, and f

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Brown bear (*Ursus arctos*)	Capelin *(Mallotus villosus)*
Chinook Salmon (*Oncorhynchus tshawytscha*)	Chum salmon (*Oncorhynchus keta*)
Copepods	Decomposers
Diatoms	Euphasiids
Herring *(Clupea harengus)*	Juvenile walleye pollock *(Theragra chalcogramma)*
Orca Whale (*Orcinus Orca*)	Pacific cod (Gadus macrocephalus)
Phytoplankton	Sand lance *(Ammodytes hexapterus)*
Stellar Sea Lion (*Eumetopias jubatus*)	ADDITIONAL SPECIES #1
ADDITIONAL SPECIES #2	ADDITIONAL SPECIES #3