# LESSON 13: SALMON NUTRIENT CYCLING


## ESSENTIAL QUESTION:

What combination of factors both natural and manmade is necessary for healthy river restoration and how does this enhance the sustainability of natural and human communities?

## GUIDING QUESTION:

Salmon nutrients find their way into terrestrial environments, how is it possible that trees show evidence of having derived nutrition from Salmon?

## OVERVIEW:

This lesson focuses on how marine-derived nutrients from salmon carcasses find their way into terrestrial environments and how scientists can track these marine-derived nutrients to analyze their importance to ecosystems today, as well as, reconstructing past ecosystem processes. Terrestrial vertebrates such as mammals and birds, as well as, insects consume salmon carcasses and then release those nutrients onto land, either by dragging the carcasses or defecating onto the forest. These nutrients then enter the soil, where they are taken up by plant roots. Once entering plant tissue, they are consumed by herbivores. Salmon nutrients have been found in every living organism investigated and up to seven miles from the stream of origin. Scientists use stable isotope $N^{15}$ to track marine-derived nutrients, because this isotope is more common in marine environments than freshwater ones. Analyzing sediment layers of lakes for this isotope, scientists can reconstruct ancient salmon abundance and can make inferences to historic climate and ecological processes.

## TIME:

One class period

## MATERIALS:

- **Lesson 13- Salmon Nutrient Cycling.pptx**
- **Lesson 13a- Salmon Nutrient Cycling.pdf**
- **Food Web Lab.pdf**
- **Food Web Quiz.pdf**
- Reflection Journal Pages (Printable Handout)
- Vocabulary Notes (Printable Handout)

## PROCEDURE:

1. Review Essential Question; introduce Guiding Question.

2. Students should take a few minutes to respond to the first reflection prompts. Discuss their answers and any questions they've generated.
3. Hand out the Vocabulary Notes. *With this lesson you may want to define the words before presenting the PowerPoint Lesson*
4. Present the PowerPoint Lesson
5. Food Web Lab Activity
6. Food Web Quiz
7. Hand out the second Reflection Journal Page. Give students time for a final reflection the lesson.

## ASSESSMENTS:

## WASHINGTON STATE STANDARDS:

### SCIENCE

1. **EALR 4: 6-8 LS2A** An ecosystem consists of all the populations living within a specific area and the nonliving factors they interact with. One geographical area may contain many ecosystems.
    a. Explain that an ecosystem is a defined area that contains populations of organisms and nonliving factors.
    b. Give examples of ecosystems (e.g., Olympic National Forest, Puget Sound, one square foot of lawn) and describe their boundaries and contents.
2. **EALR 4: 6-8 LS2B** Energy flows through an ecosystem from producers (plants) to consumers to decomposers. These relationships can be shown for specific populations in a food web.
    a. Analyze the flow of energy in a local ecosystem, and draw a labeled food web showing the relationships among all of the ecosystem's plant and animal populations.

### READING

1. **EALR 1:** The student understands and uses different skills and strategies to read.
    a. **Component 1.2** Use vocabulary (word meaning) strategies to comprehend text.

### SOCIAL STUDIES

1. **EALR 5:** The student understands and applies reasoning skills to conduct research, deliberate, form, and evaluate positions through the processes of reading, writing, and communicating.
    a. **Component 5.2:** Uses inquiry-based research.

### WRITING

1. **EALR 2:** The student writes in a variety of forms for different audiences and purposes.
    a. **Component 2.1:** Adapts writing for a variety of audiences.
    b. **Component 2.2** Writes for different purposes.

## ADDITIONAL RESOURCES AND ENRICHMENT:

http://newstandardnews.net/content/index.cfm/items/2854
http://chamisa.freeshell.org/food.htm
http://www.wildlifenews.alaska.gov/index.cfm?adfg=wildlife_news.view_article&articles_id=97

## FOR STRUGGLING LEARNERS:

http://www.snh.org.uk/Salmonintheclassroom/salmon_foodchains.shtml
http://www.scienceisart.com/B_FoodChain/FoodChain.html

## VOCABULARY TERMS:

- **Stable Isotope:** An isotope which does not spontaneously undergo radioactive decay

- **Carcass:** The dead body of an animal,

- **Marine-derived Nutrients:** Nutrients acquired by an anadromous fish and deposited in a freshwater or terrestrial ecosystem when that fish dies.

- **Nitrogen-15 isotope:** A stable, non-radioactive, rare isotope of Nitrogen containing 8 neutrons instead of 7. It is more common in marine environments that freshwater or terrestrial habitats. Thus, its elevated presence outside of a marine environment is an indication that nutrients are marine-derived

- **Terrestrial:** Of or relating to the earth or its inhabitants

- **Vertebrate;** an animal with a backbone, such as a fish, amphibian, reptile, bird, or mammal

**Elwha River Restoration**
Salmon Nutrient Cycling
**Reflection Journal 1**

How do you think it's possible that trees up to seven miles from salmon streams show evidence of having derived nutrition from Salmon?

What questions do you have about nutrients from salmon?

**Elwha River Restoration**
Salmon Nutrient Cycling
Vocabulary Notes

**Stable Isotope:**

**Carcass:**

**Marine-derived Nutrients (MDN)-**

**Nitrogen-15 Isotope-**

**Terrestrial:**

**Vertebrate:**

**Elwha River Restoration**
Salmon Nutrient Cycling
**Reflection Journal 2**

How important are salmon to marine and terrestrial ecosystems?

What questions do you have about the importance of salmon to marine and terrestrial ecosystems?

## FOOD WEB LAB

In this lab, we will be imitating a small terrestrial riparian food chain in which sunflowers represent the lowest tropic level (the producers), mice represent the primary consumers, mink represent the secondary consumers, and cougars represent tertiary consumers. The raccoon is an omnivore that can feed at multiple trophic levels.

You will draw a slip from a hat to determine which organism you are on the food chain. You will then be assigned a certain quantity of energy points. If you get eaten you will give up points to what ate you. If you eat, you will receive points from that prey item. If you encounter something you can not eat, you will lose points from the energy required to fight with or deal with that organism. At the beginning of each round, sunflowers will acquire 1 energy unit each from photosynthesis.

Once you know which organism you are, **DO NOT** tell anyone. Simply walk around until I say **FEED!** If you are an animal, at that moment, approach someone near you and say **"I am a *BLANK*, can I eat you?"** If they reveal that they are a prey item, take the appropriate number of energy points from them. If they reveal themselves to be one of your predators, you will give them the points because you were eaten. If you are sunflower, don't say anything, just let them approach you.

| **Animals** | **Total Energy Start** | **Total Energy Round 1** | **Total Energy Round 2** | **Total Energy Round 3** | **Total Energy Round 4** |
|---|---|---|---|---|---|
| **Cougar (1)** | 44 - 44 | | | | |
| **Raccoon (1)** | 30 - 30 | | | | |
| **Mink (3)** | 24 - 72 | | | | |
| **Mouse (5)** | 16 - 80 | | | | |
| **Sunflower (10)** | 12 -120 | | | | |
| ***+ Energy gained by photosynthesis*** | | | | | |
| **∑ Energy (16)** | **346** | | | | |
| ***minus Energy lost to heat*** | | | | | |

At the end of the round, write down on the back of your slip what happened and how many energy points you gained or lost. We will run four rounds and then see how the energy units end up. At the end of the lab, you will subtract 8 points (3 points for sunflowers) as heat lost to the environment and we will see how much energy is left over.

|  |  |  |  |  |
|---|---|---|---|---|
| **Cougar** | **Raccoon** | **Mink** | **Mink** | **Mink** |
| <u>*You can not be eaten*</u> | You can be eaten by a Cougar, but not a snake. | You have 24 energy points. | You have 24 energy points. | You have 24 energy points. |
| You start with 44 energy points | You have 30 energy points | You can be eaten by a cougar, but not a raccoon. | You can be eaten by a cougar, but not a raccoon. | You can be eaten by a cougar, but not a raccoon. |
| If you eat a Raccoon you **gain** 10 energy points. | If you are eaten by a Cougar you **lose** 10 energy points. | If you are eaten by a Cougar you **lose** 10 energy points. | If you are eaten by a Cougar you **lose** 10 energy points. | If you are eaten by a Cougar you **lose** 10 energy points. |
| If you eat a mink you **gain** 8 energy points. | If you eat mice you **gain** 4 energy points. | If you eat mice, you **gain** 4 energy points. | If you eat mice, you **gain** 4 energy points. | If you eat mice, you **gain** 4 energy points. |
| If you eat mice, you **gain** 4 energy points. | If you eat a sunflower you **gain** 2 energy points. | If you fight a raccoon you **lose** 5 energy points in the fight. | If you fight a raccoon you **lose** 5 energy points in the fight. | If you fight a raccoon you **lose** 5 energy points in the fight. |
| If you try to eat sunflower, you **lose** 8 energy points. | If you fight a mink, you **lose** 5 energy points. | If you try to eat a sunflower, you **lose** 2 energy points. | If you try to eat a sunflower, you **lose** 2 energy points. | If you try to eat a sunflower, you **lose** 2 energy points. |

|  |  |  |  |  |
|---|---|---|---|---|
| **Mouse** | **Mouse** | **Mouse** | **Mouse** | **Mouse** |
| You have 16 energy points | You have 16 energy points | You have 16 energy points | You have 16 energy points | You have 16 energy points |
| You can be eaten by Cougars, mink, and raccoons. | You can be eaten by Cougars, mink, and raccoons. | You can be eaten by Cougars, mink, and raccoons. | You can be eaten by Cougars, mink, and raccoons. | You can be eaten by Cougars, mink, and raccoons. |
| If you are eaten you **lose** 4 energy points. | If you are eaten you **lose** 4 energy points. | If you are eaten you **lose** 4 energy points. | If you are eaten you **lose** 4 energy points. | If you are eaten you **lose** 4 energy points. |
| If you eat a sunflower you **gain** 2 energy points. | If you eat a sunflower you **gain** 2 energy points. | If you eat a sunflower you **gain** 2 energy points. | If you eat a sunflower you **gain** 2 energy points. | If you eat a sunflower you **gain** 2 energy points. |
| If you encounter another mouse you lose 1 point. | If you encounter another mouse you lose 1 point. | If you encounter another mouse you lose 1 point. | If you encounter another mouse you lose 1 point. | If you encounter another mouse you lose 1 point. |

| | | | | |
|---|---|---|---|---|
|  |  |  |  |  |
| **Sunflower** | **Sunflower** | **Sunflower** | **Sunflower** | **Sunflower** |
| You have 10 energy points | You have 10 energy points | You have 10 energy points | You have 10 energy points | You have 10 energy points |
| You can be eaten by mice and raccoons | You can be eaten by mice and raccoons | You can be eaten by mice and raccoons | You can be eaten by mice and raccoons | You can be eaten by mice and raccoons |
| If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. |
| Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. |
| | | | | |
|  |  |  |  |  |
| **Sunflower** | **Sunflower** | **Sunflower** | **Sunflower** | **Sunflower** |
| You have 10 energy points | You have 10 energy points | You have 10 energy points | You have 10 energy points | You have 10 energy points |
| You can only be eaten by mice and raccoons | You can only be eaten by mice and raccoons | You can only be eaten by mice and raccoons | You can only be eaten by mice and raccoons | You can only be eaten by mice and raccoons |
| If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. | If you are eaten you lose 2 energy points. |
| Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. | Every round you gain 1 energy point from the sun through photosynthesis. |

## THOUGHT QUESTIONS

1) Which organisms had an overall increase in energy points?

2) Which organisms had the most decrease in total energy points?

3) Why did we have more sunflowers than mice and more mice than mink?

4) Do you think this was a realistic exercise in how a food chain operates? Why or why not?

5) If you could adjust this game to make it more realistic, how would you change it?

6) Would you change the number of organisms in each category or add any more categories?

7) Would you change the number of energy points each starts with or how many they get for feeding? What else could help?

8) If you wanted to add decomposers to this game, what would you need to do?

# Tropic Levels – Food Webs – Bioaccumulation Quiz

**Name** _____

Below is a food web. Give the **name** *and* **shortest trophic** level for each organism

1)

2)

3)

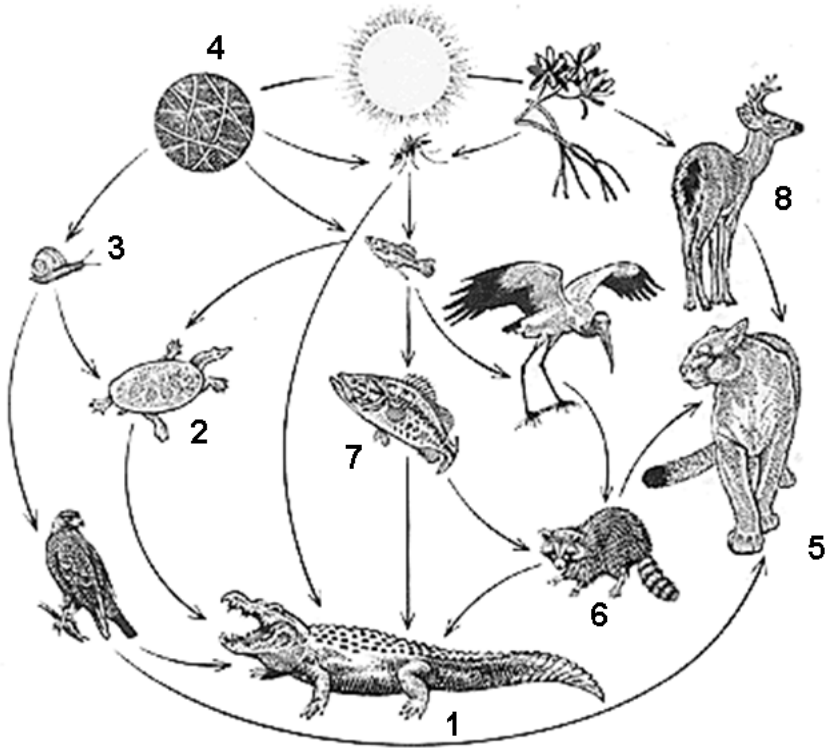
4)

5)

6)

7)

8)




Determine whether the following organisms are **Herbivores**, **Carnivores**, **Omnivores**, or if they are **Detritivores** (are they **scavengers** or **decomposers)**.

i) Deer

ii) Octopus

iii) Coyote

iv) House fly

v) Slime mold

vi) Lizard

vii) Turkey vultures

viii) Hummingbird

ix) Mouse

x) Humpback whales

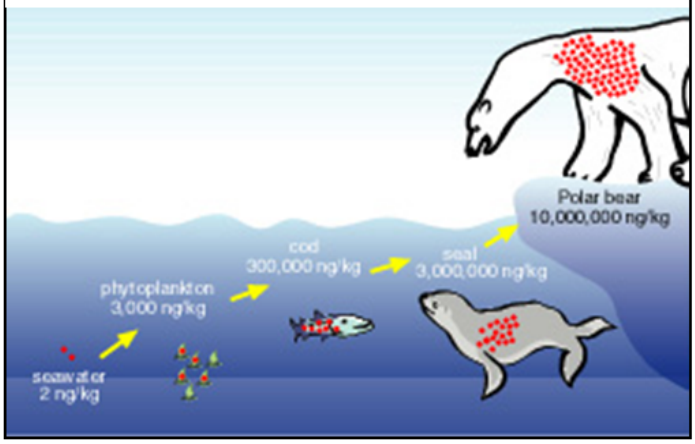
9) How much energy is generally lost at each trophic level?

10) How much of that lost energy is waste matter that was not digested?

11) Does that energy disappear from the ecosystem forever? If not, how is it used?

12) What happens to the lost energy that was digested and can it be used again?

**What does this image illustrate?**
Explain in two to three sentences what is happening




For each relationship, determine whether it is **mutualistic**, **commensal**, **parasitic**, **parasitoid**, **predatory**, or **herbivory**.

A) A mosquito releases malaria protists into a bird when it feeds. The malaria multiply rapidly inside the body, often killing the host. Other mosquitoes pick up the malaria from infected birds while they are sick.

B) A clown fish lives within the tentacles of a sea anemone, immune to the stinging cells and protected from predators.

C) A bright yellow spider lives within the flower of a dandelion, ready to strike at unsuspecting pollinators.

D) A hummingbird feeding on nectar of a flower.

E) A tick sucks blood from a deer before dropping off to lay eggs.

F) A copepod uses its legs to generate a current that sweeps algae into its mouth.