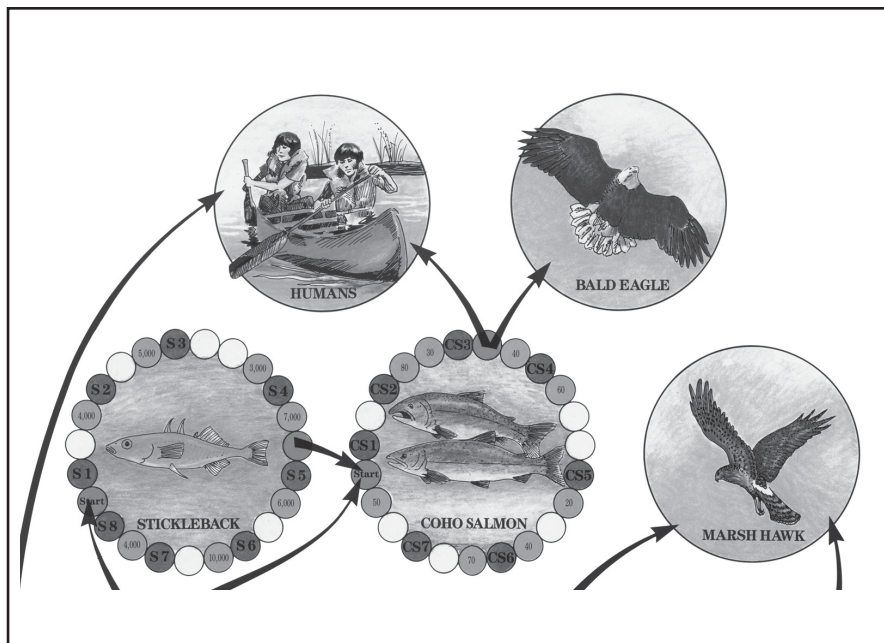


Energy Flow in an Alaska Wetland

ALASKA'S ECOLOGY CARDS REQUIRED



Section 2 Wetland Activities WETLAND ECOLOGY

Grade: 7 - 12

State Standard: Math A-1a; A-3

NGSS: MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-4, MS-ESS3-4, HS-LS2-2, HS-LS2-3, HS-LS2-4

Subjects: science, math

Skills: analysis, classification, computation, inference

Duration: two class sessions

Group Size: small groups (2 - 6 can play the game)

Setting: indoors

Vocabulary: food chain, food web, producers, consumers, herbivores, carnivores, decomposers, detritivores, photosynthesis, energy

Objectives:

Students will construct wetland food webs and trace energy flow through the system.

Teaching Strategy:

Students will play a board game illustrating energy flow.

Complementary Activities:

Energy Flow in an Alaskan Wetland

Background

See INSIGHTS: Section 1 Wetland Ecosystems "Profiles of Alaska's Wetlands" fact sheet, and Section 3 Wetland Inhabitants fact sheets.

Materials:

For each group: Energy Flow in an Alaska Wetland board game, Energy Flow in an Alaska Wetland game rules and Energy Use Charts (see following pages), one die, markers, scratch paper or calculator, Selected Ecology Cards listed below.

Procedure:

1. Post the Energy Flow in an Alaska Wetland board game where the students can see it as you introduce the game.
2. Discuss the concepts of producers, consumers, herbivores, carnivores, omnivores, detritivores, and decomposers. Have the students identify which of the plants and animals on the poster fit into each category.
3. Discuss with the students how organisms at each stage of the wetland food chain are able to store only 10% of the energy available. *Animals are generally not efficient at eating all the food available to them. If they were, plants would soon be scarce, and animals more scarce! Animals must use energy when they move, sense and respond to the environment, grow, and reproduce. Also, not all of the food consumed can be digested and stored; some is excreted as waste products.*
4. Discuss with the students how even though the energy is not used, it is not wasted. *The energy that is not captured by plants remains in the form of light and heat, but it is mostly lost to the living system. Some of the energy lost as waste products in each link of the chain can be used by detritivores and plants. Many plants and animals die without being eaten, but this*



stored energy is also recycled by the decomposers. Wetland food webs often have much more energy flowing through the detrital food chains and webs than through the webs composed of producers and consumers. Still, the energy stored in the living system constantly decreases and much cannot be recaptured.

5. Discuss how these energy facts at each link of the food chain limit the number of living things that can exist. *Carnivores are less numerous than herbivores, etc.*

6. Divide the class into four groups and distribute the Ecology Cards, as follows:

Group #1: Freshwater marsh: bacteria, green algae, water smartweed, water flea, mosquito, dragonfly, wood frog, sandhill crane, grayling, arctic fox, human

Group #2: Bog: bacteria, sedge, black spruce, sphagnum moss, muskrat, mosquito, bladderwort, little brown bat, human

Group #3: Riparian wetland: black fly larvae, willows, moose, horsetails, Eskimo potato, springtails, shrews, wolverine, wolf, brown bear, human

Group #4: Coastal wetland: amphipod, bacteria, eelgrass, arrowgrasses, black brant, Canada goose, bald eagle, pink salmon, brown bear, human

7. Have students in each group take turns reading aloud the portions of their card “Food” and “Eaten by.” The group will then work together to diagram the food chain connections among the organisms. Post these diagrams next to the posted board game.

8. Play the “Energy Flow in an Alaska Wetland” game. Rules are on the following page. For large classes, small groups can each represent one player and be responsible for making the calculations for each move.

Evaluation

After playing the game, discuss the following:

1. In your own words, tell what a food web is.
2. What happens to most of the sun’s energy that reaches a wetland?
3. Tell why or why not you agree or disagree with the statement: “A wetland is not a productive area

because so much energy is wasted in the food web.”

4. How can you explain the fact that organisms at the end of the food chain get the least amount of energy? Doesn’t that mean that they are all going to starve to death?

Curriculum Connections:

(See Appendix for full citations)

Books:

Wetlands (Moore, 2006).

Extensions

1. Students write a short story from the viewpoint of a unit of energy moving through a wetland food web.
2. Students research ecology books to determine if other types of ecosystems (for example, forests, grasslands, savannahs, oceans) do a “better job” than wetlands of capturing and storing the sun’s energy. (Consider this: can producers capture more than 3 percent and consumers store more than 10%?) They can also research comparisons between colder areas nearer the poles and warmer areas nearer the equator.



Energy Flow in an Alaska Wetland

GAME RULES

The winner of this game is the one who gets to the top of the food chain (where he or she is eaten by the marsh hawk, bald eagle, or human being) with the greatest number of calories left.

A player can quickly exhaust the calories allotted as he or she meets calorie-consuming situations and events in the lives of organisms on the food chain. Merely staying alive uses up energy (in the form of respiration).

The game has been designed to illustrate the complexity of a wetland ecosystem, the interdependence of living things, and the importance of the sun's energy in making the ecosystem work. The calorie counts for a given situation are estimates and have been calculated to make events in the game as realistic as possible. However, they should not be considered complete and accurate measures of all energy consumed.

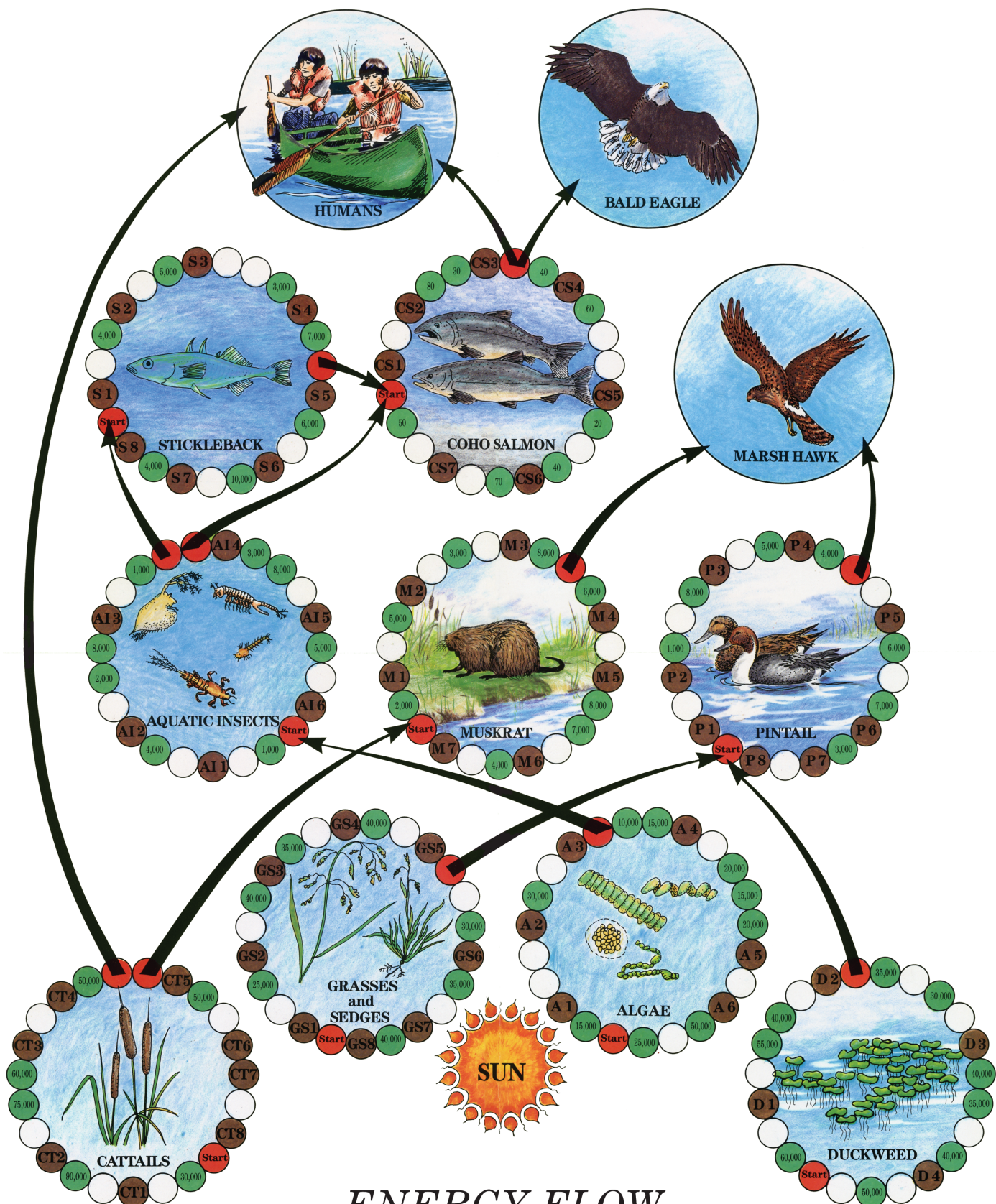
The materials you will need for this game are:

1. The Energy Flow in an Alaska Wetland Poster Game
2. The Energy Use Charts
3. A die

Here are the rules for the game:

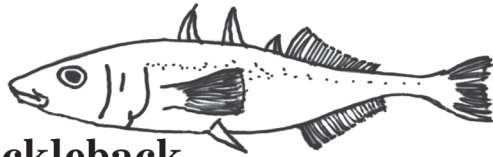
1. Two to six can play at once.
2. Each player places a marker on the sun and starts the game with solar energy equal to 10,000,000 calories.
3. Players move in turn on the throw of a die. Each player follows a sunbeam to a plant (orange start circle).
4. When moving from the sun to a plant, players lose 97 percent of their energy, so they must subtract 9,700,000 calories from the 10,000,000 with which they started the game. Players are thus left with 300,000 calories, or 3 percent of their initial energy.
5. Players advance through the food web with each roll of the die, moving as many spaces as the die indicates.
6. Players landing on green spaces must pay the respiration tax indicated on the circle. For example, if a player with 150,000 calories lands on a green space marked 15,000, the player must give up 15,000 calories. The player would then have 135,000 calories remaining.
7. When a player lands on a tan space, he or she must check the Energy Use Chart to find out what energy-consuming event has occurred and how many calories it has used. For example, CT 1 (meaning cattail space #1 on the chart) reads "fungus infection on leaves, use 100,000 calories". This means that the organism has contracted a fungus infection, and any player landing on CT 1 must subtract 100,000 calories from his or her supply.
8. When a player lands on a white space, no calories are lost.
9. When a player lands on an orange space, which allows him or her to move from one organism to another, the player becomes food for the new organism. Whenever that happens, 90% of the players remaining calories must be surrendered. (A player keeps 10%). Percentages can be figured on the scratch paper or with a calculator.
10. Players enter a new organism on its start orange circle. A player must stop on the circle; give up the 90% described in Rule 9, and wait until the next turn before advancing through the organism.
11. A player who uses all of his or her calories before reaching the top of the food chain (the marsh hawk, bald eagle, or human being) has burned out and is no longer in the game.
12. The player reaching the marsh hawk, bald eagle, or the human being with the most calories remaining is the winner. If every player burns out, there is no winner.





ENERGY FLOW in an Alaska wetland

Energy Use Chart



Stickleback

- S 1** Courtship ceremony.
Use 800 calories.

- S 2** Migrate by stream to lake.
Use 600 calories.

- S 3** Develop infection of scales.
Use 500 calories.

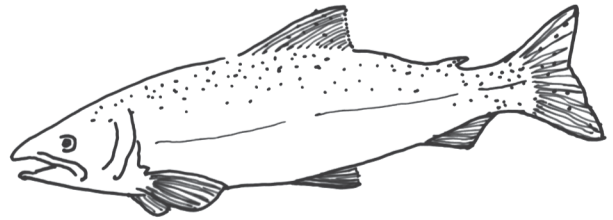
- S 4** Produce eggs.
Use 350 calories.

- S 5** Population explosion. Heavy competition for food.
Use 500 calories.

- S 6** Fin torn. Repair tissue.
Use 600 calories.

- S 7** Hot spell increases water temperature. Metabolism increases.
Use 400 calories.

- S 8** Narrowly escapes attack by coho salmon by swimming rapidly.
Use 300 calories.



Coho Salmon

- CS 1** Gill disease.
Use 85 calories.

- CS 2** Chase other males from territory.
Use 60 calories.

- CS 3** Migrate upstream.
Use 100 calories.

- CS 4** Hooked by fisherman but broke his line.
Use 10 calories.

- CS 5** Swim up wrong tributary stream, must return.
Use 50 calories.

- CS 6** Chased by brown bear.
Use 40 calories.

- CS 7** Stressed by crowding during migration.
Use 40 calories.

Aquatic Insects



- AI 1** Grow new exoskeleton.
Use 5,000 calories.

- AI 2** Bacterial disease.
Use 3,000 calories.

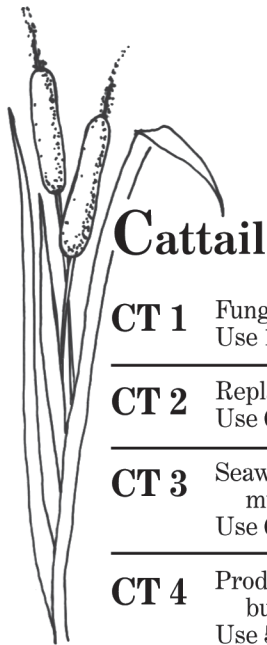
- AI 3** Change into adult insect.
Use 2,500 calories.

- AI 4** Repair wounds to body.
Use 2,000 calories.

- AI 5** Chased by stickleback.
Use 1,500 calories.

- AI 6** Time to lay eggs.
Use 3,500 calories.

Energy Use Chart



Cattail

- CT 1** Fungus infection on leaves.
Use 100,000 calories.

- CT 2** Replace tissues eaten by moose.
Use 60,000 calories.

- CT 3** Seawater floods marsh destroying much tissue.
Use 60,000 calories.

- CT 4** Produce new plants by underground buds.
Use 50,000 calories.

- CT 5** Humans gather underground stems for food, throwing away leaves and flowers.
Use 40,000 calories.

- CT 6** Chemicals seep into marsh causing abnormal growth.
Use 25,000 calories.

- CT 7** Spring fire damages new growth.
Use 10,000 calories.

- CT 8** Burrowing mammal destroy roots.
Use 50,000 calories.

Duckweed



- D 1** Fertilizers seep into marsh causing abnormal growth.
Use 50,000 calories.

- D 2** Shaded by shrub.
Use 30,000 calories.

- D 3** Attacked by fungus.
Use 25,000 calories.

- D 4** Repair damaged tissue shredded by propeller.
Use 20,000 calories.



Grasses and Sedges

- GS 1** Drought dries out ground around roots.
Use 25,000 calories.

- GS 2** Produce seeds.
Use 30,000 calories.

- GS 3** Partially covered by road construction.
Use 35,000 calories.

- GS 4** Shaded by taller growing cattails.
Use 20,000 calories.

- GS 5** Storm floods marsh and covers leaves with water.
Use 25,000 calories.

- GS 6** Fungus disease.
Use 30,000 calories.

- GS 7** Underground stems trampled by animal trail.
Use 30,000 calories.

- GS 8** Leaves used to build duck's nest.
Use 25,000 calories.

Algae



- A 1** It's time to reproduce.
Use 40,000 calories.

- A 2** Repair tissue damage caused by storm.
Use 30,000 calories.

- A 3** Mold grows into tissues and takes food.
Use 20,000 calories.

- A 4** Sewage spill stimulates abnormal growth.
Use 10,000 calories.

- A 5** Viral infection.
Use 40,000 calories.

- A 6** Water becomes deep. Grow longer branches.
Use 60,000 calories.

Energy Use Chart



Muskrat

M 1. Produce and nurse two offspring.
Use 7,000 calories.

M 2 Shed winter coat.
Use 7,000 calories.

M 3 Grow winter coat.
Use 6,000 calories.

M 4 Build house on bank of stream.
Use 5,000 calories.

M 5 Attacked by marsh hawk. Dive and swim to safety.
Use 5,000 calories.

M 6 Population explosion. Battle for territory.
Use 3,000 calories.

M 7 Late summer fire destroys habitat. Move to new location.
Use 3,000 calories.



Pintail

P 1 Habitat destroyed. Migrate 100 miles.
Use 3,000 calories.

P 2 Viral infection with high fever.
Use 2,500 calories.

P 3 Replace lost feathers.
Use 2,000 calories.

P 4 Overpopulation. Heavy competition for food.
Use 7,000 calories.

P 5 Build nest.
Use 6,000 calories.

P 6 Courtship ceremony.
Use 5,500 calories.

P 7 Search for new food supply.
Use 5,000 calories.

P 8 Predator attack. Defend nest.
Use 5,500 calories.

