

Build the Web, Then Break It: A Model of an Oak Woodland

Investigation question: How do matter and energy move among the living and nonliving parts of an oak woodland, and what ripples through the web when one population suddenly changes?

Collaborative systems modeling

Groups of 4

2 sessions

Setup 5 · Activity 80 · Cleanup 10 min

MS-LS2-3 · assesses

MS-LS2-4 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Web builder:** Sorts the cards by role, lays them out with producers at the bottom and top predators at the top, and keeps the layout readable as yarn is added.
- ☐ **Arrow caller:** Reads each card's 'what it eats' line aloud and names every arrow that must be strung, always from the food to the eater.
- ☐ **Recorder:** Fills in the card inventory, the boundary statement and the disturbance table; writes the sign chains exactly as the group agrees them.
- ☐ **Checker and presenter:** Walks the finished web checking every arrow points at the eater and every organism connects to the decomposers, then presents the group's disturbance chain to the class.

Safety

- Scissors: cut away from fingers and keep them closed on the desk when not in use.
- Yarn is a tangling and tripping hazard; keep it on the desk or poster, never around a neck or wrist, including in the human-web variant.
- Masking tape only; it lifts cleanly. No hazards beyond ordinary classroom materials.

Procedure

1. Session 1. Sort the 19 cards into four piles: producers, consumers, decomposers, and nonliving. Each card says what it eats or what it is; use that, not your memory, and talk through any card the group disagrees about.
2. Lay the cards out on the poster with the three producers along the bottom, the animals that eat producers in a row above them, animals that eat animals above that, and the decomposer and millipede cards off to one side. Put the sunlight, air and soil, and surroundings cards around the edge. Tape each card down lightly.
3. String the feeding arrows in green. The arrow caller reads each consumer card's 'eats' line, and for every food named you tape one green length from the food card to the eater card, with a small paper arrowhead or a marker arrow at the eater end. Say the rule each time: the arrow points to the eater.

4. String the brown arrows: one from every organism card, producers included, to the decomposer card, because every organism sheds wastes and eventually dies. Add a brown arrow from the millipede to the decomposers too, since its droppings and remains feed bacteria and fungi.
5. String the yellow arrows for the nonliving parts: sunlight to each producer; air and soil to each producer (carbon dioxide, water and nutrients taken in); decomposers to air and soil (carbon dioxide and nutrients released); one arrow from the producer row and one from the consumer rows back to air and soil (carbon dioxide breathed out); and one arrow from each row of living cards to the surroundings card for heat.
6. Fill in the card inventory table: role, arrows in and arrows out for every card. Then write the boundary statement: what is inside your model, what is outside it, and exactly what crosses the boundary in each direction.
7. Find and write two food chains, number their trophic levels, and name the top predators in your model. Sketch the finished web with its three arrow colors on the recording sheet. Leave the web taped down for session 2 if you can.
8. Session 2. Draw one disturbance card. Write the disturbance at the top of the disturbance table. Put a – sticky note on the population that drops (or a + on one that rises).
9. Follow the arrows one link at a time. For each neighboring population, decide whether it rises or falls and place a + or – sticky note on it. Write the row: population, direct or indirect, up or down, and the chain of reasoning in words ('fewer squirrels means less food for hawks, so hawks fall').
10. Keep going to at least two links beyond the first (at least two indirect effects). When two arrows give opposite predictions for the same card, write both and mark the card '?'. That is a real limit of the model, not a mistake.
11. Present your chain to the class in under two minutes, showing the sticky notes. Listen for whether other groups' webs predicted the same directions for the same disturbance.
12. Answer the analysis questions individually. Untape the cards, coil the yarn by color and return the set.

Record your observations

Lab 1 recording sheet: Build the web, then break it

Cut the 19 cards apart. Each card tells you what the organism eats or, for the nonliving cards, what it supplies or receives. Build every arrow from what the cards say. Remember the rule: **the arrow points to the eater**.

Oak woodland card set (one set per group)

1 Card 1: Valley oak

Producer. Builds sugar and tissue from carbon dioxide, water and sunlight. Makes leaves and acorns. Eaten by: mule deer (leaves, acorns), ground squirrel (acorns), deer mouse (acorns), acorn woodpecker (acorns), coyote (fallen acorns in autumn).

2 Card 2: Purple needlegrass (bunchgrass)

Producer. Builds sugar and tissue from carbon dioxide, water and sunlight. Eaten by: grasshopper (blades), mule deer (blades), jackrabbit (blades), ground squirrel (blades and seeds), deer mouse (seeds).

3 Card 3: Lupine (wildflower)

Producer. Builds sugar and tissue from carbon dioxide, water and sunlight. Eaten by: grasshopper (leaves), jackrabbit (leaves), ground squirrel (seeds), deer mouse (seeds).

4 Card 4: Grasshopper

Consumer. Eats: needlegrass blades and lupine leaves. Eaten by: western fence lizard, deer mouse, acorn woodpecker.

5 Card 5: California ground squirrel

Consumer. Eats: acorns, needlegrass blades and seeds, lupine seeds. Eaten by: gopher snake (young squirrels), coyote, red-tailed hawk.

6 Card 6: Mule deer

Consumer. Eats: needlegrass, oak leaves and acorns. Eaten by: mountain lion.

7 Card 7: Deer mouse

Consumer. Eats: grass and lupine seeds, acorns, and insects such as grasshoppers. Eaten by: gopher snake, coyote, red-tailed hawk.

8 Card 8: Black-tailed jackrabbit

Consumer. Eats: needlegrass and lupine. Eaten by: coyote, red-tailed hawk.

9 Card 9: Acorn woodpecker

Consumer. Eats: acorns and insects such as grasshoppers. Eaten by: red-tailed hawk (occasionally).

10 Card 10: Western fence lizard

Consumer. Eats: grasshoppers and other insects, and small millipedes. Eaten by: gopher snake, red-tailed hawk.

11 Card 11: Gopher snake

Consumer. Eats: deer mice, young ground squirrels, fence lizards. Eaten by: red-tailed hawk, coyote.

12 Card 12: Coyote

Consumer. Eats: ground squirrels, deer mice, jackrabbits, gopher snakes, and in autumn fallen acorns and fruit. Eaten by: mountain lion (occasionally).

13 Card 13: Red-tailed hawk

Consumer. Eats: ground squirrels, deer mice, jackrabbits, gopher snakes, fence lizards, occasionally woodpeckers. Eaten by: nothing else in this card set.

14 Card 14: Mountain lion

Consumer. Eats: mule deer mainly, occasionally coyotes. Eaten by: nothing else in this card set.

15 Card 15: Soil bacteria and fungi

Decomposers. Feed on the wastes and dead remains of every organism in this set, including other decomposers. Release carbon dioxide (from their respiration) and mineral nutrients into the air and soil.

16 Card 16: Millipede

Detritivore, an animal that chews dead leaves and wood. Eats: fallen oak leaves, dead grass. Its droppings and remains are fed on by bacteria and fungi. Eaten by: western fence lizard (small ones only).

17 Card 17: Sunlight

Nonliving energy source from outside the ecosystem. Not matter. Captured only by producers. Supplies: energy to cards 1, 2 and 3.

18 Card 18: Air and soil

Nonliving pool of matter: carbon dioxide and water in the air, water and mineral nutrients in the soil. Supplies: raw materials to producers. Receives: carbon dioxide breathed out by every living card, and nutrients released by decomposers.

19 Card 19: Surroundings (heat exit)

Nonliving. Receives the heat that every living card releases as it uses energy to live. No arrow ever leaves this card: no organism can capture spread-out heat to make food.

Card inventory

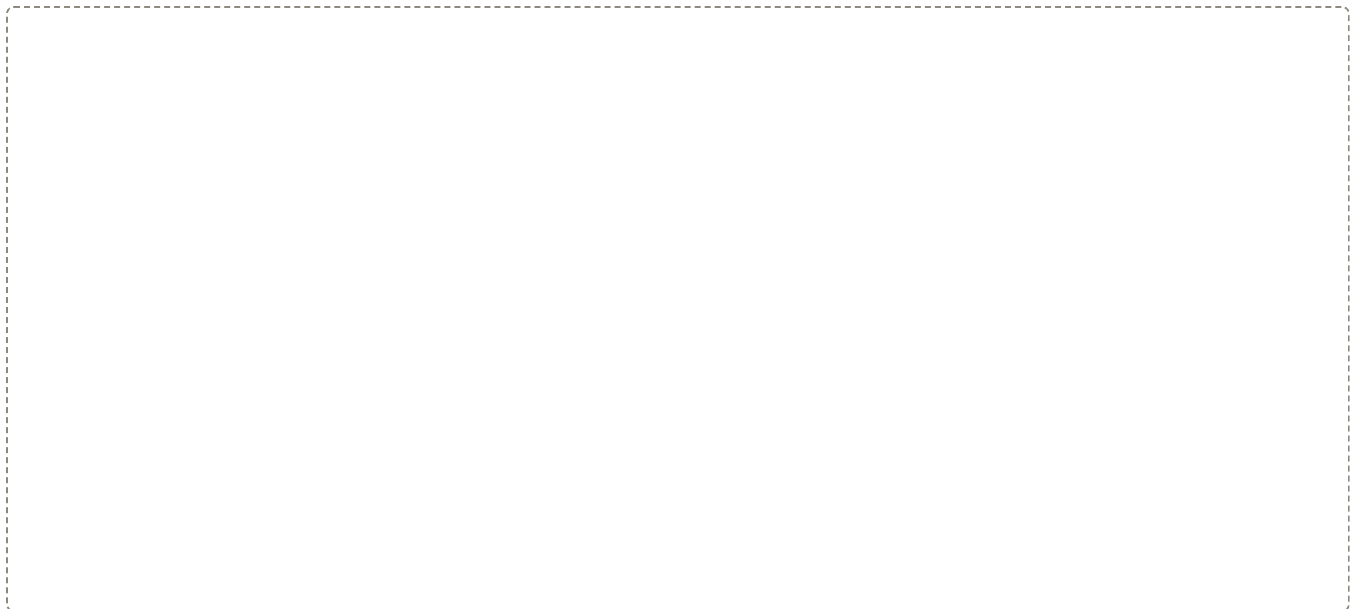
Card	Role (producer, consumer, decomposer, detritivore, nonliving)	Green arrows in	Green arrows out	Connected to decomposers? (yes/no)
1 Valley oak				
2 Needlegrass				
3 Lupine				
4 Grasshopper				
5 Ground squirrel				
6 Mule deer				
7 Deer mouse				
8 Jackrabbit				
9 Acorn woodpecker				
10 Fence lizard				
11 Gopher snake				
12 Coyote				
13 Red-tailed hawk				
14 Mountain lion				
15 Bacteria and fungi				
16 Millipede				

1. Write two different food chains from your web that both start at needlegrass. Number the trophic level of every organism in each chain.

2. Which cards are top predators in this model? Name one real animal you could add to the set that would change that answer, and say which arrow it would add.

3. Boundary statement. Inside my model: _____. Outside my model: _____. Crossing the boundary inward: _____. Crossing the boundary outward: _____.

-  Sketch your finished web. Show every card as a box, producers at the bottom. Draw the feeding arrows as solid lines with arrowheads at the eater, the arrows to decomposers as dashed lines, and the arrows to and from sunlight, air and soil, and the surroundings as dotted lines. Label the sunlight arrow 'energy in' and the surroundings arrows 'heat out'.



Session 2: break the web

Disturbance effects (write your disturbance card letter and text in the first row)

Population	Direct or indirect?	Up, down or ?	Chain of reasoning (one link at a time)
Disturbance:			

4. Pick the longest chain of reasoning in your table. Rewrite it as a sign chain, for example 'squirrels –, hawks –, mice +, grasshoppers –', and explain why the sign flips at some links and not at others.

5. Which card did your group mark '?' or argue about, and what were the two competing predictions?

Analysis questions

6. Every organism card has a brown arrow to the decomposers, but no arrow runs from the decomposers back to the producers. Explain both facts.

- 7.** Trace one carbon atom around your model, naming at least four cards it passes through and the arrow it uses for each move. Start and end at the air and soil card.

- 8.** Sunlight has arrows going into producers, and heat arrows go out to the surroundings, but no arrow ever comes back from the surroundings. What does your model say about how energy moves, compared with how matter moves?

- 9.** A group in another class built the same web but left out the air and soil card and the surroundings card. Name two questions about the woodland that their model cannot answer and yours can.

- 10.** Your model predicts the direction of change after a disturbance. Give two things it cannot predict, and explain what the model would need in order to predict them.

- 11.** Disturbance C: rat poison is set out for mice and ground squirrels. Using the arrows in your web, explain how poison meant for rodents can end up inside a red-tailed hawk, and name one more animal in the set at risk the same way.
