

Bear Creek Jigsaw: Twelve Cards, One Stream Food Web

Learning target: I can work with a team to assemble a stream food web from organism cards, trace where matter and energy go, and predict the direct and indirect effects of a disturbance.

Collaborative investigation

About 55 min

Jigsaw

MS-LS2-3 · practice

MS-LS2-4 · practice

collaboration

visual modeling

discussion

Standards connections

MS-LS2-3 (practice): Teams build a physical food web model that includes producers, consumers and decomposers and trace matter to the decomposers and energy to heat; this is the modeling practice the PE calls for, done collaboratively before the individual assessment.

MS-LS2-4 (practice): The disturbance round asks teams to predict and justify population changes after a change to the ecosystem, building the reasoning they will need to argue from data about such changes.

Purpose: practice · **Time:** about 55 minutes · **Format:** jigsaw

Answers with reasoning

Twelve organism cards from Bear Creek, a Sierra foothill stream

1 Card 1: Algae on the rocks

A thin green-brown film of tiny producers coating every sunlit stone. Makes its own food from sunlight, carbon dioxide dissolved in the water, and nutrients in the water. Eaten by mayfly nymphs, snails and tadpoles.

2 Card 2: Streamside willows

Producers growing on the bank. Make their own food from sunlight, carbon dioxide and water. Their fallen leaves drop into the creek every autumn and are eaten by caddisfly larvae and crayfish after bacteria and fungi have softened them.

3 Card 3: Bacteria and fungi in the gravel

Decomposers. Feed on droppings, dead leaves and the remains of every other organism in the creek. Release carbon dioxide and nutrients into the water, where algae and willow roots can take them up.

4 Card 4: Mayfly nymphs

Young insects that cling to stones and scrape algae off the rock. Eaten by stonefly nymphs and rainbow trout.

5 Card 5: Caddisfly larvae

Young insects that build cases of sand and twigs and shred fallen willow leaves. Eaten by stonefly nymphs and rainbow trout.

6 Card 6: Snails

Slow grazers that rasp algae from the rocks. Eaten by crayfish.

7 Card 7: Stonefly nymphs

Young insects that hunt among the stones. Eat mayfly nymphs and caddisfly larvae. Eaten by rainbow trout.

8 Card 8: Tadpoles

Young Pacific tree frogs in quiet pools. Eat algae. Eaten by rainbow trout and garter snakes.

9 Card 9: Crayfish

Clawed animals on the bottom. Eat fallen willow leaves, snails and dead animals. Small crayfish are eaten by rainbow trout; crayfish of all sizes are eaten by belted kingfishers.

10 Card 10: Rainbow trout

The creek's main fish. Eat mayfly nymphs, caddisfly larvae, stonefly nymphs, tadpoles and small crayfish. Small trout are eaten by garter snakes and belted kingfishers.

11 Card 11: Garter snake

A streamside snake that swims well. Eats tadpoles and small trout. Nothing in this creek model eats the garter snake.

12 Card 12: Belted kingfisher

A bird that dives from branches. Eats small trout and crayfish. Nothing in this creek model eats the kingfisher.

Part A: Expert round (one set per person)

1. Your expert set: _____. For each of your three cards, write its role (producer, consumer or decomposer), how many arrows should point **into** it, and how many should point **out** of it (not counting arrows to the decomposers).

Answer: Set A: algae (producer, 0 in, 3 out: mayfly, snails, tadpoles); willows (producer, 0 in, 2 out: caddisfly, crayfish); bacteria and fungi (decomposer, arrows in from everyone, 0 feeding arrows out). Set B: mayfly nymphs (consumer, 1 in, 2 out); caddisfly larvae (consumer, 1 in, 2 out); snails (consumer, 1 in, 1 out). Set C: stonefly nymphs (consumer, 2 in, 1 out); tadpoles (consumer, 1 in, 2 out); crayfish (consumer, 2 feeding arrows in from willow leaves and snails plus dead animals, 2 out: trout, kingfisher). Set D: trout (consumer, 5 in, 2 out); garter snake (consumer, 2 in, 0 out); kingfisher (consumer, 2 in, 0 out).

Why: The counts come directly from the cards. Crayfish 'dead animals' is a link to remains rather than a live prey arrow; accept 2 or 3 arrows in for crayfish.

Also acceptable: Accept crayfish with 3 in if the student counts dead animals as an arrow from the decomposer side.

- Correct role for each of the three cards
- Arrow counts match the cards

Part B: Home group task

1. Lay out the twelve cards with the two producers at the bottom, the decomposers to one side, and the kingfisher and garter snake at the top.
2. For every 'eaten by' statement on a card, lay a piece of yarn (or draw an arrow) from the food to the eater. Count your arrows; the key number is 17.
3. Add a dashed arrow from every organism to the decomposers, and one arrow from the decomposers to the water (nutrients and carbon dioxide released) that leads back to the producers.
4. Complete the group record table.

5. Draw one disturbance card from your teacher and predict the direct and indirect effects on at least four populations. Every member must be able to explain one prediction.
6. Prepare to show a neighboring group one food chain of at least four arrows and one indirect effect.

Group record (fill in)

Organism	Role	Eats (arrows in)	Eaten by (arrows out)
Algae			
Willows (fallen leaves)			
Bacteria and fungi			
Mayfly nymphs			
Caddisfly larvae			
Snails			
Stonefly nymphs			
Tadpoles			
Crayfish			
Rainbow trout			
Garter snake			
Belted kingfisher			

Disturbance cards (teacher cuts these apart) — Disturbance 1: A hot, dry summer shrinks the creek and cuts algae growth in half. Disturbance 2: Warm water kills most of the rainbow trout. Disturbance 3: A landslide buries the willows, so no leaves fall into the creek this autumn.

2. Group answer: Write the longest food chain in your web that starts at algae and ends at the kingfisher. How many arrows does it have? Then name the **two** organisms that are top predators in this model and explain why there are two.

Answer: Longest chain: algae → mayfly nymphs → stonefly nymphs → rainbow trout → belted kingfisher (4 arrows). Two top predators: the garter snake and the belted kingfisher, because nothing in this twelve-card model eats either of them. A web can have more than one top predator, and the label depends on which organisms the model includes; a hawk or a raccoon card would change it.

Why: The 17 feeding arrows are: algae→mayfly nymphs, algae→snails, algae→tadpoles, willows→caddisfly larvae, willows→crayfish, mayfly→stonefly, mayfly→trout, caddisfly→stonefly, caddisfly→trout, snails→crayfish, tadpoles→trout, tadpoles→garter snake, stonefly→trout, crayfish→trout, crayfish→kingfisher, trout→garter snake, trout→kingfisher. Groups that add an arrow for the crayfish's 'dead animals' food will count 18; accept 17 or 18 with that explanation. The chain and the two top predators are the graded parts.

Also acceptable: Accept willows → caddisfly larvae → stonefly nymphs → trout → kingfisher as another 4-arrow chain if the student notes it starts at the willows, not algae.

- A valid longest chain of 4 arrows
- Names both the garter snake and the kingfisher
- Explains top predator as depending on the model

3. Group answer: Disturbance number _____. Predict the effect on four populations. For each, say whether the change is direct or indirect and trace the path.

Answer: Disturbance 1 (algae halved): mayfly nymphs, snails and tadpoles down (direct; they eat algae); stonefly nymphs down (indirect, through mayfly nymphs); trout down a little (indirect, through mayfly, stonefly and tadpoles, though caddisfly and crayfish food remains); crayfish little change or slightly down (indirect, through snails); kingfisher and garter snake down slightly (indirect through trout). Disturbance 2 (trout die): mayfly nymphs, caddisfly larvae, stonefly nymphs, tadpoles and small crayfish up (direct; their predator is gone); garter snake and kingfisher down (direct; they lose a food) though both have another food; algae down (indirect, through more mayfly nymphs, snails and tadpoles); fallen leaves consumed faster (indirect, through caddisfly larvae). Disturbance 3 (no leaves): caddisfly larvae and crayfish down (direct); stonefly nymphs down (indirect, through caddisfly); trout down a little (indirect); snails may go down (indirect: hungrier crayfish eat more snails); kingfisher down slightly (indirect through crayfish and trout).

Why: Any four populations with correct direction, correct direct/indirect label and a traced path earn full credit; the lists above give the main options.

Also acceptable: Accept 'little change' for organisms with alternative foods if the student explains the alternative.

- Four populations named
- Direction correct for each
- Direct versus indirect labeled correctly
- Each indirect path names the population in between

4. Group answer: Trace the matter in one willow leaf through at least three organisms and back to a producer. Then say where the energy that was in the leaf ends up.

Answer: Example: leaf → caddisfly larva (eats the softened leaf) → stonefly nymph → trout → trout droppings and, eventually, the dead trout → bacteria and fungi break them down → carbon dioxide and nutrients released into the water → taken up by algae (or by willow roots). The energy in the leaf was used by each organism along the way and left as heat into the water and air at every step; the sun has to replace it.

Why: Matter must return to a producer through the decomposers and the water; energy must end as heat.

Also acceptable: A path through crayfish and kingfisher (droppings on the bank, washed into the creek) is acceptable.

- Matter passes through at least three organisms
- Returns to a producer via decomposers and the water
- Energy ends as heat

Part C: Individual accountability (complete alone)

5. The crayfish card lists three foods: living snails, fallen willow leaves and dead animals. Explain why one organism can sit at more than one trophic level. Then number the levels in the chain algae → snails → crayfish → kingfisher and state which level the crayfish is on in that chain.

Answer: A trophic level belongs to the meal being traced, not to the species. When a crayfish eats a fallen willow leaf it is one step above a producer (level 2); when it eats a snail that grazed algae it is two steps above (level 3); when it eats a dead animal it is feeding on remains, the way a detritivore does. In the chain algae (1) → snails (2) → crayfish (3) → kingfisher (4), the crayfish is on level 3.

Why: Omnivores and detritivores show that levels are properties of chains, not of organisms; the numbered chain checks that students count the producer as level 1.

Also acceptable: Accept 'the crayfish is level 2 on leaf days and level 3 on snail days' as the explanation; a student who notes that the kingfisher is level 4 here but level 3 when it eats a small trout that ate a tadpole is reasoning well.

- Explains that the level depends on which food is traced
- Numbers the chain correctly from the algae as level 1
- States that the crayfish is on level 3 in that chain

6. Pick a disturbance your group did **not** draw. Predict one direct effect and one indirect effect, and trace the indirect one.

Answer: See the q3 key for each disturbance. Example for Disturbance 2: direct effect, mayfly nymphs increase because trout no longer eat them; indirect effect, algae decrease because more mayfly nymphs (and tadpoles and snails) graze it; path: trout gone → more mayfly nymphs → less algae.

Why: The student must pick a different disturbance from the group's and reason alone.

Also acceptable: Any correct pair from the q3 key.

- Disturbance differs from the group's
- One correct direct effect
- One correct indirect effect with its path

7. Your web has 17 feeding arrows but only two producers. Using the energy pyramid idea, explain why the creek can support thousands of mayfly nymphs but only one or two kingfishers.

Answer: Only a small fraction (about one tenth on average) of the energy stored at one level becomes energy stored in the next; most is used for living and leaves as heat, or is in parts never eaten. Mayfly nymphs sit one step above the algae, so a large share of the creek's captured sunlight is available to them. A kingfisher sits three or four steps up, where only a tiny fraction of that energy remains, so the creek can feed only a bird or two.

Why: The energy pyramid explains the numbers at each level.

Also acceptable: Accept an estimate such as 'one thousandth of the energy is left by the kingfisher's level.'

- States that only a small fraction passes each level
- Explains why (heat, uneaten parts)
- Applies it to mayfly versus kingfisher positions

8. A classmate says the willows are not really part of the creek food web because they grow on land. Use your cards to argue whether the willows belong in the model, and describe what would happen to the caddisfly larvae and crayfish if they were left out.

Answer: The willows belong in the model. Card 2 says their fallen leaves are eaten by caddisfly larvae and crayfish, and card 3 says bacteria and fungi soften those leaves; the leaves carry matter and energy built on land into the water, where they are the main food of two consumers. If the willows were left out, the model would show caddisfly larvae and crayfish with no food, and it would miss the reason that a landslide on the bank (Disturbance 3) can reduce stonefly nymphs and trout in the water. A food web's boundary should include every organism that supplies matter and energy to the web, even if it grows outside the water.

Why: This targets the PE's emphasis on defining system boundaries: inputs that cross the boundary must be represented.

Also acceptable: A student who argues the willows should be shown as an input crossing the boundary rather than as an organism inside the system has a defensible, more advanced answer.

- Takes a position with card evidence
- Names caddisfly larvae and crayfish as dependent on the leaves
- Explains the consequence of leaving the willows out
- Connects to where the system boundary should be drawn

Scoring rubric

Criterion	4 • Exemplary	3 • Proficient	2 • Developing	1 • Beginning
Web construction	All feeding arrows laid from food to eater with the correct count, dashed arrows to decomposers from every organism, and a decomposer-to-water-to-producer link shown.	Arrows correct with one or two missing or reversed; decomposer links present.	Several arrows reversed or missing, or decomposers connected only to some organisms.	Cards arranged without arrows, or arrows drawn by guesswork.
Disturbance predictions	Four populations with correct direction, correct direct/indirect labels and traced paths; every member can explain one.	Four populations with mostly correct directions; one label or path is wrong or missing.	Two or three populations, or directions given without paths.	Predictions missing or unrelated to the arrows.

Matter and energy tracing	Traces leaf matter through three or more organisms back to a producer by way of decomposers and the water, and states that the energy leaves as heat.	Traces matter correctly but says energy is 'used up' without naming heat, or stops before the producer.	Traces a feeding chain only, with no return of matter and no statement about energy.	No tracing, or claims matter is destroyed or energy is recycled.
Individual accountability (Part C)	All four Part C answers accurate, use the cards as evidence, and show the student understands the group's reasoning.	Three of four accurate with evidence; one thin or partly incorrect.	Two accurate; others restate the group result without reasoning.	Part C mostly blank or inaccurate.

Teacher notes

Print and cut the twelve cards and shuffle each deck. The expert sets each contain one role from a different part of the web (A: producers and decomposers; B: grazers and shredders; C: mid-level consumers; D: fish, snake and bird). The feeding links are realistic for a Sierra foothill stream: mayfly nymphs scrape algae, caddisfly larvae shred leaves softened by microbes, stonefly nymphs of the predatory families eat other nymphs, rainbow trout take drifting insects and small crayfish, garter snakes take tadpoles and small fish, and belted kingfishers take small fish and crayfish. The card deck yields 17 feeding arrows (18 if a group adds one for the crayfish's 'dead animals' food); focus grading on direction, the chain and the predictions rather than the exact total. Cut the three disturbance cards from the callout; give each group one at random so that neighbors have different cases to compare. Crayfish are also often called detritivores; the card lists what they eat without using the term, and q5 uses the crayfish to show that a trophic level belongs to the chain being traced. This sheet covers the same ground as Lab 1 in a different ecosystem and format; if time is short, run it in place of Lab 1 session 1 or as a transfer task after Lab 1.

Scaffold offered to students: Arrows from the 'eaten by' line

Every card tells you where its arrows go: the 'eaten by' sentence lists the eaters. Lay the yarn from the card you are holding to each eater it names. Do not lay yarn for 'eats' sentences; those arrows will be laid by the group members holding the food cards. If your count is not 17 at the end, check the trout card first: it should have five arrows coming in and two going out.

Extension: Add a disturbance that comes from outside

Invent a fourth disturbance that enters the creek from outside the system, such as fertilizer washing in from a field upstream or a road culvert that blocks fish from moving. Write the disturbance card in the same style as the three provided, predict its effects on at least four populations with direct and indirect labels, and explain which arrow in the web it changes first. Trade with another group and compare predictions.