

The Mixed-Up Field Notebooks: Two Zones, One Eruption

Investigation question: Using only the clues in twelve undated field notes, can you put the return of life in two places hit by the 1980 Mount St. Helens eruption in order, and explain why one place recovered so much faster than the other?

Evidence-based mystery

Groups of 4

1 session

Setup 5 · Activity 35 · Cleanup 5 min

MS-LS2-4 · practice

MS-LS2-1 · supports

Scientific purpose

Students reconstruct two succession sequences from undated, clue-rich observation cards based on what ecologists recorded after the 1980 eruption: one from the pumice plain, where the eruption left new ground with no soil and no survivors, and one from the blowdown zone, where the forest was flattened but the soil, roots and some animals survived. They sort the cards by the clue that matters to living things, order each set by asking what each stage needed from the one before, check their order against approximate dates, and graph a teaching dataset of plant cover to compare the two rates of recovery. The product is an evidence-based timeline and an argument that the ground a disturbance leaves behind shapes how fast populations return.

Why this helps students with this chapter

Succession is usually taught as a finished diagram that students copy. Here they must build the sequence themselves, and the only way to do it is to reason about mechanism: the card where seedlings cluster inside lupine patches has to come after the card with the first lupine, because the lupine is what changed the ground. Sorting the cards by the presence of old soil and survivors turns primary versus secondary succession into a decision students defend rather than a definition they memorize. The wild card about logged and replanted land raises the question of what counts as a fair comparison, which is the heart of arguing from evidence.

Standards connections

MS-LS2-4 (practice, arguing from evidence that a change to a physical component (whether soil and survivors remained after the disturbance) affected how populations returned): Students build an argument from observation cards and a plant-cover dataset that the ground the eruption left shaped how fast plant and animal populations came back. Because the cards are summaries and the cover numbers are simulated, the lab practices the argument; Lab 3 produces the empirical evidence.

MS-LS2-1 (supports, nitrogen as a limiting resource on bare pumice): The lupine cards show plant populations growing where a pioneer added the nitrogen that bare pumice lacked. Students use the resource-limits-populations idea from Lesson 20 to explain the pattern rather than analyzing new resource data.

Roles (rotate each session)

- **Card reader:** Reads each card aloud and points out every clue in it: what is present, what is missing, and how big things are.
- **Sorter:** Places cards into the two group piles and onto the timeline strips, moving a card only when the group agrees.
- **Skeptic:** For every placement asks 'what had to happen before this?', checks that a printed clue supports the position, and flags cards that could go two ways.
- **Recorder:** Fills in Tables 1 to 3 with the clue for each placement, keeps the list of disputed cards, and counts the correct placements after the reveal.

Materials

Item	Quantity	Per	Note
Field-note card set (12 cards from the recording sheet) printed on cardstock and cut apart	1 set in an envelope	group	Shuffle each set and label the envelope with the group number. The letters A to L do not follow the real order.
Timeline strips about 1 m long (adding-machine tape or sentence strips) marked 'earlier' at one end and 'later' at the other	2	group	Label one strip 'Group 1' and the other 'Group 2'.
Small sticky notes	1 pad	group	For marking disputed cards with '?'.
Scissors (only if the cards are not pre-cut)	1 pair	group	
Reveal strip with zone names and approximate dates (copy from the answer key's teacher notes)	1	class	Keep hidden until procedure step 6.
Colored pencils in two colors	1 set	group	
Public-domain U.S. Geological Survey photographs of the pumice plain and the blowdown zone (optional)	1 set	class	
Recording sheet	1	student	

Estimated cost: 3 to 6 per class (an estimate; Estimate. About 16 sheets of cardstock for eight card sets (about 2 dollars), a roll of adding-machine tape (about 2 dollars) and envelopes; sticky notes, scissors and colored pencils are classroom stock. Laminated card sets last for years.)

Safety

- Scissors: cut away from fingers and pass them handle first.
- If the timeline is laid out on the floor, keep it along a wall and out of walkways so no one trips or slips on the paper strips.
- No other hazards beyond ordinary classroom materials.

Teacher preparation and setup

1. Print one 12-card set per group on cardstock, cut the cards apart and shuffle each set into a labeled envelope.
2. Cut and label two timeline strips per group, each with an arrow from 'earlier' to 'later'.
3. Copy the reveal strip from the answer key's teacher notes (zone names, card letters in order, approximate dates) onto chart paper or a slide, and keep it hidden until step 6.
4. Do not show presentation slide 11 before the lab; it is the pumice-plain timeline and gives the order away. Slides 8 to 10 (succession, primary versus secondary, biological legacies) are good preparation.
5. For students who need more support, prepare a reduced eight-card deck (D, F, J, H for one zone and G, I, A, E for the other) with the first and last card of each zone already placed on the strips.

Investigation design

Independent variable	The kind of ground the eruption left: new pumice with no soil or survivors (pumice plain), or ash over surviving forest soil with roots, seeds and animals (blowdown zone).
Dependent variable	The order and pace of recovery inferred from the cards (which organisms appear, plant size, soil development) and the percent plant cover in the teaching dataset.
Controlled	Both zones were hit by the same eruption on the same day; Both card sets come from the same observer using the same kinds of observations; Every placement must be justified by a clue printed on a card, not by outside knowledge; Both cover series use the same measure (percent of ground covered by living plants) in the same years
Trials	One full sort and sequence per group; after the reveal the class tallies which cards were most often misplaced and why.
Comparison	The two zones are each other's comparison: same eruption, same day, different starting ground.

Student procedure

1. Read the case at the top of the recording sheet together. An ecologist visited two study zones north of Mount St. Helens again and again after the May 18, 1980 eruption. The pages fell out of the notebook and the dates were lost. Every card belongs to one of the two zones, except possibly one.
2. The Card reader reads all twelve cards aloud. On this first pass the Recorder notes any clue that might tell which zone a card came from.
3. Sort the cards into two piles, Group 1 and Group 2, using a clue that matters to living things, not just how the place looks. Set aside any card that fits neither group. Record the sort and the clue in Table 1.
4. Lay each pile on its timeline strip from earlier to later. For every card the Skeptic asks: what had to happen before this could happen? Write that clue in Table 2 or Table 3. Mark any card that could go in two positions with a '?' sticky note and record both options.
5. Answer q1 and q2 before the reveal.

6. Reveal: your teacher posts the reveal strip with zone names and approximate dates. Without moving any cards, count how many you placed in the correct position in each zone, then answer q3.
7. Decide which zone shows primary succession and which shows secondary succession, and find the cards that prove it (analysis question q4).
8. Graph both columns of the plant-cover dataset on the same grid, using one color per zone and a key, and do the calculations in q5.
9. Answer the remaining analysis questions; finish any at home. Return the cards to the envelope in letter order.

Expected observations

- Most groups sort the cards correctly within five or six minutes once someone notices that some cards mention old soil, roots or fallen logs and others mention only pumice.
- Groups usually place the first and last card of each zone correctly; the middle of the pumice sequence (J, B, L) produces the most debate.
- Many groups first put card C with the blowdown cards because it mentions fallen logs and old soil; a Skeptic who notices 'planting' and 'outside the protected area' usually moves it aside.
- On the graph the blowdown line climbs steeply in the 1980s and levels off near the top, while the pumice line stays near zero for about a decade and then rises steadily.

Likely difficulties

- Students use outside knowledge or a remembered timeline instead of card clues. Insist that every placement cite a phrase printed on a card; that is the evidence habit the chapter builds.
- Students sort by greenness and put the late pumice cards with the blowdown cards. Ask what was under the ground in each place on the first day.
- Students read the dead lupines on card B as an early stage. Point out that caterpillars that eat lupine need plenty of lupines first.
- In q5 some students divide by the number of rows instead of the number of years. Model one example: change in cover divided by change in years.

Structured debrief

1. Ask which clue sorted the cards. Push past 'gray versus green' to the biological clue: old soil with roots, seeds and survivors versus new pumice with none. That clue is the difference between secondary and primary succession.
2. Have groups report the card they argued about most. Common disputes are J versus B on the pumice plain and A versus K in the blowdown zone; resolve each by asking what the later card needed from the earlier one (patches must exist before they merge; a tree must survive before it can grow taller than a person).
3. Use the graph to introduce resilience: the blowdown zone bounced back quickly because so much survived, while the pumice plain had to start from nothing and, forty years later, is still not a forest. Point out that the slopes are equal from 2000 to 2010 and that after 2010 the pumice line is the steeper one.

4. Show slide 11 as the official timeline and connect it to card F: published accounts disagree on whether the first lupine was found in 1981 or 1982, a small example of why scientists cross-check records.
5. Close with the wild card: replanting is a human change layered on top of the natural one, and mixing replanted land into a study of natural succession would muddle the comparison. This sets up the with-and-without reasoning in Lab 3.

Recording sheet: what students fill in

Lab 1 recording sheet: The mixed-up field notebooks

The case — After Mount St. Helens erupted on May 18, 1980, an ecologist visited two study zones north of the volcano again and again for forty years, writing a short field note on each visit. Twelve pages survived, but the dates did not. Your job: sort the pages by zone, put each zone's pages in order, and back every decision with a clue printed on the page. Some notes include background facts the ecologist added. One page may not belong to either study zone. (The ecologist is imaginary; the observations are based on what real scientists reported.)

Field-note cards (cut apart)

1 Card A

Rain has cut small gullies through the gray ash layer, and the old brown forest soil shows in their walls. Huckleberry and other shrubs have grown back from roots that survived underground and now form clumps about waist high. Small fir trees that lived through the blast under a snowbank are putting out new upward shoots above the ash.

2 Card B

Many lupine patches have grown and run together into wide mats. In other patches most of the plants are brown and dead: I found moth caterpillars tunneling inside the roots and feeding on the plants. Grasses and other wildflowers are scattered among the lupines, and elk hoofprints and droppings cross the plain.

3 Card C

Trucks are hauling fallen logs out of this valley, and crews are planting young Douglas-fir and noble fir seedlings in rows, digging each hole down through the ash to the old soil. Note to self: this land is outside the protected area, so its owners can log and replant it.

4 Card D

Gray pumice and ash stretch in every direction. I dug a pit 50 cm deep and found only more pumice: no old soil, no roots, no buried seeds. After rain, steam hisses from a few pits, so the deposit is still hot underneath. My insect traps caught many beetles, flies and spiders that had blown in on the wind; most were dead or dying.

5 Card E

A dense young forest of fir and hemlock now shades many slopes, and the ground under it is cool and dim. The giant trees that fell long ago have gone soft and crumbly, and mosses, ferns and mushrooms grow on them. Woodpeckers drum on dead trees that are still standing.

6 Card F

One lupine plant is blooming on the open pumice, with a ring of tiny lupine seedlings around it. I cannot see another plant for kilometers. Background: lupines are legumes. Bacteria living in small bumps on their roots turn nitrogen gas from the air into nutrients the plant can use, so a lupine can grow where the ground has almost no nitrogen.

7 Card G

Huge trees lie flat in rows, most pointing away from the volcano, under a gray layer of ash and broken rock. When I dig through it, I reach the old brown forest soil, still full of roots. On a steep slope that was still under snow on the day of the eruption, small fir trees are bent over, but their needles are green.

8 Card H

Thickets of willow and alder along the streams are now well over my head. A few young conifers grow in sheltered spots, far apart from one another. Under the meadow plants there is a thin layer of dark, crumbly soil on top of the pumice. From a ridge, the plain is a patchwork of green and gray; there is still no forest.

9 Card I

Fireweed and bracken fern shoots are pushing up through cracks in the ash. When I dig beside them, I find their roots and underground stems running down into the old soil. Dark mounds of soil mixed with ash dot the gray surface where pocket gophers have tunneled up from below, and tiny seedlings are sprouting on some of the mounds.

10 Card J

Lupines now grow in scattered patches a few meters wide. Inside a patch, the pumice is darker and holds dead lupine leaves and bits of litter blown in by the wind. Soil tests show more nitrogen inside the patches than in the bare pumice between them. Seedlings of other plants, such as fireweed, pearly everlasting and grasses, sprout far more often inside the patches, especially where old lupines have died, than outside them.

11 Card K

Young conifers taller than I am grow in patches between the fallen logs, and shrubs shade much of the ground. The fallen logs are starting to rot; moss and small mushrooms grow on their bark. Songbirds sing from the young trees.

12 Card L

Small streams fed by springs cross the plain, and their banks are lined with willow and alder shrubs, a few already taller than I am. I counted tadpoles in a shallow pond. Between the streams, meadows of lupine, grasses and wildflowers alternate with wide gray patches of bare pumice.

Table 1. Sorting the cards

	Card letters	The clue that sorts them, and why it matters to living things
Group 1		
Group 2		
Fits neither group		

Table 2. Group 1, earlier to later (you may not need every row)

Position	Card	Clue: what had to happen before this?
1		
2		
3		
4		
5		
6		
7		

Table 3. Group 2, earlier to later (you may not need every row)

Position	Card	Clue: what had to happen before this?
1		
2		
3		
4		
5		
6		
7		

1. Which clue did your group use to sort the cards into two groups? Explain why that clue matters to plants and animals, not just to the way the place looks.

Answer: The clue is what lay under the surface. Cards G, I, A, K and E mention old forest soil, surviving roots, fallen logs or trees that lived through the eruption; cards D, F, J, B, L and H describe pumice with no old soil, roots or seeds. This matters to living things because soil holds water and nutrients and already contains roots and seeds that can regrow at once, while bare pumice holds almost no nitrogen and every organism has to arrive from somewhere else.

Why: Sorting by greenness fails because the late pumice cards are green too. The soil-and-survivors clue is biological, and it is the basis of the primary-versus-secondary distinction in q4.

Also acceptable: Accept 'survivors versus no survivors' or 'flattened forest versus buried ground' when the student explains why it matters to organisms.

- Names the soil or survivors clue
- Explains how that clue affects organisms (water, nutrients, roots or seeds)

2. Which card was hardest to place in order? Write the two positions you considered and the clue that settled it, or the clue you wish the card had.

Answer: Answers vary. A common example: J versus B on the pumice plain. Card B says the patches 'have grown and run together' and grasses are scattered among the lupines, so the separate patches of card J must come first.

Why: Credit the reasoning about what the later card needed from the earlier one, not the particular card chosen.

- Names the card and the two positions considered
- Cites a phrase that settles it, or names the clue that is missing

After the reveal

3. How many cards did your group place in the correct position in each zone? Choose one card your group (or another group) misplaced and explain which clue was misread.

Answer: Correct order: pumice plain D, F, J, B, L, H; blowdown zone G, I, A, K, E; card C belongs to neither. Students report their own counts out of 6 and 5 and explain one misread clue, for example placing B before J by reading the dead lupines as an early stage instead of noticing that the caterpillars need abundant lupines first.

Why: The count is the group's own; full credit needs an honest count and a specific explanation that links the error to a clue on a card.

- Reports a count for each zone
- Explains one error in terms of a specific clue

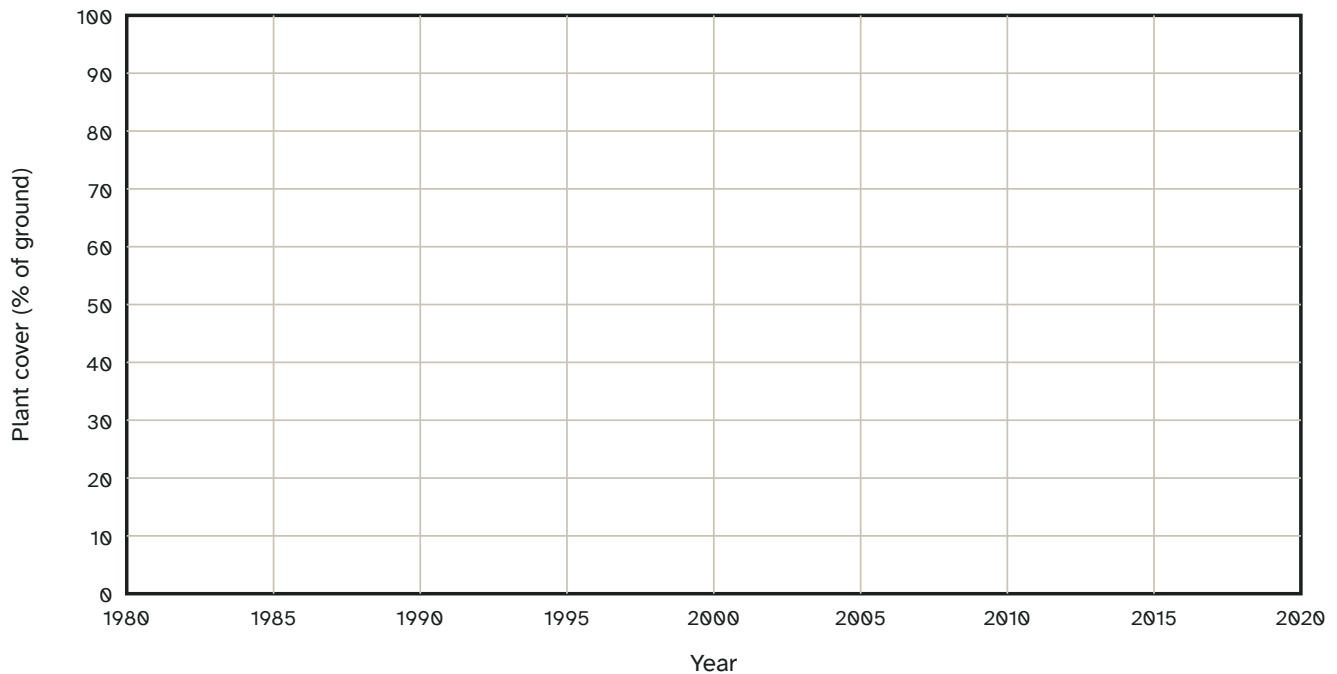
Plant cover in the two zones after the eruption

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Year	Pumice plain: plant cover (% of ground)	Blowdown zone: plant cover (% of ground)
1981	0	2
1985	1	15
1990	3	38
2000	15	70
2010	30	85
2020	45	90

Simulated teaching dataset. The numbers are invented; the pattern, with cover returning far faster in the blowdown zone, matches what ecologists described.

Plant cover over time in two zones



Analysis questions: answer key

4. Which zone shows **primary succession** and which shows **secondary succession**? Support each answer with two cards (give their letters) and the clue on each card that decided it.

Answer: The pumice plain (D, F, J, B, L, H) is primary succession. Card D shows pumice 50 cm deep with no old soil, roots or seeds, and card F shows a single plant kilometers from any other, so life had to arrive from outside and build soil; a thin soil appears only in card H. The blowdown zone (G, I, A, K, E) is secondary succession. Card G shows old forest soil under the ash and green firs that survived under snow, and card I shows fireweed and bracken resprouting from roots in the old soil and pocket gophers that survived underground.

Why: The defining difference is the starting material: no soil and no survivors (primary) versus soil and survivors left behind (secondary). Two cards per zone with the deciding clue earns full credit.

Also acceptable: Card A (shrubs regrowing from surviving roots, old soil in gully walls) and card J (soil being built inside lupine patches) are also strong choices.

- Pumice plain is primary; blowdown zone is secondary
- Two cards per zone cited by letter
- The soil or survivors clue named for each zone

5. Use the dataset. (a) Calculate the average gain in plant cover per year in each zone from 1981 to 1990, and how many times faster the blowdown zone gained cover. (b) Repeat for 2000 to 2020. What changed, and why might the blowdown zone's gain have slowed?

Answer: (a) 1981 to 1990 is 9 years. Blowdown zone: $(38 - 2) \div 9 = 36 \div 9 = 4.0$ percentage points per year. Pumice plain: $(3 - 0) \div 9 \approx 0.33$ percentage points per year. $4.0 \div (3 \div 9) = 4.0 \times 3 = 12$, so the blowdown zone gained cover about 12 times faster. (b) 2000 to 2020 is 20 years. Blowdown zone: $(90 - 70) \div 20 = 1.0$ point per year. Pumice plain: $(45 - 15) \div 20 = 1.5$ points per year, so the pumice plain was now gaining faster. The blowdown zone slowed because it was already close to full cover, so there was little bare ground left to fill; the pumice plain still had plenty of bare ground, and its pioneers had built up enough nitrogen and soil for many more plants to grow.

Why: Rate = change in cover $\div$ change in years. The second part checks that students read the changing slopes on their graph instead of assuming the faster zone always stays faster.

Also acceptable: Accept 0.3 points per year and a ratio of 12 to 13 from rounding. Accept 'cover cannot go above 100 percent' as the reason for the slowdown.

6. (a) Name two biological legacies in the blowdown cards. (b) Name the first arrivals recorded on the pumice plain and say where they came from. (c) Explain why legacies let the blowdown zone recover faster.

Answer: (a) Any two: the firs that survived under snow (G, A); roots and underground stems of fireweed and bracken in the old soil (I); shrubs regrowing from surviving roots (A); pocket gophers that survived underground (I); the old forest soil itself; the fallen logs (G, K, E). (b) The first arrivals on the pumice plain were insects and spiders blown in on the wind (D), most of which died, and then the lupine that grew into the plant on card F. Both came from outside the zone; the lupine seed was carried in by wind, water or an animal, and scientists are still not sure exactly how. (c) Legacies are in place on the first day: they do not have to travel, they start with soil water and nutrients, and roots can resprout within weeks instead of waiting years for seeds to land and survive. Gophers even mixed old soil up into the ash, making seedbeds.

Why: The distinction is survivors in place versus newcomers from elsewhere. Full credit needs two legacies, the first arrivals with their source, and a reason tied to time or resources.

- Two biological legacies from blowdown cards
- First pumice arrivals and that they came from outside
- Reason legacies speed recovery (already present, soil resources, resprouting)

7. Card J says other seedlings sprouted far more often inside lupine patches. Explain how the lupine, a living thing, changed a nonliving part of its surroundings, and how that change affected other plant populations. Then use card B to explain why the lupine did not simply take over the whole plain.

Answer: Bacteria in the lupine's roots take nitrogen from the air, so when lupine leaves and roots die they add nitrogen and organic matter to the pumice, and the patches also trap wind-blown litter and seeds (card J). That is a living part changing a nonliving part: the nitrogen and organic matter in the ground. Nitrogen was the resource missing from bare pumice, so seedlings of fireweed, pearly everlasting and grasses survived inside the patches far more often than outside, and those populations grew where lupines had been. Card B shows why lupine did not cover everything: moth caterpillars feeding inside the roots killed many lupines, so a consumer population limited the pioneer population, and the other plants moving into the enriched patches also compete with it.

Why: This is facilitation, the engine of succession: an early species changes conditions so that later species can survive. The caterpillars show that pioneers are themselves limited by interactions with other populations.

- Lupine adds nitrogen (and organic matter, trapped seeds) to the ground
- Names this as a living part changing a nonliving part
- Links the nitrogen to more seedlings of other species
- Uses card B: herbivores (and competition) limit the lupine

8. Card C is the wild card. Why does it not belong in either study zone? Why would ecologists studying natural recovery keep their study plots out of logged and replanted land?

Answer: Card C records people logging and replanting land outside the protected area, so it is not a record of natural recovery in either study zone, even though the eruption affected that land much as it affected the blowdown zone. Ecologists keep their plots out of replanted land so that the main difference between their zones is the one they are studying, the ground the eruption left. Planted seedlings would make recovery look faster for a reason that has nothing to do with survivors or arrivals. Replanted land can be compared with unplanted blowdown land as a separate with-and-without study.

Why: This is the logic of a fair comparison. A student who placed C in the blowdown zone earns full credit by explaining why it does not belong.

- Identifies C as human-replanted land, not natural recovery
- Explains that mixing it in would add a second cause and spoil the comparison

9. Claim: *the kind of ground a disturbance leaves behind affects how fast populations return*. Support or refute this claim with at least two cards and one number from the dataset, explain the reasoning that connects them, and name one weakness in this evidence.

Answer: Model response: The claim is supported. On the pumice plain the eruption left new ground with no soil or survivors (card D); the first plant appeared only after a year or two (card F), cover was still about 3 percent in 1990 and 45 percent in 2020, and there is still no forest (card H). In the blowdown zone the soil, roots and snow-protected firs survived (cards G and I); cover rose from 2 to 38 percent by 1990 and the zone became a dense young forest (card E). Reasoning: soil and survivors supply water, nutrients, roots and seeds immediately, so plant populations, and the animals that need plants, return much faster than where every organism must arrive and build soil first. Weakness: the cover numbers are a teaching dataset, there is only one site of each kind, and the zones differ in other ways, such as distance from the crater and from surviving forest that can supply seeds, so other factors could add to the difference. Surveys of many plots in each zone would strengthen the argument.

Why: This is an argument from evidence in the form the performance expectation asks for, practiced here with summarized and simulated evidence. Look for evidence that is specific (letters and numbers) and reasoning that names the mechanism, not just the pattern.

- A clear claim (supports or refutes)
- At least two cards cited by letter and one number from the dataset
- Reasoning that links soil and survivors to how fast populations return
- One real weakness (simulated data, one site per zone, other differences such as distance to seed sources)

Individual evidence of learning

Each student completes their own Tables 1 to 3 and answers q1 to q9. The q4 primary-versus-secondary decision with card evidence and the q9 argument are the main individual evidence; q5 checks the rate calculation and q7 checks the mechanism by which a pioneer changes conditions for the species that follow.

Assessment criteria

Criterion	Proficient looks like
Evidence-based sequencing	Both zones are in a defensible order, every placement is justified by a phrase from a card, and disputed cards are flagged with both options considered.
Primary versus secondary succession	Identifies the pumice plain as primary and the blowdown zone as secondary, with soil and survivors as the deciding clue, supported by two cards for each zone.
Rate calculation	Computes both average yearly gains with units and the ratio for 1981 to 1990, repeats for 2000 to 2020, and explains why the blowdown gain slowed.
Mechanism and argument	Explains how lupine changed nitrogen and organic matter for later plants and writes a claim supported by cards and a number, with connecting reasoning and one real weakness named.

Accessibility adaptations

- Reduced eight-card deck (D, F, J, H and G, I, A, E) with the first and last card of each zone already placed, for students who need more support.

- The Card reader role means no student has to decode every card alone; provide an audio recording of the cards for students who use text-to-speech.
- Add simple icons to the cards (soil, lupine, shrub, tree, animal) and a bilingual glossary for pumice, legume, nitrogen, seedling, thicket and conifer for multilingual learners.
- Run the timeline on the floor or a wall so students who need movement can stand and move cards; seated students use the same strips on a desk.
- Provide large-print cards and a graph grid with larger squares for students with low vision.

Low-cost alternative

Print the twelve cards on plain paper, six to a page, and have students sequence them by writing card letters in Tables 2 and 3 instead of laying out strips. Projecting one class set and voting on each placement also works as a whole-class mystery, with groups defending their votes.

Model limitations

The field notes are a teaching composite written for this lab. The observer is imaginary, the observations summarize what ecologists reported from the pumice plain and the blowdown zone, and the dates on the reveal strip are approximate because real changes happened gradually and unevenly. The plant-cover numbers are simulated to show the pattern ecologists describe; they are not measurements. The real blast area had more than two zones (the hummocky debris-avalanche deposit, mudflow channels, the scorched standing-dead forest, and lakes such as Spirit Lake each recovered differently), and recovery was patchy within each zone. Laying cards in a single line also hides the fact that many changes happened at once. This activity has not been physically tested with students; the timing is an estimate.

Teacher notes

Reveal strip (post at step 6). Pumice plain: D (1980 to 1981), F (1981 or 1982; published accounts differ), J (mid-1980s), B (late 1980s to 1990s), L (2000s), H (2020s). Blowdown zone: G (summer 1980), I (summer 1980 to 1981), A (early to mid-1980s), K (1990s), E (2010s to 2020s). Neither zone: C (early to mid-1980s, salvage logging and replanting on land outside the national volcanic monument). All dates are approximate. The monument was created in 1982 and most of the blast zone inside it was left to recover on its own, which is why it became a natural experiment. The cards are an original composite: the observations match published accounts (no soil or survivors on the pumice plain; wind-blown insects and spiders as early arrivals; a lone prairie lupine with a ring of seedlings, kilometers from other plants, as the first plant; more nitrogen and more seedlings of other species in lupine patches; root-boring caterpillars limiting lupine; willow and alder along spring-fed streams; conifer saplings protected by late snow, fireweed and bracken resprouting, and pocket gophers surviving in the blowdown zone; salvage logging and replanting outside the monument), but the observer and the wording are invented. Accept a different middle order only when the student's clue truly supports it; for example, L cannot come before B, because L describes willow and alder shrubs along streams and meadows across the plain that B does not have. The dataset is simulated; say so when students graph it.