

Trucks Full of Bees: The Almond Bloom Puzzle

Learning target: I can describe a pattern in how almond flowers turn into nuts, connect it to the bees that growers truck in each winter, and write a first explanation of what an orchard depends on that it does not own.

Phenomenon exploration

About 30 min

Individual

MS-LS2-5 · supports

MS-LS2-2 · supports

discussion

writing

data analysis

Standards connections

MS-LS2-5 (supports): Students meet the chapter's phenomenon: an orchard that depends on a pollination service it has to rent. This sheet raises the questions that the later work on evaluating solutions for maintaining ecosystem services will answer; it does not yet evaluate any solution.

MS-LS2-2 (supports): Part B asks students to recall the bee-and-flower relationship as a mutually beneficial interaction from earlier lessons, which is the pattern the orchard's harvest depends on.

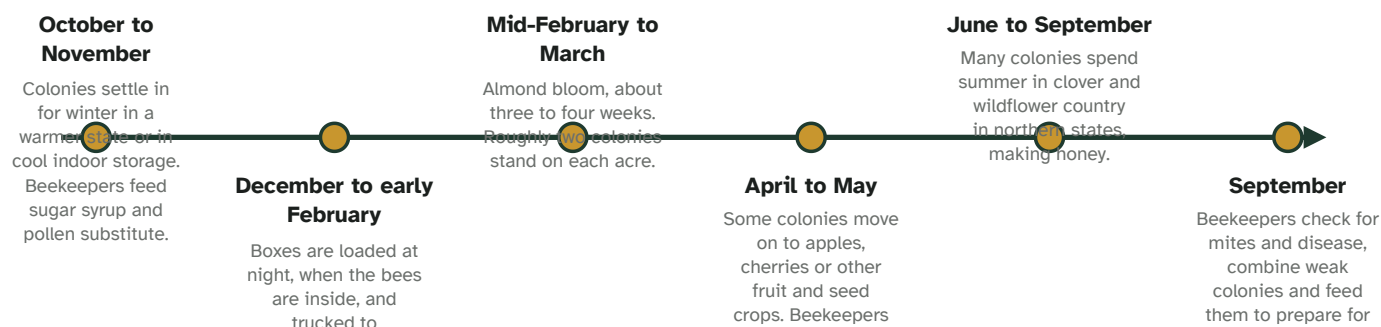
Purpose: activate · **Time:** about 30 minutes · **Format:** individual

Answers with reasoning

Observation 1: An orchard that rents its bees

Each year in late winter, usually starting in mid-February, more than a million acres of almond orchards in California's Central Valley burst into white and pale-pink blossom. California grows most of the world's almonds, and most of its trees flower within the same few weeks. Before the first buds open, trucks start arriving at night, each one stacked with wooden boxes of honey bees from beekeepers in many states. Growers pay a rental fee for each colony and usually set out about two colonies per acre. By recent estimates, the almond bloom uses most of the managed honey bee colonies in the United States. When the petals drop, the boxes go back on the trucks and leave. One more surprise: honey bees are not native to North America. European colonists brought them over in the 1600s.

One example year for a traveling honey bee colony



An example of one migratory honey bee colony's year, simplified. Real routes differ from beekeeper to beekeeper and from year to year.

Observation 2: The mesh-bag test

A grower wants to know how much her trees need the bees. Just before bloom, she slips a bag of fine mesh over one branch on each of four trees. Bees cannot reach the flowers inside, but light, air and rain can. She ties a ribbon on a second branch of similar size on each tree and leaves it open. She counts the flowers on every branch at bloom, and in early summer she counts how many of those flowers became almonds.

Flowers and almonds on bagged and open branches (teaching dataset)

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

Tree	Bagged branch: flowers	Bagged branch: almonds	Open branch: flowers	Open branch: almonds
Tree 1	120	2	115	38
Tree 2	98	0	104	31
Tree 3	132	3	126	44
Tree 4	110	1	118	35

Simulated data for teaching. The pattern is realistic for almond varieties that need pollen from a different variety, but these counts were not measured in a real orchard.

Part A: Notice and wonder

- Write three things you **notice** in the two observations. At least one must use a number from the table.

Answer: Examples: the bagged branches made only 0 to 3 almonds each while the open branches made 31 to 44; the branches had similar numbers of flowers (98 to 132); thousands of bee colonies arrive just before bloom and leave right after; growers pay for the bees; honey bees are not native to North America; the colonies travel to several crops in one year.

Why: Any accurate observation from the text, the timeline or the table counts. At least one must cite a value from the table.

Also acceptable: Accept observations about timing ('the bees come right before the flowers open') or cost ('growers pay for each colony').

- Three observations, not explanations
- At least one uses a number from the table
- Observations come from the sheet

- Write three questions you **wonder** about. Start each with *why*, *how* or *what would happen if*.

Answer: Examples: Why can't the trees make almonds without bees? How do bees find food when the almonds are not blooming? What would happen if beekeepers stopped coming? Why are honey bees used if they are not native? Do wild bees also visit almond flowers?

Why: Questions should come from the observations and be answerable by investigation or by the chapter's ideas.

Also acceptable: Questions about the method ('Did the bag change the temperature of the flowers?') are good science questions and earn credit.

- Three questions
- Each begins with why, how or what would happen if
- Each connects to the observations

3. Add up the flowers and the almonds for all four bagged branches, then for all four open branches. What percent of flowers became almonds in each group? Show your work and round to one decimal place.

Answer: Bagged: flowers $120 + 98 + 132 + 110 = 460$; almonds $2 + 0 + 3 + 1 = 6$; $6 \div 460 \times 100 = 1.3\%$.
Open: flowers $115 + 104 + 126 + 118 = 463$; almonds $38 + 31 + 44 + 35 = 148$; $148 \div 463 \times 100 = 32.0\%$.
About 32 percent of open flowers became almonds compared with about 1 percent of bagged flowers.

Why: Totals must be found before dividing. The comparison (roughly 25 times as many nuts per flower on open branches) is the pattern the chapter explains.

Also acceptable: Accept 1.3% and 31.9% or 32%; accept 'about 25 times more' as a comparison.

Part B: What you already know

4. From earlier lessons on interactions: what does a bee get from a flower, and what does the plant get from the bee? What kind of interaction is this?

Answer: The bee gets food: sugary nectar and protein-rich pollen. The plant gets its pollen carried to another flower so seeds and fruit can form. Both benefit, so it is a mutually beneficial interaction (mutualism).

Why: Recalls interactions among organisms from earlier lessons; the orchard's harvest depends on this relationship.

Also acceptable: Accept 'both organisms benefit' without the word mutualism.

- Bee gets nectar or pollen as food
- Plant gets pollen moved between flowers
- Names mutualism or a mutually beneficial interaction

Part C: Your first explanation

5. Explain why so few flowers inside the bags became almonds. Use the words *pollen* and *pollination*. Then name one other possible reason for the result that the grower would need to rule out.

Answer: The bags kept bees away, so almost no pollen was carried onto the flowers inside. Pollination, moving pollen to the sticky tip of a flower's female part, has to happen before a flower can make a seed, and an almond is the seed of the fruit. Without visiting insects, nearly no flowers were pollinated, so nearly none became nuts. Another possible reason to rule out: the bag itself might have harmed the flowers, for example by trapping heat, rubbing the petals or keeping out light. The grower could test this with a bag of the same mesh that she opens briefly to let pollen in, or by hand-pollinating some flowers inside a bag.

Why: A full answer links the bag to blocked pollen transport, links pollination to nut formation, and names a competing explanation, which is the habit the chapter builds before claims about causes.

Also acceptable: A student who says 'the flowers needed bees to make nuts' has the core idea; credit the competing explanation separately.

- Bags blocked bees from carrying pollen
- Pollination is needed for a flower to make a seed or nut
- Names one other possible cause (heat, shading, damage, disease)

6. Most almond varieties cannot make nuts from their own pollen or from pollen of trees of the same variety. Growers plant rows of a second variety between rows of the main one. Explain why this makes insects even more important to the orchard.

Answer: The pollen a flower needs must come from trees of the other variety, which grow in different rows. Something has to carry pollen across from row to row during the short bloom. Insects such as bees do this as they fly from tree to tree looking for food, so without them very little pollen would reach the right flowers.

Why: Cross-pollination between varieties is the reason almonds depend so heavily on insect pollinators.

Also acceptable: Accept 'the bees have to carry pollen from one kind of tree to the other kind'.

- Pollen must come from a different variety
- Pollen has to move between rows or trees
- Bees do that moving as they forage

7. The bees stay in the orchard for only a few weeks. Where do you think they find food the rest of the year, and what could happen to the orchard's harvest if those places disappeared? Write your best explanation of something the orchard depends on that the grower does not own or control.

Answer: When almonds are not blooming, bees need other flowers: wildflowers, clover, fruit and seed crops, and plants along roadsides and in wild areas in the states the colonies travel to. Wild bees also need nesting places such as bare ground, hollow stems or wood. If those flower-rich places were plowed, paved or sprayed, colonies would be weaker or fewer, beekeepers would have fewer to rent, and the orchard would get less pollination and fewer almonds. So the orchard depends on healthy land and flowers far away from it, and on healthy bee populations, none of which the grower owns.

Why: This is the chapter's central idea in draft form: farms rely on services from ecosystems they do not control. The key is a reasoned chain, not a perfect answer.

Also acceptable: Accept answers about beekeepers' feeding with sugar syrup if the student also notes that syrup alone cannot keep colonies healthy (they need pollen for protein).

- Names a food source for bees outside the bloom
- Connects loss of that source to fewer or weaker bees
- Connects fewer bees to a smaller harvest
- States that the orchard depends on something outside its control

8. List three other things the orchard gets from nature without paying for them directly. Think about soil, water, weather and other living things.

Answer: Examples: fertile soil built and kept fertile by decomposers; rain and snowmelt that fill rivers and groundwater used for irrigation; wild bees and other insects that also pollinate; birds or insects that eat pests; earthworms and soil microbes that recycle nutrients; winter chill and spring sunshine the trees need.

Why: Students are listing ecosystem services before learning the term; any natural benefit to the orchard counts.

Also acceptable: Accept weather and sunlight even though they are not provided by living ecosystems; note during discussion that the chapter's term 'ecosystem service' focuses on benefits from living systems.

- Three distinct benefits from nature
- Each benefits the orchard

9. Write one question you could investigate about the orchard and its bees, and one measurement that would help answer it.

Answer: Examples: 'Do orchards next to wild land get more almonds per flower?' measured by counting nuts per flower on trees at different distances from wild land; 'How many bee visits does a flower need?' measured by watching flowers and counting visits, then counting which flowers became nuts.

Why: The question must be testable and the measurement must be something that could actually be counted or measured.

Also acceptable: Accept questions about bee health or travel if paired with a measurable quantity.

- A testable question about the orchard or bees
- A specific measurement that would help answer it

Keep this page — At the end of the chapter you will reread your answers to q5 and q7 and mark what you would keep, change or add. An explanation that changes as you learn is a sign of good thinking, not a mistake.

Teacher notes

The bag-test dataset is simulated but follows a realistic pattern: with good pollination, roughly a quarter to a third of almond flowers become nuts, and most varieties set almost nothing without insect visits because they need pollen from a compatible variety (pollinator exclusion bags are a standard field method). Statements in Observation 1 are hedged deliberately: acreage and colony numbers change every year, and the share of U.S. managed colonies used in the bloom is an estimate. Expect students to assume honey bees are wild natives and to say bees 'make' the almonds; both come back in later sheets (W5 on replacement cost, W7 on honey bees and biodiversity). q8 previews the term ecosystem service; collect the lists for the vocabulary work in W2.

Scaffold offered to students: Sentence starters for Part C

For q5 try: 'Inside the bag, pollen could not ___ because ___. Without pollination, a flower cannot ___.' For q7 try: 'When almonds are not blooming, the bees need ___, which they can find in ___. If those places were plowed or paved, then ___.' For q8 think about what you would have to buy or build if nature stopped doing it.

Extension: A tree that can pollinate itself

Plant breeders have developed a few almond varieties that can set nuts with their own pollen, and growers of these varieties often rent fewer colonies per acre. Predict what the mesh-bag test would show on a self-fertile variety, and explain why such growers may still place some bees in the orchard. Then name one advantage and one risk of planting a whole orchard of a single self-fertile variety.