

Twelve Years at Hollow Creek: Graphing Voles and Owls

Learning target: I can graph predator and prey counts, calculate lags, percent changes and prey-per-predator ratios, and use the results to explain a repeating pattern and the factors that bend it.

Data and graphing

About 45 min

Individual

MS-LS2-2 · practice

MS-LS2-1 · supports

data analysis

independent practice

Standards connections

MS-LS2-2 (practice): Students quantify the lagged predator-prey pattern in one meadow and then argue whether the same pattern should appear in a different ecosystem with different species, which is the core of predicting interaction patterns across ecosystems.

MS-LS2-1 (supports): Voles are the owls' main food resource, so the owl counts show how the availability of a resource affects a population; the sheet also includes a dry year in which the voles' own food ran short.

Purpose: practice · **Time:** about 45 minutes · **Format:** individual

Answers with reasoning

Each spring, a field crew counts meadow voles (small, fast-breeding rodents) on a marked 10-hectare patch of Hollow Creek Meadow, and counts the breeding pairs of barn owls nesting in the valley around it. Voles are the owls' main prey. The crew also notes anything unusual about the year.

Hollow Creek Meadow spring counts, years 1-12 (teaching dataset)

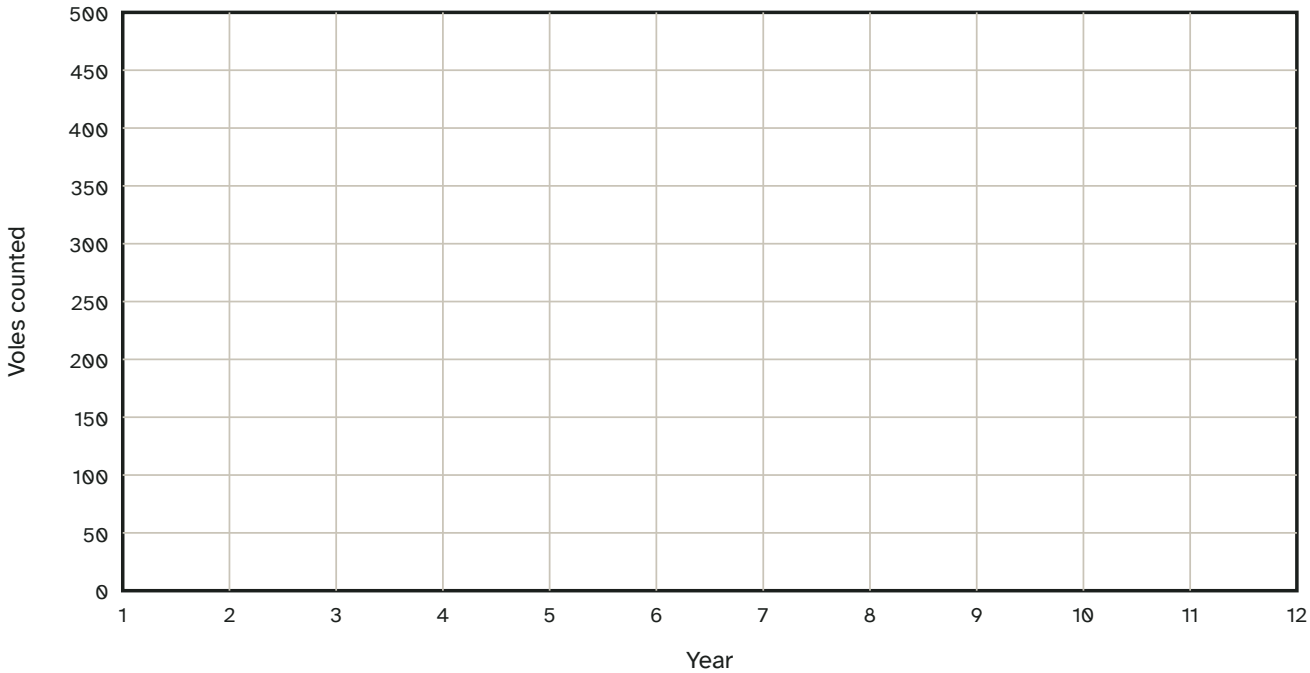
Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Year	Voles counted on the 10 ha patch	Barn owl breeding pairs in the valley	Crew notes
1	120	4	
2	260	5	
3	410	9	
4	380	14	
5	190	13	
6	90	8	
7	140	4	
8	300	6	
9	450	11	

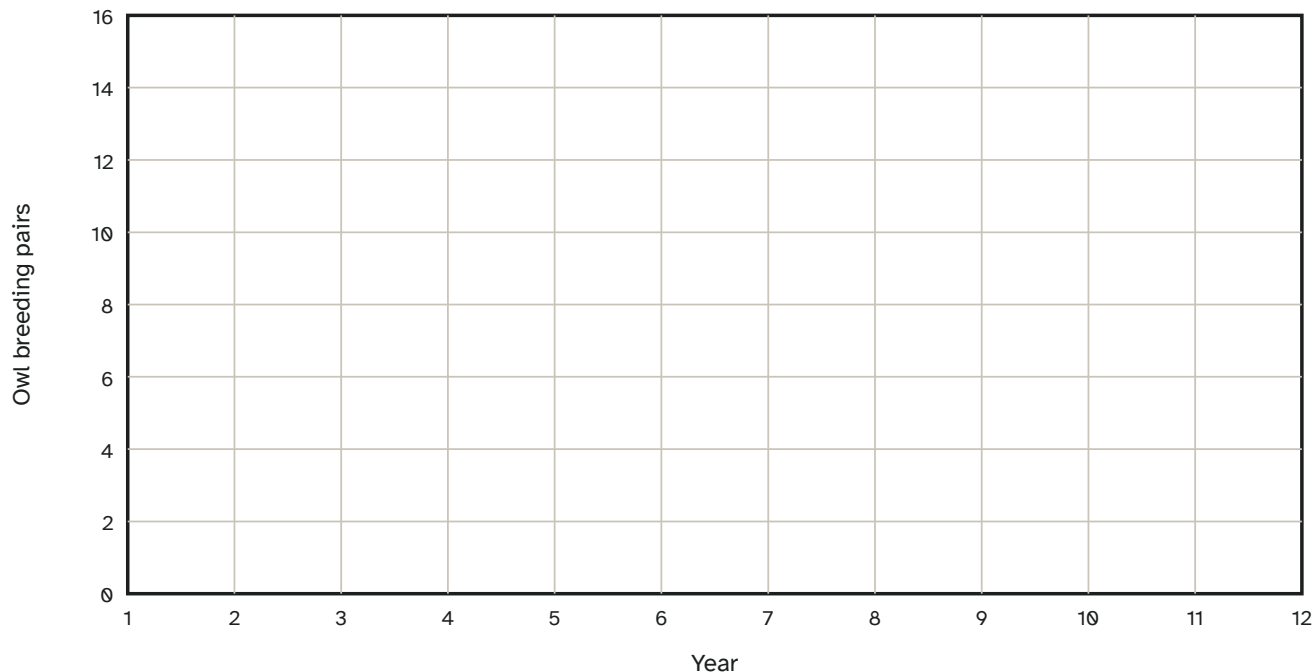
Year	Voles counted on the 10 ha patch	Barn owl breeding pairs in the valley	Crew notes
10	330	15	Dry summer; grass set very little seed
11	150	12	
12	110	7	

Simulated data for teaching. Realistic for a vole population that cycles every few years and a small owl population that depends on it.

Graph 1. Voles counted on the patch, years 1-12



Graph 2. Barn owl breeding pairs, years 1-12



Part A: Find the pattern

- Complete the table from your graphs.

Answer: Voles: first peak year 3, 410; second peak year 9, 450; lowest point year 6, 90. Owl pairs: first peak year 4, 14; second peak year 10, 15; lowest point year 7, 4 (year 1 also shows 4, but it is the start of the record rather than a low after a peak).

Why: Read directly from the dataset. Year 12 (110 voles, 7 pairs) is still falling at the end of the record and is not a low.

Also acceptable: Accept year 1 or year 7 for the owl low if the student explains the choice.

- Calculate the lag between each vole peak and the owl peak that follows it. Then calculate the length of one full cycle for voles (first peak to second peak) and for owls. Show the subtractions.

Answer: Lag 1: owl peak year 4 – vole peak year 3 = 1 year. Lag 2: owl peak year 10 – vole peak year 9 = 1 year. Vole cycle: year 9 – year 3 = 6 years. Owl cycle: year 10 – year 4 = 6 years.

Why: Both lags are one year and both cycle lengths are six years; the owl cycle matches the vole cycle because the owls are driven by the voles.

Also acceptable: None; the subtractions are exact.

3. Calculate the percent change in the vole count from its first peak (year 3) to its lowest point (year 6). Use: $(\text{new} - \text{old}) \div \text{old} \times 100$. Round to the nearest whole percent.

Answer: $(90 - 410) \div 410 \times 100 = -320 \div 410 \times 100 = -0.780 \times 100 = -78$ percent. The vole count fell by about 78 percent.

Why: A negative result indicates a decrease; students may report 'a 78 percent decrease.'

Also acceptable: Accept -78% or 'fell 78%'. Accept 78.0% or 78.05% if not rounded.

4. Calculate the number of voles per owl pair in year 3, year 6 and year 9. Round to one decimal place. In which year did each owl pair have the least prey available?

Answer: Year 3: $410 \div 9 = 45.6$ voles per pair. Year 6: $90 \div 8 = 11.3$ voles per pair. Year 9: $450 \div 11 = 40.9$ voles per pair. Each pair had the least prey available in year 6.

Why: $410/9 = 45.56$; $90/8 = 11.25$; $450/11 = 40.91$. Year 6 combines a vole low with an owl population that has not yet fallen, so food per pair is at its worst; this is why the owl count drops the following year.

Also acceptable: Accept 45.6, 11.3 (or 11.25) and 40.9 with the work shown.

Part B: Explain the pattern

5. Describe the shape of the two graphs in one or two sentences, using the words **peak**, **lag** and **cycle**.

Answer: Both graphs rise and fall in a repeating cycle about six years long; each owl peak comes one year after a vole peak, so the owl graph lags behind the vole graph.

Why: The answer must use the three words correctly and state the lag direction (owls after voles).

Also acceptable: Accept 'wave' for cycle if the lag is correctly described.

- Uses peak, lag and cycle
- States that owls trail voles

6. Why does the owl peak come **after** the vole peak instead of in the same year? Explain in terms of what has to happen inside the owl population.

Answer: Owls do not multiply the moment voles become abundant. A year of plentiful voles lets pairs lay more eggs and raise more chicks, and those chicks have to survive the winter and find mates before they are counted as new breeding pairs the next spring. So the owl count responds to the previous year's vole supply, which puts the owl peak one year behind the vole peak.

Why: Full credit needs the reproduction-and-growth delay as the mechanism of the lag.

Also acceptable: Accept 'it takes time for owls to have babies and for the babies to grow up.'

- Explains that owl increase comes from breeding more chicks
- Explains that raising chicks to breeding age takes about a year

7. Look at year 10. Voles dropped from 450 to 330 while owl pairs were still rising to their peak. Using the crew notes, give a cause of the vole drop **other than** owls, and explain what this year shows about predicting population changes.

Answer: The crew notes say year 10 had a dry summer and the grass set very little seed, so the voles' own food ran short; voles started falling because of food, not only because of owls. The year shows that predators are not the only cause of a prey decline: weather and food supply can bend the pattern, so a prediction based on the predator-prey loop alone can be off in timing or size.

Why: This is the sheet's built-in irregularity; the point is that the predator-prey pattern is one cause among several.

Also acceptable: A student who adds that owls at their peak were also eating many voles, so both causes acted together, is giving a stronger answer.

- Names the dry summer or seed shortage as the other cause
- Concludes that predictions from the loop alone are uncertain

8. On the Arctic tundra, lemmings are the main prey of Arctic foxes. Neither species lives at Hollow Creek. Predict whether a 12-year dataset of lemmings and Arctic foxes would show the same pattern as your graphs. State what you expect to be the same, what might be different (for example, the cycle length or the size of the peaks), and why the pattern is likely to repeat even though the species are different.

Answer: Model response: I predict the same shape: lemming peaks followed by Arctic fox peaks, then a lemming crash followed by a fox crash, repeating. The cycle length might differ (lemming cycles are often shorter, around three to five years), the peaks might be far taller because lemmings breed very fast, and the lag might differ depending on how fast foxes breed. The pattern should repeat because the cause-and-effect links are the same: more prey means more food for predators, so predators increase after a delay; more predators then reduce the prey; fewer prey starve the predators; fewer predators let the prey recover. Those links do not depend on which species is involved, only on one species depending on the other for food.

Why: This is the explanation-that-predicts item for MS-LS2-2. Full credit needs a prediction, a same/different split, and the reason (shared cause-and-effect links, not shared species).

Also acceptable: A student who predicts a messier pattern because foxes also eat birds and eggs, or because Arctic weather is harsh, is reasoning well and should get full credit if the shared mechanism is also stated.

- Predicts the lagged cycle
- Names at least one thing that might differ
- Explains that the pattern repeats because the cause-and-effect links are the same regardless of species

9. Suppose a second vole predator, the long-tailed weasel, moves into the valley in year 13 and becomes common. Predict the effect on the owl graph over the following years and explain which interaction between owls and weasels you are describing.

Answer: Weasels and owls both eat voles, so this is competition (both harmed). With weasels taking a share of the voles, each owl pair finds less food, so the owl peaks after year 13 would be lower and the owl population might fall sooner after each vole peak. The vole crashes might also be deeper because two predators are hunting them.

Why: The item asks students to combine two interaction types: owls and weasels compete; both prey on voles.

Also acceptable: Accept 'owls would have fewer chicks because weasels eat some of their food.'

- Names competition between owls and weasels
- Predicts lower owl peaks or faster owl declines

Teacher notes

The dataset is fully simulated and was built so that both lags are exactly one year and both cycles are exactly six years, with one deliberate irregularity (the dry year 10) so that q7 can show a non-predator cause. Real vole and owl data are much noisier; barn owls in particular respond strongly to prey, laying larger clutches and sometimes raising two broods in good vole years. Lemming cycles are typically three to five years, which is why q8 accepts 'shorter cycle' as a likely difference. For the extension, $14 \text{ pairs} \times 1,500 \text{ voles} = 21,000$ voles per year, far above the 380 counted on 10 hectares, which shows the owls hunt over an area many times larger than the counting patch (the patch is a sample, not the whole meadow). Check q4 carefully: the most common error is dividing pairs by voles.

Scaffold offered to students: Percent change in three lines

Write the new value minus the old value on line 1 (the answer is negative if the count fell). Divide by the old value on line 2. Multiply by 100 on line 3 and add the percent sign. Example with made-up numbers: $50 - 200 = -150$; $-150 \div 200 = -0.75$; $-0.75 \times 100 = -75$ percent. For the voles-per-owl-pair question, you are dividing voles by pairs, so the unit of your answer is 'voles per pair'.

Extension: The owls' point of view

Barn owls lay more eggs when prey is abundant and may skip breeding when it is scarce. Using the dataset, estimate how many voles the whole owl population needed in year 4 if each breeding pair plus its chicks eats about 1,500 voles in a year, and compare that number with the 380 voles counted on the 10-hectare patch. Explain why the comparison does not mean the owls ate every vole in the meadow, and what it tells you about how large the owls' hunting area must be compared with the counting patch.