Population Limits Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/populations (two pages, 16 questions; a low-write version has the same numbers). Environmental Science, Chapter 5, Lesson 5.3: What Limits the Growth of Populations? © 2026 Ryan Sajdak. Free to use, share and change under CC BY-NC-SA 4.0 (creativecommons.org/licenses/by-nc-sa/4.0): give credit, do not sell it, share your version the same way.

Objectives

The same four statements are printed on the worksheet, two at the top of each side, with a box to tick. Day 1 is the front (Tabs 1 and 2) and Day 2 is the back (Tabs 3 and 4). They match the lesson objective ES.2.5.6, use mathematical representations to explain carrying capacity and limiting factors, and are worded the same as on the two lesson worksheets. Q16 draws on both days.

Day	I can	Questions
1	use a pond model's numbers to tell exponential (J-curve) growth from logistic (S-curve) growth.	1 to 4
1	use the St. Matthew Island reindeer numbers to explain overshoot and a population crash.	5 to 9
2	use survival numbers to find a range of tolerance and say why too much or too little limits.	10 to 13
2	match survivorship curves to r- and K-selected species and say which is most at risk.	14, 15

Performance expectations: building toward

The lab and worksheet give students evidence for these performance expectations. They are one step on the way, not a full assessment of any one of them.

> **HS-LS2-1**
> *"Use mathematical and/or computational representations to support explanations of biotic and abiotic factors that affect carrying capacity of ecosystems at different scales."* Worksheet link: this is the heart of the lab. Students change abiotic limits (pond space, nutrients, frost, pH) and biotic ones (lichen supply, wolves) in computational models and read the effect on carrying capacity (Parts 1 to 3).

> **HS-LS2-2**
> *"Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales."* Worksheet link: population density (Q2, Q6), overshoot as a multiple of carrying capacity (Q6), comparing a model with real counts (Q5), and recovery times (Q14, Q15).

> **HS-LS2-6**
> *"Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem."* Worksheet link: wolves hold the reindeer near a steady number and the lichen survives (Q9); without them the island is stripped and the herd dies out (Q7, Q8). Students write a claim, evidence and reasoning (Q16).

DCI LS2.A: *"Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not for the fact that environments and resources are finite."*

Part by part

Part	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	What students do
1. Duckweed pond Q1 to 4	SEP 4 Analyzing and interpreting data SEP 5 Using mathematics and computational thinking	LS2.A carrying capacity	Scale, Proportion, and Quantity	Compare exponential (J) and logistic (S) growth, read the carrying capacity, compute density, name space and nutrients as limiting factors, and sort frost as density-independent.
2. Reindeer island Q5 to 9	SEP 2 Developing and using models SEP 4 Analyzing and interpreting data	LS2.A; LS2.C ecosystem dynamics	Stability and Change	Check a model against real counts on St. Matthew Island, measure overshoot, separate the trigger (hard winter) from the cause (lichen), and test a predator as a limit (textbook Figure 5-12 is the St. Paul Island herd, also in the lab).
3. Trout tanks Q10 to 13	SEP 3 Planning and carrying out investigations (one variable changed)	LS2.A abiotic limits; range of tolerance	Cause and Effect	Map brook trout survival across pH to build a range-of-tolerance curve like Figure 5-8, explain why the design gives causal evidence (the 5.3 assessment's Crosscutting Concepts question), and apply it to acid Adirondack lakes.
4. Life strategies Q14 to 15	SEP 4 Analyzing and interpreting data SEP 6 Constructing explanations	LS2.A; reproductive patterns	Patterns	Match bears, robins and perch to late, constant and early loss curves (Figure 5-13) and to K- and r-selection, then use recovery times to explain why K-selected species are more vulnerable to extinction.
Wrap it up Q16	SEP 6 Constructing explanations SEP 7 Engaging in argument from evidence	LS2.A	Stability and Change	Claim, evidence and reasoning that no population can grow forever, with evidence from two tabs.

Also in play

- **Explore, then explain, then apply:** data questions come first in each part (Q1 and 2, Q5 to 7, Q10 and 11, Q14's number columns). A READ FIRST line then sends students to the tab's **Learn It** box (it opens once they have the data), then to the questions that use the ideas (Q3 and 4, Q8 and 9, Q12 and 13, Q14's last two columns and Q15). The deck has matching Learn It slides. Taught there: J- and S-curves, carrying capacity, limiting factors, density-dependent and -independent factors; overshoot, crash, trigger against cause, predators; range of tolerance, acid rain, controlled experiments; survivorship curves, r- and K-selection.
- **Key terms from 5.3 used on the page:** population density, limiting factor, range of tolerance, carrying capacity, exponential and logistic growth, overshoot, population crash, r- and K-selected species, survivorship curve. Age structure and environmental resistance are not modeled here.
- **Link to Day 2 (Room to Grow):** the pond is the 36-square grid again, with a knob for space and nutrients.
- **Real data:** the reindeer model is tuned to the published counts: St. Matthew 29 in 1944, 1,350 in 1957, about 6,000 in 1963, 42 in 1966 (David Klein's study); St. Paul 25 in 1911, about 2,000 in 1938, 8 in 1950. Density at the St. Matthew peak comes out near 47 per square mile, the figure in the teacher edition.
- **Made-up numbers:** the pond, tank and life-strategy numbers are built to show each pattern. The page and the worksheet say so.

Standards text quoted from the New York State P-12 Science Learning Standards, High School Life Science (NYSED). The answer key is a separate file, kept off the public site.