Sea Otters and Kelp Lab: NYSSLS Alignment

Teacher guide for the student worksheet at mrsajdak.com/otters (two pages, 16 questions). Environmental Science, Chapter 5: Explorers at Work, Sea Otters Step Up (Jim Estes), and the chapter Case Study, The Southern Sea Otter: A Species in Recovery. Plan-book objectives ES.2.5.2 (how field researchers study species interactions) and ES.2.5.3 (use the case study to frame a question about population control). © 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 two statements are printed at the top of the worksheet, each with a box to tick. They are worded the same as on the lesson worksheet (plan-book objectives ES.2.5.2 and ES.2.5.3). The lesson has a third statement, "I can count quadrats along a transect and use averages to compare two places"; Q1 to 5 assess it.

I can	Questions
explain why the sea otter is a keystone species in a kelp forest.	6 to 9
use the southern sea otter case study to ask a testable question about what controls a population.	10 to 16

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: quadrat counts become averages per square metre and are scaled up to a 100 m^2 reef (Part 1); a computational model shows shark bites and disease (biotic factors) holding California's otters near half the carrying capacity of their range (Part 3, Q11 to 13).

> **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: students compare one quadrat, a transect and a whole island (Q2 to 4), then revise a population model against real census data, using average miss as the measure of fit (Q11, Q12).

> **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: a reef with otters stays a kelp forest for decades; add killer whales or fur hunters and it becomes an urchin barren, and the forest is slow to return (Q6 to 9); students evaluate a classmate's claim that the coast is "full" (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."* DCI LS2.C: *"A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem."*

Part by part

Part	Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts	What students do
1. Survey the seafloor Q1 to 5	SEP 5 Using mathematics and computational thinking SEP 7 Engaging in argument from evidence	LS2.A interdependent relationships	Scale, Proportion, and Quantity	Estes's field method done on screen: mark and count urchins and kelp in 20 one-square-metre quadrats along transects at two islands, compute totals, averages and a ratio, scale to 100 m^2, claim which island has otters, then reveal Amchitka and Shemya.
2. Keystone coast Q6 to 9	SEP 2 Developing and using models (predict, run, compare)	LS2.A; LS2.C resilience	Cause and Effect; Stability and Change	Predict, then run an otter, urchin and kelp model with fur hunters, killer whales or returning otters. Trace the trophic cascade, use numbers to argue the otter is a keystone species, and see that a lost forest recovers more slowly than the otters.
3. California comeback Q10 to 14	SEP 4 Analyzing and interpreting data SEP 5 Using mathematics and computational thinking	LS2.A carrying capacity, predation, disease	Stability and Change; Cause and Effect	Read the real USGS census series (about 50 in 1938, 3,272 in 2016, 2,962 in 2019), then tune a growth model (growth rate, shark bites, disease, range limits) until it fits the dots, and explain what holds the population below its carrying capacity and the recovery goal.
Wrap it up Q15 to 16	SEP 1 Asking questions and defining problems SEP 7 Engaging in argument from evidence	LS2.A; ETS link: managing a threatened species	Cause and Effect	Write a testable question about population control (one thing to change or compare, one thing to measure). Argue against "the coast is full" with the model's numbers.

Also in play

- **Explore, then explain, then apply:** each part starts with data questions (Q1 to 3, Q6 and 7, Q10 to 12). A READ FIRST line on the sheet then sends students to the **Learn It** box in the lab, which opens once they have the data, before the questions that use the ideas (Q4 and 5, Q8 and 9, Q13 to 16). The slideshow has a matching Learn It slide at each of those points for whole-class teaching. Sampling (quadrats, transects, why one square can mislead), keystone species, trophic cascade, why an urchin barren is slow to recover, carrying capacity, births against deaths, and what makes a question testable are all taught there before they are asked.
- **Misconceptions:** "a predator only affects the animal it eats" (Q7, Q8: otters never touch kelp but decide whether it grows); "one quadrat tells you about the whole island" (Q4); "a population stops growing only when it runs out of room" (Q13, Q16).
- **Nature of models:** the Tab 1 counts are practice numbers in Estes and Palmisano's pattern; the Tab 2 model is tuned; the Tab 3 carrying capacity (6,500) and death rates are tuned to fit the real counts, not measured. Students can see that a model that fits the past (Q12) is still only one explanation.
- **Leads into:** Lesson 5.3, What Limits the Growth of Populations? (mrsajdak.com/populations). This lab raises the question of population control; 5.3 names limiting factors, environmental resistance and survivorship.

Standards text quoted from the New York State P-12 Science Learning Standards, High School Life Science (NYSED). Sources: Estes and Palmisano, Science 185:1058 (1974); Estes, Tinker, Williams and Doak, Science 282:473 (1998); Hatfield and others, USGS Data Series 1118 (2019); Tinker and others, Marine Mammal Science (2016), white shark bites; Miller and others, International Journal for Parasitology (2002), Toxoplasma and runoff; U.S. Fish and Wildlife Service, Southern Sea Otter Recovery Plan (2003). The answer key is a separate file, kept off the public site.