

EXPLORE-FIRST LESSON

Where Did the Kelp Go?

Launch → Explore → Synthesize → Apply → Assess

Teacher	Science Teacher	School	Sample High School
Subject	Biology of the Living Earth	Grade	9
Class / Period	Period 2	Date	_____
Block length	55 minutes	Framework	LAUSD TLF

Phase times are targets, not stopwatches.

Framework: Danielson Framework for Teaching, 2013 component language. If your district uses the 2022 edition the component names differ — 1e is Planning Coherent Instruction and 1f is Designing and Analyzing Assessments.

Standards & Objectives

1c Setting Instructional Outcomes

Standard (as published)	Student-facing “I Can”	Language objective
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.	I can use evidence to explain why removing one species can change an entire ecosystem.	Use trophic cascade, keystone species, indirect effect and stability in speech and writing. Frames: “The evidence shows ____, which means ____.” · “ ____ affected ____ indirectly because ____.”
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.	I can read population data and use it to support an explanation.	Frame: “Between ____ and ____, the population of ____ changed by ____, which suggests ____.”

Dimension	Which one, and does this lesson center on it
Disciplinary Core Idea	LS2.C Ecosystem Dynamics, Functioning, and Resilience · LS2.A Interdependent Relationships in Ecosystems
Science & Engineering Practice	Engaging in Argument from Evidence — THIS LESSON CENTERS HERE. Students build and defend a causal explanation before any mechanism is named for them.
Crosscutting Concept	Stability and Change · Scale, Proportion, and Quantity

Who Does This Work — and Who Got the Credit

1b Demonstrating Knowledge of Students

Who did this work. The idea students are building today has a name and a date. In the 1960s Robert Paine removed starfish from tide pools in Washington and watched the whole community collapse — that experiment produced the term keystone species. James Estes then worked out the sea otter, urchin and kelp connection along this coast, which is the specific case in front of students.

And who was already doing it. Coastal Indigenous nations in California managed sea otter and shellfish populations for thousands of years before either study. That knowledge was not published in journals, so it does not appear in the citation record — which is a fact about who controlled publishing, not about who understood the system. Today the Tolowa Dee-ni’ Nation runs its own Marine Program on this coast, surveying urchins and sea stars and monitoring seaweed abundance. Rosa Laucci manages their Natural Resources Marine Division. In 2023 the Tolowa Dee-ni’ Nation, Resighini Rancheria and Cher-Ae Heights designated the first Indigenous Marine Stewardship Area in United States history — roughly 700 square miles, kelp forests among the protected habitats.

Who does this work now. Tribal marine resource specialists, fisheries technicians, restoration divers, aquaculture technicians, state and federal wildlife biologists. The day-to-day is counting, measuring, diving transects, recording data and deciding what it means — the same thing students are doing with the evidence cards. Marine biology usually runs through a four-year degree, but fisheries and restoration technician work is commonly entered through a two-year program or a certification, and commercial dive certification is its own route. Tribal natural resource departments hire and train directly. Certification requirements vary by state.

Ask the class: “The Tolowa Dee-ni’ have been watching this coast far longer than anyone has been publishing about it. What could they tell you that a data card cannot?”

The Phenomenon

3c Engaging Students in Learning

Along the Northern California coast, underwater forests of giant kelp once grew thick enough to slow boats. Divers today swim over the same rock and find it bare — covered edge to edge in purple sea urchins, with almost no kelp at all. Nobody cut the kelp down.

Driving question students are working to answer:

Nobody removed the kelp. So where did it go?

Key Questions

3b Using Questioning and Discussion Techniques

Question, exactly as I ask it	Level	Where	Strong answer sounds like
“Something ate the kelp. What would have to be true about that eater for the kelp to disappear this completely?”	DOK 2	Launch	Recognizes the eater must have increased dramatically, or lost something that was limiting it.
“Your group says urchins ate it. What let the urchins get that numerous — and what changed first?”	DOK 3	Explore — to a stuck group	Pushes past “urchins ate it” toward a cause upstream. Names a predator or a condition.
“Three groups explained this differently. Which explanation does the 1911 data support, and which does it rule out?”	DOK 3	Synthesize	Uses a date and number to eliminate a rival explanation, not just to support their own.
“Sea otters never ate kelp. How can a kelp forest depend on them?”	DOK 3	Synthesize	Articulates the indirect effect — otter acts on urchin, urchin acts on kelp.

Accountable-talk stems, posted at each table: “Our evidence for that is ____.” · “I’d read that data differently, because ____.” · “What would have to be true for that to work?”

Wait time: seven seconds before I take any answer.

Materials, Prep & Safety

1d Demonstrating Knowledge of Resources

Prepare before the bell	Copies / quantity
Evidence Packet (Appendix A), double-sided — four data cards	32
Explanation Card (Appendix B)	32
Chart paper and markers, one set per group	8 sheets
Bilingual glossary cards — trophic cascade, keystone species, indirect effect, stability, population	Spanish / English
Sentence-frame strips taped to each table	8
Board pre-divided into three columns: What changed · What it affected · How we know	before the bell
Sticky notes	1 pad per group

SAFETY: No laboratory equipment, chemicals or biological specimens are used in this lesson. No protective equipment is required. If preserved urchin tests or dissection specimens are substituted for the printed evidence cards, add goggles and gloves, and brief students on handling before any material is distributed.

Grouping Plan

1b Demonstrating Knowledge of Students

Eight heterogeneous groups of four. Heterogeneous fits exploration because there is no procedure to execute correctly — the task is interpretive, and mixed groups produce more competing explanations, which is exactly what the synthesis needs.

Group	Composition	Notes
Groups 1–8	Four students each, mixed reading confidence	Every group receives the identical evidence packet

How the support lanes are made available flexibly:

Three versions of the evidence packet sit in a stack at every table — scaffolded, core, and the extension printed on the reverse. Any student takes whichever gets them working and may switch mid-task. I offer a lane based on what I hear during circulation. No lane belongs to a group.

Seating and access principles:

- Pair students still building English proficiency according to what the task actually demands — they may think and clarify in whichever language helps them, and produce the required response in English. Each holds a glossary card and sits within a step of the co-teacher's route.
- Distribute students with reading and writing goals across different groups rather than clustering them.
- Place the three twice-exceptional students in separate groups so each has room to push an explanation rather than compete for it.

Forming groups in under a minute: table tents are out before the bell with names on the reverse. Students find their table during entry.

Anticipated Student Responses

Ordered deliberately — least sophisticated first, building toward the target explanation.

1a Demonstrating Knowledge of Content and Pedagogy

What students will try	Why they will try it	When I call on it
"Pollution killed the kelp."	The default explanation for any environmental decline. Requires no data.	FIRST. Testable against the evidence, and the data does not support it — a clean demonstration of what argument from evidence means.
"The urchins ate it."	The urchin data is the most visually obvious card in the packet.	SECOND. Correct but incomplete. The pivot: true, and it does not explain itself.
"Otters ate the kelp and then died out." (productive wrong turn)	Students assume a direct relationship because indirect effects are counterintuitive.	THIRD. Correcting this out loud is how the indirect step becomes visible.
"The water got too warm." (partially supported)	Climate is the available explanation for most students, and there is a temperature card.	FOURTH. Warming is real and does contribute. Shows two causes can operate at once without one being wrong.
"The otters were hunted, so urchins increased, so kelp got eaten."	Only reached by groups that connect the 1911 fur trade card to the urchin card.	FIFTH. The target explanation. It arrives from a student, not from me.
"The kelp came back where otters came back."	Some groups read the recovery card.	LAST. Confirms the explanation and opens tomorrow's lesson on resilience.

Adults in the Room

1e Designing Coherent Instruction

Phase 2 co-teaching model: parallel teaching. Two adults, eight groups — we split the room and each takes four, circulating continuously. Parallel fits exploration because neither adult is instructing; both are listening and questioning, so there is no lead-and-assist distinction to make. Station teaching would be wrong here — the groups are not doing different tasks.

Phase	Lead Teacher	Special Education Teacher
1 Launch	Presents the phenomenon, sets the task, checks understanding	Places packets; watches for students who have not started and cues them quietly
2 Explore	Circulates Groups 1–4. Withholds all explanation. Asks only questions; logs which group produced which explanation	Circulates Groups 5–8. Withholds all explanation. Reads a data card aloud on request without interpreting it; notes students reasoning but not writing

Phase	Lead Teacher	Special Education Teacher
3 Synthesize	Calls groups in the sequenced order; formalizes vocabulary on the anchor chart	Records the emerging explanation on chart paper so students have a visual trace
4 Apply	Circulates; confers with students whose Phase 2 talk stayed at “urchins ate it”	Confers with students who chose a scaffolded packet
5 Assess	Circulates; collects in group order	Sits beside anyone who has not started and reads the prompt aloud

Both adults are told the same thing before this lesson: if you explain it in Phase 2, the lesson is over.

PHASE 1 — LAUNCH (about 6 minutes)

Present the phenomenon. No method is demonstrated.

3c Engaging Students in Learning

Time	Teacher steps & script	Student action
0:00–6:00	- Two images displayed as students enter — a kelp forest, and bare rock covered in purple urchins. - Say: “Same stretch of coast. Same rock. About sixty years apart. Nobody cut the kelp down.” - Say: “Your job today is to figure out where it went. You have an evidence packet with four data cards. I am not going to tell you the answer, and I am not going to confirm whether you are right — so do not ask me. Ask your group.” - Ask: “Something ate the kelp. What would have to be true about that eater for the kelp to disappear this completely?” Take two responses, write both on the board, evaluate neither. - Say: “Hold those. Eighteen minutes. Your group produces one written explanation on chart paper and the evidence that supports it. Go.” - Check that every group has opened the packet and someone is holding a marker before stepping away.	- Sit; look at the two images - Two students offer an initial idea; the rest listen - Open the packet, begin reading data cards - Assign a scribe within the group

PHASE 2 — EXPLORE (about 18 minutes) Level: DOK 3 · Strategic Thinking

Students work before being taught. Questions only — no teaching moves.

3b Using Questioning and Discussion Techniques

Time	Teacher steps & script	What I am listening for
6:00–24:00	- Circulate Groups 1–4; co-teacher takes 5–8. Move continuously; do not settle. - To a stalled group: “Which card have you not used yet?” - To a group that says urchins ate it: “What let the urchins get that numerous — and what changed first?” - To a group that is guessing: “Show me the line on the card that makes you think that.” - To a group asking if they are right: “I’m not going to tell you. What does your group think, and what would settle it?” - To a group that finished early: “Now argue against yourselves. What evidence would prove you wrong?” - At 14:00 say: “Four minutes. Your explanation needs to be on chart paper and it needs at least two pieces of evidence.” - Log which group produced which explanation. No teaching moves in this phase.	- Which groups reach pollution, urchins, temperature, or otters — I need at least one of each for the synthesis Whether anyone connects the 1911 fur trade card to the urchin population card. This is the hinge of the whole lesson. - Students using because and pointing at a card rather than asserting - Any group claiming otters ate kelp directly — I want that one; it makes the indirect step visible - Which quiet students are reasoning aloud but not writing — noted for Phase 4

PHASE 3 — SYNTHESIZE (about 14 minutes)

Formalize from their work. This is where direct instruction lives, and it is short.

3a Communicating with Students

Time	Teacher steps & script	Check for understanding
24:00–38:00	1. Say: “Four different explanations in this room. We’re going to test them against the evidence, in order.” 2. Call the pollution group first. Ask: “Which card would show pollution? What does it actually say?” Let them discover the data does not support it. Then: “That is what argument from evidence means. You had a reasonable idea and the evidence did not back it. That is not failure — that is the method.” 3. Call the urchin group. Say: “This one the evidence supports. And it raises a bigger question — what let the urchins get that numerous?” 4. Call the otters-ate-kelp group. Ask: “Did otters eat kelp?” When the packet says no: “Then how could losing them matter?” Write INDIRECT EFFECT on the anchor chart. 5. Call the temperature group. Say: “This is supported too. Two causes can be true at once — that is what makes real ecosystems hard.” 6. Call the otter-urchin-kelp group last. Have them trace it on the board. Formalize: TROPHIC CASCADE — a change at one level moving down through the levels beneath it. KEYSTONE SPECIES — a species whose effect is far larger than its numbers suggest. 7. Say: “Every one of those words came from something your group already said. I just gave it a name.”	• Whiteboard hold-up: one word for what otters do to urchins, one for what urchins do to kelp. Scanning for eat / control rather than blank boards • Cold call, no hands up, two students: “Say the chain out loud, otter to kelp.” Listening for three links, not two • Watching whether ELL students are using the glossary cards while speaking

PHASE 4 — APPLY (about 11 minutes) Level: DOK 3 • Strategic Thinking

A new case they have not seen.

3c Engaging Students in Learning

Time	Teacher steps & script	Differentiated accommodations
38:00–49:00	1. Say: “New case, and you have not seen this one. Wolves were removed from Yellowstone in the 1920s. By the 1990s, the willow and aspen along the rivers were nearly gone — and the riverbanks themselves were collapsing.” 2. Distribute Appendix B. 3. Say: “Two questions. What is the chain? And what would you predict happened when wolves were put back in 1995?” 4. Say: “Use the words on the anchor chart. I want to see trophic cascade or indirect effect in your answer, used correctly.” 5. Circulate; confer with students whose Phase 2 talk stayed at the direct-cause level. Ask: “What is the middle step?” Note the answer; do not supply it. 6. At 47:00: “One minute. Finish the sentence you are on.”	Scaffolded Access 1. Card with the first link supplied (wolves → elk) and the remaining links blank. 2. Chain diagram with three empty boxes and an arrow bank; students place rather than generate. Core Task Students construct the full chain and make a prediction. Accessible as written. Extension / 2e Strength-Forward 1. Identify one way the Yellowstone case is not parallel to the kelp forest, and defend it. 2. Predict what would happen if wolves returned but elk had already collapsed for another reason. <i>All three are available to any student at any point, offered on what I hear during circulation.</i>

PHASE 5 — ASSESS (about 6 minutes)

Independent evidence of what each student can do alone.

1f Designing Student Assessments

Time	Assessment task	Success criteria
49:00–55:00	1. Say: “This one is yours alone. Half a page, no talking.” 2. Display: “A fishery removes one predator from a coastal system. Using evidence from today, explain what could happen to the plants at the bottom of that system — and name what would have to be true for it to happen.” 3. Lead teacher circulates and collects in group order. 4. Co-teacher sits beside anyone who has not started and reads the prompt aloud. 5. Say as they pack: “Tomorrow: the kelp is coming back in some places. We are going to work out why there and not everywhere else.”	Full credit: describes a three-link chain, not a two-link one; uses trophic cascade or indirect effect correctly; states at least one condition that would have to be true. Partial: names a chain but only two links, or uses the vocabulary without the conditional reasoning. Reteach: asserts that removing the predator harms the plants directly. These students begin tomorrow at the anchor chart.

Phase 6 — Post-Lesson Reflection

Completed by hand after teaching.

4a Reflecting on Teaching

What worked well?

What would I change?

Student evidence of mastery:

Adjustments for next lesson:

Appendix A — Evidence Packet

Print one per student. Four data cards, double-sided.

Card	Data provided	Your notes
1	Kelp coverage along one stretch of coast, 1900–2020	
2	Purple sea urchin density, same location, same period	
3	Sea otter population, including the 1911 fur trade closure	
4	Ocean surface temperature, same location, same period	

Our group’s explanation:

Evidence that supports it (at least two):

Evidence that argues against it:

Appendix B — Explanation Card

Print one per student for Phase 4.

#	Prompt	Your answer
1	The chain: wolves → _____ → _____ → riverbanks	
2	What I predict happened after 1995, and why	
3	One condition that would have to be true for this chain to work	