

Bring Back the Forest: Choosing a Restoration Plan for Driftwood Cove

Investigation question: Which plan, or combination of plans, can bring back Driftwood Cove's kelp forest and its species within ten years, on a fixed budget, with enough community support to go ahead?

Data-driven decision

Groups of 4

2 sessions

Setup 5 · Activity 90 · Cleanup 5 min

MS-LS2-5 · assesses

MS-ETS1-3 · practice

MS-ETS1-2 · practice

Name _____

Group _____

Date _____

Your role today

- ☐ **Data reader:** Reads the projections aloud and checks every pass or fail mark against the actual numbers.
- ☐ **Budget keeper:** Totals the cost of every plan and hybrid over years 1 to 10 and checks it against the 60-point constraint.
- ☐ **Community advocate:** Speaks for the people affected (shellfish divers, dive and kayak businesses, coastal residents), tracks the support constraint and keeps the abalone numbers in the discussion.
- ☐ **Spokesperson:** Drafts the group's final justification from the recorded numbers and presents the decision to the class.

Safety

- Paper-and-pencil activity with no physical hazards.
- The cove, the costs, the community survey and every projection are fictional. When students talk about real groups, such as shellfish divers or tribes with long ties to the coast, keep the discussion respectful and avoid claiming to know real people's positions.

Procedure

1. Session 1. Read the background and the plan cards. In q1, name the ecosystem services Driftwood Cove has lost and who has lost them.
2. Read the projection datasets. For each single plan, the Data reader finds kelp canopy in years 5 and 10 and fish species in year 10, the Budget keeper totals the cost, and the Community advocate finds the support. Fill the single-plan scorecard with pass or fail for C1, C2, C3, K1 and K2, including plan C with the shellfish support step.
3. Graph kelp canopy against year for plans A, B and C in three colors and draw a line across the graph at 25 percent.
4. Answer q2 and q3: which single plan comes closest, and what is the best characteristic of each plan that is worth keeping?

5. Session 2. Design a hybrid using parts of at least two plans: you may run urchin removal for fewer years, add the shellfish support step to an otter plan, or combine any plans. Check the cost against K1 before committing. Write the design and your predicted pass or fail marks in the hybrid design table and answer q4.
6. When your design is committed in writing, collect the hybrid results card. Find the row that matches your hybrid (or the closest one), complete the results rows of the design table, and compare them with your predictions (q5).
7. If your hybrid fails a criterion or constraint, you may modify it once and look up the new row in the Hybrid 2 column.
8. Decide. Write the group's final choice and justification (q6), including the trade-off you accept and the biggest uncertainty. Present in under two minutes, post your choice on a sticky note, and listen for what groups that chose differently valued. Answer the analysis questions individually.

Record your observations

Lab 3 recording sheet: Bring Back the Forest

Driftwood Cove is a **fictional** cove on the California coast where purple urchins grazed a kelp forest down to bare rock. Today the cove has 3 percent kelp canopy, 48 urchins per m², only 8 kinds of kelp-forest fish and 6 red abalone per 100 m². Most of its **ecosystem services** are gone: young rockfish once sheltered in the kelp, red abalone fed on drifting kelp and supported a harvest, and dive and kayak businesses brought visitors. A coastal partnership has money for one 10-year plan. Every number below is a **teaching dataset**: the three kinds of plan are real ideas being studied on the Pacific coast, but these results are projections invented for this lab.

Plan cards

Plan	What it does	Cost (points)	Community support	Main uncertainty
A. Urchin removal	Divers remove purple urchins by hand every year for years 1 to 5, then stop.	7 per year of removal (35 for years 1-5)	80%	Urchins crawl and drift back in from nearby barrens once removal stops.
B. Sea star return	Raise sunflower sea stars in an aquarium lab and release them in years 1 to 3; they eat urchins.	20 to set up breeding in year 1, plus 2 per year to monitor (40 total)	70%	The wasting disease could return, and captive-raised stars may not survive well.
C. Sea otter return	Move a small group of sea otters from the central coast in year 1, then monitor them.	10 to capture, check and move the otters, plus 2 per year to monitor (30 total)	35%	Otters may swim away; they eat abalone, crabs and urchins that divers harvest, and mostly skip thin, starved urchins on bare rock.
Shellfish support step (optional add-on)	A fund and monitoring program for abalone, crab and urchin divers, added to any plan that includes otters.	10 extra	Raises an otter plan's support to 55%	Works only while the fund lasts.

Criteria (what success means): **C1** kelp canopy at least 25 percent by year 5. **C2** kelp canopy at least 25 percent in year 10. **C3** at least 14 kinds of kelp-forest fish in year 10 (there were 17 before the collapse).

Constraints (limits): **K1** total cost at most 60 points over years 1 to 10. **K2** at least 50 percent community support, or the plan cannot get its permits.

Projected kelp canopy (% of the cove's area) for each single plan

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

Plan	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 10
No action	3	3	3	3	3	3	4
A. Urchin removal (years 1-5)	3	15	30	38	40	40	12
B. Sea star return	3	3	5	8	11	15	28
C. Sea otter return	3	3	3	4	5	6	20

Teaching dataset: model projections for a fictional cove, not measurements.

Other projected measures for each single plan

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

Plan	Fish species, year 5	Fish species, year 10	Red abalone per 100 m ² , year 10	Purple urchins per m ² , year 10
No action	8	8	3	46
A. Urchin removal (years 1-5)	14	10	8	30
B. Sea star return	11	14	14	10
C. Sea otter return	9	12	3	22

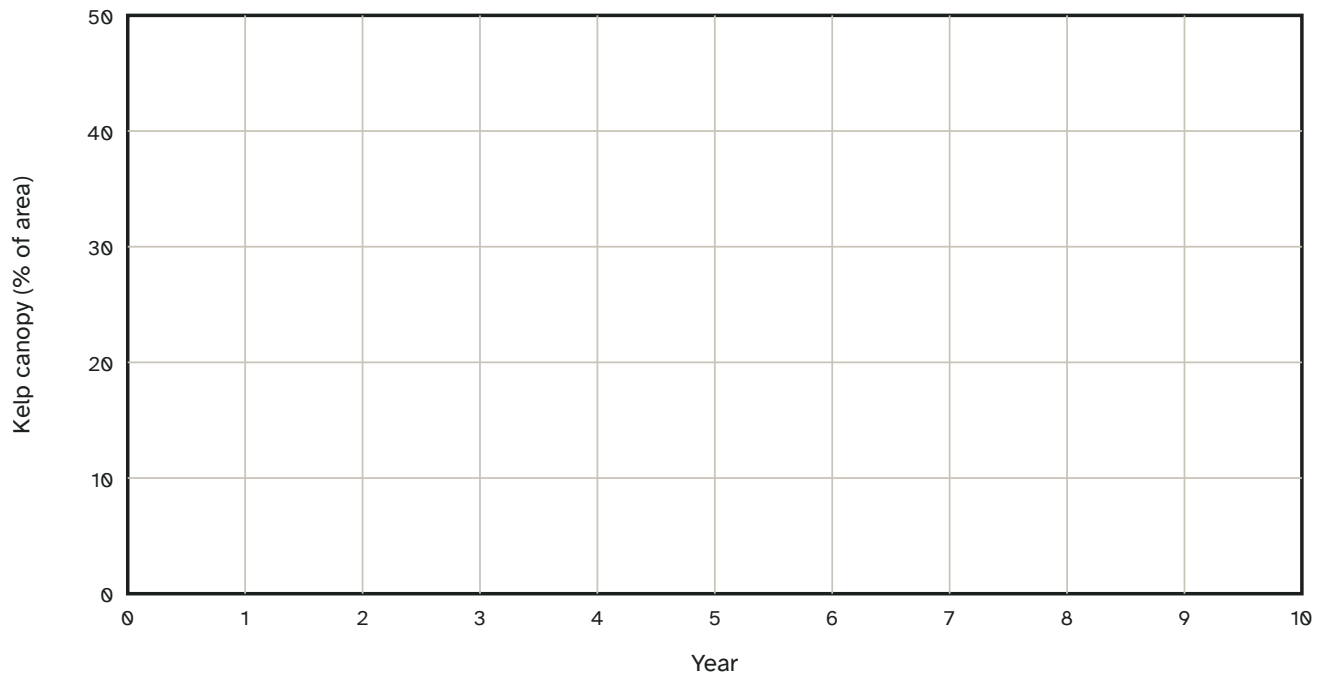
Teaching dataset. Year-0 values for every plan: 8 fish species, 6 red abalone per 100 m², 48 urchins per m².

1. Name two ecosystem services Driftwood Cove has lost, and for each one say who has lost it.

Single-plan scorecard (write pass or fail and the number that decides it)

Plan	C1: kelp ≥ 25% by year 5	C2: kelp ≥ 25% in year 10	C3: ≥ 14 fish species in year 10	K1: cost ≤ 60	K2: support ≥ 50%	Passes all?
A. Urchin removal						
B. Sea star return						
C. Sea otter return						
C plus shellfish support step						

Projected kelp canopy for plans A, B and C



2. Which single plan comes closest to passing everything? Which criteria or constraints does each plan fail, and by how much?

3. Name the best characteristic of each plan, the one worth keeping in a combination, and the data that shows it.

Hybrid design table

	Hybrid 1 (first design)	Hybrid 2 (after one modification, if needed)
Parts used and years		
Cost calculation		
Community support		
Predicted C1 / C2 / C3 (pass or fail)		
Results card: kelp in year 5 and year 10		
Results card: fish species and abalone in year 10		
Passes all? If not, which fails?		

4. Before you see the results card: describe your hybrid, show its cost, and explain which characteristic you took from each plan and why you predict it will pass C1 and C2.

5. After reading the results card: did your hybrid perform as you predicted? Explain any difference.

6. Final decision: which plan or hybrid does your group choose? Justify it with numbers for every criterion and constraint, compare it with at least one other option, state the trade-off you accept, and name the biggest uncertainty.

Hybrid results card (the teacher hands this out after your group commits to a design)

Projected results for combined plans

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

Hybrid	Total cost (points)	Support	Kelp, year 5 (%)	Kelp, year 10 (%)	Fish species, year 10	Red abalone per 100 m ² , year 10
H1. Removal years 1-2 + sea stars	54	75%	22	30	15	13
H2. Removal years 1-3 + sea stars	61	75%	27	32	15	14
H3. Removal years 1-2 + otters + support step	54	55%	27	44	16	4
H4. Removal years 1-3 + otters + support step	61	55%	33	46	16	4
H5. Removal years 1-2 + otters, no support step	44	40%	27	44	16	4
H6. Sea stars + otters + support step	80	55%	16	34	15	6
H7. Removal every year, years 1-10	70	80%	40	40	14	15

Teaching dataset. In the otter hybrids, divers' early clearing lets kelp patches regrow; well-fed urchins at the patch edges then become otter food, so the otters keep the patches from being grazed after removal stops.

Analysis questions

7. A group proposes urchin removal for years 1 to 3 plus the sea star plan. Compute its cost, say which constraint it breaks and by how much, and suggest one change that brings it within budget. What does your change cost in kelp at year 5?

- 8.** Plan C alone does worst on kelp, yet otters are part of the strongest hybrid. Use the plan card (and clue 4 from Lab 2 if you did it) to explain why otters work better after divers have cleared some urchins.

- 9.** Your chosen plan affects more than one ecosystem service. Use the fish and abalone data to describe one trade-off between ecosystem services, or between biodiversity and a fishery, in the plan you chose.

- 10.** Why is community support a real constraint rather than just an opinion? What could go wrong if a plan with 35 percent support went ahead anyway?

- 11.** Name the biggest uncertainty in your chosen plan and one measurement that would warn you early that the plan needs to change. Give the year and the value that would trigger a change.

- 12.** How is designing your hybrid like the way engineers developed the gecko-and-mussel adhesive described in the lesson?
