

Clearing Alder Reservoir: Choose a Food-Web Fix and Plan the Test

Learning target: I can use a trophic pyramid model to predict how competing solutions would change a green, algae-choked reservoir, evaluate them against criteria and constraints, choose one, and plan how to test and improve it.

Transfer and design

About 55 min

Pairs

MS-ETS1-2 · assesses

MS-LS2-3 · practice

MS-ETS1-4 · supports

engineering design

data analysis

writing

Name

Date

Period

Directions

You are advising the town of Alder Springs. Read the problem, the survey data and the criteria and constraints. Study the four options and the reservoir's trophic pyramid. Use the pyramid to predict what each option would do, score each option in the decision matrix, choose one option or a combination, and justify your choice with the model. Then plan the test that would show whether your fix is working and say what you would change if it is not. All numbers in this scenario are teaching estimates, not measurements from a real lake.

You will need: This worksheet, Pencil, Calculator

The problem

Alder Reservoir is a 40-hectare lake that supplies drinking water to the town of Alder Springs and is used for swimming and fishing. For years a leaking sewer line fed nutrients into the lake. Algae grew so thickly that the water turned pea-green, and each late summer dead algae sinking to the bottom were broken down by decomposers that used up so much oxygen that fish died. The town repaired the sewer line in 2024, cutting the nutrients flowing in by about 70 percent. One year later the water is still green. Nutrients already stored in the bottom mud keep feeding the algae, and the lake's food web has not changed: it is full of small plankton-eating fish called shiners and has very few predatory fish.

Alder Reservoir surveys before and after the sewer repair (teaching dataset)

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

Measurement	2024 (sewer leaking)	2025 (sewer repaired)
Nutrient input from land (kg of phosphorus per year)	900	270
Algae cells per drop of water	1800	1500
Zooplankton per liter	12	15
Shiners (plankton-eating fish) per net haul	140	150
Largemouth bass (predatory fish) per net haul	2	2
Secchi depth in August (m)	0.3	0.4
Late-summer fish kill	yes	yes, smaller

Simulated data for teaching. Secchi depth is how deep a white disk can be seen; larger means clearer water. A Secchi depth of 1.5 m is the town's standard for safe swimming.

Alder Reservoir trophic pyramid (top to bottom)

Largemouth bass (predatory fish): very few	top
Shiners (plankton-eating fish): very many	
Zooplankton (tiny drifting animals): few	
Algae (producers): enormous	bottom

The reservoir's food web as a trophic pyramid. Each level eats the level below it. Arrows of matter and energy run upward; only a small fraction passes each step.

Criteria and constraints set by the town council — Criteria (what success looks like): (1) August Secchi depth of at least 1.5 m by the third summer; (2) no late-summer fish kills; (3) swimming and fishing stay open. Constraints (limits you must respect): (a) total cost no more than \$40,000 over three years; (b) no chemicals may be added, because the lake is a drinking-water source; (c) the reservoir cannot be drained; (d) the sewer repair stays in place.

Four options proposed at the town meeting

Options and the engineer's estimates (teaching dataset)

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

Option	What is done	Cost over 3 years	How fast it acts	Known side effects
A: Stock predatory fish	Release 20,000 young largemouth bass in year 1 and 10,000 in year 2	\$12,000	Bass need 2 to 3 years to grow large enough to eat many shiners	Fishing improves; bass also eat some zooplankton while small
B: Net out shiners	Hire a crew to net and remove about half the shiners each spring for three years	\$27,000 (\$9,000 per year)	Shiner numbers drop within weeks of each netting	Shiners breed back quickly if nothing eats them; nutrients leave the lake in the removed fish
C: Algaecide	Spray a copper-based algaecide twice each summer	\$18,000 (\$6,000 per year)	Algae die within days	Also kills zooplankton; dead algae sink and use up oxygen as they decay; copper is a chemical
D: Add zooplankton	Buy and release water fleas each spring	\$12,000 (\$4,000 per year)	Zooplankton rise for a few weeks	Shiners eat most of the added zooplankton within a month

Simulated estimates for teaching. Costs and timelines are invented to be realistic for a small reservoir.

Part A: Predict with the model

1. Use the pyramid to explain why the reservoir has so much algae even though it has a level of zooplankton that eats algae. Name the level that is out of balance and the arrow that is the problem.
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2. For each option, use the pyramid to predict whether each level goes up, down or stays about the same after two to three years, and whether the change would be lasting or temporary. Write up, down or same in each cell.

Shiners	Zooplankton	Algae	Lasting or temporary?
Option A			
Option B			
Option C			
Option D			

Part B: Evaluate against the criteria and constraints

3. Complete the decision matrix. Any option that fails a constraint (a 'no' in either of the first two columns) is eliminated no matter its score. Score the three criteria from 0 (no) to 2 (yes), then total.

Meets cost limit? (yes/no)	No chemicals? (yes/no)	Likely clear water by year 3? (0-2)	Avoids fish kills? (0-2)	Lasting effect? (0-2)	Total score
Option A					
Option B					
Option C					
Option D					

4. Which option is eliminated by a constraint before scoring, and which constraint does it break? Explain why that option could also make the fish kills worse, using the word *decomposers*.

Part C: Decide and justify

5. State your recommendation (one option or a combination that stays within the \$40,000 limit). Justify it with the trophic pyramid: trace the chain of direct and indirect effects from what you change to the algae, and explain why your choice should last. Give the total cost.

6. Plan the test. Name three measurements the town should make each August, say what values after year 3 would show success, and explain why the Secchi depth alone is not enough.

7. Suppose that after two summers the shiners are down but the algae are still high. Name one thing the model may have left out, and describe one specific change you would make to your plan.

8. Explain why repairing the sewer line was necessary but not sufficient, and why any food-web fix would likely fail if the sewer were still leaking.

Follow the arrows one level at a time

To predict an option, write the four levels in a column: bass, shiners, zooplankton, algae. Mark the level the option changes first with a big arrow. Then move one level at a time: if a level goes down, the level it eats goes up (less eating) and the level that eats it goes down (less food). The first step is a direct effect; every step after that is indirect. Stop when you reach the algae.

Pitch it in one page

Write a one-page proposal to the town council for your recommendation. Include a labeled pyramid showing the lake now and the lake after your fix, a three-year budget, the August measurements you will report, and the single result that would make you change the plan. Then add a paragraph on one risk the model cannot predict, such as a warm summer, a new fish species arriving, or nutrients still stored in the mud, and how you would watch for it.