

Run a Fishery Simulation

Test resource choices with a working spreadsheet.

HS-ESS3-3 "Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity..."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB Read the rules. Underline the stock limits and circle what a zero shortfall means. Complete the computer work as well as these notes.

Model rules and spreadsheet setup

A fictional fishery model

Use a spreadsheet to simulate five years. All quantities are tonnes of fish. Each year, fish grow before people harvest. Potential growth is 50 when starting stock is below 400, 100 from 400 through 799, and 200 at 800 or more. Zero stock produces zero growth. Actual growth cannot raise stock above 1,600; actual catch cannot exceed available fish. There is no immigration or other mortality in this simplified model.

The community needs 180 tonnes each year. A bird-food indicator is met when ending stock is at least 800. This single indicator does not measure all biodiversity. Food supply is one part of human sustainability. A five-year outcome is not proof of long-term sustainability.

Enter inputs and the growth lookup

In column A, label the inputs; enter their numbers in column B: B2 initial stock = 1000; B3 annual quota = 300; B4 annual food need = 180; B5 bird-food cutoff = 800; B6 stock capacity = 1600. Use nonnegative whole numbers, keep initial stock at or below capacity, and keep both thresholds positive.

Create a sorted lookup table: J2 = Starting-stock minimum; K2 = Potential growth. Enter J3 = 0, K3 = 50; J4 = 400, K4 = 100; J5 = 800, K5 = 200. VLOOKUP with TRUE selects the greatest listed minimum at or below the starting stock. The IF formula below handles extinction separately.

Build the calculation

Put these headers in A9:H9: Year, Start, Potential growth, Actual growth, Catch, End, Bird shortfall, Food shortfall. Enter these formulas in row 10. A zero shortfall means that year meets the corresponding threshold.

- A10: =1; B10: =\$B\$2
- C10: =IF(B10=0,0,VLOOKUP(B10,\$J\$3:\$K\$5,2,TRUE))
- D10: =MIN(C10,MAX(0,\$B\$6-B10))
- E10: =MIN(\$B\$3,B10+D10); F10: =B10+D10-E10
- G10: =MAX(0,\$B\$5-F10); H10: =MAX(0,\$B\$4-E10)

For year 2 enter A11: =A10+1 and B11: =F10. Copy C10:H10 down to row 11. Fill A11:H11 down through row 14 for years 3-5. Keep the dollar signs so input and lookup references stay fixed.

Summary measures: final stock =F14; total catch =SUM(E10:E14); bird-threshold years =COUNTIFS(G10:G14,0); food-need years =COUNTIFS(H10:H14,0). Put these in unused cells.

2 ANSWER WITH EVIDENCE Use the passage

- 1 Run Model A in your spreadsheet. Record year 1 ending stock and both shortfalls. Explain how the formulas prevent overharvesting and fish reappearing after extinction.

- 2 Duplicate A as Model B; change only B3 to 150. Compare final stock, total catch, and years meeting each threshold. Graph both models digitally: year versus ending stock, with labels and a key. Explain the tradeoff.

- 3** Duplicate A as Your Plan. Test a constant quota from 0 to 300 that meets both annual thresholds without decreasing stock. Record your quota and the four summary measures. Explain how it improves on A and B.

- 4** Duplicate Your Plan as Lower Stock; change only initial stock to 750. Record five yearly ending stocks and both threshold-year counts. Explain the effect of starting conditions. Propose a management response and one real-world factor to add.

3 YOUR TURN _____ Your own words

Write a recommendation using your baseline and lower-stock results. Explain the relationship among fish management, community food supply, and the bird-food indicator. State one limit on what your simulation can show.

Recommend and qualify

Cite numerical results from both runs. Submit the working workbook with all four named tabs and the comparison graph along with these notes.

PART 1 • READ AND MARK

Read the rules. Underline the stock limits and circle what a zero shortfall means. Complete the computer work as well as these notes. Accept any marking that follows this job and points at the right text.

PART 2 • ANSWERS

#	QUESTION	ANSWER
1	Run Model A in your spreadsheet. Record year 1 ending stock and both shortfalls. Explain how the formulas prevent overharvesting and fish reappearing after extinction.	Year 1: end 900, bird shortfall 0, food shortfall 0. MIN caps catch at starting stock plus actual growth. IF makes potential growth zero at zero stock, so extinct stock stays zero. Inspect actual formulas and an input change; handwritten arithmetic alone does not complete the task.
2	Duplicate A as Model B; change only B3 to 150. Compare final stock, total catch, and years meeting each threshold. Graph both models digitally: year versus ending stock, with labels and a key. Explain the tradeoff.	A: final stock 300, catch 1500, bird years 2, food years 5. B: 1250, 750, 5, 0. Graph A: 900, 800, 700, 500, 300; B: 1050, 1100, 1150, 1200, 1250. A depletes stock; B has an annual food shortfall of 30. Check graph labels, scale, and plotted values.
3	Duplicate A as Your Plan. Test a constant quota from 0 to 300 that meets both annual thresholds without decreasing stock. Record your quota and the four summary measures. Explain how it improves on A and B.	Quotas from 180 through 200 work with these starting conditions. At quota 200, stock stays 1000, catch totals 1000, and both thresholds are met in all 5 years. Accept other tested quotas in that interval with correct results. Compare both human food supply and the bird indicator, not just total catch.
4	Duplicate Your Plan as Lower Stock; change only initial stock to 750. Record five yearly ending stocks and both threshold-year counts. Explain the effect of starting conditions. Propose a management response and one real-world factor to add.	At quota 200, endings are 650, 550, 450, 350, 200; bird years 0, food years 5. Other quotas need recalculation. Less starting stock yields less growth. Lower catch plus another food source could support recovery. Adding weather, habitat, or other species would improve realism; the proposed response still needs testing.

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would test a quota of 200 with monitoring. With initial stock 1000, it supplies the required 180 tonnes each year, keeps stock at 1000, and meets the bird-food threshold in all five years. Starting at 750 instead lowers ending stock to 200 by year five and misses the bird threshold every year. I would reduce catch during recovery and arrange another food source rather than assume the same quota always works. This toy model omits weather and other species; its bird indicator cannot establish the health of the whole ecosystem.

TEACHER ASSESSMENT NOTES

Students need spreadsheet access. Allow two lessons for construction, graphing, and analysis. Verify saved formulas, fill-down references, and automatic recalculation after changing an input; written answers alone are insufficient. Require all four model tabs and the digital graph. Accept different tested plans and evidence-based proposals. Growth rates, capacity, and food and bird thresholds are invented classroom assumptions, not empirical fishery advice. Check zero stock, capacity, and limited-stock harvest as boundary cases.