KELP FOREST ECOSYSTEM INVESTIGATION

Predict • Run • Record • Compare • Explain

Name: _____	Class Period: _____	Date: _____

THE CHALLENGE You are part of a coastal ecosystem team. Use the model to determine which conditions keep an Oregon kelp forest stable for 30 years and which conditions lead to very different outcomes.

Driving Question

How do changes in otters, urchins, climate, and disturbance affect kelp forest stability over time?

EVIDENCE YOU WILL TRACK

Sea otters	Sea urchins	Kelp coverage	Habitat health
Population	Population	Percent cover	Model score

1 Make Predictions

Use what you already know before running the model.

If the sea otter population increases, I predict sea urchins will: ☐ Increase ☐ Decrease ☐ Stay about the same
If sea urchins increase, I predict kelp coverage will: ☐ Increase ☐ Decrease ☐ Stay about the same
If ocean temperature increases, I predict kelp recovery will: ☐ Improve ☐ Decline ☐ Stay about the same
If storm pressure increases, I predict kelp coverage will: ☐ Increase ☐ Decrease ☐ Change only briefly
Which variable do you think will create the biggest difference after 30 years? Explain your reasoning.

2 Map the Expected Relationships

Show the chain of cause and effect you expect to observe.

Use ↑ or ↓ in each blank. Then explain the predicted sequence.

Sea otters _____ → Sea urchins _____ → Kelp coverage _____ → Habitat health _____

3 Survey Five Starting Systems

Run every preset for 30 years. Reset before beginning the next preset.

RECORD THE OUTCOME At Year 30, record the exact values shown by the model. In the final column, copy the model message or describe the ecosystem state in a few words.

Scenario preset	Final otters	Final urchins	Final kelp coverage	Habitat health	Final outcome / message
Healthy Kelp Forest					
Urchin Outbreak					
Marine Heat Wave					
Otter Recovery					
Storm Years					

Which preset produced the healthiest long-term kelp forest? Cite at least two final values.

Which preset produced the most damaged ecosystem? Describe the outcome and one graph pattern.

Did all five presets produce the same final ecosystem outcome? ☐ Yes ☐ No

Did the highest final otter population always match the highest kelp coverage? ☐ Yes ☐ No

Did any ecosystem decline and later recover? ☐ Yes ☐ No ☐ Not sure

Describe one important difference between two outcomes that surprised you.

4

Plan a Controlled Investigation

Change one main variable and keep the other settings constant.

Variable I will investigate: ☐ Starting sea otters ☐ Starting sea urchins ☐ Kelp growth potential ☐ Ocean temperature ☐ Storm pressure ☐ Otter protection level

Independent variable - the setting I will change:

Dependent variables - the outcomes I will measure:

Controlled variables - settings that will remain the same:

Controlled setting	Value used in all three trials
1.	
2.	
3.	

TRIAL SETTINGS

Trial	Independent-variable setting	Why this setting helps create a useful comparison
1: Low		
2: Medium		
3: High		

Prediction: How do you expect the three trials to produce different outcomes after 30 years?

FAIR-TEST CHECK ☐ I am changing one main variable. ☐ Every trial will run for 30 years. ☐ The other controls will stay the same. ☐ My three settings are different enough to compare.

5

Run Three Controlled Trials

Save each run. Record the Year 30 values and the overall ecosystem outcome.

Trial	Variable setting	Final otters	Final urchins	Final kelp coverage	Habitat health	Outcome / ecosystem state
1: Low						
2: Medium						
3: High						

NOTE THE PATH, NOT ONLY THE FINAL NUMBER

Use the graphs to record how each system changed across time. A system can end with a similar value but follow a very different path.

Trial	Early years (1-10)	Middle years (11-20)	Final years (21-30)
1			
2			
3			

Which population or measurement changed first in most trials?

Describe one trial in which the outcome changed direction, leveled off, or recovered.

6

Compare the Different Outcomes

Use patterns and numbers to identify the strongest cause-and-effect relationship.

OUTCOME COMPARISON

Comparison question	Trial 1	Trial 2	Trial 3
Kelp remained stable for most of 30 years	Yes / No	Yes / No	Yes / No
Urchins increased rapidly	Yes / No	Yes / No	Yes / No
Otter population remained present	Yes / No	Yes / No	Yes / No
Kelp recovered after a decline	Yes / No	Yes / No	Yes / No
Habitat health improved by Year 30	Yes / No	Yes / No	Yes / No
Final outcome was healthy or stable	Yes / No	Yes / No	Yes / No

Which two trials produced the strongest contrast? Identify the settings and compare at least three final values.

Describe the sequence of changes in the strongest contrast. What changed first, next, and last?

Did changing one variable affect several parts of the ecosystem? Explain using the graph and final data.

Did your evidence support your original prediction? ☐ Yes ☐ Partly ☐ No

Revise your original idea based on the evidence.

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7 Make a Kelp Forest Management Decision

Recommend conditions or actions that support a stable forest and explain trade-offs.

Model factor	Recommended setting or action	Evidence from a run or graph
Starting sea otters		
Starting sea urchins		
Kelp growth potential		
Ocean temperature		
Storm pressure		
Otter protection level		

My recommendation is mainly designed to: ☐ Protect otters ☐ Limit urchin growth ☐ Support kelp recovery ☐ Reduce climate stress ☐ Improve long-term habitat stability

Explain why your plan would support the kelp forest for 30 years. Use evidence from at least two trials.

Describe one trade-off or limitation. For example, a plan may help one population without removing climate or storm pressure.

8 Critique the Model

Identify what the simulation simplifies or leaves out.

Does this model include every factor affecting a real Oregon kelp forest? ☐ Yes ☐ No

Would a real ecosystem always produce exactly the same outcome as the model? ☐ Yes ☐ No

Name one omitted or simplified factor and explain how it could change the results.

9

Final Scientific Explanation

Use complete sentences, quantitative evidence, and cause-and-effect reasoning.

CLAIM

Which conditions produced the healthiest long-term kelp forest, or which variable had the strongest effect?

EVIDENCE

Use at least three numerical values from two different runs and one pattern from a graph.

REASONING

Explain how the evidence shows a chain of interactions among otters, urchins, kelp, habitat, and any physical stress you tested.

NGSS ALIGNMENT Primary: MS-LS2-2 - predict patterns of interactions among organisms; MS-LS2-4 - construct an argument from empirical evidence that ecosystem changes affect populations. High-school extension: HS-LS2-1 - use computational representations to explain factors affecting carrying capacity. Practices: analyzing data and constructing explanations. Crosscutting concepts: cause and effect; stability and change; systems and system models.