



MODULE 04 | TEACHER GUIDE

## Baykeepers

Save the Living Bay | English C1 | Ages 15–18 | 75–90 minutes

Students act as an independent advisory panel. They use a simplified coastal food web to examine ecological dependencies, challenge claims about biodiversity loss and defend a conservation strategy under uncertainty. Their final exhibit must communicate both a recommendation and the limits of its evidence.

### Learning outcomes

Students can synthesise ecological relationships, evaluate the explanatory limits of a model and distinguish local loss from wider biodiversity change. They can justify priorities, acknowledge opportunity costs and specify evidence that would warrant revising a recommendation.

### Lesson sequence

| Time      | Activity                                                                                | Result                 |
|-----------|-----------------------------------------------------------------------------------------|------------------------|
| 0–5 min   | Ask: Can a tiny organism matter as much as a large animal?<br>Read the mission on p. 2. | Initial ideas          |
| 5–15 min  | Read the science brief and glossary together. Check the example arrow.                  | Shared vocabulary      |
| 15–30 min | Use p. 3 and the cards on pp. 4–5 to build the food web.                                | Eight-card network     |
| 30–48 min | Work through the two events on p. 6. Reset before Event B.                              | Cause-and-effect notes |
| 48–68 min | Choose a plan and design the mini-poster on p. 7.                                       | Conservation message   |
| 68–75 min | Pair teams. Explain one link and one reason for your plan.                              | Peer questions         |

### Preparation and support

Print pp. 2–7 for each team of four. Print pp. 4–5 single-sided and cut on the dashed lines. Retain p. 8 for the teacher. Supply two A3 sheets, pens and eight small paper markers. Use the first A3 sheet for the food web and the second for the poster.

Roles: ecological analyst, model critic, policy adviser and spokesperson. Require all members to contribute to the argument. Encourage precise qualification and reasoned disagreement. Cards mix individual species with broad groups; they are unsuitable for estimating species richness. Illustrations are not to scale.

### Optional extension to 90 minutes

Add 15 minutes for a 180–220-word advisory memo. Require a competing explanation, a rejected policy alternative and a monitoring design that could reveal whether the recommendation should change.

This fictional bay and its event rules are classroom models. They do not predict population numbers or automatic extinction. No live organisms, field collection, online accounts or public posting are required.

Ocean Literacy links: principle 5, the ocean supports diverse life and ecosystems; principle 6, people and the ocean are connected. Scientific background and suggested answers appear on p. 8.



## STUDENT SHEET 1 | YOUR MISSION

## Small lives matter

A coastal council faces competing demands for wildlife protection, boating access and construction. Its public campaign focuses on fish and birds, while the ecological case for protecting less visible organisms receives little attention. Your panel must evaluate two disturbances and defend a strategy without treating a simplified model as a forecast.

### Read before you play

An ecosystem consists of organisms, their physical environment and their interactions. Biodiversity encompasses variation within species, between species and across ecosystems. A list of conspicuous organisms offers an incomplete account: ecological roles, habitat conditions and the resolution of identification also matter.

Photosynthetic producers convert light energy into chemical energy stored in food. Consumers obtain energy through feeding. Food-web arrows run from resource to consumer. The network represents feeding relationships, but an arrow alone says nothing about the amount eaten or the strength of that dependency. [1]

Feeding relationships must be distinguished from habitat functions. Seagrass is a marine flowering plant, unlike seaweed, which is algae. It creates shelter and foraging areas for fish and invertebrates. Its absence from a diet list therefore does not imply ecological insignificance. [2]

Habitat loss and food loss can produce different responses. Relocation or prey switching may partly compensate for a disturbance, while also increasing pressure elsewhere. The direction and scale of any wider effect depend on conditions the cards do not specify. A plausible mechanism is not evidence that the predicted outcome will occur.

### Our model

The eight cards combine species-level examples with broader groups. Treat their listed diets and habitat codes as modelling assumptions. Real organisms may use additional resources and habitats. Neither the number of cards nor the number of arrows is a direct measure of biodiversity or ecosystem stability.

Seagrass is represented as habitat rather than as a food-web node. Decomposers and detritus are also omitted, despite their role in nutrient recycling. Population sizes, interaction strengths and time delays are unspecified. These omissions constrain both causal claims and comparisons of management options. [1]

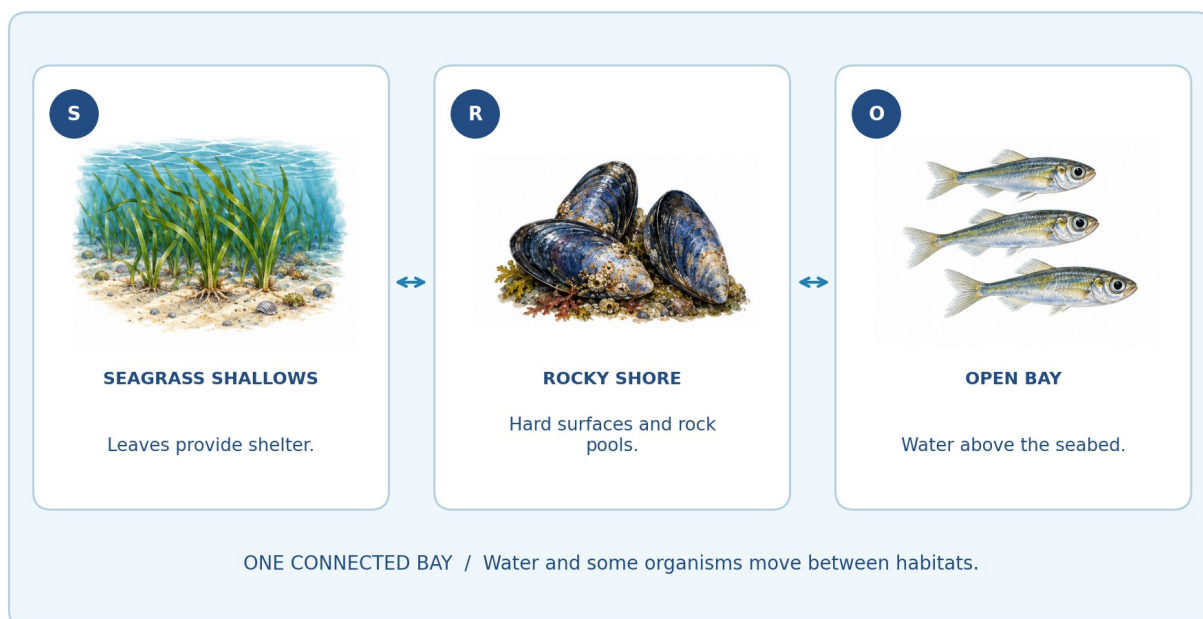
### Key concepts

| Concept            | Meaning                                                                 |
|--------------------|-------------------------------------------------------------------------|
| dependency         | A relationship in which one organism relies on a resource or condition. |
| compensation       | An alternative that partly replaces a lost resource or function.        |
| indirect effect    | A change transmitted through another relationship.                      |
| opportunity cost   | The benefit forgone when another option is chosen.                      |
| confounding factor | Another influence that could explain an observed change.                |

Challenge the claim: "Protect the largest animals and the rest of the ecosystem will take care of itself." Identify the assumption behind it.

## STUDENT SHEET 2 | BUILD THE BAY

# Connect the living world



A schematic habitat board, not a map to scale. S, R and O are habitat codes on your cards. A card may use more than one habitat.

## Round 1 Build your food web

- 1 Distribute and synthesise the eight organism profiles.
- 2 Construct the complete directed food web on A3, using every listed diet link. Label producers and keep habitat dependencies separate.
- 3 Identify two producer-to-heron pathways and any shared nodes.
- 4 Explain why counting a node's links does not establish its real-world ecological importance.

Arrow convention: 01 → 03 denotes energy transfer from phytoplankton to zooplankton. Habitat movement is a different relationship. Plankton transported by water can connect O with mussel feeding at R.

## Check your network

Assess the claim: "Two prey types make a consumer resilient." State a supporting mechanism and an assumption.

Distinguish loss of a food resource from loss of refuge.

Explain how omitted decomposers or alternative prey could alter the apparent consequences.

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## Language help

"The inference is plausible only if ..."

"An alternative interpretation would be ..."

"This model captures ... but leaves ... unspecified."

"The apparent redundancy may not compensate for ..."

Before the event rounds, record one prediction and the assumption on which it depends.

STUDENT SHEET 3 | CUT-OUT ORGANISM CARDS

## The start of the food web

01



### PHYTOPLANKTON

PRODUCER / HABITAT O

Microscopic drifting algae. Photosynthesis supports consumers even when these producers are difficult to see.

**Food link: no food card needed.**

Tiny does not mean unimportant.

BAYKEEPERS / LIFE IN THE BAY

02



### SEAWEEDS

PRODUCER / HABITAT R

Attached macroalgae convert sunlight into food. Their structure can also shelter small organisms.

**Food link: no food card needed.**

They also give small animals shelter.

BAYKEEPERS / LIFE IN THE BAY

03



### ZOOPLANKTON

CONSUMER / HABITAT O

Drifting animal plankton. This profile represents grazers that transfer energy from algae to predators.

**Eats in our model: 01.**

Many larger animals depend on tiny food.

BAYKEEPERS / LIFE IN THE BAY

04



### BLUE MUSSELS

CONSUMER / HABITAT R

Attached filter feeders that obtain suspended food from water. Their feeding links habitats through water movement.

**Eats in our model: 01.**

Water can carry food to an animal.

BAYKEEPERS / LIFE IN THE BAY

Cut along the dashed lines. S = seagrass shallows; R = rocky shore; O = open bay. The artwork shows examples of each group and is not to scale.

STUDENT SHEET 4 | CUT-OUT ORGANISM CARDS

## Small animals and their hunters

05



### AMPHIPODS

CONSUMER / HABITAT S + R

Small crustaceans associated with vegetation and rocks. Some graze algae and consume detritus, or dead material.

#### Eats in our model: 02.

They are food for fish and crabs.

BAYKEEPERS / LIFE IN THE BAY

06



### SHORE CRABS

CONSUMER / HABITAT S + R

Mobile omnivores with several potential foods. Losing prey may alter feeding choices without causing immediate disappearance.

#### Eats in our model: 04 and 05.

Losing one food source may change a diet.

BAYKEEPERS / LIFE IN THE BAY

07



### SMALL FISH

CONSUMER / HABITAT S + O

Represents fish feeding on small invertebrates. Food availability and access to protective habitat are separate dependencies.

#### Eats in our model: 03 and 05.

Open water does not offer the same shelter.

BAYKEEPERS / LIFE IN THE BAY

08



### GREY HERON

CONSUMER / HABITAT S + R

A shallow-water predator whose diet includes fish. Changes below water may affect its feeding opportunities.

#### Eats in our model: 07.

A bird can depend on life below water.

BAYKEEPERS / LIFE IN THE BAY

These cards show selected feeding links. They are not full diets or complete habitat lists. Use the card numbers to build and check your web.



STUDENT SHEET 5 | EVENT ROUNDS

## What changes when a habitat is lost

### Event A Damaged seagrass

In our fictional bay, repeated boat anchoring damages the seagrass meadow. For this round, treat S as unavailable. Cover S on every card that uses it. Add a small warning marker to those cards. Keep the food arrows for now.

- 1 Identify the affected nodes and distinguish lost habitat functions from retained feeding links.
- 2 Explain why an alternative habitat code does not demonstrate successful compensation.
- 3 State one assumption about movement, space or resources that would need testing.

| Card number | Other habitat | Function at risk and a condition |
|-------------|---------------|----------------------------------|
| _____       | _____         | _____                            |
| _____       | _____         | _____                            |
| _____       | _____         | _____                            |
| _____       | _____         | _____                            |

"Retaining access to ... does not establish that ..., because ... remains unknown."

### Reset your bay

Uncover S and remove all warning markers. Event B is a separate scenario. Do not carry damage from Event A into Event B.

### Event B Mussels disappear locally

Construction removes the mussel-covered surface in part of the rocky shore. For this simplified round, take card 04 out of the food web and cross out its food arrows. All other cards stay. This represents local loss, not global extinction.

- 1 Calculate the proportion of listed arrows removed. Explain why this is not a percentage loss of biodiversity or ecosystem function.
- 2 Develop two contrasting responses involving crab feeding and implications for fish.
- 3 Identify a testable difference between the responses and a possible confounding factor.

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Design a brief monitoring test: variable, comparison location, timing and one limitation. Card removal represents local model loss, not global extinction.



## STUDENT SHEET 6 | THE PROTECTION CHALLENGE

# Make a case for the whole bay

Allocate a maximum of six fictional planning tokens to two or three actions. Compare your package with a feasible alternative. Defend your priority under uncertainty, identify whose interests may be affected and state what evidence would trigger reconsideration.

| Action                  | Cost | Benefit and limit                                                                                                      |
|-------------------------|------|------------------------------------------------------------------------------------------------------------------------|
| A Protect seagrass      | 3    | Create a marked no-anchor zone. Reduces future anchor damage; does not instantly regrow lost plants.                   |
| B Protect rocky habitat | 3    | Change construction plans to avoid living rocky surfaces. Protects habitat; building work may need a different design. |
| C Survey the bay        | 2    | Count selected organisms and map habitats regularly. Helps check change; does not directly stop damage.                |
| D Inform visitors       | 1    | Create signs and a short guide about wildlife. Helps people understand; results depend on their actions.               |

Our actions: \_\_\_\_\_ Total: \_\_\_\_\_ / 6 tokens.

We chose them because: \_\_\_\_\_

One problem they do not solve: \_\_\_\_\_

## Create a mini-exhibition poster

Create an exhibition panel on your second A3 sheet. Include:

- An annotated habitat and food-web extract with at least three organisms.
- A 100–130-word recommendation distinguishing model evidence from inference.
- A rejected alternative, an opportunity cost and one affected stakeholder.
- A measurable review criterion and evidence that could change your decision.

You can choose three organisms from a longer chain. Your poster is a small example, not the whole food web.

## Argument support

Build a coherent argument: establish the dependency, qualify the projected effect, justify the priority and specify how it will be reviewed. Use precise concessions rather than repeatedly stating that everything is uncertain.

## Gallery conversation

Present your panel in 90 seconds. The other team challenges one causal assumption and one policy trade-off. Respond with a concession where justified, then revise the least defensible claim.

Final discussion: when is acting on incomplete evidence justified, and what makes that action open to responsible revision?



## TEACHER SHEET | ANSWERS AND SOURCES

## Connections and suggested responses

### Food web and habitats

Producers: 01 and 02. Eight feeding arrows: 01 → 03, 01 → 04, 02 → 05, 03 → 07, 05 → 07, 04 → 06, 05 → 06, 07 → 08. Example chains: 01 → 03 → 07 → 08 and 02 → 05 → 07 → 08. Cards 06 and 07 each have two listed foods. Accept only listed links for checking this model; real webs include many more. [1, 3–5]

Habitat S: 05, 06, 07, 08. Their remaining habitats are R, R, O and R respectively. Losing S can reduce shelter or feeding opportunities even when another code remains. The codes describe this activity, not universal species requirements. Seagrass is a habitat-forming plant and producer, although it has no separate food card. [2]

### Event reasoning

Event A: mark the four S cards; do not remove any organism automatically. Movement may help, but alternative places may have less space, food or suitable shelter. Event B: remove 04 and arrows 01 → 04 and 04 → 06. Crab 06 still has amphipods 05. If crab feeding on amphipods increases, fish may have less of that food and herons could be affected through fish. This is a hypothesis, not a certain cascade: other prey, movement and population responses could change the outcome.

Event B removes 2 of 8 arrows = 25%, not 25% of biodiversity or function. Compare increased amphipod predation with crab relocation or use of unlisted prey. Test using repeated crab-diet observations and amphipod counts at affected and reference sites. Season, tides or other disturbances may confound change. Equal sampling effort improves comparison but does not remove every causal uncertainty.

### Plans and sample poster text

A+B = 6 prioritises preventing physical damage but funds no survey or visitor guide. A+C+D = 6 supports seagrass protection, monitoring and information but does not directly change rocky-shore construction. B+C+D = 6 leaves the anchoring problem untreated. Other two- or three-action plans within budget are valid with reasons. Treat benefits as aims, not measured guarantees.

"We recommend rocky-habitat protection, monitoring and visitor information for six tokens. The model establishes a mussel–crab feeding link; it does not establish that mussel loss will cause a predictable decline in fish. Increased crab predation on amphipods is one plausible mechanism, conditional on feeding responses. Avoiding habitat damage is therefore our priority, while monitoring tests the interpretation. Protecting both habitats would address anchoring too, but leave no funded assessment of change. Our package still leaves boat-related damage unresolved and may require developers to redesign work. We will compare matched habitat surveys and organism counts before and after intervention, using reference sites. Continued deterioration or evidence that anchoring dominates would justify reconsideration."

### Assessment

Award 0–2 each for accurate synthesis, evaluation of model limits, contrasting causal explanations, defensible policy trade-offs and precise C1 communication. Strong responses connect claims to evidence, address objections and specify conditions for revision. Complexity of vocabulary alone is insufficient.

### Sources

- [1] NOAA. Aquatic food webs. <https://www.noaa.gov/education/resource-collections/marine-life/aquatic-food-webs>
  - [2] NOAA Fisheries. The Importance of Eelgrass. <https://www.fisheries.noaa.gov/feature-story/importance-eelgrass>
  - [3] MarLIN. Common shore crab. <https://www.marlin.ac.uk/species/detail/1497>
  - [4] MarLIN. A gammarid shrimp. <https://www.marlin.ac.uk/species/detail/1699>
  - [5] RSPB. Grey Heron. <https://www.rspb.org.uk/birds-and-wildlife/grey-heron>
- Last visited: 13 October 2026.