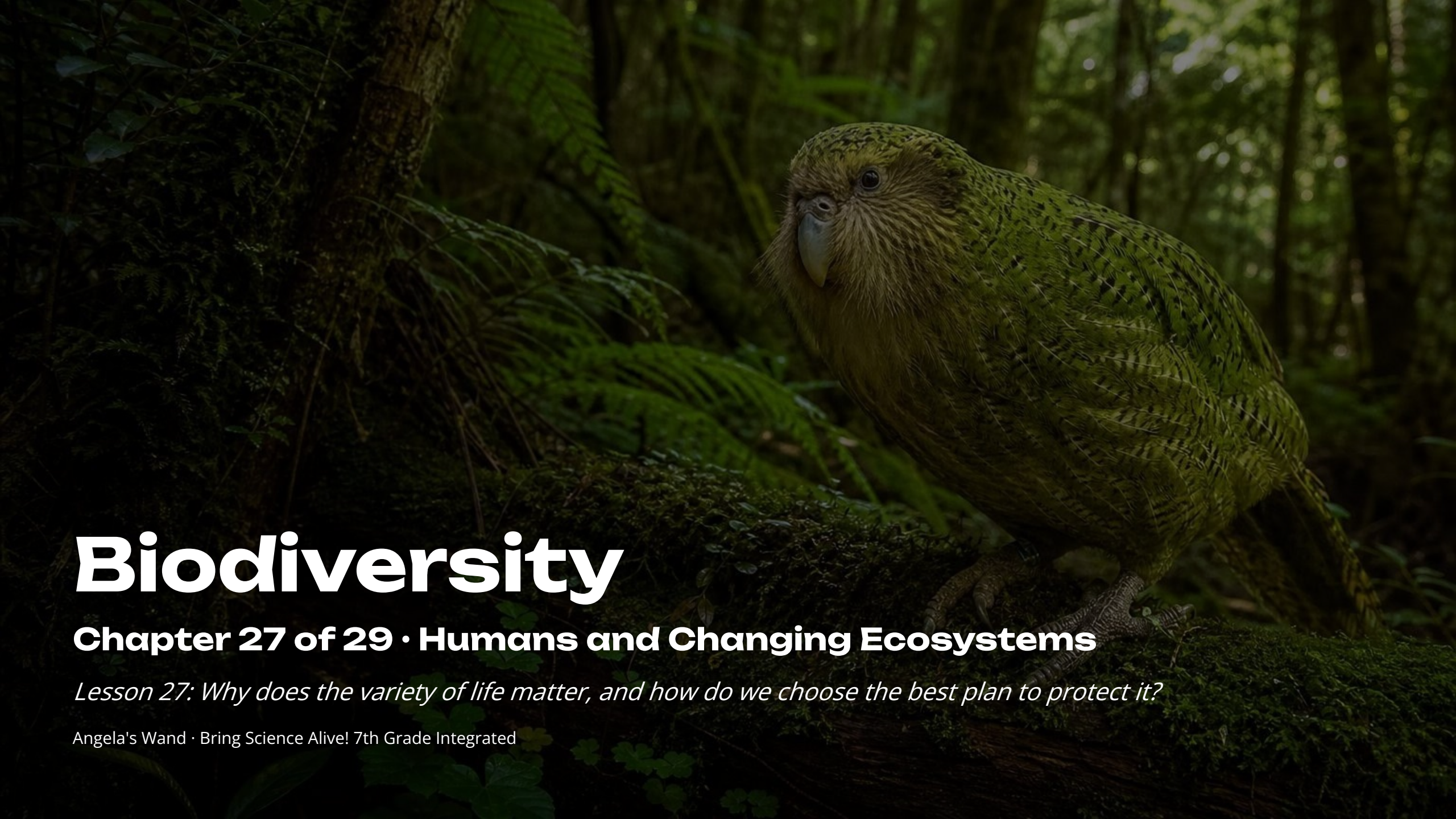


A Kakapo bird, a large, flightless parrot, is perched on a mossy log in a dense, lush forest. The bird has green and brown mottled feathers and a large, hooked beak. The background is filled with various green plants and trees, creating a vibrant and natural setting.

Biodiversity

Chapter 27 of 29 • Humans and Changing Ecosystems

Lesson 27: Why does the variety of life matter, and how do we choose the best plan to protect it?

Angela's Wand • Bring Science Alive! 7th Grade Integrated

PHENOMENON

From 51 birds to 325: the kākāpō comeback

The kākāpō is a heavy, flightless parrot that feeds at night and lives only in New Zealand. In 1995 just 51 were known to be alive. Rangers moved every known bird to offshore islands, cleared those islands of predators such as cats and rats, and watched over each nest. On 1 September 2026 the official count reached 325, after a record 90 chicks survived from one breeding season.

- Notice: which numbers changed, and what did people change?
- Wonder: why could a flightless parrot thrive in New Zealand before people came?
- Predict: what will limit how far this comeback can go?





What you will be able to do

Learning targets

- Describe biodiversity at three levels and measure it with richness and a diversity index.
- Explain why each ecosystem has its own natural level, and why the tundra is fragile.
- Trace how losing a keystone species or another population changes many others.
- Explain how specialized niches pack a rainforest, and how people depend on biodiversity.
- Evaluate competing plans against criteria and constraints, then combine their best parts.

Biodiversity: more than a species count

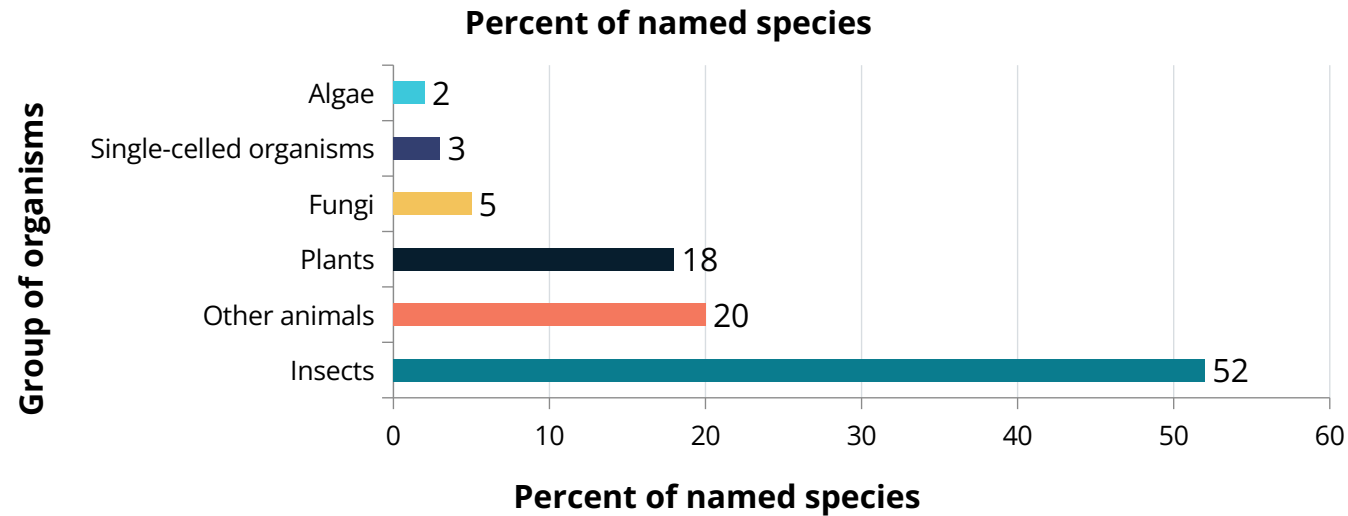
- Biodiversity is the variety of life, at three levels: genes, species and ecosystems.
- Species richness counts how many kinds live in a place.
- Evenness asks whether individuals are shared fairly equally or one kind dominates.
- Scientists have named a little over 2 million species; many millions more are unnamed.
- Insects are about half of all named species; plants hold most of life's mass but far fewer kinds.



Model

Who has been named? Shares of known species

Model: Approximate share of named species in each group



Approximate shares from the lesson's circle graph, based on about 1.9 million named species when the book was written; newer catalogs list over 2 million.



Three words for measuring variety

VOCABULARY IN CONTEXT

species richness: The number of different species, or recognizable kinds, found in a place or a sample.

*A mowed lawn quadrat with grass, clover and one dandelion-like weed has a richness of **3**.*

biodiversity index: One number combining richness and evenness. Simpson's index runs from 0 (one kind) toward 1 (many, evenly mixed).

*Two patches with the same 4 plants: **0.66** when shares are 50, 25, 12.5 and 12.5 percent; **0.14** when one plant has 92.5 percent.*

proportion: A part compared with the whole, as a fraction, decimal or percentage.

*If 20 of 80 points touch clover, clover's proportion is $20 \div 80 =$ **0.25**, or 25 percent.*

Every ecosystem has its own natural level

- On land, biodiversity is highest in warm, wet tropics and falls toward the poles.
- In the sea, it peaks in warm, sunlit shallows such as coral reefs and in rich coastal waters.
- Arctic tundra: low. Kelp forest: in between. Rainforest and coral reef: very high.
- A healthy ecosystem keeps the full set of species that naturally belong there.
- So compare a tundra with healthy tundra, not with a rainforest.



MODEL

Low and high: why the tundra is more fragile

Model: Arctic tundra compared with tropical rainforest

Arctic tundra	Tropical rainforest
Long, cold winters and a short growing season	Warm and wet nearly all year
Few species; many eat several kinds of food	Huge numbers of species, many of them specialists
Each role is filled by one or a few species	Some roles are shared by several species
Losing one species can ripple widely	Some losses are buffered, but not all

Fragility is a tendency: high biodiversity helps but does not protect against every disturbance.





CHECK FOR UNDERSTANDING

Quick check: which plot is healthier?

A survey finds 35 plant species in an Arctic tundra plot and 280 in a rainforest plot. Which conclusion does this evidence support?

- A. The rainforest plot is healthier because it has eight times as many species.
- B. The tundra plot must have been damaged by people.
- C. Neither: each plot must be compared with healthy plots of its own ecosystem type.
- D. The tundra plot is healthier because fewer species compete.

Fragile tundra: one hunter, many diners

- Polar bears are the chief hunters of grown seals, waiting at breathing holes in the sea ice.
- Arctic foxes and gulls eat their leftovers, an important food in the lean winter months.
- Warming breaks up sea ice earlier, so bears catch fewer seals and leave fewer scraps.
- With so few species, there may be no one to take over a lost role.
- Polar bears do not hibernate; only pregnant females den, to give birth.



A small change spreads through the tundra web

Model: Less sea ice, less food for scavengers

- 01 Warmer Arctic → (melts the ice)
- 02 Less sea ice, breaking up earlier → (fewer hunting platforms)
- 03 Fewer seals caught by polar bears → (fewer leftovers)
- 04 Fewer carcasses left on the ice → (scavengers go hungry)
- 05 Less winter food for Arctic foxes and gulls

Each arrow is a cause-and-effect link; the change at the start is physical, the changes downstream are in populations.





The kelp forest's keystone: the sea otter

- Sea otters eat urchins, crabs, clams and abalone; urchins graze on kelp.
- Fur hunters wiped out otters along most of the Pacific coast by the early 1900s.
- Without otters, urchins swarmed and grazed kelp down to bare 'urchin barrens'.
- Kelp is food and shelter for many fish and invertebrates, so they declined too.
- Where protected otters returned, kelp recovered in many places, though not everywhere.

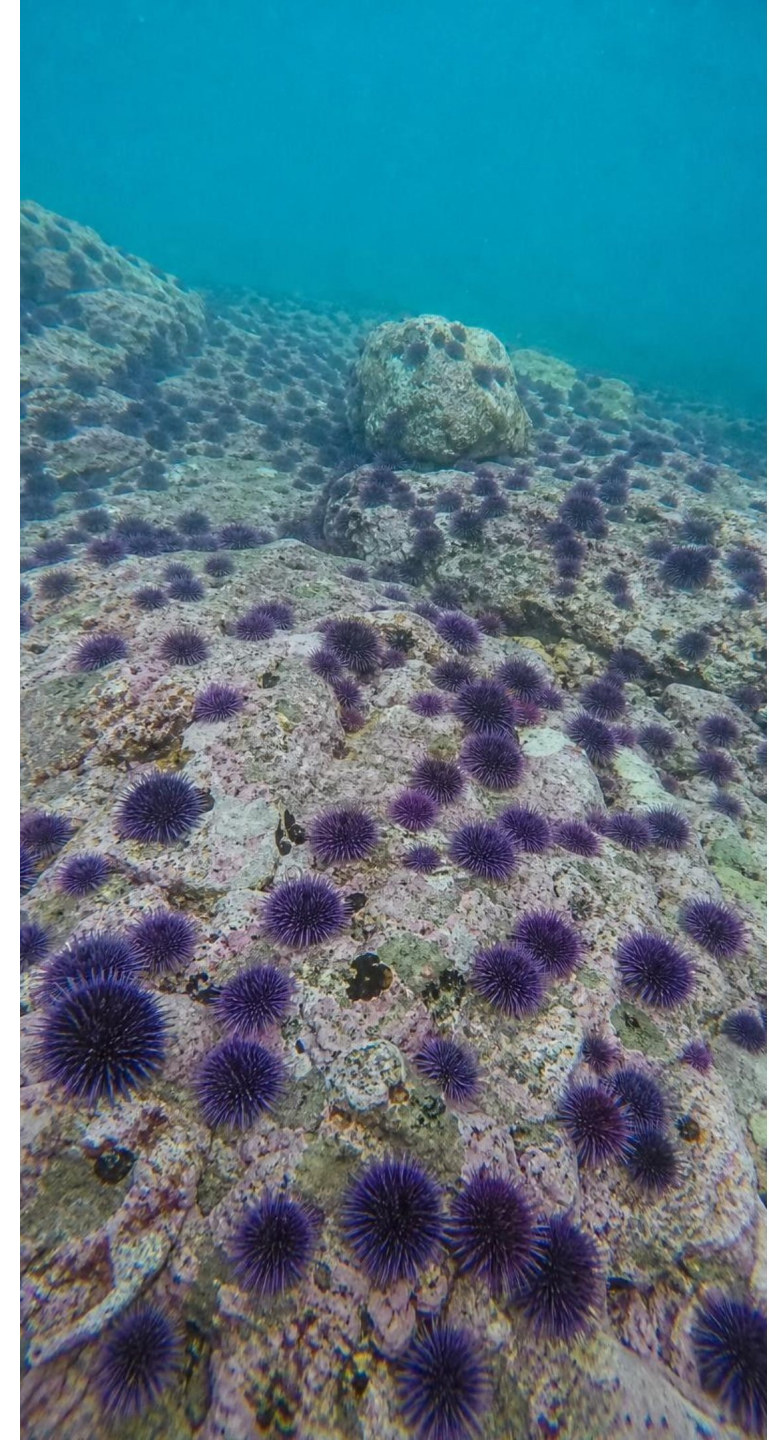
MODEL

A keystone at work: otters, urchins, kelp

Model: Removing one predator changes a whole forest

1. Fur hunters remove sea otters → (urchin predator gone)
2. Sea urchins multiply and leave their cracks → (grazing fronts spread)
3. Urchins graze kelp down to bare rock → (food and shelter lost)
4. Fish, abalone and other kelp dwellers decline

The effect on the kelp is indirect: otters never eat kelp.





VOCABULARY IN CONTEXT

Words for losing and holding up species

- **keystone species:** A species whose effect on its ecosystem is far larger than its numbers suggest. *A small number of sea otters keeps urchins scarce enough for a kelp forest to stand.*
- **extirpation:** Loss of a species from one area while it survives elsewhere; a local extinction. *Sea otters were extirpated from Washington by 1910 but survived in Alaska.*
- **extinction:** Death of the last member of a species anywhere. It cannot be undone. *Both species of gastric brooding frog disappeared in the 1980s and are now listed as extinct.*

CHECK FOR UNDERSTANDING

Quick check: extirpated, extinct or neither?

- Sea otters vanish from the Oregon coast but survive in Alaska.
- The last southern gastric brooding frog dies, and none survive anywhere.
- 1987: the last wild California condor is caught; 27 condors live on in zoos.
- A tree that grows only in one valley is lost when the valley is cleared, with no seeds saved.

Label each case extirpation, extinction or neither, and give a one-line reason.





Rainforests: room for specialists

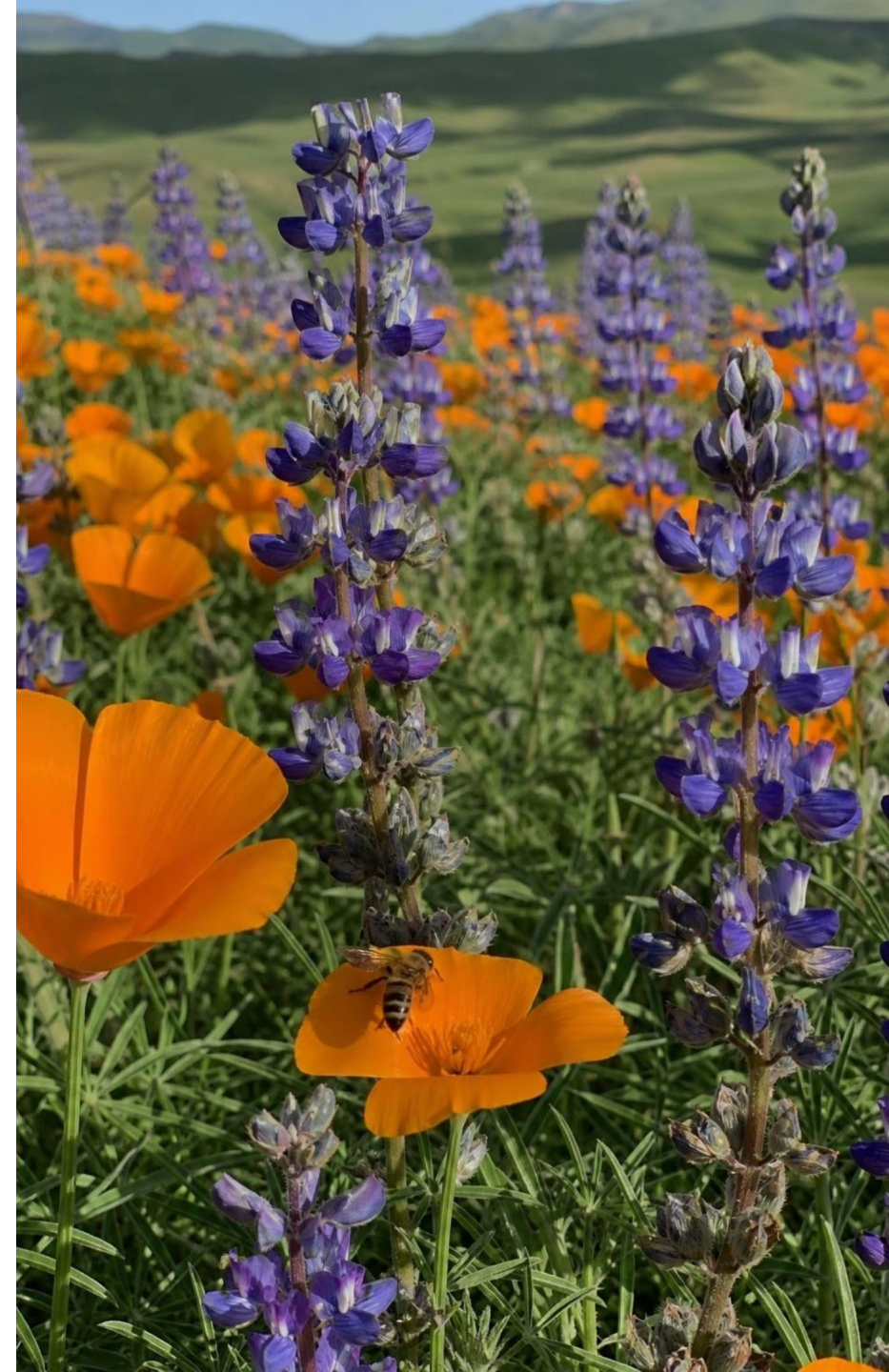
- Warmth, light and rain all year feed a huge mass and variety of producers.
- Steady food lets species specialize: one diet, one forest layer, one partner.
- The lesser anteater eats mainly ants and termites; few rivals share that niche.
- Many orchids grow on high branches, catching light and rain far above the soil.
- Specialists compete less with each other, so many species can live side by side.

THINK, PAIR, SHARE

Discuss: is more species always healthier?

- What does each place naturally hold?
- What are the invasive plants doing to the native plants and animals?
- Which one feeds native pollinators, insects and birds?

A roadside strip has 15 plant species, 10 of them invasive species from other continents. A nearby native meadow has 11, all native. Which is healthier, and what would you need to know?





People depend on biodiversity

- Medicines: Madagascar periwinkle gave vinblastine and vincristine, used against some cancers.
- Willow bark's salicin led chemists to aspirin; foxglove plants yield heart medicines.
- Food and materials: every crop and farm animal, silk and timber came from wild species.
- Knowledge: gastric brooding frogs vanished before we learned how they switched off stomach acid.
- Ecosystem services: pollination, clean water, soil held in place, nurseries for fish.

REAL-WORLD CONNECTION

California connection: comebacks that still need help

California condors fell to 22 birds in 1982, and by 1987 every survivor was in captivity. Releases began in 1992; at the end of 2025 there were 607 condors, 392 of them flying free. About 50 southern sea otters survived the fur trade near Big Sur; the 2019 population index was 2,962. White abalone have fallen about 99 percent since the 1970s.

- Condors: lead from bullet fragments in carcasses is still the leading known cause of death.
- Sea otters: threatened since 1977; shark bites have become a major cause of death.
- North coast red abalone: sport fishing closed since 2018 after the kelp collapse, now until 2036.
- White abalone raised in captivity have been released off southern California since 2019.





Judging a plan: criteria, constraints, trade-offs

- Criteria: what success means, such as kelp cover, fish species or clean water.
- Constraints: the limits, which are scientific, economic and social.
- Compare every plan against the same criteria, using test or pilot data.
- Few plans win on everything; name the trade-off you accept.
- Often the best plan combines the strongest parts of several.

MODEL

Engineers test, compare, then combine

Model: Designing an adhesive that works wet or dry

1. Criteria: sticks wet and dry, peels off gently → (build and test)
2. Test a gecko-like textured pad: dry yes, wet no → (build and test)
3. Test a mussel-like glue: wet yes, peels off poorly → (keep the best of each)
4. Combine: textured pad coated with mussel-like glue → (check the criteria)
5. Retest: held and released in wet and dry lab tests

Based on a 2007 lab prototype; a bandage for patients would need more testing.





THINK, PAIR, SHARE

Discuss: otters back on the north coast?

- Who gains, and who loses?
- What evidence would each side want to see?
- Could a plan reduce the harm to one group?

Returning sea otters to Northern California could help kelp recover, but otters also eat abalone, crabs and urchins that people harvest. How should this trade-off be decided?

Task: where should 40 young kākāpō go?

- Criteria: low predator risk, enough food to breed, room for at least 40 more birds.
- Constraint: at most 30 points over 10 years.

Option	Predator risk	Food for breeding	Cost (points, 10 yr)	Room for more birds
A. Add birds to existing islands	Very low	Shared rimu; may run short	5	About 10
B. Clear a new, larger island	Low once cleared; rats may swim back	Plenty of rimu	40	150 or more
C. Fenced mainland sanctuary	Low if the fence holds; breaches happen	Some rimu	25	About 60

Simulated data for practice.

Use the table to judge three options against the criteria and the budget. Which would you choose, and which trade-off are you accepting?





CHECK FOR UNDERSTANDING

Quick check: combine the best parts

Plan X brings kelp back fast but stops working when its funding ends. Plan Y is slow but keeps working on its own. Which choice best uses both test results?

- A. Choose X, because fast results matter most.
- B. Choose Y, because it costs less over time.
- C. Run X for the first years as a bridge while Y builds up, then stop X.
- D. Wait until someone designs a plan with no weaknesses.

MISCONCEPTION CHECK

True or false? Numbers are up, so the job is done

"Kākāpō and condor numbers have risen for years, so the protections can stop now and both populations will keep growing on their own."

True or false? Explain your reasoning.





PUTTING IT TOGETHER

Putting it together

- Biodiversity is variety at three levels; richness and evenness both matter.
- Each ecosystem has its own natural level; health means keeping the species that belong.
- Low-biodiversity systems like the tundra are easier to knock off balance.
- Keystone species, like sea otters, hold up far more of a system than their numbers suggest.
- People depend on biodiversity for medicines, food, materials, ideas and ecosystem services.
- Good conservation plans are judged on criteria and constraints, combined and monitored.

EXIT TICKET

Exit ticket

- Two patches each have 5 plant kinds. Why might their biodiversity index differ?
- Why can losing one predator matter more in the tundra than in a rainforest?
- California's last wild gray wolf was killed in 1924; wolves lived on in Canada. Extirpation or extinction?
- Name one criterion and one constraint for judging a plan to protect condors.

