●●●○○ **Level 3 · Science S3.2**

Ecosystems

All the living things in a place, and how they depend on each other.

Sort living things into groups, use and make a key, join food chains into a web, follow energy up a chain, see how dead things are recycled, learn how living things compete and adapt, count plants with a frame, and plan a small action to protect a place.

YOU ARE READY FOR THIS BOOK IF

You can draw a food chain with a plant, a plant eater and a meat eater.

One step up	S4.1 Cells, photosynthesis and respiration
This book	**S3.2 Ecosystems**
One step down	S2.2 Food chains and habitats

Contents

S3.2.1 Sorting living things

S3.2.2 Using and making keys

S3.2.3 Food webs

S3.2.4 Energy through a food chain

S3.2.5 Decomposers and recycling

S3.2.6 Competition and adaptation

S3.2.7 Counting living things

S3.2.8 People and ecosystems

Key words, A to Z

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S3.2.1 CHAPTER 1

Sorting living things

A mushroom grows out of the soil, but it is not green. Is it a plant?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** No. It is a fungus, which is a group of its own.
- ☐ **B** Yes. It grows in the soil and stays in one place, like a plant.
- ☐ **C** No. It is an animal, because it is not green.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.1. A living thing feeds, grows and has young.
- Level 2, Food chains and habitats, S2.2.2. Animals can be grouped by how their bodies look.

BY THE END YOU CAN

- Sort living things into plants, animals, fungi and microbes
- Sort animals into vertebrates and invertebrates, with examples

All the living things in one place, and the way they depend on each other, make an **ecosystem**. A pond is one. A forest is another. To study an ecosystem, you first need names for what lives in it.

There are millions of kinds of living things. Nobody can learn them one by one. So we sort them into groups.

A group tells you what to expect. If you know a thing is in a group, you already know a lot about it. Watch the four big groups build up.

DRAW IT FIRST

The four groups of living things

plants
grass
fern
tree

1 Plants stand in one place. Grass, ferns and trees are plants.

plants	animals
grass	ant
fern	fish
tree	goat

2 Animals move about to find food. An ant, a fish and a goat are animals.

plants	animals
grass	ant
fern	fish
tree	goat

fungi
mushroom
mould
puffball

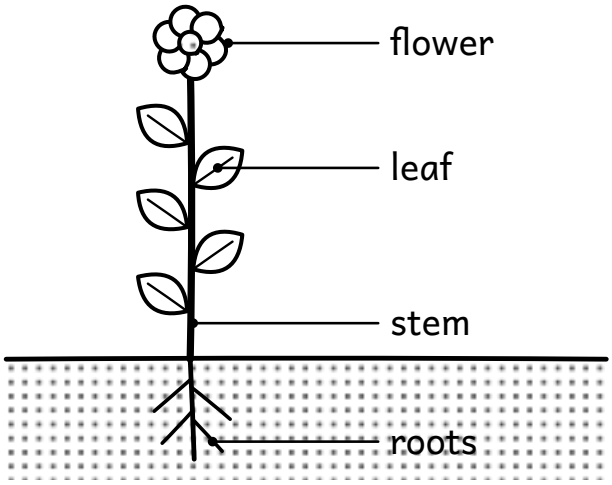
3 Fungi are mushrooms, moulds and puffballs. They are not plants.

plants	animals
grass	ant
fern	fish
tree	goat

fungi	microbes
mushroom	bacteria
mould	amoeba
puffball	

4 Microbes are living things too small to see without a microscope.

Plants make their own food from light. They have green leaves for this. Animals cannot make food, so they eat other living things.

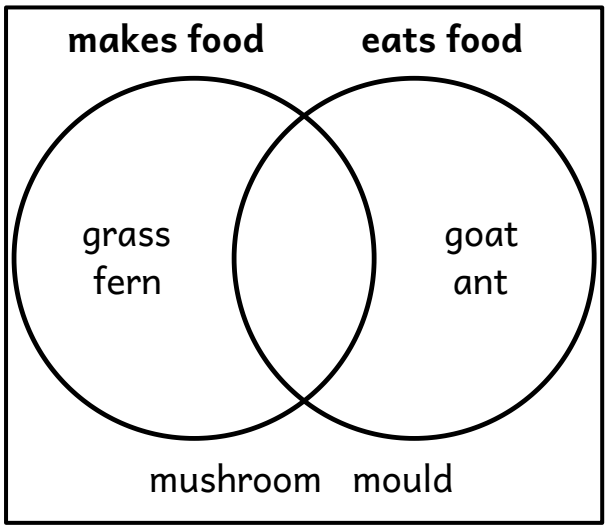


A plant. The green leaves catch light to make food.

Fungi (one is a fungus) have no leaves and no green. They cannot make food from light. They soak up food from the things they grow on, such as dead wood or old bread.

SEE IT THREE WAYS

As a picture



In words

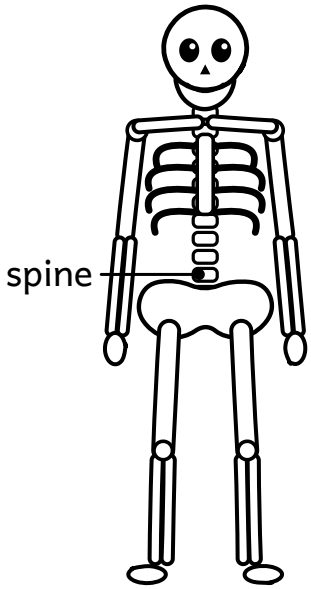
Plants make food from light. Animals eat food. A mushroom does neither, so it fits in neither circle. It is a fungus.

Microbes are the smallest living things. They are all around you, in soil, water and air. One drop of pond water holds thousands. Some microbes help us and some make us ill. Some fungi, such as yeast, are microbes too. Algae, which grow in ponds and the sea, make food from light like plants.

group	gets food by
plants	making it
animals	eating
fungi	soaking it up
microbes	many ways

How each group gets food.

Now look inside the animal group. Some animals have a **backbone**, a row of small bones down the back. We call them **vertebrates**. People, fish, frogs, snakes, birds and goats are vertebrates.



The spine is the backbone. A person is a vertebrate.

Animals with no backbone are **invertebrates**. Ants, spiders, snails, worms and crabs are invertebrates. Most animals on Earth are invertebrates.

vertebrates	invertebrates
fish	ant
frog	spider
snake	snail
bird	worm
goat	crab

Animals with a backbone, and animals without one.

TRY IT

Find and sort

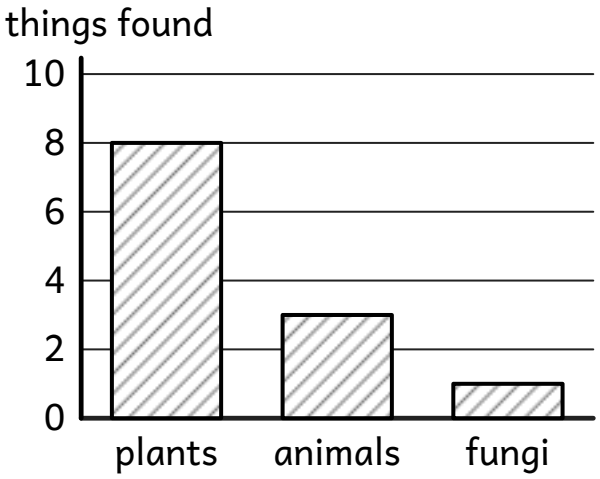
You need: a pencil, a sheet of paper, a small place outside, such as a yard or a path edge.

Be safe: Do not touch or taste a mushroom. Stay away from nests and from animals that sting or bite. Wash your hands when you finish.

1. Draw three columns on the paper. Write plants, animals and fungi at the top.
2. Look around the place for ten minutes. Write the name or draw each living thing in its column.
3. Do not pick, dig or catch anything. Look, count, and leave it as you found it.
4. Count each column.

What you will see: Most of what you find is plants. You find fewer animals, because many hide or move away. You may find no fungi at all. Microbes are there too, but too small to see.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~**A mushroom is a plant.**~~

Why it feels right: It grows out of the soil and stays in one place.

The test that breaks it: Look for green leaves. A mushroom has none. It can grow in a dark, damp place where a plant would die for lack of light.

What is true: A mushroom is a fungus. Fungi are a group of their own. They cannot make food, so they soak it up from what they grow on.

KEY WORDS

ecosystem
all the living things in one place and the way they depend on each other.

fungi
living things such as mushrooms and moulds. They have no leaves and soak up food.

microbes
living things too small to see without a microscope.

backbone
the row of small bones down the back, also called the spine.

vertebrates
animals with a backbone.

invertebrates
animals with no backbone.

BACK TO YOUR GUESS

The answer is A: No. It is a fungus, which is a group of its own.

A mushroom is a fungus. Fungi make no food from light and have no leaves, so they are not plants. They do not eat and move like animals either.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. A mushroom grows from the soil. It has no leaves and makes no food from light. Which group is it in?

   A Fungi

   B Plants

   C Animals

   Answer at the back of the book.

2. Which living things are too small to see without a microscope?

   A Fungi such as mushrooms

   B Invertebrates such as ants

   C Microbes

   Answer at the back of the book.

3. Which group is made of living things that make their own food from light?

   A Animals

   B Fungi

   C Plants

   Answer at the back of the book.

4. Which of these animals is a vertebrate?

   A An ant

   B A fish

   C A spider

   Answer at the back of the book.

5. A worm has no backbone. What is it called?

   A A vertebrate

   B An invertebrate

   C A plant

   Answer at the back of the book.

6. In a yard, Ana found 8 plants, 3 animals and 1 fungus. How many living things did she find in all?

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Living things go in four groups: plants, animals, fungi and microbes. A fungus is not a plant. Animals with a backbone are vertebrates. Animals with none are invertebrates.

Draw: Draw four boxes and write the groups. Put two living things in each. Write vertebrate or invertebrate by each animal.

S3.2.2 CHAPTER 2

Using and making keys

> **I found a small creature under a stone. How can I find out its name?**

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Answer yes or no questions, one at a time, until only one name is left.
- ☐ **B** Pick the clue that stands out most, such as its colour, and match it to a picture.
- ☐ **C** Look at how big it is. Big and small animals have different names.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.2. Animals can be grouped by clues such as legs, wings and a shell.

BY THE END YOU CAN

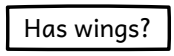
- Use a branching key to name an unknown leaf or insect
- Make a key with yes or no questions for four animals

Naming a living thing is hard when there are so many. A **key** helps. It is a set of yes or no questions. Each answer leads you along a **branch**, and each branch ends at a name.

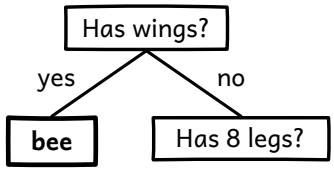
This key is for four small animals only. Watch it grow, one row at a time.

DRAW IT FIRST

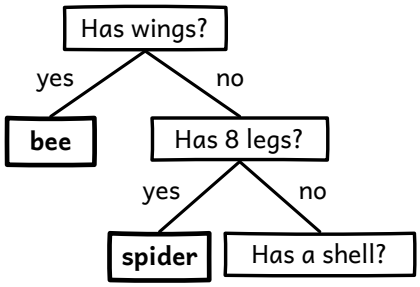
A key for four small animals



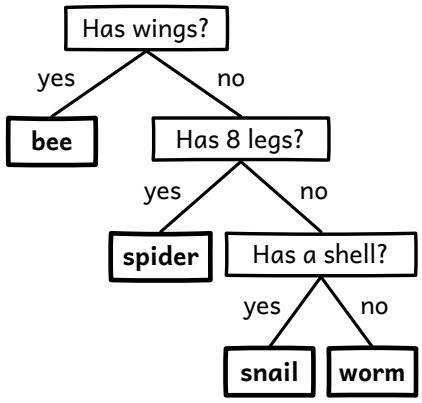
1 Start at the top with one question. Does the animal have wings?



2 Yes goes left to bee. No goes right, to the next question.



3 The next question is about legs. Yes goes to spider. No goes down.



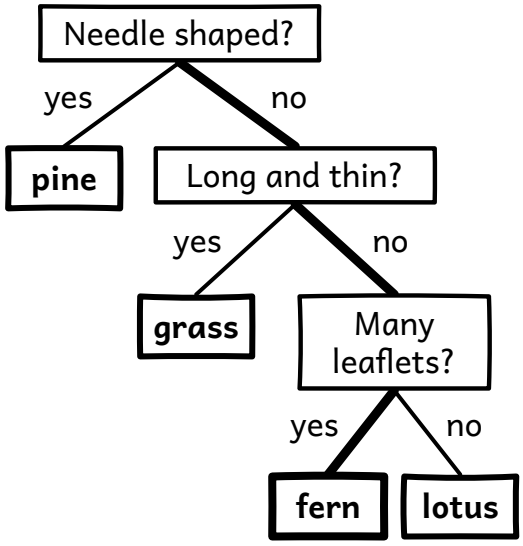
4 The last question is about a shell. Yes is a snail. No is a worm.

Every animal in the key has one path to its name, and no other. To use the key, look at your animal and answer each question truthfully. Do not skip a question.

animal	wings	legs	shell
bee	yes	6	no
spider	no	8	no
snail	no	0	yes
worm	no	0	no

The clues the key uses. Each question asks about one column.

A key also works for plants. Look at a leaf. Is it shaped like a needle? Is it long and thin? Does it have many small leaflets? The heavy line shows the way to a fern.



A leaf key. The heavy line is the path to fern.

Now make your own key. Choose questions with a clear answer that you can see. Wings, legs, fins, feathers and a shell are good clues. Colour and size are poor clues. They change from one animal to the next of the same kind. A key like this one works only for the things in it.

good	poor
Has wings?	Is it nice?
Has 8 legs?	Is it big?
Has a shell?	Is it scary?

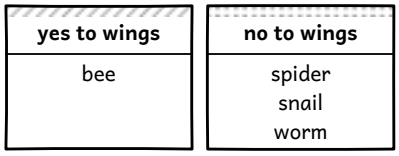
A good question has a clear answer that is the same for everyone.

SEE IT THREE WAYS

With things

Put four animals in a row. Ask a question that sorts out one of them. The rest stay in a group.

As a picture



In words

Each question splits the animals into two groups. The next question splits one group again. You stop when every group holds one animal.

In symbols

Four animals need three questions: $4 - 1 = 3$. A key for n animals has $n - 1$ questions.

TRY IT

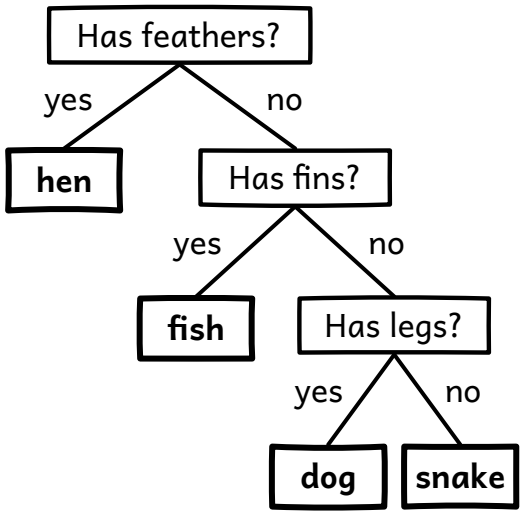
Make a key for four animals

You need: a pencil, a sheet of paper, four animals you know, such as a hen, a fish, a dog and a snake.

1. Write the four names. Find a question that is true of only one of them.
2. Draw the question in a box. Draw a branch to the left for yes, with that name at the end.
3. Draw a branch to the right for no. Write a new question that sorts out the next animal.
4. Keep going until every animal has its own end. Ask a friend to name an animal with your key.

What you will see: Three questions are enough for four animals. If two animals end in one place, you need one more question. If a question has no clear answer, change it.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~Questions about colour or size make a good key.~~

Why it feels right: Colour and size are the first things you see.

The test that breaks it: Look at the ants from one nest. Some are big and some are small. No one answer about size is true of every ant.

What is true: Choose clues that stay the same, such as the number of legs, wings or a shell. A key is only as good as its questions.

KEY WORDS

key
a set of yes or no questions that leads you to the name of a living thing.

branch
one path in a key, from one answer to the next question or to a name.

BACK TO YOUR GUESS

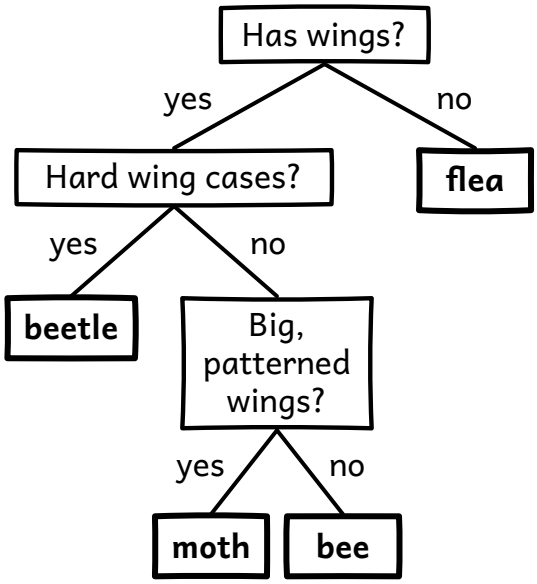
The answer is A: Answer yes or no questions, one at a time, until only one name is left.

A key uses yes or no questions about clear clues. Each answer rules some names out, until one name is left. Colour and size are poor clues, because they vary in one kind of animal.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. An insect has wings. They are hard wing cases. This key is for these four insects only. Use it to name the insect.



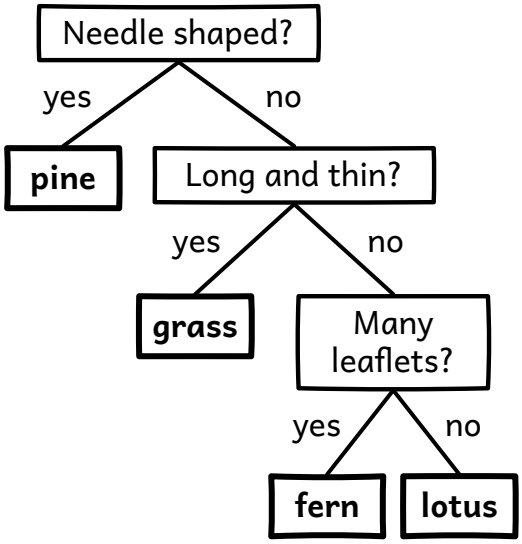
A flea

B beetle

C moth

Answer at the back of the book.

2. A leaf is not a needle. It is not long and thin. It has many small leaflets. This key is for these four leaves only. Which plant is it?



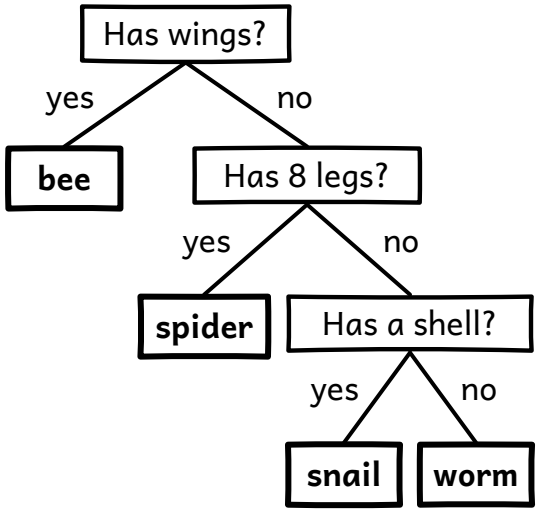
A grass

B fern

C lotus

Answer at the back of the book.

3. An animal has no wings and not 8 legs. It has a shell. Use the animal key. Which animal is it?



A snail

B spider

C worm

Answer at the back of the book.

4. Which is the best question to use in a key for animals?

   A Is it pretty?

   B Is it big?

   C Does it have wings?

   Answer at the back of the book.

5. You make a key for 6 animals. Each end of the key holds one animal. How many questions does the key have?

   A 6 questions

   B 5 questions

   C 7 questions

   Answer at the back of the book.

6. **From an earlier chapter**

   Which of these animals is an invertebrate?

   A A goat

   B A fish

   C A snail

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A key is a set of yes or no questions. Each answer leads along a branch to a name. Choose clear clues such as legs, wings or a shell. A key for n animals has n − 1 questions.

Draw: Draw a key for a bee, a spider and a worm. Write each question in a box with yes on the left and no on the right.

S3.2.3 CHAPTER 3

Food webs

What happens to the rabbits if all the foxes go away?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Nothing changes. Foxes and rabbits do not affect each other.
- ☐ **B** The rabbits are safe, so there will be more and more of them for ever.
- ☐ **C** At first there are more rabbits. Later they may eat most of the grass, and many go hungry.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.7. An arrow in a food chain points from the food to the eater.

BY THE END YOU CAN

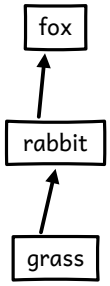
- Join food chains into a food web
- Predict what happens to a food web if one animal disappears

A food chain shows one path of food. But most animals eat more than one thing. A fox eats rabbits and also mice. A hawk eats snakes and also rabbits.

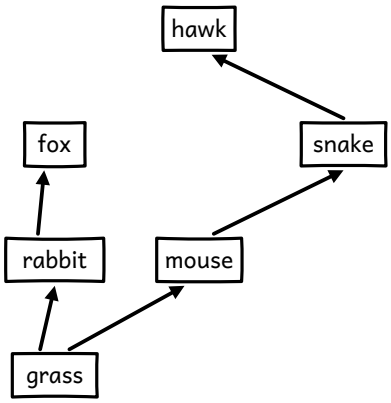
So the chains cross. Watch two chains join up.

DRAW IT FIRST

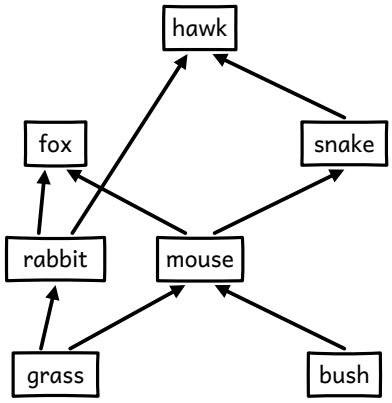
Join food chains into *a* web



1 Start with one chain. Grass is eaten by *a* rabbit. The rabbit is eaten by *a* fox.



2 Add *a* second chain. Grass is eaten by *a* mouse, the mouse by *a* snake, and the snake by *a* hawk.



3 Add the links that cross. A bush feeds the mouse with its berries. The fox eats mice. The hawk eats rabbits.

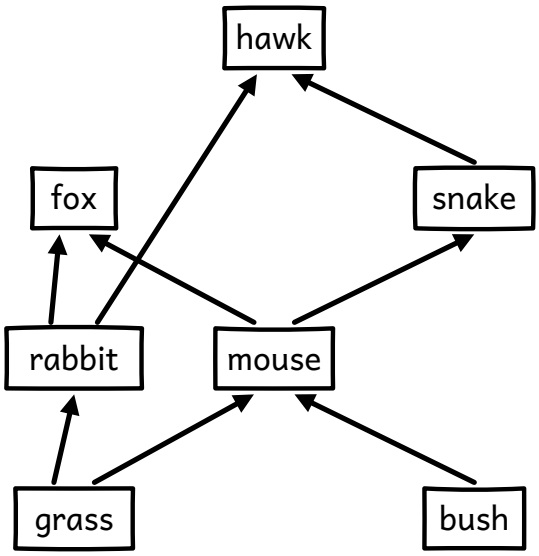
Now the chains are joined. This is *a* **food web**. Look at the arrows. Each one still points from the food to the animal that eats it.

The plants are at the bottom. They are the **producers**, because they make food from light. Algae in *a* pond do the same. Every other living thing in the web eats something.



One chain is only one path through the web.

A **predator** is an animal that hunts and eats other animals. Its **prey** is what it eats. In the web, the fox is a predator, and the rabbit and the mouse are its prey. The rabbit is also prey for the hawk.



The food web. Follow any arrow from the food to its eater.

The table lists who eats each living thing. It comes from the same web, so it never disagrees with the picture.

food	eaten by
grass	rabbit, mouse
bush	mouse
rabbit	fox, hawk
mouse	snake, fox
snake	hawk

Each food and the animals that eat it.

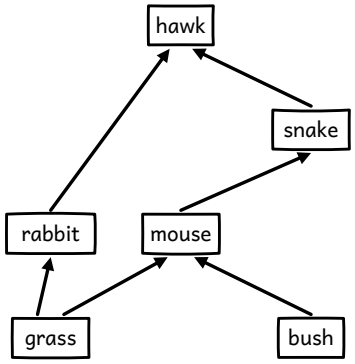
Now ask a question. What if all the foxes went away? Disease, hunting or drought could do it. Take the fox out of the web.

SEE IT THREE WAYS

With things

Write each living thing on a scrap of paper. Lay them out like the web. Join them with string. Pull away the fox.

As a picture



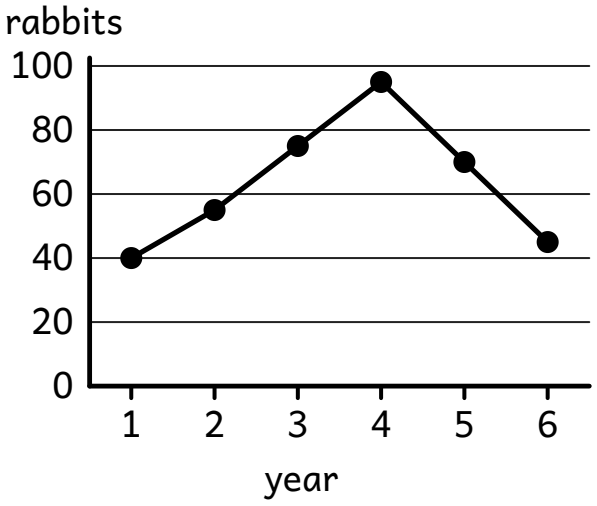
In words

The rabbit and the mouse lose a predator. The rabbit is still eaten by the hawk. The mouse is still eaten by the snake. But fewer of them are eaten, so their numbers can rise.

In symbols

The fox ate 2 kinds of animal, so 2 kinds lose a predator.

A **population** is all the animals of one kind in a place. With fewer foxes, the rabbit population can grow. More rabbits eat more grass. Then the grass runs low. Look at the graph.



A made-up example. The foxes went before year 1.

At first the rabbits rise. Then the grass is eaten down. Many rabbits go hungry, and the number falls. The hawk, which eats rabbits, also has less food. One change spreads along the arrows.

TRY IT

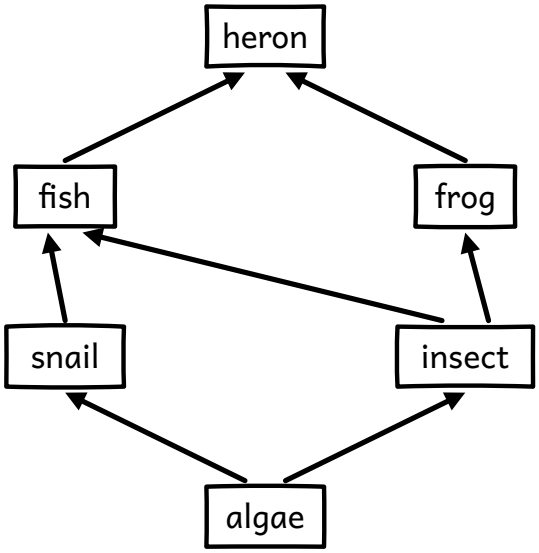
Be the web

You need: a few scraps of paper or flat stones, a pencil, a piece of string.

1. Write algae, snail, insect, fish, frog and heron on six scraps. Lay them on the floor with algae at the bottom.
2. Lay a piece of string from each food to the animal that eats it. Algae is eaten by the snail and the insect.
3. Fish eat snails and insects. Frogs eat insects. Herons eat fish and frogs.
4. Pull the snail scrap away. See which strings go loose, and what each animal still has to eat.

What you will see: The fish lose one food but still have the insect. The algae lose one eater, so the insect may eat more of it. Nothing is left without food, but every animal is touched.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~If a predator disappears, its prey is better off.~~

Why it feels right: Nothing is hunting them any more.

The test that breaks it: Look at the graph. Without foxes the rabbits rise, but then they eat the grass, and many go hungry.

What is true: Everything in a web is joined. Taking one living thing away changes the others, often in ways that hurt in the end.

KEY WORDS

food web
food chains joined together, showing what eats what in a place.

predator
an animal that hunts and eats other animals.

prey
an animal that a predator eats.

population
all the living things of one kind in a place.

producers
living things that make food from light, such as plants and algae. Most food chains start with one.

BACK TO YOUR GUESS

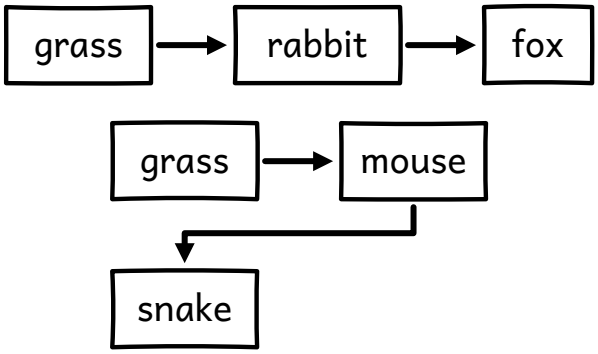
The answer is C: At first there are more rabbits. Later they may eat most of the grass, and many go hungry.

Fewer rabbits are eaten, so their number can rise. But more rabbits eat more grass. When the grass runs low, many rabbits go hungry. Everything in a web is joined.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Two chains are drawn below. One living thing is in both chains. Which one?



A grass

B rabbit

C snake

Answer at the back of the book.

2. In a food web, what does an arrow point to?

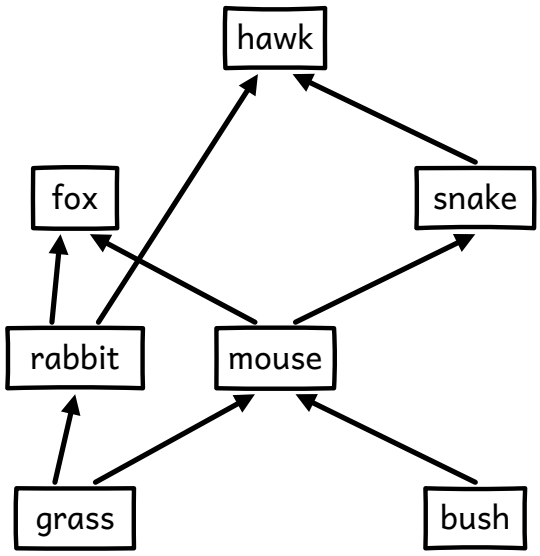
A The animal that is eaten

B The animal that eats

C The bigger animal

Answer at the back of the book.

3. All the foxes in the web disappear. Which animals lose a predator?



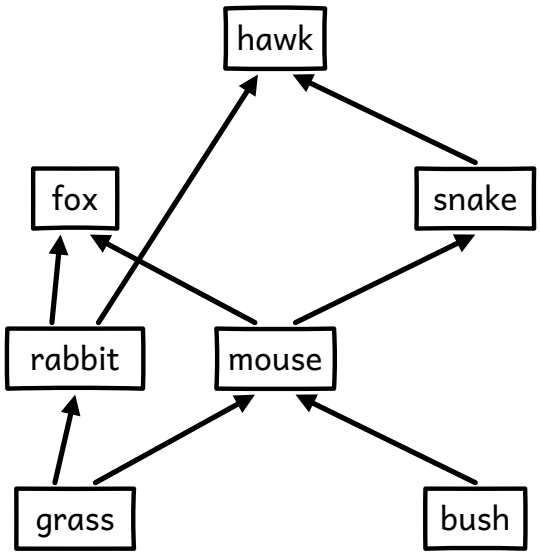
A The snake and the hawk, 2 animals

B The rabbit and the mouse, 2 animals

C The grass and the bush, 2 plants

Answer at the back of the book.

4. The snake disappears. What happens to the hawk?



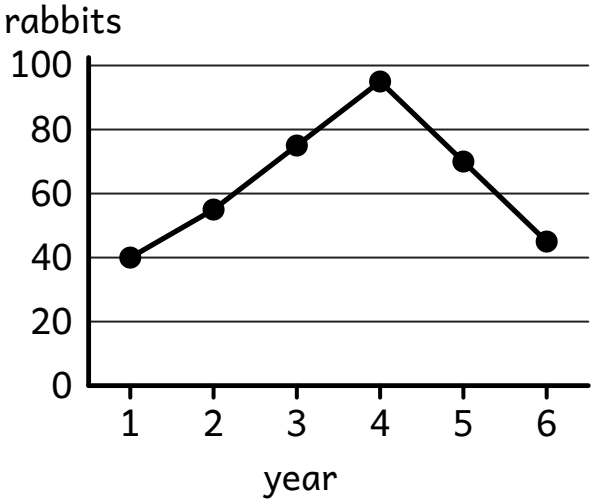
A It loses the snake but still has 1 food, the rabbit.

B It has no food left.

C It gets more food.

Answer at the back of the book.

5. Use the graph. Why do the rabbits fall in number after year 4?



A The rabbits ate the grass down, so many went hungry.

B The foxes came back.

C Rabbits only live for four years.

Answer at the back of the book.

6. **From an earlier chapter**

The fox, the snake and the hawk are all vertebrates. What do they have in common?

A Fur

B Wings

C A backbone

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

A food web is food chains joined together. Arrows point to the eater. Take one living thing away and the others change. A population is all the animals of one kind in a place.

Draw: Draw a web with grass, rabbit, mouse and fox. Draw arrows from food to eater. Cross out the fox and say what changes.

S3.2.4 CHAPTER 4

Energy through a food chain

There is plenty of grass but only a few foxes. Why?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** Foxes are big, so only a few can fit in a place.
- ☐ **B** Animals get less energy from the Sun than plants do.
- ☐ **C** Only about a tenth of the energy passes up each step, so higher animals get less.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.7. A food chain starts with a plant and shows who eats what.

BY THE END YOU CAN

- Explain why food chains rarely have more than five links
- Draw a pyramid of numbers for a food chain

Every living thing needs **energy** to move, grow and stay alive. Plants take in energy from sunlight. Animals get theirs from the food they eat.

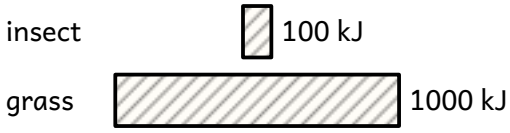
We measure energy in kilojoules, written kJ. Say the grass in a field holds 1000 kJ. A stack of bars that shows the energy at each link is a **pyramid of energy**. Watch one build up.

DRAW IT FIRST

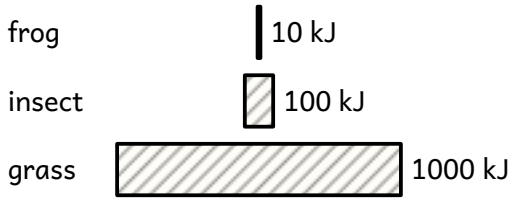
A pyramid of energy



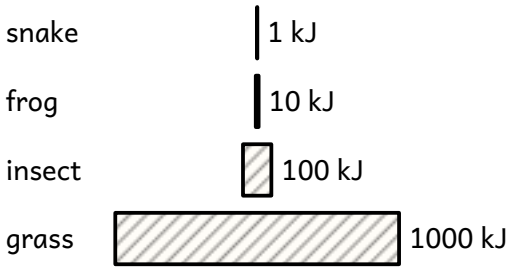
1 The grass holds 1000 kJ of energy from the Sun.



2 An insect eats the grass. About a tenth passes on, so the insect gets 100 kJ.

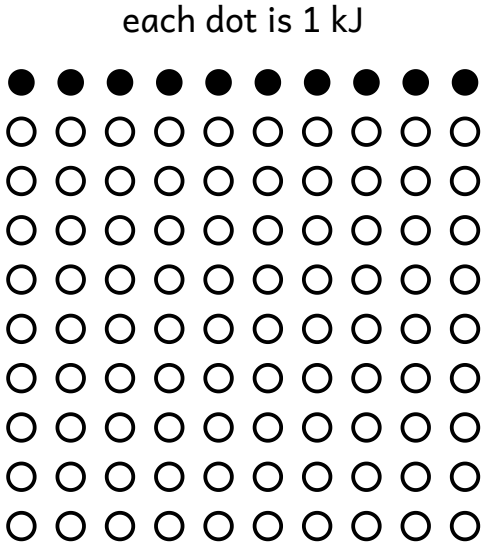


3 A frog eats the insect. It gets about a tenth of that, 10 kJ.



4 A snake eats the frog. Only 1 kJ is left for the snake.

Where does the rest go? The animal uses most of its food to move and to keep warm. That energy ends as heat. Some of the food passes out as droppings. Some parts, such as bones, are never eaten. Only the food built into its body can pass on.



Of every 100 kJ an animal eats, about 10 kJ pass on to the next animal.

The tenth is a rule of thumb. The real share changes from one chain to another, but it is always a small part.

Now work it out. Each step keeps about a tenth, so divide by 10 to go one step up.

WORKED EXAMPLE

The grass in a field holds 1000 kJ. About a tenth passes on at each step. How much energy reaches the frog, the third link in the chain?

1. The insect gets a tenth of the grass: 1000 ÷ 10 = 100 kJ.
2. The frog gets a tenth of that: 100 ÷ 10 = 10 kJ.

Answer: 10 kJ

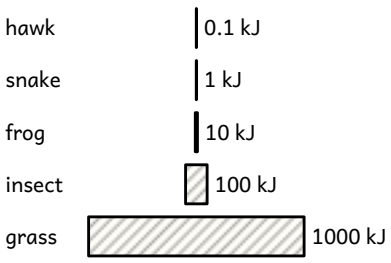
Now follow the energy to the end of a chain of five. This is a pyramid of energy too. Each step has a tenth of the one before. The bars are as wide as the energy. The last two are too thin to see.

SEE IT THREE WAYS

With things

Imagine a field of grass. A chain of five living things feeds from it, one after another.

As a picture

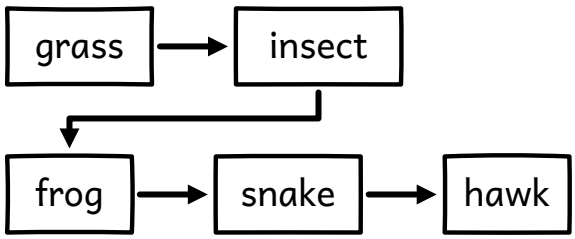


In words

The fifth living thing gets only a ten thousandth of the energy in the grass. That is too little to feed a sixth. So food chains rarely have more than five links.

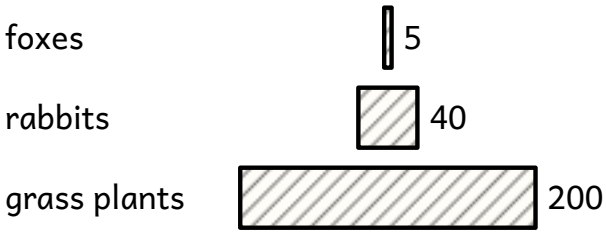
In symbols

1000 ÷ 10 ÷ 10 ÷ 10 ÷ 10 = 0.1 kJ



A chain of five links is about as long as a chain gets.

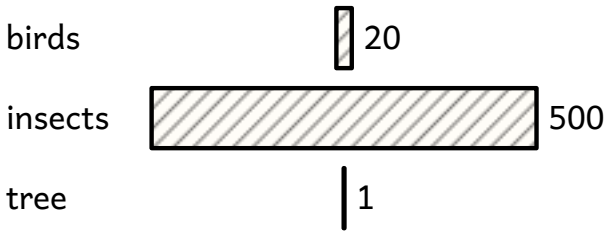
Scientists also count living things. A **pyramid of numbers** has one bar for each link in the chain. The producer is at the bottom. Each bar is as wide as the number of living things in it.



Numbers of living things in a field. The producer is at the bottom.

A pyramid of numbers is not always the shape of a pyramid. One big tree can feed hundreds of insects. A few birds eat those insects. The bottom bar is then thin and

the middle bar is wide. A pyramid of energy always narrows going up, because energy is lost at every step. A pyramid of numbers need not.



One tree, many insects, a few birds. This is not a pyramid.

TRY IT

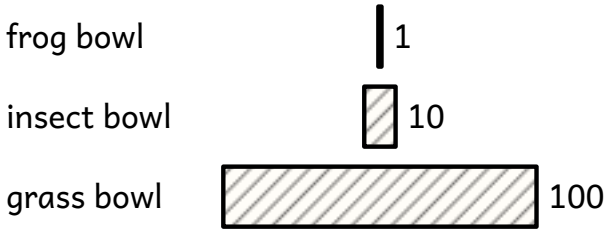
Pass the beans

You need: 100 beans, seeds or small stones, three bowls or cups.

1. Put 100 beans in the first bowl. They stand for the energy in the grass.
2. Move only 10 beans to the second bowl, for the insect. Push the other 90 to one side. They are used or lost.
3. From the 10, move only 1 bean to the third bowl, for the frog. Push the other 9 aside.
4. Try to pass on a tenth of one bean to a fourth bowl for the snake.

What you will see: One bean is too little to feed a snake. In a real chain, too little energy is left after a few links. The next animals cannot live on it.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~The animal at the top of a chain has the most energy.~~

Why it feels right: It is big and strong, and it eats the most food.

The test that breaks it: Look at the energy bars. Each step up holds only a tenth of the step below. All the hawks together hold the least energy of any step.

What is true: Energy gets less at each step. The top has the least. That is why there are few big hunters and so much grass.

KEY WORDS

energy
what a living thing needs to move, grow and stay alive.

pyramid of energy
a stack of bars that shows the energy at each link. It always narrows going up.

pyramid of numbers
a picture with a bar for each link in a chain. Each bar is as wide as the number of living things.

BACK TO YOUR GUESS

The answer is C: Only about a tenth of the energy passes up each step, so higher animals get less.

At each step of a food chain, most energy is used for living and ends as heat. About a tenth passes on. So each step up has less energy, and can feed fewer living things.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. About how much of the energy in food passes on to the next animal in a chain?

   A All of it

   B About a tenth

   C About a half

   Answer at the back of the book.

2. The grass in a field holds 5000 kJ. About a tenth passes on at each step. How much reaches the frog, the third link?

   A 50 kJ

   B 500 kJ

   C 5 kJ

   Answer at the back of the book.

3. Why do food chains rarely have more than five links?

   A Animals at the top are too big to fit in a place.

   B There is too little energy left to feed another link.

   C Plants stop growing after five links.

   Answer at the back of the book.

4. A chain has 500 grass plants, 50 insects and 5 birds. How should its pyramid of numbers be drawn?

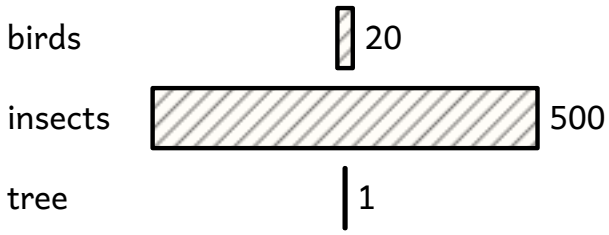
   A The widest bar at the top, for the birds

   B All the bars the same width

   C The grass at the bottom as the widest bar, the birds at the top as the narrowest

   Answer at the back of the book.

5. Look at the picture of one tree. Why is it not a pyramid?



A The picture is drawn wrongly.

B One big tree feeds a great many insects, so the middle bar is the widest.

C Insects are the producers, so they belong at the bottom.

Answer at the back of the book.

6. **From an earlier chapter**

In a food web, which way does the arrow between a rabbit and a fox point?

A From the rabbit to the fox

B From the fox to the rabbit

C There is no arrow between them

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Energy goes up a food chain, but only about a tenth passes on at each step. The rest is used for living or lost as heat. A pyramid of energy always narrows going up. A pyramid of numbers need not.

Draw: Draw a pyramid of numbers for grass 200, rabbits 40 and foxes 5. Make each bar as wide as its number.

S3.2.5 CHAPTER 5

Decomposers and recycling

What happens to a leaf that falls to the ground and nobody picks up?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** It stays there for ever, because nothing eats a dead leaf.
- ☐ **B** It dries up and blows away into nothing.
- ☐ **C** Living things break it down. Some goes into the air as gas, and the nutrients go into the soil.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.7. A food chain starts with a plant.

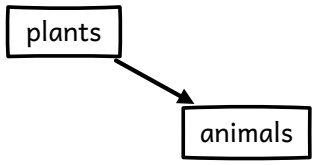
BY THE END YOU CAN

- Explain how fungi, bacteria and worms break down dead things
- Make a compost heap and record what rots first

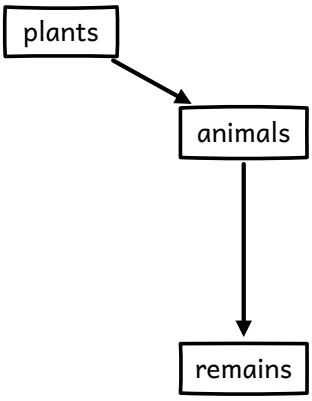
A forest drops leaves every year. Animals die too. Yet the ground is never buried deep in dead things. Something is clearing them away. Watch the cycle build up.

DRAW IT FIRST

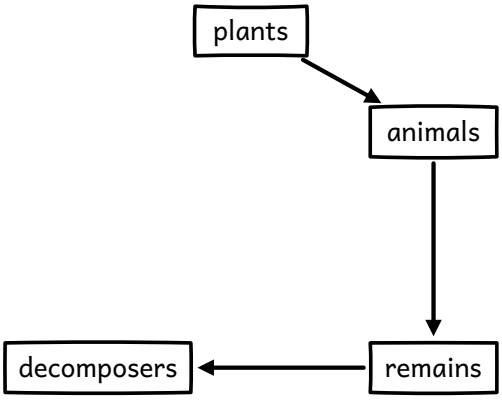
Dead things are recycled



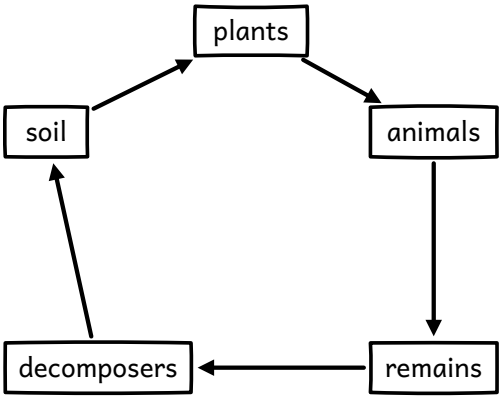
1 Plants make food from light. Animals eat the plants, or each other.



2 Plants and animals die, and leaves and waste fall. These are the remains.



3 Decomposers feed on the remains and break them down.



4 This puts nutrients into the soil. Plants take them up and grow.

Decomposers are living things that break down dead plants, dead animals and waste. **Nutrients** are the simple substances that plants need from the soil, such as those in a rotted leaf.

The decomposers are fungi and bacteria. A fungus sends fine threads into a dead thing and soaks up food from it. Bacteria are microbes. They live on every surface and feed on dead things too.

Worms and woodlice help in a different way. They are **detritivores**. They eat dead leaves and tear them into small pieces. Small pieces have more surface, so fungi and bacteria can reach more of the leaf.

decomposers	detritivores
fungi bacteria	worm woodlouse millipede

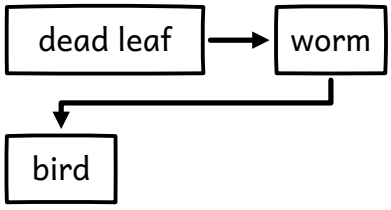
Decomposers break things down. Detritivores eat dead things and make small pieces.

SEE IT THREE WAYS

With things

Look under dead leaves on the ground. You may see a worm or a woodlouse eating them.

As a picture



In words

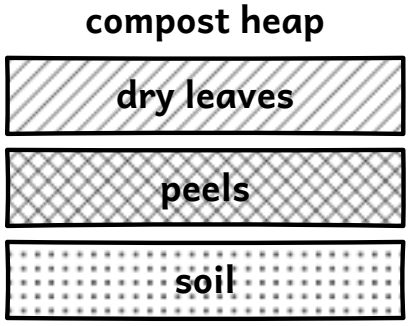
Not every food chain starts with a living plant. A dead leaf can feed a worm, and a worm can feed a bird.

Decomposers are living things, so they need the same as other living things: warmth, water and air. Food goes bad fast on a warm, damp day. It lasts longer when it is kept cold or dried.

condition	rots
warm and damp	fast
cold	slow
very dry	slow

Decay is fastest when it is warm and damp.

Compost is rotted plant waste. Gardeners and farmers make it in a heap. The decomposers turn the waste into dark, crumbly soil that is full of nutrients. You can make a small heap and watch.



Layers of plant waste and soil. Put in plant waste only, because meat and bones attract rats.

TRY IT

Make a compost pot

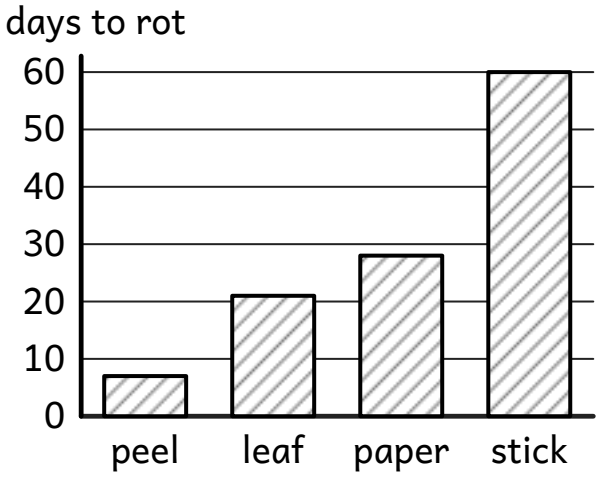
You need: a pot, tin or box with a few holes in the bottom, damp soil, a fruit peel, a leaf, a piece of paper and a small stick, gloves, or water and soap for your hands.

Be safe: Wear gloves, or wash your hands well afterwards. Do not put your face near mould. Do not eat or taste anything from the pot. Use plant waste only.

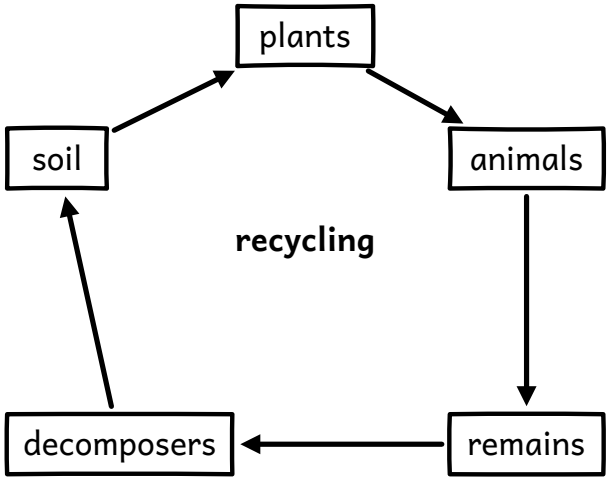
1. Half fill the pot with damp soil. Bury the peel, the leaf, the paper and the stick in four places. Mark each place with a pebble.
2. Keep the soil damp, not wet. Put the pot in a warm place out of the rain.
3. Every few days, dig gently at each place. Look, then cover it again.
4. Write down the day each thing has rotted. Put the numbers in a table.

What you will see: Most often the peel rots first, then the leaf, then the paper. The stick takes longest, because wood is tough. Decomposers work on soft things first.

If you cannot try it, this is what happens.



This ring is the cycle again. The same nutrients are used by plant after plant, because decomposers return them to the soil.



Decomposers close the ring. Plants that die go straight to the remains too.

A WRONG IDEA MANY PEOPLE HAVE

~~Dead things just disappear.~~

Why it feels right: A fallen leaf is gone after a few weeks.

The test that breaks it: Turn over the leaves on the ground. Under the top ones they are in bits. Below that is dark, crumbly soil from the leaves that fell before.

What is true: Nothing disappears. Decomposers change dead things. Some of the matter goes into the air as gas. The nutrients go back into the soil, where plants use them.

KEY WORDS

decomposers
fungi and bacteria that break down dead things.

nutrients
simple substances that plants take from the soil to grow.

detritivores
animals such as worms and woodlice that eat dead leaves in small pieces.

compost
rotted plant waste that makes good soil.

BACK TO YOUR GUESS

The answer is C: Living things break it down. Some goes into the air as gas, and the nutrients go into the soil.

Fungi and bacteria feed on the dead leaf and break it down. Some of it goes into the air as gas. The nutrients go back into the soil, and plants use them to grow.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Which living things are the decomposers?

   A Worms and woodlice

   B Grass and rabbits

   C Fungi and bacteria

   Answer at the back of the book.

2. What do worms and woodlice do to a dead leaf?

   A They do nothing, because only microbes break things down.

   B They eat it and tear it into small pieces.

   C They make food from it using light.

   Answer at the back of the book.

3. Where do the nutrients go when a dead leaf is broken down?

   A They vanish.

   B They are lost in the air.

   C Into the soil, where plants take them up

   Answer at the back of the book.

4. Which of these will rot last in a compost pot?

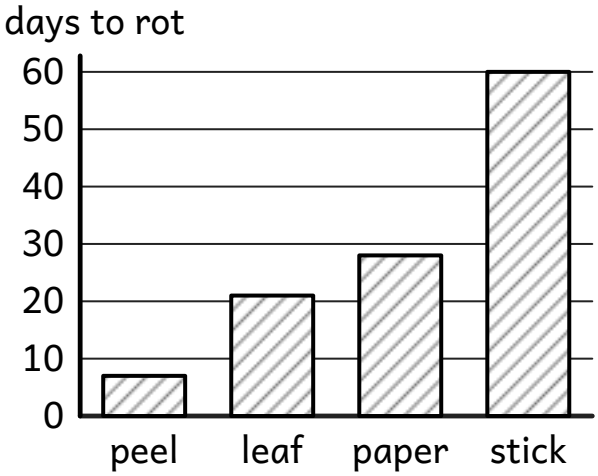
   A A small stick

   B A fruit peel

   C A soft leaf

   Answer at the back of the book.

5. The chart shows how many days each thing took to rot. How many more days did the stick take than the paper?



   A 60 days

   B 32 days

   C 88 days

   Answer at the back of the book.

6. **From an earlier chapter**

   About how much of the energy in food passes on to the next animal in a chain?

   A All of it

   B About a half

   C About a tenth

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Decomposers are fungi and bacteria. They break down dead things and put nutrients back in the soil. Worms and woodlice tear dead leaves into small pieces. Decay is fastest when it is warm and damp.

Draw: Draw a ring of five boxes: plants, animals, remains, decomposers, soil. Draw arrows round the ring.

S3.2.6 CHAPTER 6

Competition and adaptation

> **How can anything live in a desert, where it is hot, dry and bare?**

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** They have features that save water and help them cope with the heat and the cold.
- ☐ **B** Desert plants and animals do not need water.
- ☐ **C** They make their own water out of sand.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.5. A living thing has a body that fits where it lives.

BY THE END YOU CAN

- Explain what plants and animals compete for
- Describe how living things are adapted to deserts, rainforests and polar seas

Many living things share a place. But the place has only so much light, water and food. When living things need the same thing and there is not enough, they **compete**. A mate is an animal of the same kind that it breeds with.

DRAW IT FIRST

What living things compete for

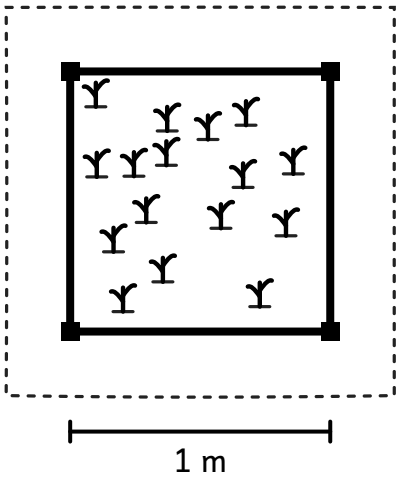
plants
light
water
space
nutrients

1 Plants compete for light, water, space and nutrients from the soil.

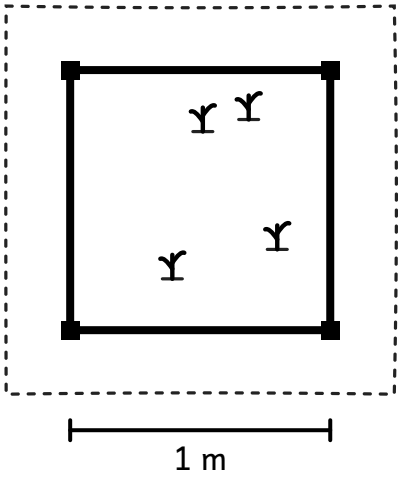
plants	animals
light	food
water	drinking water
space	shelter
nutrients	mates

2 Animals compete for food, drinking water, shelter and mates.

Now look at plants in a crowd. Both squares below are 1 m wide. They are drawn to the same size.



16 plants share one square metre.



4 plants share one square metre.

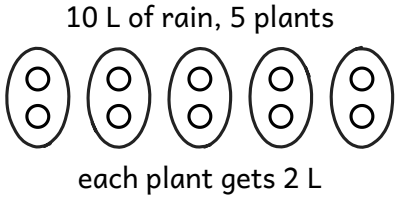
In the crowd, each plant gets less light and less water. A crowded plant stays thin and weak. The same is true for animals. Two foxes that hunt the same rabbits each find less food.

SEE IT THREE WAYS

With things

Imagine 10 litres of rain falling on a patch of ground. 5 plants share it equally.

As a picture



In words

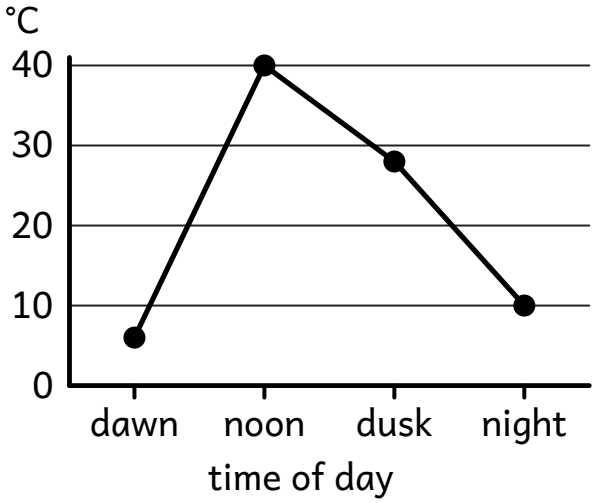
The same water is shared by more plants, so each plant gets less. Twice as many plants means half the water each.

In symbols

10 L ÷ 5 plants = 2 L each

Living things that cope well in a place are said to be adapted to it. An ***adaptation*** is a feature that helps a living thing live in its habitat. Each habitat needs different ones.

First, a desert. A desert is very dry. In many deserts it is hot by day and cold at night. Look at the temperature through one day.



An example. Many deserts swing from hot to cold like this.

Plants of dry places often store water in thick stems. Spines lose less water than wide leaves. Many desert animals rest in a cool burrow by day. The fennec fox of the hot desert has big ears that lose heat.

feature	job
thick stem	holds water
spines	lose less water
big ears	lose heat

Hot desert: a thick stem and spines for plants, big ears for a fennec fox.

Next, a tropical rainforest. It is warm and wet all year. Rain is heavy, and the forest floor is dark. Rainforests also grow in cooler places, but this picture is of the tropics. Tall trees race for the light. Many leaves end in a drip tip that lets the rain run off. Tree frogs have sticky toes to grip branches.

feature	job
tall trunk	reaches light
drip tip	sheds rain
sticky toes	grip branches

Tropical rainforest: tall trunks and drip tips for plants, sticky toes for tree frogs.

Last, a polar sea. The water is near freezing, at about 0 °C or a little below. Seals and whales have a thick layer of fat under the skin called **blubber**. It keeps the heat in. A smooth body helps them swim fast.

White fur hides a polar bear on the ice. Polar bears live only in the far north. Emperor penguins live in the far south.

feature	job
blubber	keeps heat in
smooth body	swims fast
white fur	hides on ice

Polar sea: blubber and a smooth body for seals and whales, white fur for a polar bear.

TRY IT

Crowded seedlings

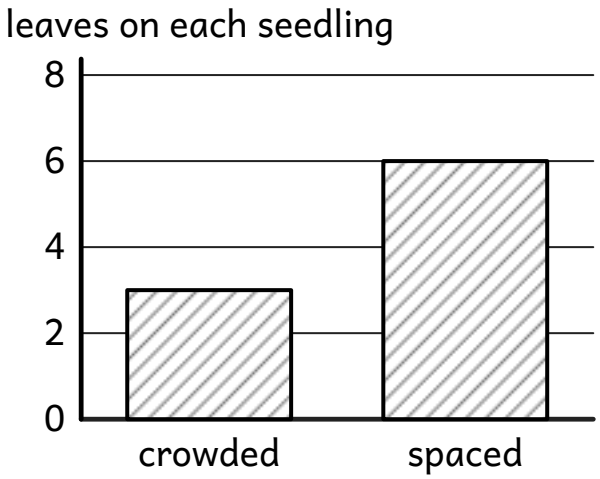
You need: two cups with soil, 8 bean seeds, water, a ruler.

Be safe: Wash your hands after touching soil. Do not eat the seeds or seedlings.

1. Plant 6 seeds in one cup, and 2 seeds in the other. Use the same soil.
2. Give both cups the same water, and put them in the same light.
3. Look every few days. After three weeks, count the leaves on every seedling, and note how many are alive.
4. Find the mean number of leaves on a seedling in each cup. Notice the colour and the height too.

What you will see: The crowded seedlings often grow tall and thin, because they stretch for light. But they have fewer leaves, look paler, and some may die. Count leaves and look at colour, not height alone.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~**An animal grows a new adaptation when it needs one.**~~

Why it feels right: A polar bear lives in the cold of the far north and has thick fur. It seems it grew the fur because it was cold.

The test that breaks it: A person who moves to a cold place does not grow fur. A dog with short fur has puppies with short fur, however cold the yard is.

What is true: Adaptations are features that parents pass to their young. Animals with useful features live longer and have more young. Over many years, more of them have the feature.

KEY WORDS

compete
to need the same thing when there is not enough for all.

adaptation
a feature that helps a living thing live in its habitat.

blubber
a thick layer of fat under the skin that keeps heat in.

BACK TO YOUR GUESS

The answer is A: They have features that save water and help them cope with the heat and the cold.

Every living thing needs water. Desert living things have adaptations that save water. Thick stems store it. Other features help them cope with heat by day and cold at night.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Plants in a crowd compete. What do they compete for?

   A Light, water and space

   B Food from other animals

   C Mates and shelter

   Answer at the back of the book.

2. Two foxes hunt in the same wood. What are they competing for?

   A Space to grow

   B The rabbits and mice, their food

   C Light, to make food

   Answer at the back of the book.

3. A waterhole holds 60 litres. 5 animals share the water equally. How many litres does each animal get?

   A 5 L

   B 300 L

   C 12 L

   Answer at the back of the book.

4. Why does a desert plant have a thick stem?

   A To store water for dry times

   B To reach the light above taller plants

   C To keep the plant warm at night

   Answer at the back of the book.

5. A seal swims in a polar sea at about 0 °C. What helps it stay warm?

   A Big ears that lose heat

   B A thick layer of blubber

   C White fur like a polar bear

   Answer at the back of the book.

6. Why do many rainforest trees grow very tall?

   A To store water for dry times

   B To keep warm at night

   C To reach the light above the other trees

   Answer at the back of the book.

7. **From an earlier chapter**

   Which living things are the decomposers?

   A Rabbits and foxes

   B Fungi and bacteria

   C Grass and trees

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Living things compete for light, water, space and food. An adaptation is a feature that helps a living thing live in its place. Parents pass adaptations to their young.

Draw: Draw three boxes: desert, rainforest, polar sea. Write one adaptation in each box and what it does.

S3.2.7 CHAPTER 7

Counting living things

How can anyone count the daisies in a whole field?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** They cannot. A field has too many plants to count.
- ☐ **B** They look at the field and guess a number.
- ☐ **C** They count the plants inside a few small frames, then use the counts to estimate the whole field.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Tables and charts. A mean needs adding and dividing, and a bar chart shows counts.

BY THE END YOU CAN

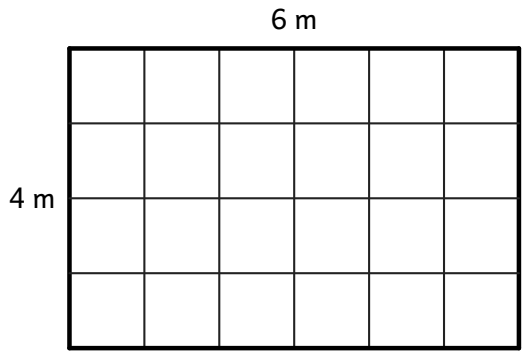
- Estimate the number of plants in a field using a square frame
- Explain why samples should be placed at random

Counting every plant in a big field would take days. So scientists count a small part and use it to **estimate** the whole. The small part is called a **sample**.

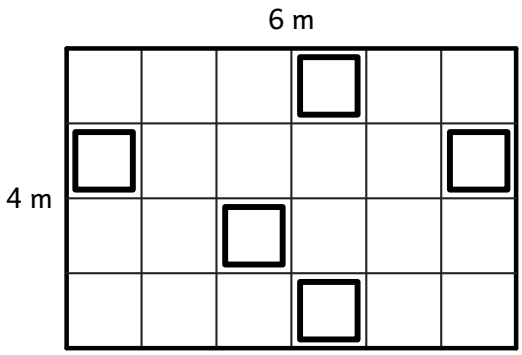
For plants, the sample is taken with a **quadrat**. A quadrat is a square frame made of sticks and string. Here the frame is 1 m on each side, so it covers 1 m^2.

DRAW IT FIRST

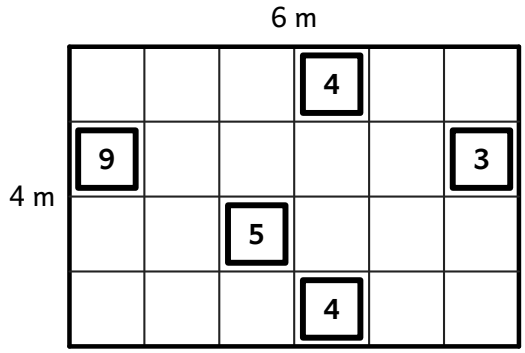
Count plants with *a* frame



1 Measure the field and mark it in squares the size of the frame. This field is 6 m by 4 m, so it has 24 squares.

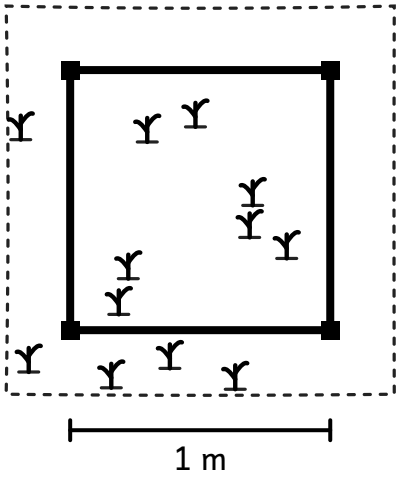


2 Put the frame down on 5 squares. Choose the squares at random.



3 Count the plants inside each frame, and write the count in the frame.

Look closely at one frame. Count only the plants inside it. A plant lying across the string counts if its middle is inside. Use the same rule every time.



7 plants are inside this frame. The plants outside are not counted.

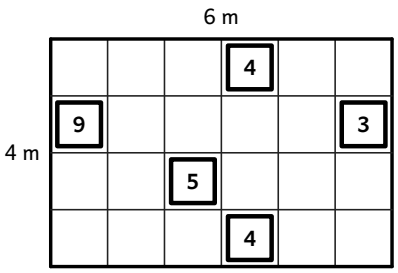
The next picture shows five frames placed at random. Each number is the plants counted in that frame.

SEE IT THREE WAYS

With things

Write the numbers 1 to 24 on scraps of paper, one for each square. Fold them and put them in a cup. Shake the cup and draw 5 scraps without looking. Put a frame on each square you draw.

As a picture



In words

Each square had the same chance of being drawn. Some frames fell on thick patches and some on thin ones. That is what a fair sample looks like. Throwing a pebble is not fair. Squares near you are hit more often, and far squares are never hit.

In symbols

9 + 4 + 5 + 4 + 3 = 25 plants in 5 frames

Now work out the **mean**. To find the mean, add the counts and divide by how many counts there are. The mean is the number of plants in a typical frame.

frame	plants
1	9
2	4
3	5
4	4
5	3
total	25
mean	5

The counts from the five frames, with their total and mean.

Each frame covers one square. The field has 24 squares. If a typical square holds 5 plants, the field holds 5 times 24.

WORKED EXAMPLE

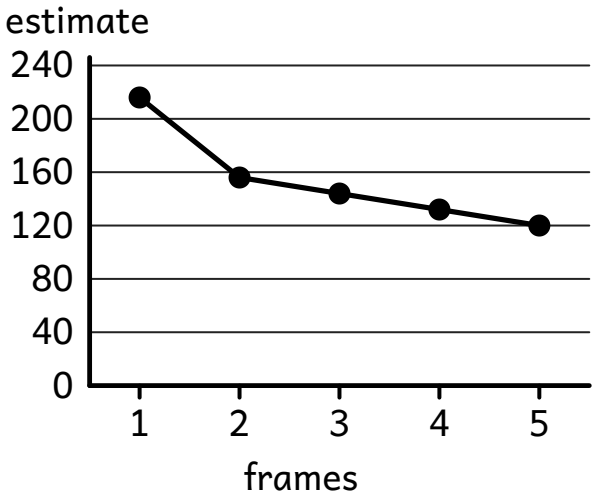
Five frames hold 9, 4, 5, 4, 3 plants. The field is 6 m by 4 m, so it has 24 squares the size of the frame. Estimate the plants in the field.

1. Add the counts: 9 + 4 + 5 + 4 + 3 = 25.
2. Divide by the number of frames: 25 ÷ 5 = 5 plants in a typical frame.
3. Multiply by the squares in the field: 5 × 24 = 120.

Answer: 120 plants

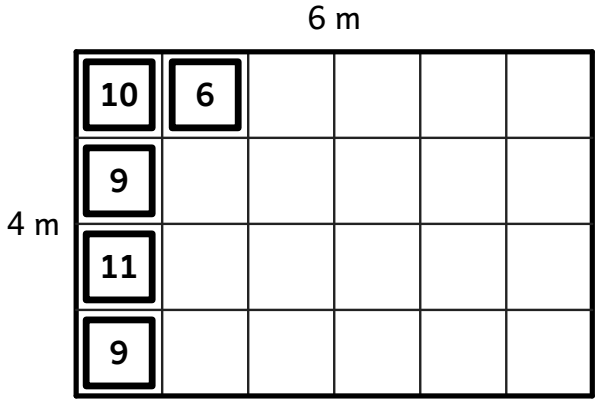
This is an estimate, not an exact count. Say that every plant had been counted, and the total was 125. The estimate of 120 is close. A different set of squares would give a slightly different estimate.

More frames make a better estimate. The graph shows the estimate after one frame, two frames and so on. It comes closer to the real total as more frames are counted.



The estimate after each frame. The real total is 125.

Now, why at ***random***? Random means chosen by chance. Suppose you put every frame near the thick left edge. You would count a lot of plants and think the whole field is thick.



All the frames sit near the thick left edge. The mean is 9, so the estimate is 216. That is far too high.

TRY IT

Count a patch

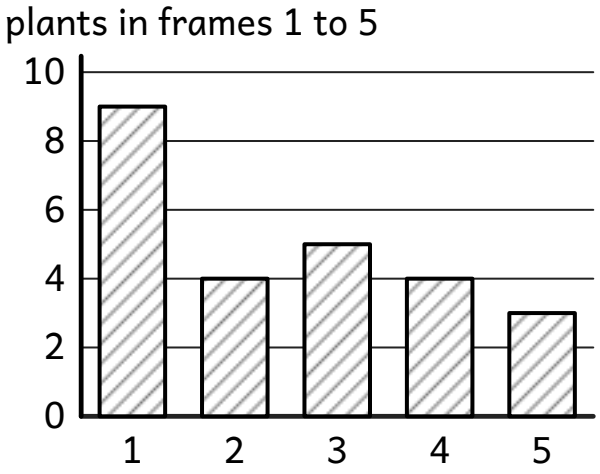
You need: four sticks of equal length, about 1 m each, string to tie them into a square, 24 scraps of paper and a cup, a pencil and paper, a grassy patch of known size, such as 6 m by 4 m.

Be safe: Look for glass, thorns and nests before you start, and keep away from any you find. Look, count and leave the plants as they are.

1. Tie the sticks into a square frame. Pick one kind of plant to count, such as clover or daisies.
2. Lay a 1 m stick along the long side and then the short side. Multiply the two counts to get the squares. Say it is 24. Number them 1 to 24 row by row from one corner. Write the numbers on scraps and put them in the cup.
3. Shake the cup and draw 5 scraps without looking. Put the frame on each square you draw, and do not choose the square yourself.
4. Count the plants of your kind inside the frame. Write the number. Do this 5 times.
5. Find the mean. Multiply it by the number of squares in the patch.

What you will see: Each frame gives a different count. The mean smooths them out. Another time, with other draws, the answer will change a little but stay close.

If you cannot try it, this is what happens.



A WRONG IDEA MANY PEOPLE HAVE

~~Put the frames where the plants are thickest, so you do not miss them.~~

Why it feels right: You want a good count, and thick patches have plenty to count.

The test that breaks it: Look at the picture of frames near the left edge. The estimate is 216, but the real total is 125.

What is true: Choose the squares at random. Then thick and thin patches both get a fair chance. The mean is a fair guide to the whole field.

KEY WORDS

sample
a small part that you count or measure to learn about the whole.

quadrat
a square frame, here 1 m on each side, laid on the ground to count plants.

estimate
a careful guess worked out from a sample.

mean
the total of the counts divided by how many counts there are.

random
chosen by chance, so that every place has the same chance.

BACK TO YOUR GUESS

The answer is C: They count the plants inside a few small frames, then use the counts to estimate the whole field.

Scientists count the plants in a few square frames and work out the mean. Then they multiply by the number of frames that fit in the field. It is an estimate, and a fair one if the frames are placed at random.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Why do scientists count plants in a few frames, not in the whole field?

   A Counting all the plants would take too long, and a sample gives a good estimate.

   B A field cannot be counted at all.

   C A frame counts better than a person.

   Answer at the back of the book.

2. A student counts 3, 5, 6 and 2 plants in 4 frames. What is the mean number of plants in a frame?

   A 16 plants

   B 4 plants

   C 5 plants

   Answer at the back of the book.

3. The mean is 6 plants in each frame. The field has 30 squares the size of the frame. Estimate the plants in the field.

   A 180 plants

   B 36 plants

   C 5 plants

   Answer at the back of the book.

4. Why should the frames be placed at random?

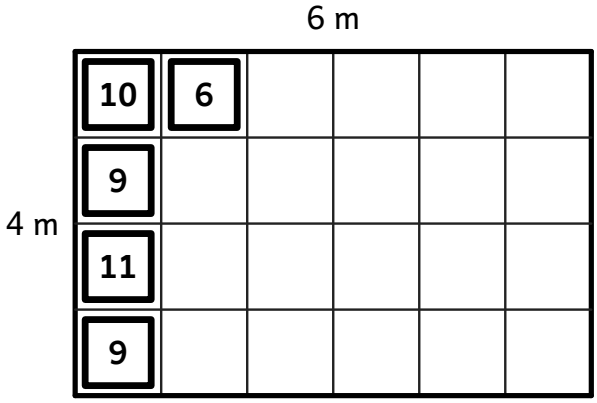
   A So that the frames are easy to find again

   B So that every part of the field has a fair chance of being counted

   C So that more plants are found

   Answer at the back of the book.

5. A student puts all five frames near the thick left edge. What goes wrong?



A The estimate is too high.

B The estimate is too low.

C Nothing, because every frame is the same size.

Answer at the back of the book.

6. **From an earlier chapter**

Plants in a crowd compete. What do they compete for?

A Light, water and space

B Food from other animals

C Mates and shelter

Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Count plants in a few square frames put down at random. Find the mean count. Multiply by the number of frames that fit in the field. Random choice makes the sample fair.

Draw: Draw a field as a grid of squares. Mark five squares with frames and write a count in each.

S3.2.8 CHAPTER 8

People and ecosystems

Can one person really change a whole forest, or a river?

YOUR GUESS

Pick one before you read on. It is fine to be wrong.

- ☐ **A** No. Ecosystems are far too big for people to change.
- ☐ **B** Only very large machines can change an ecosystem.
- ☐ **C** Yes. Farming, cutting trees and pollution all change the living things in a place.

IF THIS FEELS HARD, READ THIS FIRST

- Level 2, Food chains and habitats, S2.2.8. People can change a habitat and can also protect it.

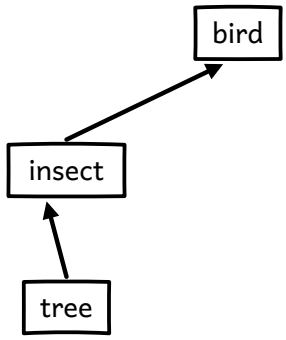
BY THE END YOU CAN

- Explain how farming, cutting trees and pollution change ecosystems
- Plan a small action to protect an ecosystem near you

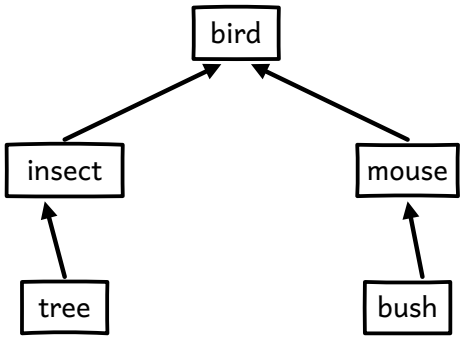
People live in ecosystems too. We grow food, cut wood and make waste. Each of these changes the living things around us. Start with a small forest web.

DRAW IT FIRST

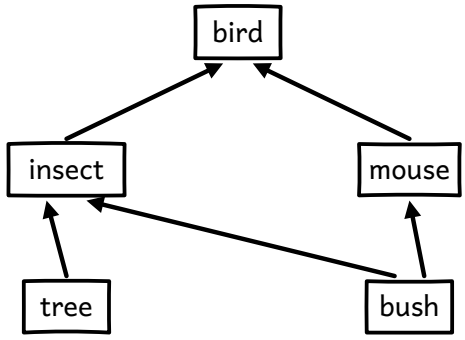
A forest food web



1 A tree feeds an insect. The insect feeds a bird.



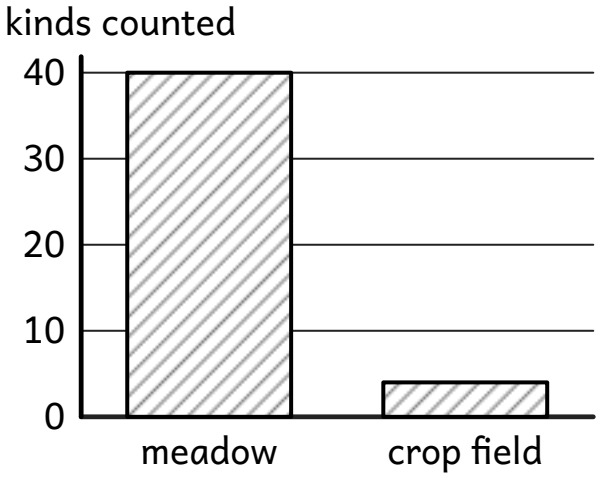
2 A bush feeds a mouse with its berries. The mouse feeds the same bird.



3 The insect also eats from the bush. The chains are now joined.

Now see three ways that people change a web like this. The first is farming.

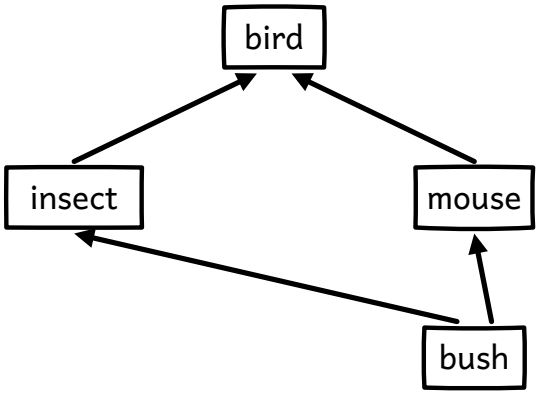
To farm, people clear land and plant one crop, such as wheat. A meadow or a forest holds many kinds of plant. A field of one crop holds very few. Fewer kinds of plant mean fewer kinds of food, so fewer kinds of animal can live there.



An example. A meadow holds many more kinds than a field of one crop.

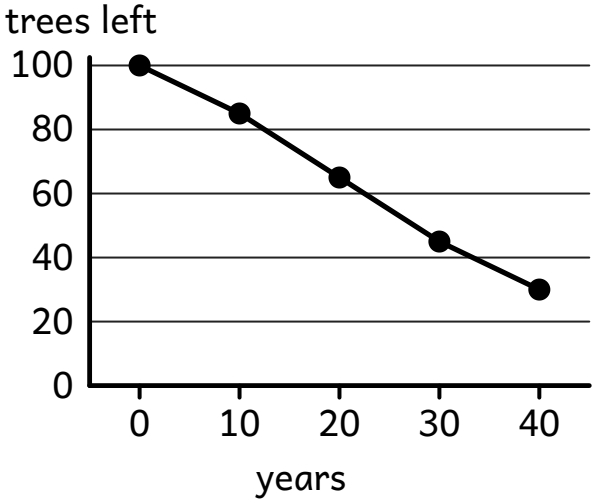
A **pest** is a living thing that harms a crop. With one crop and few predators, pests can spread fast. Farmers can help by leaving strips of wild plants, and by growing different crops in turn. Farming is needed to feed people, so how we farm matters.

The second change is cutting trees. Trees are the main producers of a forest. Cut them and the web loses its base. Look at the web after the tree is cut.



The insect lost one food. Animals that lived in the trees lost their homes too.

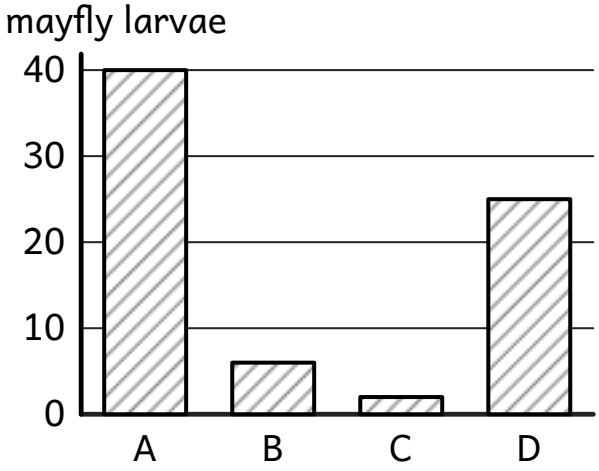
Animals that ate the trees lose food. Animals that lived in them lose their homes. Without roots, soil can wash away in the rain. Wood is useful, so people can cut some trees and plant new ones.



An example. The forest loses trees faster than they grow back.

The third change is **pollution**. Pollution is waste that harms living things. Litter, oil, smoke and chemicals are pollution. Too much fertiliser washed into a river is pollution too. It makes water plants grow too fast. When they die, bacteria use up the oxygen in the water, and fish die.

Some small animals need clean water. Most mayfly larvae need clean water with plenty of oxygen. If you find none, the water may be polluted. Scientists counted mayfly larvae at four places along a river. Place A is above a town. Place B is at the town. C is just below it, and D is far below.

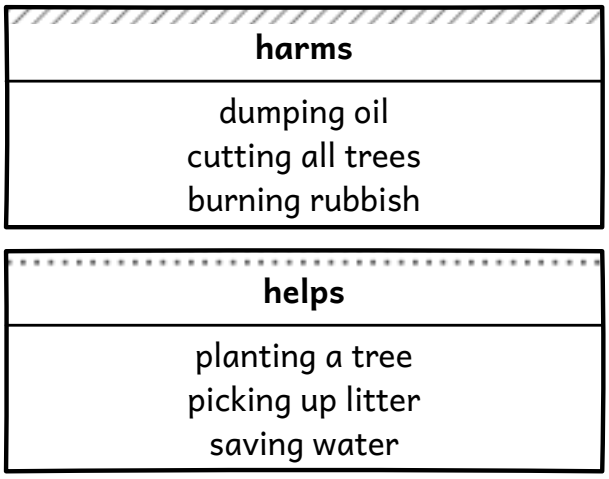


An example. Few larvae at the town, so something there harms the water.

People can harm an ecosystem, and people can protect one. Sort some actions.

SEE IT THREE WAYS

As a picture



In words

An action harms a place when it removes producers, poisons the water or air, or takes away homes. It helps when it does the opposite.

TRY IT

Plan a small action

You need: a pencil and paper, ten minutes to look at a place near you, such as a yard or a stream bank.

Be safe: Wear gloves to pick up litter. Do not touch broken glass or sharp things. Keep away from deep water. Leave nests and animals alone, and ask an adult before you dig.

1. Look at the place. Write down one problem you can see, such as litter or bare soil.
2. Choose one small action you can really do, such as picking up litter or planting a tree.
3. Write the plan: what you will do, who will help, when, and how you will check it worked.
4. Do it. Look again after a month and write down what has changed.

What you will see: A good plan is small, near and clear. You can finish it, and you can see whether it worked.

If you cannot try it, this is what happens.

ask	answer
what	plant a tree
who	my class
when	this week
check	count in a month

A WRONG IDEA MANY PEOPLE HAVE

~~One person cannot make a difference to an ecosystem.~~

Why it feels right: An ecosystem is huge, and one person is small.

The test that breaks it: Plant one tree. Insects come to eat it. Birds come to eat the insects. The soil under it stays in place. Ten neighbours who each plant one tree make a small wood.

What is true: Everything in an ecosystem is joined, so a small change spreads. Small actions, done by many people, add up.

KEY WORDS

pest
a living thing that harms a crop.

pollution
waste that harms living things, such as litter, oil, smoke and chemicals.

BACK TO YOUR GUESS

The answer is C: Yes. Farming, cutting trees and pollution all change the living things in a place.

People change ecosystems all the time. Farming, cutting trees and pollution each change what lives in a place. The good news is that people can also help, and small actions add up.

CHECK YOURSELF

Try each one before you look. A wrong answer tells you where to go next.

1. Why does a field of one crop hold fewer kinds of living thing than a meadow?

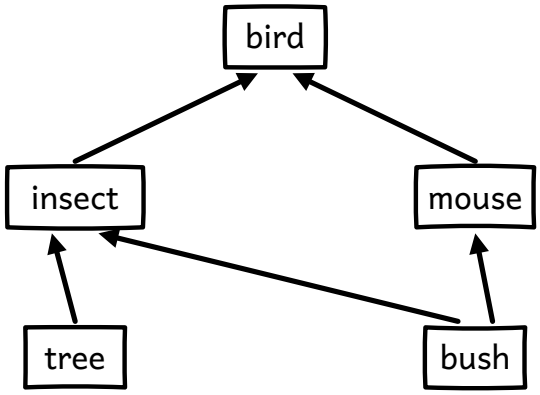
   A There is less sunlight on a farm.

   B A crop is not a living thing.

   C Few kinds of plant mean few kinds of food, so fewer kinds of animal can live there.

   Answer at the back of the book.

2. All the trees in the forest web are cut down. What happens?



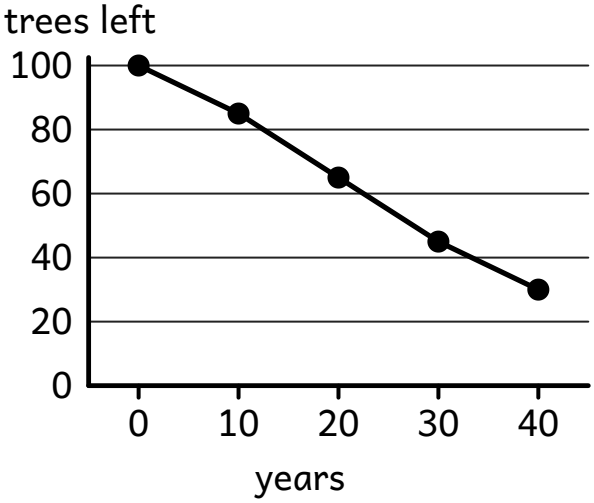
   A Nothing changes, because the insect also eats from the bush.

   B The web loses a producer, so the insect loses a food.

   C More animals can live there, because there is more room.

   Answer at the back of the book.

3. The graph shows the trees left out of 100 in a forest. How many trees were lost in the first 20 years?



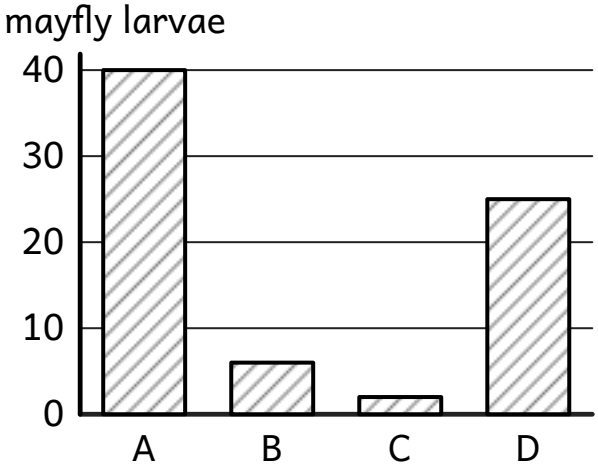
A 35 trees

B 65 trees

C 165 trees

Answer at the back of the book.

4. Most mayfly larvae need clean water. The chart shows larvae at four places along a river. Place B is at a town. What does it suggest?



A Something in the town may be polluting the water.

B Mayflies prefer to live near towns.

C The river is too deep for them.

Answer at the back of the book.

5. What is a good first step in planning an action to protect a place near you?

   A Pick the biggest problem in the world and fix it.

   B Start digging at once.

   C Look at the place and choose one small problem you can solve.

   Answer at the back of the book.

6. **From an earlier chapter**

   A student counts a mean of 4 plants in a frame. The field has 25 squares the size of the frame. Estimate the plants in the field.

   A 29 plants

   B 100 plants

   C 21 plants

   Answer at the back of the book.

KEEP IT

Copy this into your exercise book.

Farming, cutting trees and pollution change ecosystems. Fewer kinds of plant mean fewer kinds of animal. Plan a small action: a problem, an action, helpers, and a check.

Draw: Draw a plan as a table with four rows: what, who, when, check. Fill it in for one action near you.

Key words, A to Z

Every key word in this book, what it means, and the chapter that teaches it.

adaptation
a feature that helps a living thing live in its habitat. S3.2.6

backbone
the row of small bones down the back, also called the spine. S3.2.1

blubber
a thick layer of fat under the skin that keeps heat in. S3.2.6

branch
one path in a key, from one answer to the next question or to a name. S3.2.2

compete
to need the same thing when there is not enough for all. S3.2.6

compost
rotted plant waste that makes good soil. S3.2.5

decomposers
fungi and bacteria that break down dead things. S3.2.5

detritivores
animals such as worms and woodlice that eat dead leaves in small pieces. S3.2.5

ecosystem
all the living things in one place and the way they depend on each other. S3.2.1

energy
what a living thing needs to move, grow and stay alive. S3.2.4

estimate
a careful guess worked out from a sample. S3.2.7

food web
food chains joined together, showing what eats what in a place. S3.2.3

fungi
living things such as mushrooms and moulds. They have no leaves and soak up food. S3.2.1

invertebrates
animals with no backbone. S3.2.1

key

a set of yes or no questions that leads you to the name of a living thing. S3.2.2

mean
the total of the counts divided by how many counts there are. S3.2.7

microbes
living things too small to see without a microscope. S3.2.1

nutrients
simple substances that plants take from the soil to grow. S3.2.5

pest
a living thing that harms a crop. S3.2.8

pollution
waste that harms living things, such as litter, oil, smoke and chemicals. S3.2.8

population
all the living things of one kind in a place. S3.2.3

predator
an animal that hunts and eats other animals. S3.2.3

prey
an animal that a predator eats. S3.2.3

producers
living things that make food from light, such as plants and algae. Most food chains start with one. S3.2.3

pyramid of energy
a stack of bars that shows the energy at each link. It always narrows going up. S3.2.4

pyramid of numbers
a picture with a bar for each link in a chain. Each bar is as wide as the number of living things. S3.2.4

quadrat
a square frame, here 1 m on each side, laid on the ground to count plants. S3.2.7

random
chosen by chance, so that every place has the same chance. S3.2.7

sample
a small part that you count or measure to learn about the whole. S3.2.7

vertebrates
animals with a backbone. S3.2.1

Answers

S3.2.1. Sorting living things

1. **Fungi**

   A mushroom has no leaves, makes no food from light and does not eat. It soaks up food from what it grows on. That makes it a fungus.

   - **If you chose B:** You may be thinking that anything growing from soil is a plant. Plants make food from light with green leaves. A mushroom cannot. Go to S3.2.1.
   - **If you chose C:** You may be thinking that a thing that is not green must be an animal. Animals eat and move about. A mushroom stays put and soaks up its food. Go to S3.2.1.

2. **Microbes**

   Microbes are so small that you need a microscope to see one. A drop of pond water can hold thousands.

   - **If you chose A:** You can see and hold a mushroom. Size is what marks out microbes, and they are far smaller. Go to S3.2.1.
   - **If you chose B:** You can see an ant easily. Invertebrates are animals with no backbone, and many are big enough to see. Go to S3.2.1.

3. **Plants**

   Green leaves catch light and plants use it to make food. No other group does this.

   - **If you chose A:** Animals cannot make food. They eat plants or other animals. Go to S3.2.1.
   - **If you chose B:** You may think a fungus is a kind of plant. Fungi have no leaves and cannot use light to make food. Go to S3.2.1.

4. **A fish**

   A fish has a backbone, so it is a vertebrate. An ant and a spider have none.

   - **If you chose A:** An ant has no backbone. Its body is held up by a hard case on the outside. Go to S3.2.1.
   - **If you chose C:** A spider has eight legs but no backbone, so it is an invertebrate. Go to S3.2.1.

5. **An invertebrate**

   An animal with no backbone is an invertebrate. A worm is one.

   - **If you chose A:** A vertebrate has a backbone. A worm has none, so it is not one. Go to S3.2.1.
   - **If you chose C:** A worm eats and moves about, so it is an animal. Plants stay in one place and make their own food. Go to S3.2.1.

6. **12 living things**

   Add the three groups. 8 + 3 + 1 = 12.

S3.2.2. Using and making keys

1. **beetle**

   Yes to wings, then yes to hard wing cases. That path ends at beetle.

   - **If you chose A:** You may have taken the wrong turn at the first question. This insect has wings, so the answer is yes and the path goes left. A flea is at the end of no. Go to S3.2.2.
   - **If you chose C:** A moth has big, patterned wings but no hard cases. This insect has hard wing cases, so the answer to that question is yes. Go to S3.2.2.

2. **fern**

   No to needle, no to long and thin, then yes to many leaflets. That path ends at fern.

   - **If you chose A:** Grass is the end of yes to long and thin. This leaf is not long and thin, so the path goes on to the next question. Go to S3.2.2.
   - **If you chose C:** Lotus is at the end of no to many leaflets. This leaf has many leaflets, so the answer is yes. Go to S3.2.2.

3. **snail**

   No to wings, no to 8 legs, yes to a shell. That path ends at snail.

   - **If you chose B:** A spider is at the end of yes to 8 legs. This animal does not have 8 legs, so the path goes down to the next question. Go to S3.2.2.
   - **If you chose C:** A worm is at the end of no to a shell. This animal has a shell, so the answer there is yes. Go to S3.2.2.

4. **Does it have wings?**

   You can see wings, and an animal either has them or does not. The answer is yes or no for every animal.

   - **If you chose A:** People do not agree about pretty. A good question has a clear answer that is the same for everyone. Go to S3.2.2.
   - **If you chose B:** Big depends on what you compare it with, and animals of one kind differ in size. Choose a clue that does not change. Go to S3.2.2.

5. **5 questions**

   Each question adds one end. A key for 6 animals has 6 ends, so it has 6 − 1 = 5 questions.

   - **If you chose A:** You may be giving one question to each animal. The last two animals share a question, because its two answers lead to one animal each. Go to S3.2.2.
   - **If you chose C:** A key never needs more questions than animals. Each question splits one group into two, and that adds one end. Go to S3.2.2.

6. **A snail**

   A snail has no backbone, so it is an invertebrate.

   - **If you chose A:** A goat has a backbone, so it is a vertebrate. Go to S3.2.1.
   - **If you chose B:** A fish has a backbone, so it is a vertebrate. Go to S3.2.1.

S3.2.3. Food webs

1. **grass**

   Both chains start with grass. A web joins chains at the living things they share.

   - **If you chose B:** The rabbit is only in the first chain. The second chain has a mouse instead. Go to S3.2.3.
   - **If you chose C:** The snake is only in the second chain. The first chain ends with a fox. Go to S3.2.3.

2. **The animal that eats**

   An arrow shows the way the food goes: from the food into the animal that eats it.

   - **If you chose A:** It is the other way round. An arrow follows the food, so it points to the one that eats. Go to S3.2.3.
   - **If you chose C:** Size does not matter. The arrow shows where the food and its energy go, and that is to the eater. Go to S3.2.3.

3. **The rabbit and the mouse, 2 animals**

   The arrows into the fox come from the rabbit and the mouse. They are the fox's prey, so they lose a predator.

   - **If you chose A:** The fox does not eat these. Look at the arrows that end at the fox. They come from rabbit and mouse. Go to S3.2.3.
   - **If you chose C:** A fox does not eat plants, so plants do not lose a predator. Plants are eaten by the rabbit and the mouse. Go to S3.2.3.

4. **It loses the snake but still has 1 food, the rabbit.**

   The hawk eats two things: the snake and the rabbit. Without the snake it still has the rabbit, so it is not left without food.

   - **If you chose B:** The hawk also eats rabbits. One food is gone, but another is left. Go to S3.2.3.
   - **If you chose C:** The snake was one of its foods, so the hawk has less to eat, not more. It may hunt more rabbits. Go to S3.2.3.

5. **The rabbits ate the grass down, so many went hungry.**

   With no foxes the rabbits rose, and a large population ate most of the grass. With too little food, the number fell.

   - **If you chose B:** The story says the foxes had gone. Nothing in the graph says they returned. Go to S3.2.3.
   - **If you chose C:** Rabbits do not all die at four years. The fall is because there is too little food for so many. Go to S3.2.3.

6. **A backbone**

   Every vertebrate has a backbone. Fur, scales and wings differ from one kind to another.

   - **If you chose A:** A snake has scales and a hawk has feathers. Only some vertebrates have fur. Go to S3.2.1.
   - **If you chose B:** A hawk has wings but a fox and a snake do not. Look for what every vertebrate has. Go to S3.2.1.

S3.2.4. Energy through a food chain

1. **About a tenth**

   An animal uses most of its food for living, and loses much as heat. About a tenth passes on to the next animal.

   - **If you chose A:** Animals use most of the energy to live, and lose much as heat. Far less than all passes on. Go to S3.2.4.
   - **If you chose C:** It is much less than half. A rough rule is about a tenth. Go to S3.2.4.

2. **50 kJ**

   The insect gets 5000 ÷ 10 = 500 kJ. The frog gets 500 ÷ 10 = 50 kJ.

   - **If you chose B:** That is the energy that reaches the insect, the second link. The frog is one step further. Go to S3.2.4.
   - **If you chose C:** That is the energy that reaches the snake, the fourth link. Stop at the frog, the third. Go to S3.2.4.

3. **There is too little energy left to feed another link.**

   At each step only about a tenth of the energy passes on. After four or five steps the amount is too small to feed more.

   - **If you chose A:** Size is not the reason. Chains of tiny animals are short too. The limit is energy. Go to S3.2.4.
   - **If you chose C:** Plants are not affected by how long the chain is. Energy is lost at each step, so there is too little left. Go to S3.2.4.

4. **The grass at the bottom as the widest bar, the birds at the top as the narrowest**

   The producer is at the bottom. Each bar is as wide as its number: 500, then 50, then 5. So the bars get narrower going up.

   - **If you chose A:** The producer goes at the bottom. The grass has the biggest number, so its bar is the widest. Go to S3.2.4.
   - **If you chose B:** Each bar must be as wide as its number. The numbers differ, so the widths differ. Go to S3.2.4.

5. **One big tree feeds a great many insects, so the middle bar is the widest.**

   A pyramid of numbers counts living things, not size. One tree is one living thing, but it feeds hundreds of insects.

   - **If you chose A:** Each bar is exactly as wide as its number. The picture is right. The numbers do not make a pyramid. Go to S3.2.4.
   - **If you chose C:** The tree is the producer, because it makes food from light. It stays at the bottom, even though it is a single living thing. Go to S3.2.4.

6. **From the rabbit to the fox**

   The rabbit is the food and the fox is the eater. An arrow points the way the food goes, to the fox.

   - **If you chose B:** That would mean the rabbit eats the fox. An arrow points to the eater, from the food. Go to S3.2.3.
   - **If you chose C:** A fox eats a rabbit, so they are joined by an arrow from the food to the eater. Go to S3.2.3.

S3.2.5. Decomposers and recycling

1. **Fungi and bacteria**

   Fungi soak up food from dead things, and bacteria feed on them. Together they break dead things down.

   - **If you chose A:** They help by eating dead leaves into small pieces. The breaking down of those pieces is done by fungi and bacteria. Go to S3.2.5.
   - **If you chose B:** Grass makes food from light and rabbits eat grass. Neither breaks down dead things for nutrients. Go to S3.2.5.

2. **They eat it and tear it into small pieces.**

   Small pieces have more surface, so fungi and bacteria can work faster. These animals are detritivores.

   - **If you chose A:** Worms and woodlice are a big help. They tear leaves into small pieces, so fungi and bacteria can reach more of each leaf. Go to S3.2.5.
   - **If you chose C:** Only green plants make food from light. Worms and woodlice are animals and have to eat. Go to S3.2.5.

3. **Into the soil, where plants take them up**

   Decomposers put nutrients back in the soil. Plants take them in through their roots and use them to grow.

   - **If you chose A:** Nothing disappears. What the leaf was made of is changed into nutrients that stay in the soil. Go to S3.2.5.
   - **If you chose B:** Some gas goes into the air, but the nutrients plants need stay in the soil. Go to S3.2.5.

4. **A small stick**

   Wood is tough, so decomposers need much longer. Soft things such as peels and leaves go first.

   - **If you chose B:** A peel is soft and rots first. Decomposers work fastest on soft things. Go to S3.2.5.
   - **If you chose C:** A soft leaf rots quite fast. A tough thing takes much longer. Go to S3.2.5.

5. **32 days**

   The stick took 60 days and the paper took 28. 60 − 28 = 32.

   - **If you chose A:** That is the time the stick took altogether. The question asks how many more days than the paper, so take the paper's time away. Go to S3.2.5.
   - **If you chose C:** You have added the two times. To find how many more, subtract the smaller from the larger. Go to S3.2.5.

6. **About a tenth**

   An animal uses most of its food for living and loses much as heat. About a tenth passes on.

   - **If you chose A:** Animals use most of the energy to live, and lose much as heat. Far less than all passes on. Go to S3.2.4.
   - **If you chose B:** It is much less than half. A rough rule is about a tenth. Go to S3.2.4.

S3.2.6. Competition and adaptation

1. **Light, water and space**

   A plant needs light, water, space and nutrients. In a crowd there is less of each for every plant.

   - **If you chose B:** Plants make their own food from light. They do not eat. What they share is light, water and space. Go to S3.2.6.
   - **If you chose C:** Animals compete for mates and shelter. Plants compete for light, water, space and nutrients. Go to S3.2.6.

2. **The rabbits and mice, their food**

   Both foxes need the same food, and there is only so much of it. Animals compete for food, drinking water, shelter and mates.

   - **If you chose A:** Foxes do not grow in one place like plants. What they share is the food in the wood. Go to S3.2.6.
   - **If you chose C:** Foxes do not make food from light. Only green plants do. A fox has to find food to eat. Go to S3.2.6.

3. **12 L**

   60 ÷ 5 = 12. Each animal gets 12 litres.

   - **If you chose A:** You may have used the number of animals as the answer. Divide the water by the number of animals. Go to S3.2.6.
   - **If you chose B:** You have multiplied. Sharing means dividing: more animals share the same water, so each gets less. Go to S3.2.6.

4. **To store water for dry times**

   A desert is very dry and rain is rare. A thick stem holds water so that the plant can live between rains.

   - **If you chose B:** That is why rainforest trees grow tall. In a desert the problem is water, not shade. Go to S3.2.6.
   - **If you chose C:** The stem is full of water, not warmth. Its job is to store water for the long dry spells. Go to S3.2.6.

5. **A thick layer of blubber**

   Blubber is a thick layer of fat under the skin. It keeps the heat in, so the seal stays warm in cold water.

   - **If you chose A:** Big ears let animals of hot deserts lose heat. A seal in icy water needs to keep heat in. Go to S3.2.6.
   - **If you chose C:** White fur hides animals such as polar bears on the ice. A seal in cold water relies on blubber to keep warm. Go to S3.2.6.

6. **To reach the light above the other trees**

   The forest floor is dark, because the trees above shade it. Tall trees compete for light, and the tallest get the most.

   - **If you chose A:** That is a desert adaptation. A rainforest is wet all year, so water is not the problem there. Go to S3.2.6.
   - **If you chose B:** A tropical rainforest is warm all night. The tall trunk is not for warmth. Go to S3.2.6.

7. **Fungi and bacteria**

   Fungi and bacteria feed on dead things and break them down, so that nutrients return to the soil.

   - **If you chose A:** These are animals that eat plants or other animals. Decomposers break down dead things. Go to S3.2.5.
   - **If you chose C:** Grass and trees are producers, because they make food from light. Fungi and bacteria break down dead things. Go to S3.2.5.

S3.2.7. Counting living things

1. **Counting all the plants would take too long, and a sample gives a good estimate.**

   A sample is a small part of the whole. Counting it is quick, and it tells you a good deal about the whole field.

   - **If you chose B:** It can be counted, but it would take days. A few frames give a good estimate in an hour. Go to S3.2.7.
   - **If you chose C:** A person does the counting. The frame only marks off a small, known area to count. Go to S3.2.7.

2. **4 plants**

   Add: 3 + 5 + 6 + 2 = 16. Divide by 4 frames: 16 ÷ 4 = 4.

   - **If you chose A:** That is the total of the counts. To find the mean, divide the total by the number of frames. Go to S3.2.7.
   - **If you chose C:** You may have picked one of the counts. The mean is the total divided by the number of counts. Go to S3.2.7.

3. **180 plants**

   Each square holds about 6 plants and there are 30 squares. 6 × 30 = 180.

   - **If you chose B:** You have added the two numbers. Each of the 30 squares holds about 6 plants, so multiply. Go to S3.2.7.
   - **If you chose C:** Dividing 30 by 6 gives a number that means nothing here. Each square holds about 6 plants, so multiply. Go to S3.2.7.

4. **So that every part of the field has a fair chance of being counted**

   Random choice gives thick and thin patches the same chance. The sample then matches the whole field.

   - **If you chose A:** Finding them again does not matter. What matters is that no part of the field is favoured over another. Go to S3.2.7.
   - **If you chose C:** Frames on thick patches would find more plants, but the estimate would be too high. A fair sample finds the plants a typical square holds. Go to S3.2.7.

5. **The estimate is too high.**

   The frames sit where the plants are thickest. The mean is too high, so the estimate for the whole field is too high.

   - **If you chose B:** The left edge has more plants than the rest of the field. The counts are high, so the estimate is too high. Go to S3.2.7.
   - **If you chose C:** The frames are the same size, but they all sit on the thickest part. They do not stand for the whole field. Go to S3.2.7.

6. **Light, water and space**

   A plant needs light, water, space and nutrients. In a crowd there is less of each for every plant.

   - **If you chose B:** Plants make their own food from light. They compete for light, water and space. Go to S3.2.6.
   - **If you chose C:** Animals compete for mates and shelter. Plants compete for light, water, space and nutrients. Go to S3.2.6.

S3.2.8. People and ecosystems

1. **Few kinds of plant mean few kinds of food, so fewer kinds of animal can live there.**

   A meadow has many plants, and each feeds different animals. A field of one crop offers one food, so fewer animals can live there.

   - **If you chose A:** A field has plenty of light. The difference is the number of different plants, and so of different foods. Go to S3.2.8.
   - **If you chose B:** A crop is a living plant. It is one kind of plant growing over a large area. Go to S3.2.8.

2. **The web loses a producer, so the insect loses a food.**

   The tree is a producer. The insect ate it, so it loses a food. The web is smaller and weaker without it.

   - **If you chose A:** The insect still has the bush, but it lost one of its two foods. The animals that lived in the trees lose their homes, so something does change. Go to S3.2.8.
   - **If you chose C:** Taking away the producers does not help animals. They lose food and shelter, so fewer can live there. Go to S3.2.8.

3. **35 trees**

   There were 100 trees at the start and 65 left after 20 years. 100 − 65 = 35.

   - **If you chose B:** That is how many trees were left after 20 years. The question asks how many were lost, so take that away from the start. Go to S3.2.8.
   - **If you chose C:** You have added. To find how many were lost, subtract what is left from what there was. Go to S3.2.8.

4. **Something in the town may be polluting the water.**

   There were many larvae above the town and few at it. Larvae need clean water, so something at the town may be harming it.

   - **If you chose B:** It is the other way round. Most mayfly larvae need clean water, so few of them suggests the water is not clean. Go to S3.2.8.
   - **If you chose C:** Depth is not what the counts tell us. The larvae were plentiful above the town and far below it, so the river there suits them. Go to S3.2.8.

5. **Look at the place and choose one small problem you can solve.**

   A good plan starts by looking. A small, near problem is one you can finish, and you can then check whether it worked.

   - **If you chose A:** A plan that is too big never gets done. Start with a small, near problem that you can really solve. Go to S3.2.8.
   - **If you chose B:** Look first. Digging can harm nests and roots. A plan needs a problem, an action, helpers and a way to check. Go to S3.2.8.

6. **100 plants**

   Each square holds about 4 plants and there are 25 squares. 4 × 25 = 100.

   - **If you chose A:** You have added the two numbers. Each of the squares holds about the mean, so multiply the mean by the number of squares. Go to S3.2.7.
   - **If you chose C:** You have taken one number from the other. To estimate the whole field, multiply the mean by the number of squares. Go to S3.2.7.

About this book

For learners who can read a page alone and use the four operations. In many schools this fits children of about 11 to 13, and older learners can use it too. Activities use sticks, string, paper, a cup of soil and a walk outside. A learner looks, counts and puts everything back, and never collects live animals. Gloves or washed hands go with soil

and compost. A learner can work alone: every exercise has its answer and the reason for it.

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