KnowAtom™
Focus on what matters.

Forests

UNIT 8

Lab Manual

Front Cover:

The cover shows a photograph of a large tree in a forest with some of its roots exposed.

Unit 8: Forests

Table of Contents

Section 1: How Plants Make Food

Studying How Trees Communicate

Scientist Suzanne Simard has been studying forests in Canada for 30 years. A **forest** is an area of land covered with trees. In 1997, Suzanne had a question: Do trees in a forest communicate with one another and share resources?

Her hypothesis was that trees in a forest are connected together in some kind of network.

There are both beech and fir trees in this forest.

Suzanne designed an experiment to test her hypothesis. She focused on an area of the forest that had two kinds of trees: birch trees and fir trees.

Testing Trees and Carbon

She put plastic bags over individual trees. She then injected carbon-14 into one bag covering a birch tree to see if it would transfer some of the carbon to other trees nearby.

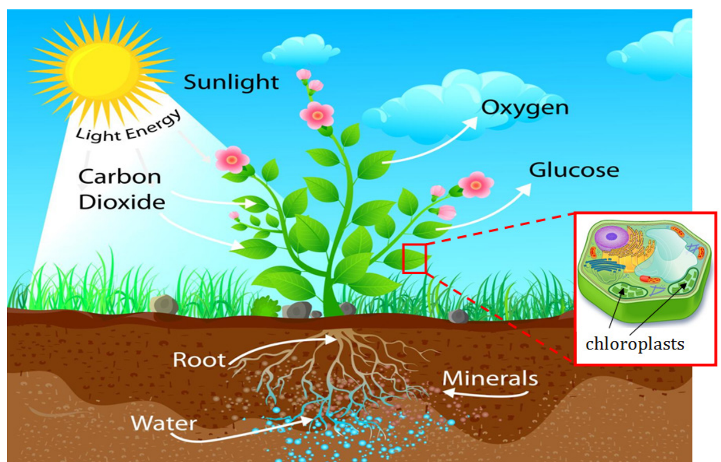
Carbon-14 is an isotope of carbon. This means it is one form of carbon. All isotopes of an element have the same number of protons, but they have a different number of neutrons. Carbon-12 is the most common form of carbon, making up 99 percent of all carbon in Earth's atmosphere. Carbon-13 makes up 1 percent, and carbon-14 is found in trace amounts.

Suzanne knew that carbon-14 molecules would bond with oxygen molecules in the environment to form carbon dioxide (CO_2). She also knew that plants need carbon dioxide to survive.

Making Food

Plants need carbon dioxide because it is an important part of photosynthesis. **Photosynthesis** is the process of turning sunlight, carbon dioxide, and water into glucose and oxygen. All plants carry out photosynthesis. This is how they make food. The glucose is a kind of sugar that holds chemical potential energy. Plants need this energy for growth and development.

Different parts of the plant work together so that photosynthesis can happen. Photosynthesis happens in the chloroplasts of plant cells. Remember that plant cells are the only kind of cells with chloroplasts. Chloroplasts make chlorophyll, which is a pigment that absorbs sunlight. Not all plant cells have chloroplasts. These organelles are most common in the cells of plant leaves.



All plants carry out photosynthesis. This is the process in which they make their own food.

Plant leaves have pores called stomata. These pores open and close to take in carbon dioxide from the environment and release oxygen.

Plants are constantly taking in carbon dioxide and releasing oxygen. This is similar to how people are always breathing, but people breathe in oxygen and release carbon dioxide. The back-and-forth exchange of carbon dioxide and oxygen between plants, animals, and the environment is called the **oxygen cycle**.

The roots collect water and minerals from the soil. Plants use minerals as building blocks for their different structures. The stem transports water and minerals between the roots and the rest of the plant. The stem also absorbs some water, although not as much as the roots.

Photosynthesis in a Forest

Plants need sunlight to carry out photosynthesis because photosynthesis is a chemical reaction. The sun provides the input of energy that turns carbon dioxide and water into glucose and oxygen. Plants use the glucose to grow and develop. They store any extra glucose in their different structures. Plants use some of the oxygen they produce. They release the rest back into the environment.

When Suzanne carried out her experiment, she waited about an hour after she injected the carbon-14 into the bag covering the tree. She then used an instrument called a Geiger counter to detect whether carbon-14 had been transferred to the other trees.

This is a Geiger counter. It detects levels of carbon-14.

Experiment Results

Suzanne's results showed that at that time of year, in the summer, the birch trees sent extra carbon to the fir trees. Suzanne believes this benefited the fir trees because the fir trees were in the shade more than the birch trees. Suzanne and her team did follow-up experiments. They observed that at later times of the year, the fir trees sent more carbon to the birch trees. She believes this is because the birch begins to lose its leaves in the fall, while the fir keeps its leaves. Without its leaves, the birch trees can't carry out photosynthesis as easily.

In other words, the experiments showed that the trees shared resources with each other. Experiments also showed that healthy trees sometimes share their nutrients with sick trees.

Scientists have since learned that trees in forests are connected by fungi mycelium. Trees send their extra carbon through the mycelium network to other trees.

Sunlight in Different Parts of a Forest

Suzanne's research also led her to conclude that there are "hub trees." She calls these trees mother trees because they nurture their young. The mother trees have grown tall enough to reach the forest's canopy. The **canopy** is the upper layer of the forest. It is where the treetops meet and form a thick cover. Canopy trees access most of the forest's energy because of the amount of sunlight they receive.

The mother trees help their young, which grow in the understory. The **understory** of a forest exists below the canopy. Less sunlight reaches the understory because it filters through the canopy. As a result, plants in this layer must be able to make food with a limited amount of sunlight. Suzanne's research showed that mother trees send extra carbon to the seedlings growing in the understory. This helps the seedlings survive because plants use some carbon atoms to build and repair their different structures. It also benefits the mother trees. When their offspring survive, they are more likely to reproduce and pass their genes along to future offspring.

There is even less sunlight on the forest floor than in the understory. The **forest floor** is blanketed with decaying leaves, twigs, fallen trees, animal scat, moss, and other organic particles.

There are different layers in a forest. Each layer receives different amounts of sunlight.

Understanding pH and Its Effect on Ecosystems

When carbon dioxide mixes with water, a chemical reaction occurs. This chemical reaction forms carbonic acid, and it makes the water more acidic.

Scientists can measure how acidic a water source is by testing its pH. pH is short for "potential for hydrogen." It is a measure of the number of hydrogen ions (H_3O^+) in a solution on a scale of 0 to 14.

- A solution that measures less than 7 is *acidic*.
- A solution that measure more than 7 is *basic*.
- A solution that measures 7 is *neutral*.

Chemists use litmus paper test strips or a liquid indicator to measure pH. Litmus paper and pH indicators will turn different colors depending on how acidic or basic the substance is. Red indicates the most acidic solutions. Blue indicates the most basic solutions.

pH litmus paper test strips


pH liquid indicator

Organisms survive in environments with a certain pH range. For example, most freshwater lakes, streams, and ponds have a natural pH in the range of 6 to 8. Seawater can range from a pH of 7.5 to 8.5.

However, aquatic ecosystems can sometimes become too acidic. For example, high levels of carbon dioxide from the atmosphere can increase water's acidity. This causes the pH of the water to decrease. This can harm the organisms that live there.

Section 1 Review

<u>**Multiple Choice**</u>	<u>**Critical Thinking**</u>
MC1. Which of the following **best** explains what happens to carbon dioxide and water once plants absorb them from the environment? A. The atoms that make up the carbon dioxide and water stay as they are so the plant can carry out photosynthesis. B. All of the atoms that make up carbon dioxide and water are stored in the plant for future use. C. The atoms that make up the carbon dioxide and water are destroyed so the plants can form oxygen and glucose. D. The atoms that make up the carbon dioxide and water are rearranged to form oxygen and glucose.	**CT1.** Why is photosynthesis important for plants? **CT2.** What resources from the environment do plants need to carry out photosynthesis? **CT3.** How would a plant's ability to survive be affected if it couldn't access sunlight? **CT4.** According to Suzanne Simard's research, how do "mother trees" help their offspring plants survive?

Section 2: Flow of Energy in an Ecosystem

Storing Food

an Eastern gray squirrel

Eastern gray squirrels love acorns. Acorns are the seeds of oak trees. Right before a squirrel eats an acorn, it shakes it.

The shaking happens so quickly it can be hard to see. But Michael Steele has videoed squirrels eating. When he watched the videos in slow-motion, he saw squirrels shaking the acorns.

Michael is a researcher who has studied squirrel behaviors. He says there is a simple explanation for why the squirrels shake acorns. They want to know if the quality of the seed is good. Depending on what they sense, they will either eat the seed right away or bury it to eat later.

Why Squirrels Bury Seeds

Squirrels bury seeds so they will have enough food to last them through the winter. Squirrels need to eat acorns and other plant materials because they are animals. They cannot make their own food, as plants can. Instead, they have to eat other organisms for energy and nutrients.

When squirrels eat acorns, they access some of the energy that the oak tree has produced through photosynthesis and stored in glucose molecules.

Ecosystem Relationships

Michael is particularly interested in relationships between squirrels and the trees that produce squirrels' food. Both the squirrels and the trees are part of an ecosystem. An **ecosystem** is a community of different species that depend on interacting with each other and their physical environment for survival. All ecosystems include living things that must eat one another for energy and nutrients. They also include oxygen and carbon dioxide from the atmosphere, water, and energy from the sun.

An ecosystem can be as large as a forest or as small as an oak tree. Regardless of its size, all the parts of an ecosystem work together to make a balanced system.

This squirrel is burying food for later.

Mutually Beneficial Relationships

Michael has found that squirrels and oak trees have a mutually beneficial relationship. The squirrels benefit because they need the seeds' energy and nutrients. They also need oxygen to breathe in. The oak trees benefit because acorns don't grow well if they are right beneath the parent tree. The branches of the parent tree will block the sun.

The squirrels move acorns to bury them. Gray squirrels are known as scatter hoarders. This is because they bury acorns and other seeds in many places. Researchers have found that gray squirrels have a system when they bury acorns from an oak tree. They bury less-desirable acorns closest to the tree. They bury more-desirable acorns farther away from the tree.

If the squirrel doesn't make it back to its acorns, those acorns might grow into new trees. This benefits the oak tree because it has passed along its genes. It also benefits the squirrels because it means more food sources.

Squirrels have a competitive relationship with one another. **Competition** between organisms occurs whenever two or more organisms require the same limited resource. Water and food are both resources. Shelter is another resource. Squirrels will often take another squirrel's supply of buried seeds if they find them. Because of this, gray squirrels will bury thousands of seeds each season.

There are competitive interactions in every ecosystem. There are also mutually beneficial interactions in every ecosystem.

There are also predatory interactions in every ecosystem. **Predation** is an interaction that occurs when one organism (a predator) eats another organism (prey). Organisms can be both predators and prey. For example, squirrels are prey to hawks and foxes. Squirrels are also predators of acorns and other plants.

Hawks are predators. They prey on squirrels and other animals.

In a balanced ecosystem, predators and prey act as checks on one another so that no one population of organisms becomes too large. A population is all of the members of a species within a particular area.

Food Chains and Food Webs

Oak trees, squirrels, and hawks are all connected together in a food web. A **food web** is a visual that shows the network of food chains in an ecosystem. **Food chains** show specific paths that energy travels as one organism eats another. Each level of a food web or food chain is called a trophic level.

Scientists study how energy flows through ecosystems to better understand how different organisms are connected together. They group organisms within an ecosystem according to how they obtain energy in a food web.

How Energy Flows

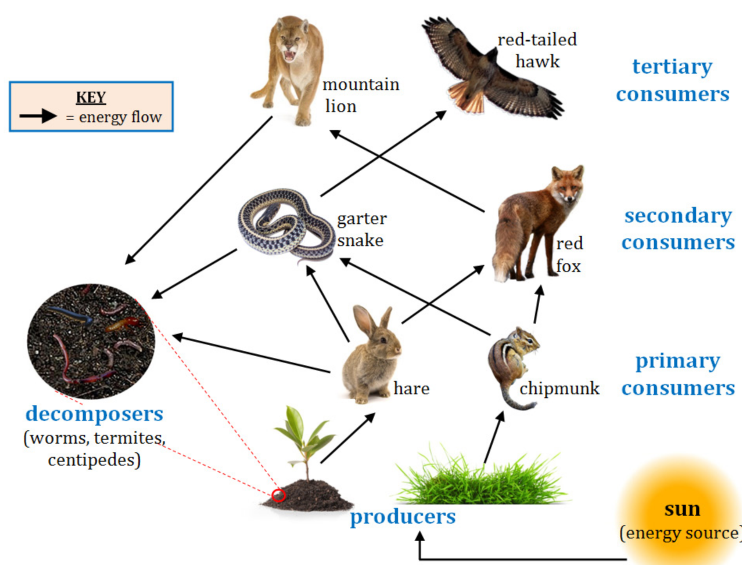
Plants are producers because they make their own food.

All energy in a food chain begins with the sun. As it shines, oak trees and other plants capture the sunlight. For this reason, plants are producers. **Producers** capture energy directly from the sun to make their own food. Producers always make up the first trophic level of any food web. They are the link between the energy source—the sun—and the rest of the organisms that live in an ecosystem.

The next trophic levels of a food web are made up of consumers. **Consumers** are organisms that eat other organisms for energy. All predators are consumers. Consumers can be herbivores (animals that eat only plants), carnivores (animals that eat other animals), or omnivores (animals that eat plants and other animals).

There are three different levels of consumer. The second trophic level of a food web consists of a kind of consumer called a primary consumer. **Primary consumers** are the first organisms that get energy by eating producers. Many primary consumers are herbivores. Squirrels are primary consumers because they eat acorns and other plant seeds.

This diagram shows a forest food web. The arrows show the path that energy flows as organisms eat one another.



The third trophic level of organisms in a food web consists of **secondary consumers**, which eat the primary consumers. Foxes and hawks are secondary consumers because they eat squirrels, which eat producers. In some food chains, there is a fourth trophic level, which is made up of **tertiary consumers** that eat secondary consumers. Mountain lions are tertiary consumers because they eat foxes, which eat squirrels, which eat acorns and other seeds.

Decomposers are their own level in a food web. Decomposers are organisms that break down organic waste and feed on the nutrients. When decomposers feed on the nutrients, they are also accessing some of the energy that is stored in the organic matter. As organic matter decomposes, the nutrients within it, including nitrogen and carbon, are recycled back into the environment. Plants can access these nutrients and use them as building blocks to help them grow.

Stability and Change in Ecosystems

Ecosystems are dynamic. They are constantly adjusting to remain balanced. If there are too many organisms competing for the same resources, there will not be enough resources, and some organisms will not survive.

Any event that changes conditions in an ecosystem is called a **disturbance**. A change to any part will impact the rest of the forest. Volcanoes, severe storms, drought, flooding, and disease are all natural disturbances that alter the forest ecosystem.

Disturbances are a natural part of any ecosystem. A disturbance can be devastating. Sometimes many organisms die. Others have to move because their home or food source was destroyed. But healthy ecosystems are often able to adapt to the new situation. Sometimes the same kinds of organisms will reappear. Other times, the environment changes enough that new species move in. These changes can take place quickly, or they can take many years.

Forest Field Guide

Animal	Diet	Behaviors
wild turkey	grasses, berries, acorns, and insects	Wild turkeys forage on the ground or climb shrubs and small trees to feed.
bobcat	deer, rabbits, chipmunks, and wild turkeys	Bobcats stalk their prey over long distances and then leap to catch them.
coyote	deer, rabbits, and chipmunks	Coyotes typically hunt in small packs to take down large prey.
cottontail rabbit	grasses, leaves, nuts, and flowers	Cottontail rabbits live in burrows. Hearing is their primary defense against predators.
chipmunk	berries, nuts, and insects	Chipmunks live in underground nests with extensive tunnel systems. They carry food in pouches in their cheeks.
barred owl	rabbits, chipmunks, and wild turkeys	Barred owls hunt for prey during the night.
white-tailed deer	grasses, leaves, flower buds, and nuts	White-tailed deer communicate with sounds, scent, and body language.
insects (butterfly and grasshoppers)	grasses and flowers	Grasshoppers are often camouflaged to avoid predators. Butterflies migrate both north and south every year.
fungi, centipedes, and worms	feed on dead or decaying animal and plant matter	
Plants		
ferns and **grasses**, **flowers**, **acorns**, **blackberry bushes** (produces blackberry fruit) and **forest trees** (oak, maple, and pine)		

Name: ______________________________________ Date: _________________

Forest Food Web Investigation

Focus question: How could long-term drought conditions in Massachusetts affect the food web in temperate deciduous forests in the state?

Investigation Summary: Use the materials and procedures below to create a model of a temperate deciduous forest food web.

Materials

- 2 scissors
- 1 Forest Organism Template set
- 1 Forest Field Guide (lab manual)
- 1 sheet of yellow paper
- 1 poster paper
- 1 glue stick
- 1-2 markers or colored pencils

Model-Set Up

1. Cut out a sun from the yellow paper.
2. Cut out the plants and animals from the Forest Organisms Templates.
3. Use the Forest Field Guide to group the organisms into the following categories on your poster paper: producers, herbivores, omnivores, carnivores, and decomposers.
4. Arrange the different groups of organisms on your poster paper in rows based on their trophic level, starting with the sun and producers.
5. Use the glue stick to glue the sun and organisms onto your poster paper when you're satisfied with their position. Label the organism groups.

Food Web Procedure

1. Use information from the Forest Field Guide to draw arrows from the sun in the direction that energy travels through the forest ecosystem as one organism eats another.

2. Create a title for your model and include a legend to show what the arrows represent.

Analyze the Model

1. Use your forest food web model to identify which trophic level in the forest ecosystem would be most directly affected by a drought and to explain why.

____

____

____

____

____

2. How do you expect changes to the trophic level you described in Question 1 to impact other trophic levels in the food web? Use your model to help you answer the question.

____

____

____

____

____

____

____

____

____

____

Section 2 Review

Multiple Choice

MC2. Some algae form a partnership with a fungus to create a new organism called lichen. The algae make food for the lichen through photosynthesis, and in return, the fungus protects the algae and gets water and minerals for the lichen. Which of the following **best** describes the pattern of interaction between the algae and fungus?

A. competitive
B. mutually beneficial
C. predatory
D. none of the above

MC3. One forest food chain is below:

worms → sparrows → owls

Using only the relationships shown above, what is **most likely** to occur if most of the worms are killed?

A. The number of sparrows will increase because there are fewer worms to eat them.
B. The number of sparrows will decrease because there are not enough worms for them to eat.
C. The number of sparrows will stay the same because the worms are killed, not the sparrows.
D. none of the above

Critical Thinking

CT5. How does the squirrel behavior of burying seeds help squirrels survive?

CT6. How does the squirrel behavior of burying seeds increase the chances of oak trees successfully reproducing?

CT7. How does energy flow through a food web made up of fungi, squirrels, hawks, and oak trees? Include the source of energy and how that energy is changed and/or transferred in your response.

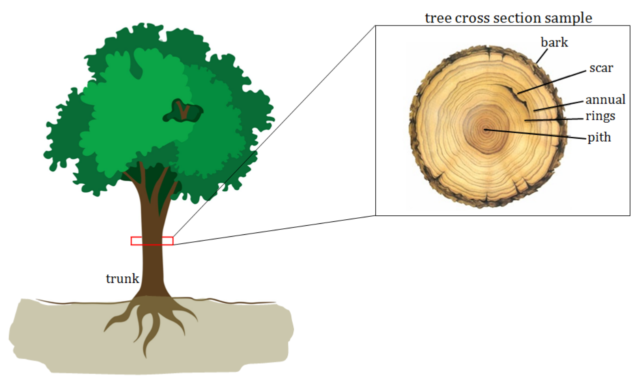
CT8. Why are decomposers an important part of all food webs?

Section 3: Tracking Changes

Collecting Tree Core Samples

Christina Restaino has traveled around the western United States to study trees. For three years, she went to 122 different locations where Douglas fir trees grow. She used a tree corer, which looks like a large corkscrew, on more than 2,000 individual trees. By turning the tree corer again and again, she was able to pull out core samples without hurting the trees. These core samples are pencil-shaped sections of the trunk.

Scientists like Christina look for patterns in the tree core samples to tell them about past disturbances. This is because trees keep a diary of disturbances in their trunks.



How Tree Rings Form

The trunk is the main stem of a tree that gives it shape and strength. It supports the leaves and branches. It also transports nutrients between the roots and the rest of the tree. The trunk grows in diameter each year. As a tree grows, a new ring is added to its trunk each year. An **annual ring** refers to the light- and dark-patterned wood that forms as a tree grows in diameter over time. The light-colored layer grows in the spring. The dark-colored layer forms in the late summer.

The trunk, branches, and twigs of the tree are covered with bark. The bark protects the tree from insects, disease, storms, and extreme temperatures. Inside the bark is a pipeline of living tissue called the pith. The pith carries water and nutrients throughout the tree. The pith is surrounded by dense, hard, inner wood called heartwood. Sapwood is the softer wood between the heartwood and the bark.

Tree Growth and Drought

Christina and her team found that the trees didn't grow as much during times of drought and increased temperatures. A **drought** is a prolonged period of unusually low rainfall, resulting in water shortages. They observed a cause-and-effect relationship between the amount of rainfall, the temperature, and tree growth. The rising temperatures caused the amount of water in the soil and atmosphere to decrease. This meant the trees took in less water.

In response, the trees closed their stomata to try to reduce water loss through their pores. This meant the trees weren't collecting carbon dioxide for photosynthesis, so they weren't getting the energy they needed to grow. The evidence for this was in the tree rings. Thin rings mean the tree didn't grow as much as normal because of a lack of water. Thick rings mean the tree had plenty of water and so it grew a lot.

Why Understanding Tree Growth Matters

Many scientists study tree rings to learn about past conditions. They look for patterns that can help them make predictions in the future. For example, one team of scientists used a variety of different data to evaluate how competition among trees affects which trees survive a drought and which ones die.

These scientists focused on forests in California during four years of extreme drought. They found that the driest and densest forests are the most at risk of dying. These findings make sense. There is a limited amount of water in the area. Each tree in that area is competing for the same water. When there is plenty of water, this competition isn't very noticeable because there is enough water for all of the trees.

During a drought, however, the competition becomes a matter of life and death for the trees. This research can help forest managers help to protect forests during times of drought. They can focus on watering trees in the driest and densest areas.

Genetics and Drought

Other scientists have focused on genetics to determine which species of trees are more likely to survive a drought. This is because some species of trees have adaptations that help them survive dry conditions. Remember that an adaptation is a trait that helps an organism survive in its environment.

Those species that are adapted to dry conditions are more likely to survive periods of drought and reproduce, passing along their traits to offspring.

Studying Tree Traits

William Anderegg has studied this issue. Along with other scientists, William looked for patterns in data about tree mortality. He wanted to see whether the species that survived drought had traits in common.

Junipers are well-adapted to dry conditions.

He found that the traits most likely to affect a tree's ability to survive drought had to do with how it pulled in water from the soil. When there is less water in the soil, a tree's roots have to pull harder to pull in water. Some tree species, such as junipers, are better adapted to dry conditions. They can pull in more water without harming themselves.

Aspen trees don't have adaptations to help them survive long periods of drought.

Other tree species, such as trembling aspens, are used to wet conditions. Because of this, they aren't as well adapted to dry conditions. In times of drought, they end up pulling so hard they harm themselves.

Common Core Connection – ELA

Reading Informational Text – Key Ideas and Details

Read the following news article about a scientist who studies tree rings, and then answer the questions below.[1]

How long can droughts last? Los Angeles County's trees may have the answer[2]

If trees could talk about the weather, Dave Meko would be out of a job. Meko interprets stories hidden within California's ancient pine trees. He studies the trees for clues about rainfall, stream flows, climate patterns and most importantly, droughts.

Meko and his team use tree-ring research. They want to learn about the history of droughts in the state going back 1,000 years. They are doing this by examining hundreds of tree-ring samples he has collected from around the state.

By studying the shapes of tree rings, Meko can get a glimpse into the past. He tries to determine whether droughts last five, 10, 50 or 100 years. By measuring the cores of living trees, Meko's research will provide 400 urban water suppliers with a new planning tool. It may answer the question of whether "megadroughts" lasting decades or 100 years really did happen in the past. And if they happened in the past, could they happen again?

Douglas-fir trees can live between 500 and 800 years. The older the tree, the further back in time his conclusions can reach. He said it's hard to know the drought's timing as samples are being collected. This makes it difficult to calculate the lengths of current drought periods. "Our research can't tell us exactly what the future will be. It will tell us what natural variability has preceded (come before)," Meko said.

Questions:

1. What is the key idea of this text?
2. According to the text, what does Meko hope to be able to do as a result of his data?
3. What are the limitations of Meko's data?

[1] Adapted from a 2016 article in the San Gabriel Valley Tribune by Steve Scauzillo

Name: ____ Date: ________________

Tree Growth Investigation

Part 1 Focus Question: How can tree ring data be used to reveal patterns of growth in trees over time?

Use the materials and procedures below to analyze tree cross-sections and then answer the questions that follow.

Materials

- 2 tree cross-sections
- 1 ruler

Observations

Record observations for each tree cross-section in Table 1.

Table 1: Tree Cross-Section Observations

	Tree Type	Diagram (Label the pith, bark, sapwood, heartwood, and one annual ring.)
Tree Cross-Section 1		

	Tree Type	Diagram (Label the pith, bark, sapwood, heartwood, and one annual ring.)
Tree Cross-Section 2		

Analyze the Tree Cross-Sections

1. Count the number of rings on your tree cross-section to determine the approximate age of the tree. Record this information in Table 2.
2. Count the number of wide growth rings you notice on the tree cross-section to determine how many years the tree experienced an increase in growth. Record this information in Table 2.
3. Count the number of narrow growth rings you notice on the tree cross-section to determine how many years the tree experienced a decrease in growth. Record this information in Table 2.
4. Repeat steps 1-3 with your second tree cross-section.

Table 2: Tree Cross-Section Growth Data		
	Tree Cross-Section 1	Tree Cross-Section 2
Approximate Tree Age (Years)		
Number of Years with Increased Growth		
Number of Years with Decreased Growth		

Analyze the Data

1. Describe any growth patterns you noticed among the tree cross-section samples.

____

____

____

____

____

____

____

____

____

Part 2 Focus Question: From 1985-1995, West Virginia experienced some times of increased precipitation and some times of decreased precipitation, including a drought from 1987-88. How did changes in precipitation during this time most likely affect the growth of yellow poplar trees in West Virginia?

Use what you know about how environmental conditions can affect the growth of organisms to write a hypothesis for the question.

____

____

____

____

____

____

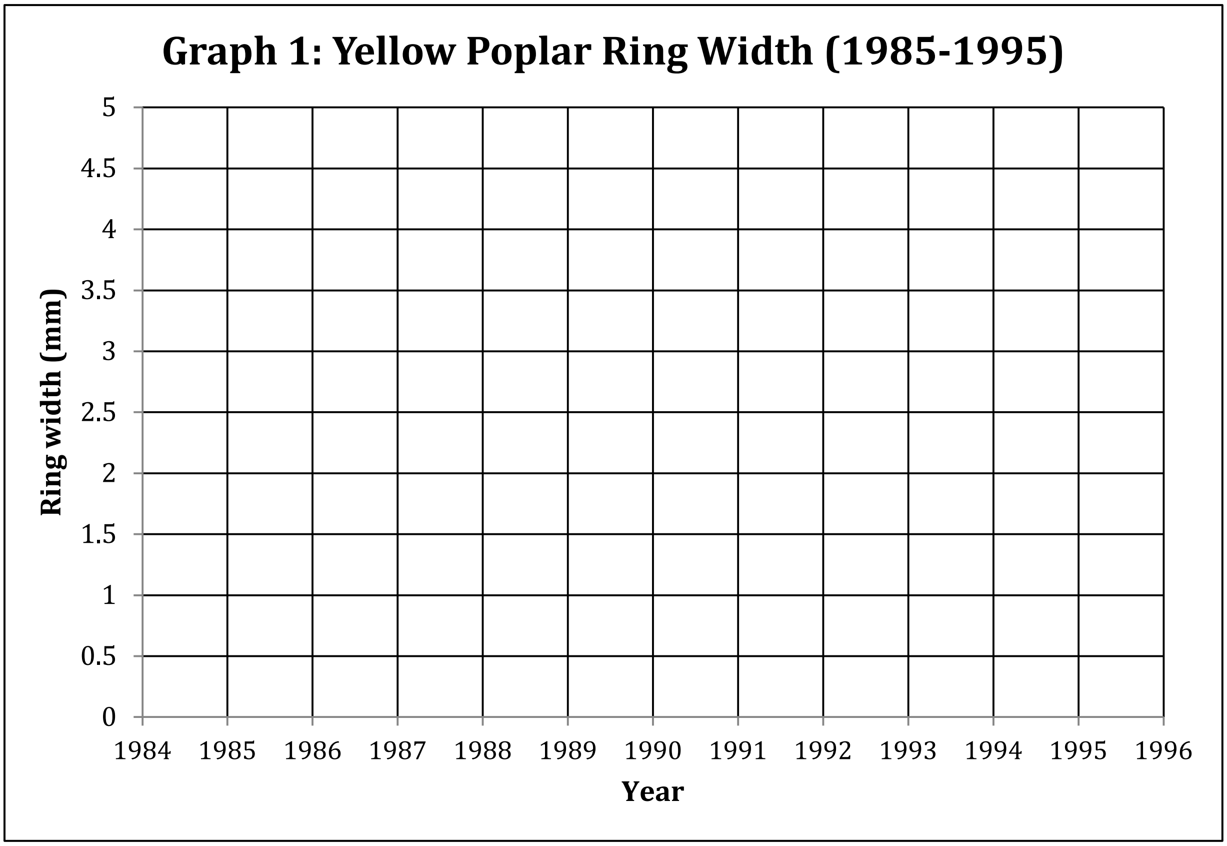
Graph the Data

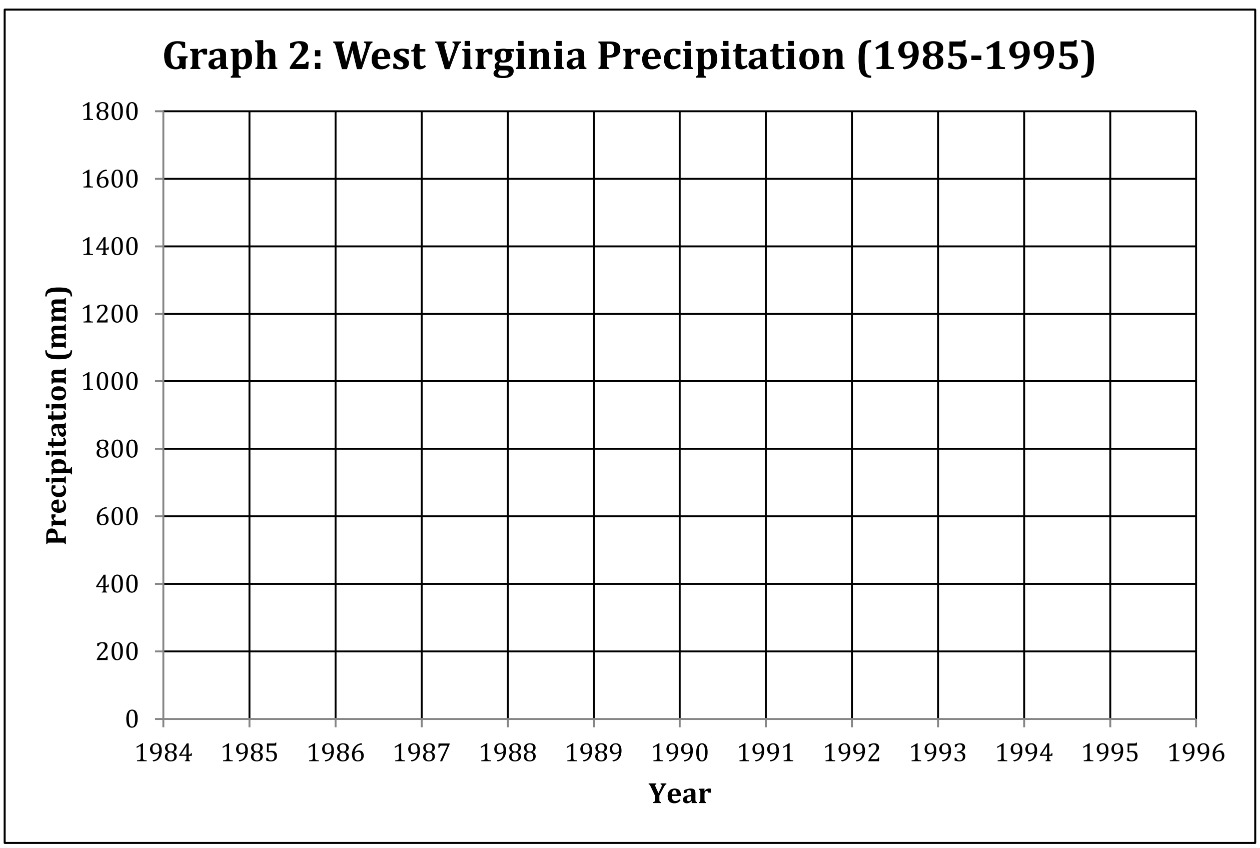
Analyze the West Virginia average yellow poplar tree ring width and precipitation data in the tables below. Graph the data in each table on the corresponding blank line graphs on the next page.

Table 1: Average Yellow Poplar Ring Width from 1985-1995	
Year	**Ring-Width (mm)**
1985	4.5
1986	3
1987	2.5
1988	1
1989	1.5
1990	2.5
1991	2.5
1992	2
1993	2
1994	3
1995	4.5

Table 2: West Virginia Precipitation from 1985-1995	
Year	**Precipitation (mm)**
1985	1,200
1986	1,150
1987	950
1988	900
1989	1,450
1990	1,350
1991	1,100
1992	1,110
1993	1,150
1994	1,150
1995	1,600

**Climate data from www.ncdc.noaa.gov*


Graph 1: Yellow Poplar Ring Width (1985-1995)
Ring width (mm)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
Year


Graph 2: West Virginia Precipitation (1985-1995)
Precipitation (mm)
1800
1600
1400
1200
1000
800
600
400
200
0
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
Year

Analysis and Conclusion

1. Describe any patterns you notice in the tree ring growth and precipitation data in Graphs 1 and 2.

____

____

____

____

____

____

____

2. Explain how the data in the graphs do or do not support the hypothesis you wrote. Use specific evidence from the data to support your argument.

____

____

____

____

____

____

____

____

____

____

____

Section 3 Review

Multiple Choice	Critical Thinking
MC4. Which of the following do organisms need to survive in their environment? A. food B. water C. air D. all of the above **MC5**. Which of the following is **true** about environmental conditions on Earth? A. Environmental conditions on Earth have always stayed the same except for some small changes from year to year. B. Environmental conditions on Earth changed in the past, but they aren't changing now. C. Environmental conditions on Earth were constant in the past, but they are changing now. D. Environmental conditions on Earth changed in the past, and they are changing now.	**CT9.** Why does Christina Restaino study tree core samples? **CT10.** What evidence did Christina gather about the Douglas fir trees she studied? **CT11.** According to the text, what environmental factors influenced the growth and survival of trees? Cite specific parts of the text to support your answer. **CT12.** According to the text, what is one genetic factor that influences the ability of trees to survive a drought?

Science Words to Know

annual ring – the light- and dark-patterned wood that forms as a tree grows in diameter over time

canopy – the upper layer of a forest where the treetops of most of the trees meet to form a layer of habitats for insects, birds, and tree-climbing mammals

competition – an interaction between organisms that occurs whenever two or more organisms require the same limited resource

consumer – an organism that eats other organisms; there are three possible levels of consumer in a food web: primary, secondary, and tertiary

decomposer – an organism that breaks down organic waste and feeds on the nutrients

disturbance – an event that changes conditions in an ecosystem

drought – a prolonged period of unusually low rainfall, resulting in water shortages

ecosystem – a community of different species that depend on interacting with each other and their physical environment for survival

food chain – the path that energy travels as one organism eats another

food web – a visual that shows the network of food chains in an ecosystem

forest – an area of land covered by trees

forest floor – the part of the forest that is blanketed with decaying leaves, twigs, fallen moss, and other organic particles

oxygen cycle – a back-and-forth exchange of carbon dioxide and oxygen between plants, animals, and the environment

photosynthesis – the process of turning sunlight, carbon dioxide, and water into glucose and oxygen

predation – an interaction between two organisms that occurs when one organism (predator) eats another organism (prey)

primary consumer – the second level of a food web but the first level of organisms that get energy by eating producers

producer – an organism that captures energy directly from the sun to make their own food; trees, grasses, and some microbes do this with photosynthesis; the first level of organisms in all food webs are producers

secondary consumer – the third level of a food web; an organism that eats primary consumers

tertiary consumer – the fourth level of a food web; an organism that eats secondary consumers

understory – the middle layer of the forest that contains a mixture of small and immature trees that provide shelter for animals

Back Cover:

The back cover shows a photograph of a squirrel eating an acorn. When squirrels eat plants, they access some of the plant's energy and nutrients.

KnowAtom™
Focus on what matters.