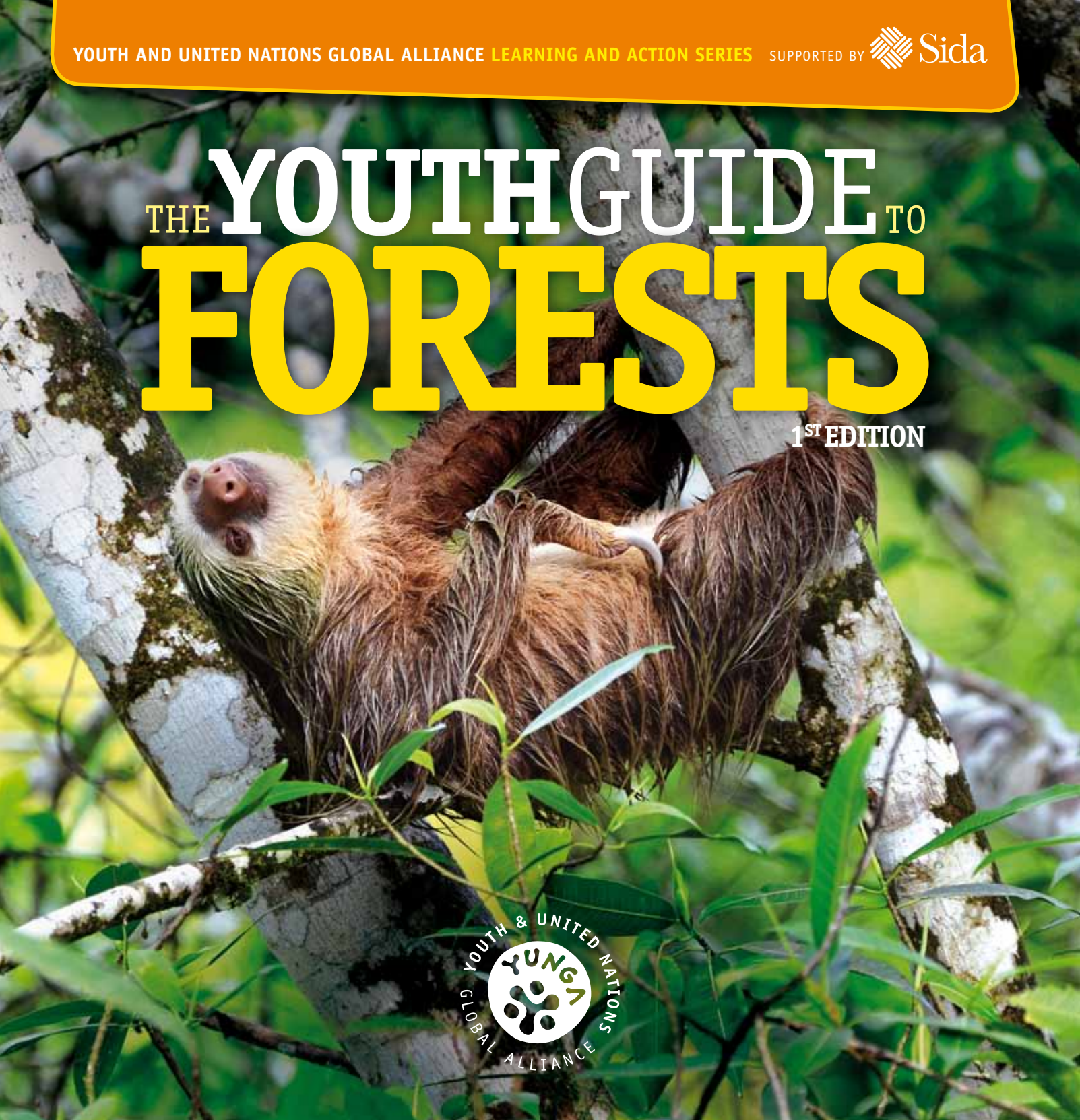
YOUTH AND UNITED NATIONS GLOBAL ALLIANCE LEARNING AND ACTION SERIES SUPPORTED BY Sida

THE YOUTH GUIDE TO FORESTS

1ST EDITION



WE ARE MANY
WE ARE **YUNGA**!

www.yunga-un.org



THE YOUTH GUIDE TO FORESTS

1ST EDITION



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Convention on Biological Diversity

FAO FIAT PANIS

TakingITGlobal INSPIRE INFORM INVOLVE

UNESCO United Nations Educational, Scientific and Cultural Organization

WWF

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PREFACE

FORESTS ARE INCREDIBLE PLACES. THEY ARE SO MUCH MORE THAN JUST A BUNCH OF TREES!

Forests are home to a huge variety of plant and animal life – from tiny microscopic fungi species, to enormous trees that are sometimes taller than 80 metres high. Forests provide vital services that ensure people have clean air to breathe and water to drink (and they do it all for free!). For some people, the forest is a place where they go for work, for religious practices or even just for sport, fun and recreation. Because forests are such wondrous and beneficial places, you'd think they would be a top priority for protection so that everyone alive today (and everyone in the future) can enjoy them, right? Unfortunately, this isn't always the case. In fact, there are many dangers that threaten the very existence of the Earth's forests. Luckily, there are groups of people (including young people like you) who are persevering to protect forests.

If you want to learn more about forests, then... go and explore a forest or some trees near you! After you've experienced some of the wonders of the forests first-hand, and maybe even witnessed some of the challenges forests face, it's time to deepen your learning. This Guide will help you learn about forests around the world and really understand forest issues. The ***Youth Guide to Forests*** aims to provide you with information, questions and ideas.

Section A introduces what a forest is, the different forest types, and the factors that determine these differences. Section B illustrates the many different forest biomes found around the world and the key differences between them. Section C then goes on to describe the myriad ways in which forests provide a huge range of benefits to the planet and to people everywhere, such as forest biodiversity; forest ecosystem services; and cultural and recreational uses of forests. The final two sections discuss current and future challenges to the world's forests and highlight some of the most urgent areas for action. Section D addresses threats to forests, whilst Section E presents what various groups of people are doing to ensure a better future for the world's forests and explains how you can get involved in this important work.

A great complementary resource to this Guide is the ***Forests Challenge Badge***. It is designed to help educate children and young people in a fun and active way about the vital part that forests play in sustaining life on Earth. The badge curriculum includes a range of fun and engaging activities and ideas to help young people gain the knowledge, skills and values needed to protect, preserve and sustainably manage forests as well as how to sustain the benefits they provide to people and the planet. Check it out at: **www.yunga-un.org**.

Happy reading!







EDUARDO ROJAS-BRIALES

Assistant Director-General,
Forestry Department,
Food and Agriculture Organization of the United Nations (FAO)

"Forests are one of the Earth's greatest natural resources. There is a reason why we often figuratively speak of 'the tree of life'; forests are key to supporting life on Earth. They give us wood that can be used for shelter, furniture or fuel; and they provide us with invaluable ecosystem services such as purifying the air we breathe, protecting watersheds and offering homes to an unimaginable wealth of biodiversity. They are also important places of cultural value and great places for recreation and relaxation. We cannot allow this precious resource to be damaged or destroyed! Delve into this Guide to admire and learn, – and then put it down and leap to action!"

BRAULIO FERREIRA DE SOUZA DIAS

Convention on Biological Diversity

Executive Secretary of the Convention on Biological Diversity (CBD)

"Trees and forests are central components of biodiversity and essential to sustainable development. Hundreds of different species of insects, birds, amphibians, reptiles, mammals, fungi, mosses and plants can be found on a single tree in the tropical rainforest. Deforestation causes intense pressure not only on these species and ecosystems, but also on 1.6 billion people whose livelihoods depend directly on forests, as well as on all of us who benefit from the ecosystem services that forests provide; for example, in climate regulation, clean water supplies and recreation. Among its targets, the Strategic Plan for Biodiversity 2011-2020 aims to at least halve the rate of deforestation, to manage all of the world's forests sustainably, and to restore 15 percent of degraded forests by 2020. This *Youth Guide to Forests* will provide you with knowledge and countless ideas on how to take action for forests and to contribute towards achieving these goals."

CBD, FAO & YUNGA AMBASSADORS



© FAO/Simone Casetta

ANGGUN

YUNGA AND FAO GOODWILL AMBASSADOR

" Did you know that forests cover just over 30 percent of the Earth's land area? Unfortunately, this area is decreasing every day because humans are cutting down trees to use their wood and to use the land for other purposes such as agriculture. Read on through this Guide to find out more about the threats to forests, and some simple actions that we can all take to help look after them. "

CARL LEWIS

YUNGA AND FAO GOODWILL AMBASSADOR

" Do you enjoy eating chocolate, berries, or mushrooms perhaps? Do you have things at home made from wood? Do you like reading books, newspapers or magazines? If so, you are relying on forests to produce these things! However, forests provide us with so much more than just a few snacks and pieces of furniture – get stuck into this Guide and find out exactly why forests are so important for us. "



© FAO/Simone Casetta



DEBI NOVA

YUNGA AMBASSADOR

" What is your favourite kind of tree? Did you know that there are some trees that live in the ocean, as well as others that survive in deserts? The diversity of plant and tree species that make up forests really is fascinating – there are so many different and wonderful creatures that call these places home. Let's go and explore what makes forests such cool habitats. "

EDWARD NORTON

UNITED NATIONS GOODWILL AMBASSADOR FOR BIODIVERSITY



" However remote our daily activities appear to be from trees and forests, our lives depend on their extraordinary capacities to filter the water that we drink, to clean the air that we breathe and to support thousands of species of living organisms. Until the world understands this interconnectedness, millions of acres of forests will continue to be destroyed by unsustainable industries. Learn about forest biodiversity and discover ways to act wherever you are. Together we can design a better future for the world's natural resources. "



© FAO/Simone Casetta

FANNY LU

YUNGA AND FAO GOODWILL AMBASSADOR

" Let this Guide inspire you to care about the incredible wonders of our planet's forests – from the many amazing things that forests provide us with, to the invisible yet vital ecosystem services that we would not be able to live without. Forests have also been a popular site for many cultural activities for communities around the world for many centuries – what do forests give or mean to YOUR community? "



JEAN LEMIRE

AMBASSADOR TO THE GREEN WAVE FOR BIODIVERSITY

" Today, habitat destruction is the biggest threat to life on Earth. Living species are losing their safe habitats to reproduce, protect and feed themselves. This situation is particularly visible in and around tropical rainforests which face intense pressure from agriculture and infrastructure development. Humanity has to reflect on these destructive patterns. Understanding that we, as human beings, are part of a whole, that our lives depend on forests perhaps located on the other side of the globe, is the starting point in tackling the causes of deforestation and habitat destruction. Learn, share and act! "

LEA SALONGA

YUNGA AND FAO GOODWILL AMBASSADOR

" What do you and your friends like about forests? Isn't it nice to know that children and young people have had fun forests for centuries? We need to make sure we look after them today, so that they stay as strong and healthy tomorrow – and so that groups of friends in the future can enjoy having adventures in the forest, too. "



© FAO/Simone Casetta



NADÉAH

YUNGA AMBASSADOR

" Forests are hugely important to help us mitigate the negative effects of climate change. Did you know that forests store more carbon in their biomass and surrounding soils than the carbon that can be found in the Earth's atmosphere? They also provide us with the air we breathe by converting carbon dioxide into oxygen through photosynthesis. There are so many things that we can be thankful to forests for, let's show them a little appreciation in return! "

PERCANCE

YUNGA AMBASSADOR

" Did you know that the one of the oldest living trees is more than 4 700 years old? It's amazing to think that a single tree has withstood so many factors and changing climates in its lifetime! Let's hope that such long lifetimes continue for other trees and forests into the future – but to do so, we need to ensure that we protect and preserve the Earth's forests with good forest management and sustainable resource use now. "





© FAO/Simone Casetta

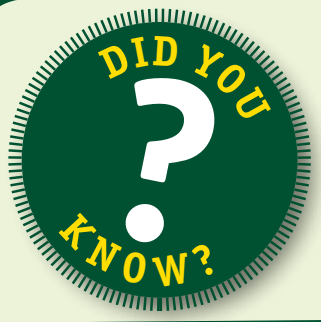
VALENTINA VEZZALI

YUNGA AMBASSADOR

" What do you think is the biggest threat to forests? Whilst there are many that you are probably thinking of, it's not all doom and gloom – we can do something to ensure that they have a sustainable and healthy future. Let's join together to take action on forest issues – we are many, we are YUNGA! "

HOW TO USE THIS GUIDE

Throughout this Guide, you will come across little icons. These provide a quick way to see what you are reading about:



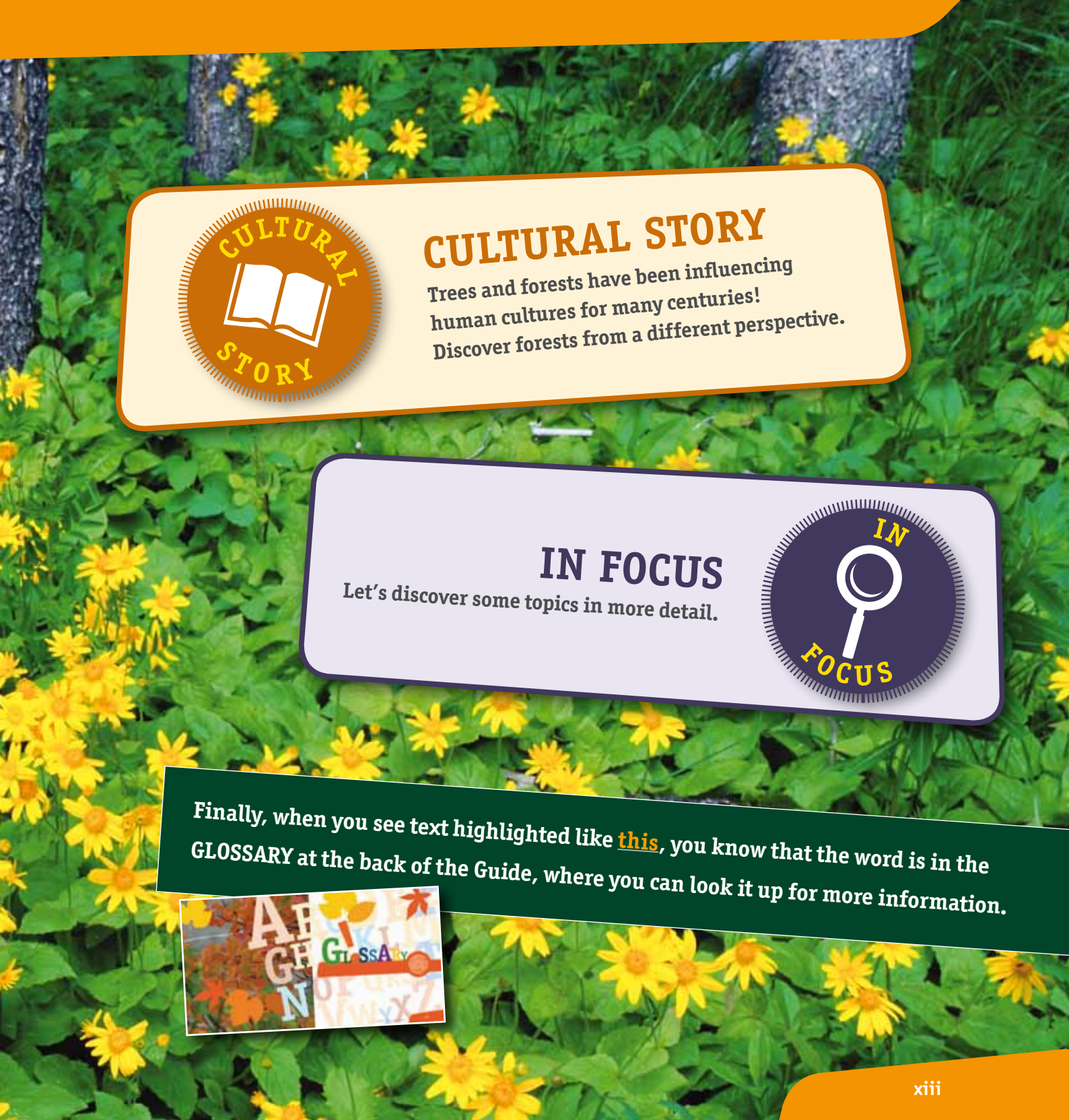
DID YOU KNOW?

Our world is full of strange and wonderful things. Learn more about it with these fun facts!

THINK ABOUT IT

The information contained in these boxes will help you to reflect on issues affecting the world's forests.





CULTURAL STORY

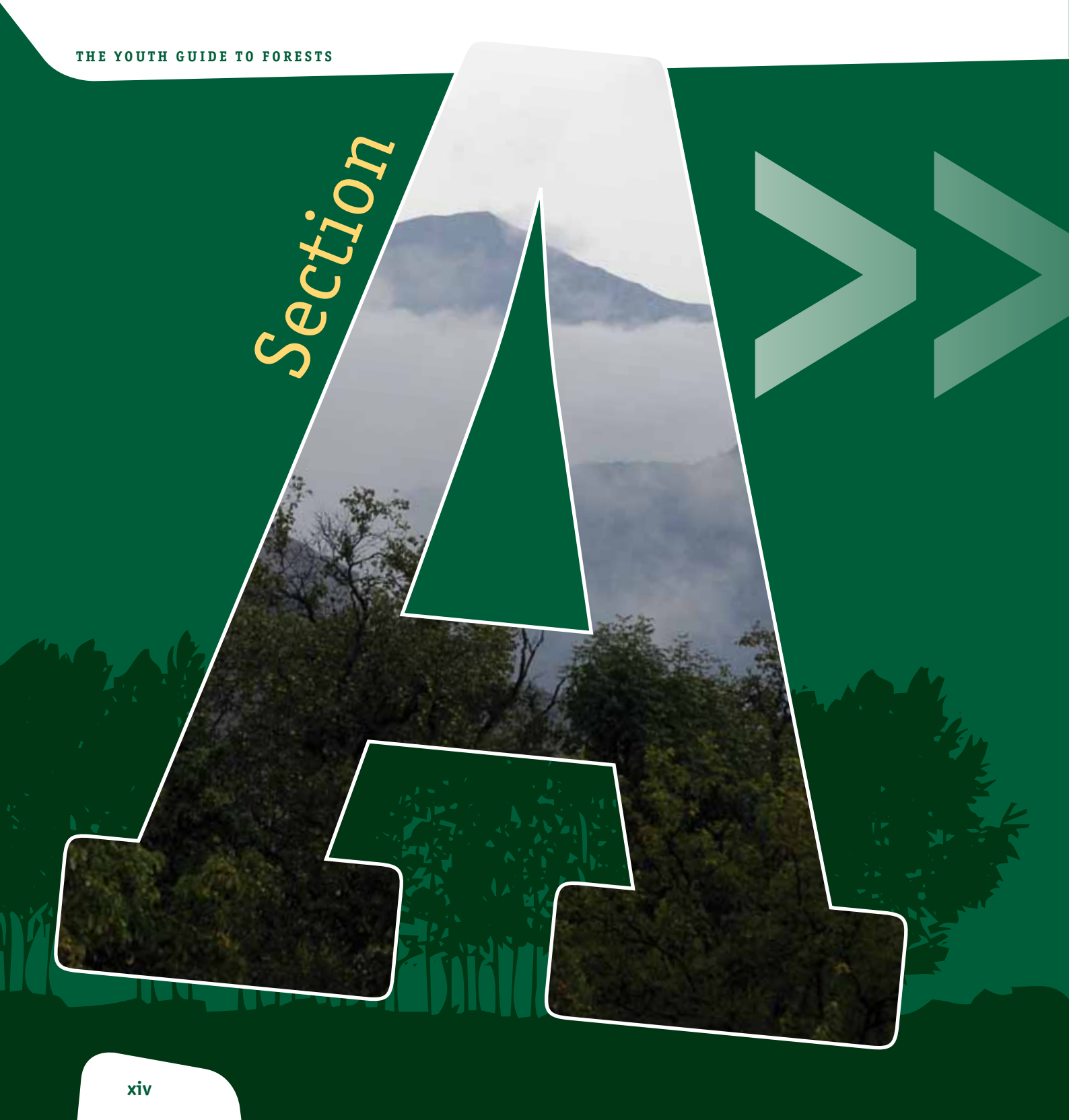
Trees and forests have been influencing human cultures for many centuries! Discover forests from a different perspective.

IN FOCUS

Let's discover some topics in more detail.

Finally, when you see text highlighted like this, you know that the word is in the GLOSSARY at the back of the Guide, where you can look it up for more information.

Section A



INTRODUCING FORESTS





Chapter 1
WHAT IS A FOREST?

Chapter 2
CLASSIFYNG FORESTS



WHAT IS A FOREST?



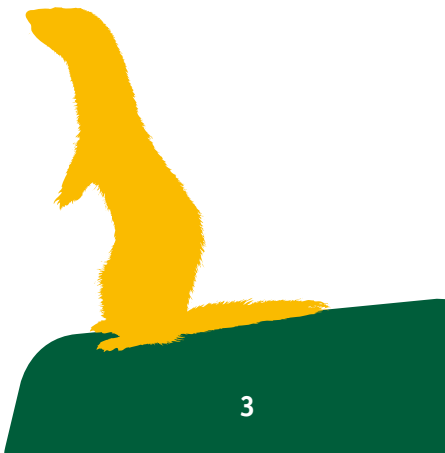
FORESTS COVER ABOUT 30 PERCENT OF THE EARTH'S LAND AREA AND ARE HOME TO 80 PERCENT OF THE WORLD'S LAND-BASED BIODIVERSITY. THAT'S A LOT!

1

There are many questions that we can ask about forests.

- **What exactly is a forest?**
- **Why are there so many different types of across the world?**
- **How do humans impact forests?**
- **What types of organisms live in forests?**

In this chapter we will begin to answer these questions.



LA FORTUNA WATERFALL, COSTA RICA.
© Hannu

HOW CAN WE DEFINE A FOREST?

There is no single correct definition for a forest, but the simplest way to describe it is as a natural ecosystem made up of trees. What is an ecosystem, though? An ecosystem is made up of everything that you find in a specific area. That is both living organisms (plants and animals) and non-living (like rocks and soil). Ecosystems are also defined by how these different components interact with one another. Therefore, a forest ecosystem is defined by which plants and animals you find in it, and their relationships with each other and the non-living elements around them.

Now, although we know forests are a type of ecosystem, actually defining 'a forest' specifically is still not that easy. Different groups, such as naturalists, economists, foresters and farmers each use a different definition because they all have different types of relationships with forests. There are actually more than 1 000 different definitions for 'forest'! However, having just one definition helps us understand each other better. Plus, it gives us a common starting point for counting trees and measuring the size of forests – which are important if we want to be able to see how healthy a forest ecosystem is.

A commonly used global definition of a forest is the one provided by the Food and Agriculture Organization of the United Nations (FAO). It says that a forest should include the following three characteristics:

- a minimum forest area size of 0.5 hectares;
- a minimum tree height of 5 metres; and
- at least 10 percent crown cover.

This might seem a bit abstract but you can easily visualize this definition by using the following size comparisons. According to the FAO, a forest must:

- be at least as big as an American football field;
- have trees as tall as (or taller) than an adult giraffe; and
- have enough branches, leaves and vines in the treetops to hide at least one tenth of the sky if you're standing on the forest floor looking up.

Urban parks, orchards, **agro-forestry** systems and other agricultural tree crops are all excluded from the FAO definition because they are not natural **ecosystems** (as they are created by humans). However, these **ecosystems** are still very valuable and are sometimes included in other definitions.



MANGO TREE, ETHIOPIA.
© FAO/Astrid Randen

THINK ABOUT IT

How would you describe a forest?

What's the nearest forest to where you live?

What kinds of plants, animals and trees and people live there?

TREES

So, we know that a forest is an **ecosystem** made up of trees – but what exactly are trees? Unfortunately, as with forests, there is no set definition for trees. This is because they are defined differently depending on who is talking about them, just like forests. However, we all agree that a tree is usually a tall plant with a long woody stem, called a trunk, which has leaves and branches growing from it. A tree can be defined by the length of its trunk – if the trunk is too short then it is a shrub or a bush and not a tree. Some people also define trees as anything that can be used to produce wood, or **timber**.

DID YOU KNOW?

The first trees, like the ones we know today, appeared 370 million years ago. The first true tree was called *Archaeopteris* and grew up to 30 metres tall and had a trunk up to 1 metre wide. No plants before *Archaeopteris* had been able to grow this tall because their stems were not strong and reinforced like those of trees today.

CULTURAL STORY

YGGDRASIL: **THE TREE OF LIFE**

In old Norse mythology, Yggdrasil was the name given to the sacred tree of life. There were nine worlds and this great, eternal ash tree spread over all of them and even into the heavens above! The tree also had three huge roots that extended to three wells that provided the tree with water.

At the bottom of one of these roots lived a dragon called Nidhug, who would gnaw on the root of the tree. The second root extended into the land of the giants. Near the third root lived the three 'Norns' named 'past', 'present' and 'future'. These Norns were called the Goddesses of Fate because they were thought to decide the fate of every human being.

Yggdrasil was believed to bring life and knowledge and to unite the heavens and the Earth. The metaphor of a tree of life is also important in many other religions and cultures. Why do you think that is?



PAINTING OF THE TREE OF LIFE.
Author: LUDWIG BURGER (1825-1884).
Source: WÄGNER, WILHELM. 1882.

IN FOCUS

DON'T LOSE YOUR LEAVES!

You may have noticed the huge variety of trees in the world! Have you seen that in winter, some trees keep their leaves while others lose them? Well, those trees that keep their leaves in winter are called '**evergreens**' and those whose leaves turn brown and fall off in autumn are called '**deciduous**' trees.

These two types of trees live in different conditions and are adapted to different environments.

Which types of trees can you see in the forest nearest to you?



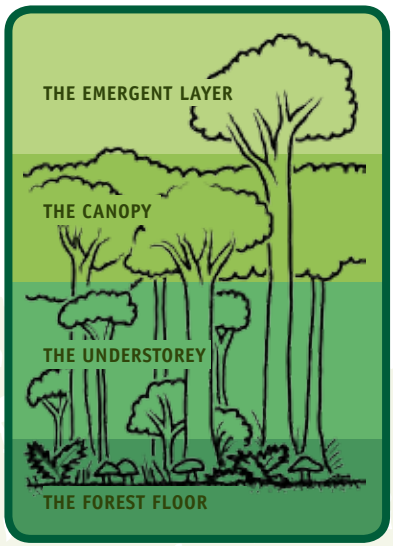
AN AERIAL VIEW OF A DECIDUOUS FOREST SHOWING ITS COLOURFUL AUTUMN LEAVES. TEXAS, USA.
© Wing-Chi Poon



THIS CEDAR TREE, IN THE UNITED KINGDOM, IS AN EXAMPLE OF AN EVERGREEN.
© Bugdog

FOREST LAYERS

Obviously, not all trees and plant species in forests are the same size. In the diagram below you will see that forests have different layers featuring different plant growth. Although these layers might look different in different types of forests, they all have some things in common. Let's take a look.



FOREST LAYERS.
© YUNGA, Emily Donegan

THE EMERGENT LAYER

This is the top layer of the forest and consists of really tall trees that stick out above all the others (they 'emerge' from the other layers). This means that these trees can collect more sunlight and grow even more!

THE CANOPY

This is formed by the 'crowns' of the trees (the leafy branches at the top). How thick the **canopy** is determines how much light enters the rest of the forest and what other types of plants grow below. For example, the **canopy** of a typical rainforest blocks out about 95 percent of the sunlight!

THE UNDERSTOREY

This is the layer between the **forest floor** and the **canopy**. It is where you see a lot of the amazing forest life, such as insects and big animals! The bushes, shrubs and young trees that you find in the **understorey** have adapted to living in the shade of the **canopy**. (When a **species** develops special traits to better survive in a particular environment, this is called **adaptation**. We'll explore lots of clever – and crazy! – **adaptations** throughout this Guide.)

THE FOREST FLOOR

This is the bottom layer of the forest. It's quite dark down here because not much sunlight gets through the other forest layers. This is where you find lots of **fungi** and other **decomposers** who break down all the leaves and dead **organisms** that fall to the floor. It is a very important place for **nutrient** recycling and providing organic matter to the soil and plants living in it.

FORESTS AND BIODIVERSITY



CULTURAL STORY

THE JUNGLE BOOK

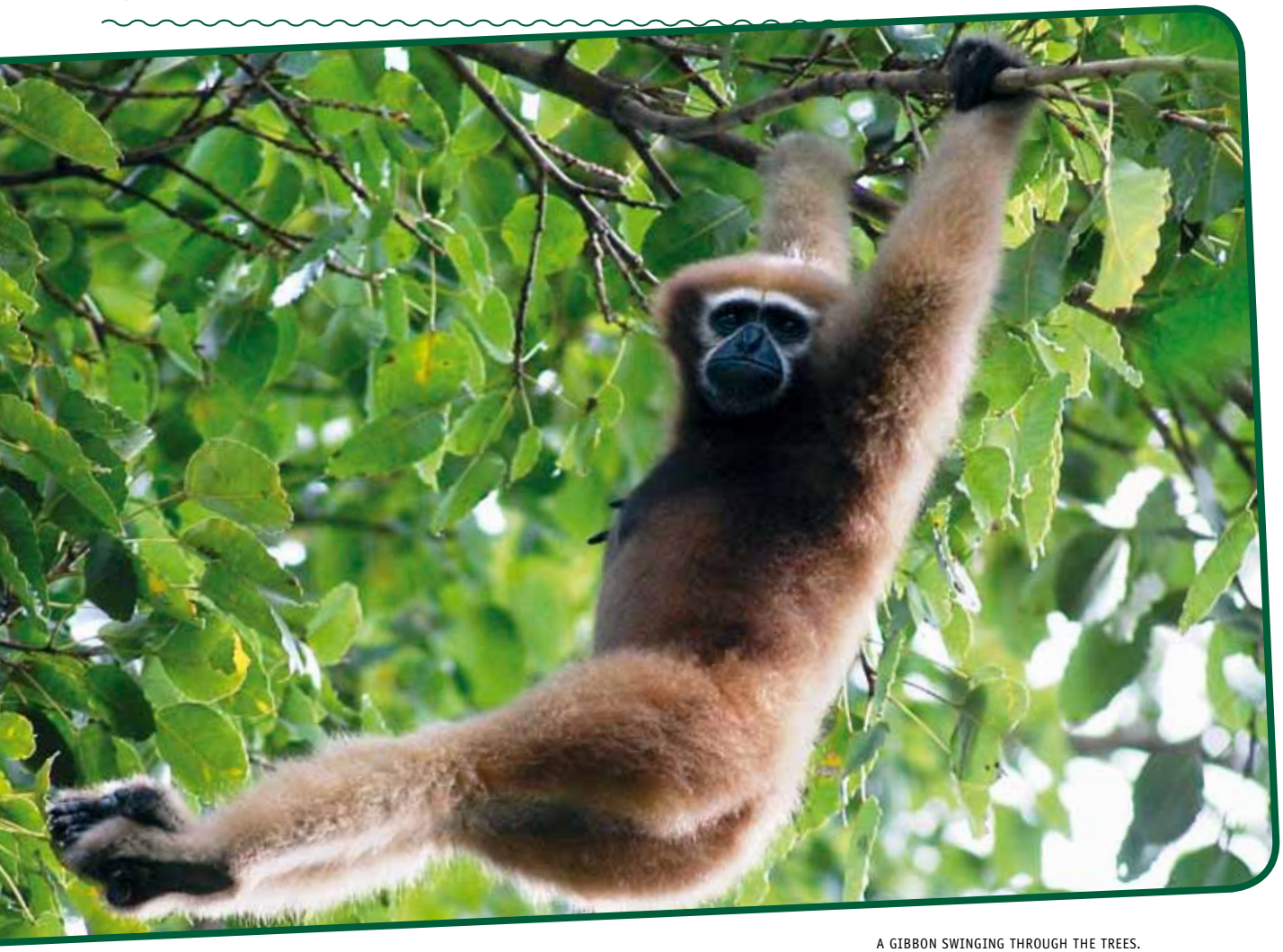
In 1894 Rudyard Kipling wrote *The Jungle Book* which is a series of short stories about a young boy named Mowgli, who loses his human parents and is adopted by a pack of wolves. The wolves raise Mowgli as one of their own cubs, teaching him how to survive in the **tropical forest** and respect the animals around him. Mowgli has many adventures in the jungle, finding his own food and discovering the many secrets of the forest through the help of the wolves and his mentors Baloo the bear, Bagheera the panther and Kaa the rock python.

Mowgli is taught how to live by the 'law of the jungle', which provide a set of moral indicators for how individuals, families and communities should respect each other in order to live in harmony together. Due to these moral standards, themes from *The Jungle Book* have been adopted by the Scouting movement. For example, young Scouts are known as 'Cub Scouts' who join together to form a 'pack' through which they can learn many skills and learn to respect others and the environment around them. Cub Scout leaders are also named after jungle book names, like Akela, Baloo, Bagheera and Kaa.

You can read *The Jungle Book* stories here: **www.gutenberg.org/files/236/236-h/236-h.htm**

When you read *The Jungle Book*, especially an illustrated version, you'll notice many, many different kinds of mammals, reptiles, trees, vines and other jungle life in the story. The jungle life in this fictional tale is actually illustrative of the real-world diversity of life that exists in the world's forests. This diversity, often called 'biological diversity' or 'biodiversity' for short, does not only include animals but also plants, fungi and microorganisms.

The diversity seen between **organisms** and among all the different **species** is due to **genes**. **Genes** are found in every **cell** of every **organism**. They are the codes that tell the **cell** what to do, giving each **organism** its own unique characteristics. Unless you are an identical twin, your **genes** are different from the **genes** of every other person on the planet; they are what make you unique. The information found in **genes** is passed down from parent to child. That's why people may say you look like your parents – you share quite a few of the same characteristics.



A GIBBON SWINGING THROUGH THE TREES.
© Programme HURO

So how do we measure **biodiversity**? Well, counting the number of **species** found in a specific place is one common way to measure the amount of **biodiversity** in an area. A **species** is a group of **organisms** that can breed together to produce healthy offspring. For example, human beings are a **species** and so are Emperor penguins, Gibbons and the Death Cap mushroom. Presently, around 1.75 million **species** of plants, animals and **fungi** are known to science but it is thought that there could be up to 100 million **species** and that we just haven't found them all yet!



A RED DEATH CAP MUSHROOM.
© Rosendahl

Forests are amazingly rich in **biodiversity**. An estimated two thirds of all land-based (**terrestrial**) **species** live in forests, or depend on them for their survival. However, not all forests contain the same amount of **biodiversity** or the same **species**. There are many types of forest **ecosystems** and each one of these is characterized by a variety of different **species**, with different **genes**, living under different environmental conditions and interacting with one another in different ways.

THINK ABOUT IT

What types of forests exist near your home?

Describe the **biodiversity** *living in these forests.*



IN FOCUS

To learn more about biodiversity, take a look at the ***Youth Guide to Biodiversity*** and the ***Biodiversity Challenge Badge***.



IN FOCUS

DEFINING 'BIODIVERSITY'

The Convention on Biological Diversity (CBD) is one of the key international organizations in charge of protecting, using and sharing **biodiversity**. After lots of debating over definitions, official government negotiators agreed upon these official definitions of **biodiversity** and **ecosystems**:

"'Biological diversity' (or '**biodiversity**') means the variability among living **organisms** from all sources including, among others, **terrestrial**, marine and other aquatic **ecosystems** and the **ecological** complexes of which they are part; this includes diversity within **species**, between **species** and of **ecosystems**."

"'**Ecosystem**' means a dynamic complex of plant, animal and **microorganism** communities and their non-living environment interacting as a functional unit."

(*Source:* CBD, Article 2)

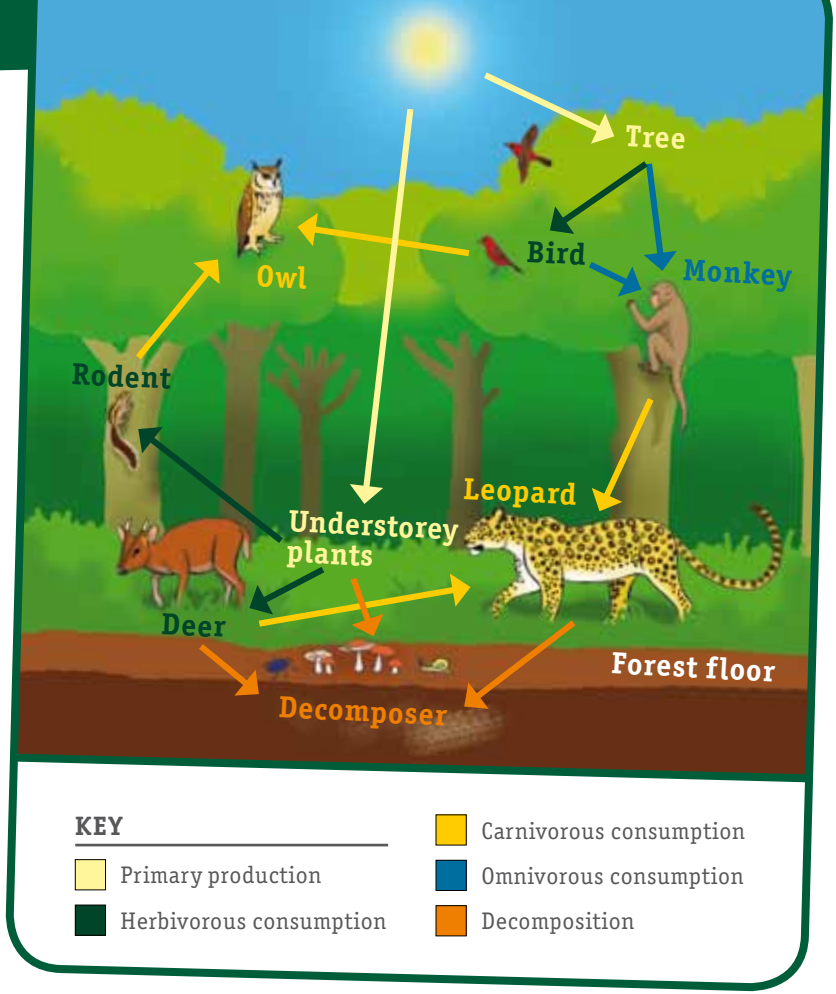
Convention on Biological Diversity

THE ENDANGERED ACADIAN FOREST OF EASTERN CANADA.



THE FOREST FOOD WEB

The amazing thing about all these species is that they couldn't live on their own. In each ecosystem, the species interact with each other and it is these different interactions that are what make each ecosystem unique. All the different species make up a food web, which starts with plants. Plants are known as 'producers' because they can make their own food through a process called photosynthesis (see p.14).



FOREST FOOD WEB.
© YUNGA, Emily Donegan

Along come the consumers who eat the plants – and each other. Consumers who eat plants are called 'herbivores'; consumers who eat animal meat are called 'carnivores'; and consumers who eat plants *and* animals are called 'omnivores'. There are also decomposers who eat the dead and decaying plants and animals and recycle all of the nutrients found in the dead matter they eat. Therefore, when we are looking at forest biodiversity, we need to always think about the links between the species and the whole forest food web.

THINK ABOUT IT

Where are you in the food web?

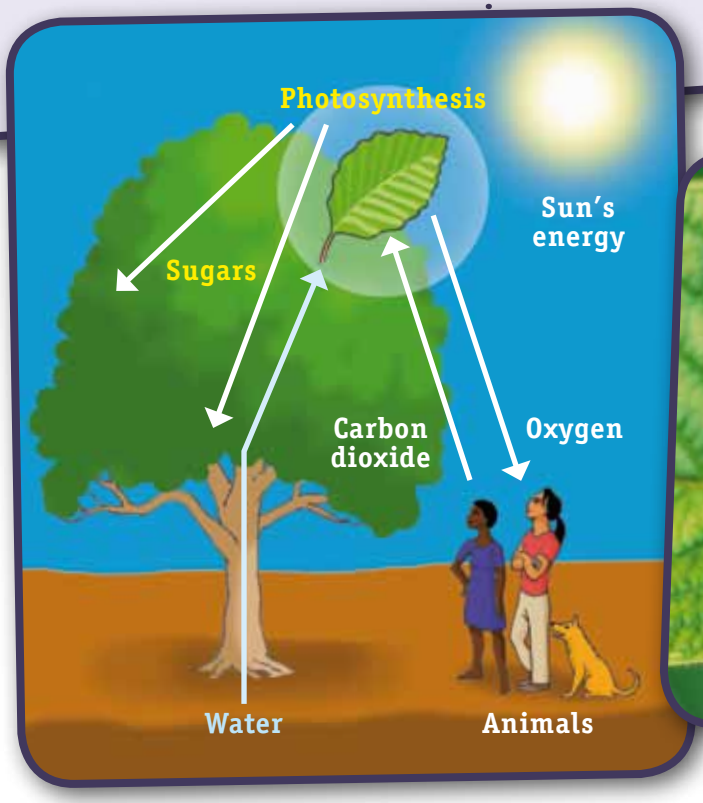
What other organisms make up your food web?

IN FOCUS

PHOTOSYNTHESIS

Here's how it works: plants are able to store energy from sunlight in little green **cells** called 'chloroplasts'. Using this energy from the Sun, they combine **carbon dioxide** from the air and water and nutrients from the soil into sugars off which they (and, as we've seen, others) can live.

This transformation also produces a very valuable 'waste' product: **oxygen**. This is because during **photosynthesis**, **carbon dioxide molecules** are broken down, so the plant can use the **carbon** to build up its **cells**. The **oxygen atoms** that are left over are simply released back into the **atmosphere** – for us to breathe.



© YUNGA, Emily Donegan



A PLANT PHOTOSYNTHESIZING IN YAUPI, ECUADOR.
© Geoff Gallice

CONCLUSION

In this chapter we learned how to define a 'forest' and a 'tree', and how to describe the four key forest layers. We also discovered many other definitions for terms such as species, ecosystem, biodiversity and food web – can you remember what they all mean? Forests are home to huge amounts of biodiversity, which vary significantly depending on where the forest is located and the type of climate. We will discover more about factors affecting forest types in Chapter 2 and also in Section B.



LEARN MORE:

:: All about trees: http://urbanext.illinois.edu/trees3/intro.html

:: Forest facts: www.ecokids.ca/pub/eco_info/topics/forests/what_is_a_forest.cfm

:: *Of Forests and Men* film: www.yannarthusbertrand.org/en/films-tv/forests-and-people

:: Play the Forest Academy game: www.theforestacademy.com/en

:: United Nations Forum on Forests: www.un.org/esa/forests

:: To learn more about biodiversity, take a look at YUNGA's ***Youth Guide to Biodiversity:*** www.fao.org/docrep/017/i3157e/i3157e00.htm and the ***Biodiversity Challenge Badge***: www.fao.org/docrep/014/i1885e/i1885e.pdf



CLASSIFYING FORESTS



FIND OUT HOW SCIENTISTS GROUP FORESTS!

2

In Chapter 1 we learnt that it is very difficult to find one single definition for forests. One of the reasons for this is that there are so many different types – there is so much diversity! That's why scientists classify forests in order to make it easier to distinguish between them. Forests are classified according to two factors:

- **The influence that human activities have on the forest.**
- **The type of forest. This is determined by the climate of the area.**

This chapter investigates how these two factors influence what a forest looks like, the type of things that live in the forest, and all the different processes that occur in it.

PRIMARY FOREST IN SIERRA NEVADA DE SANTA MARTA, COLOMBIA.
© Daisy Tarrier

HUMAN IMPACTS
ON FORESTS

Humans influence forests in many different ways. To explain how humans impact the world's forests, forests are classified into three broad categories:

Primary forests

Forests with native tree species. Evidence of human activities is not visible. The forest's ecological processes are not widely disturbed.



THE AMAZON INTERIOR. THE AMAZON BASIN HAS THE WORLD'S LARGEST PRIMARY FOREST.
© FAO/A. Brack



Other natural forests

Forests growing naturally (without human assistance) but where there are visible signs of human activities (e.g. occasional logging). These forests may include both **native** and introduced (or **exotic**) tree **species**.

A NATURAL PINE FOREST, TUNISIA.
© FAO/Guilio Napolitano



Planted forests/plantations

Forests that have been planted by humans (find out more about this on pp.73-74).

COCONUT PLANTATION, PHILIPPINES.
© FAO/Franco Mattioli

We will look more closely at these categories, and how humans impact forests, in **Section D**.

FOREST BIOMES

Although humans have a large impact on what forests look like, they are not the only thing influencing the differences among the world's forests. Have you noticed that the forests in your country may look very different from those you have seen in other countries or in the books you have read? If you visited five natural forests in Kazakhstan, Indonesia, Malawi, Peru and Canada, you'd see five vastly different types of forest. And in some countries, such as Qatar, there is no forest at all! Why is this?

These different types of forests exist because forests grow in different climatic conditions. Climate is the long-term average, or overall picture, of the everyday weather experienced in a location. The climate can be affected by a number of different factors, including latitude and altitude. In each different climate, there is a different temperature, amount of precipitation (water falling from the sky, such as rain, hail or snow), sunlight and wind. All these factors determine the plants and animals that live in the area and how they interact with one another.

Specific geographic areas are split into 'biomes', and each biome is a defined by the species living there. Therefore, the climate determines what kind of ecosystem exists in an area and the type of forest biome that we see there. Let's investigate these climatic factors and how each one affects forests.



IRON TREES GROWING IN THE TROPICAL AND SUBTROPICAL BIOMES OF UGANDA.
© FAO/Roberto Faidutti

LATITUDE

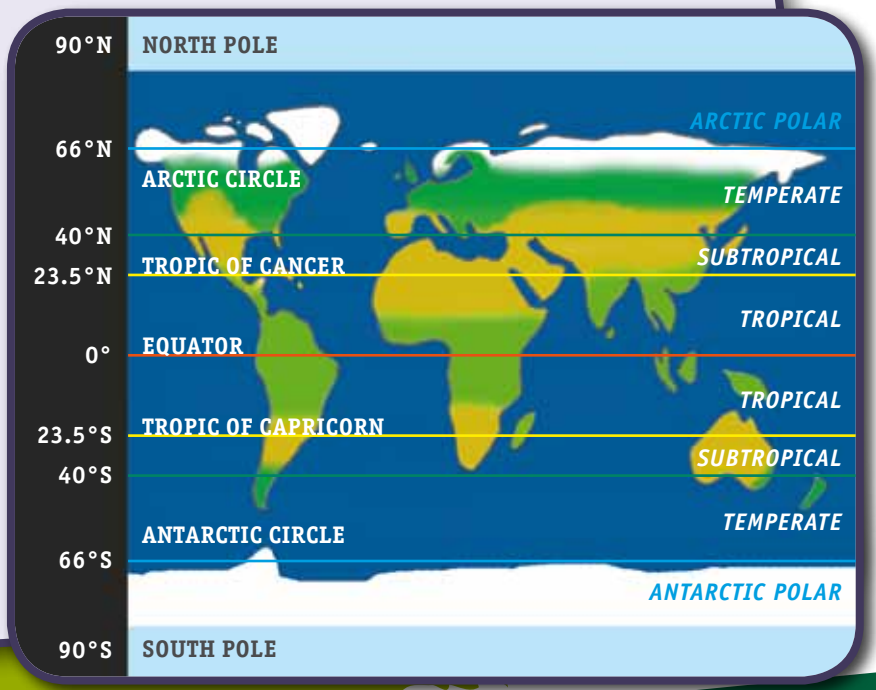
Latitude tells us where something is on the Earth in terms of north and south. It is measured in degrees, similar to how you would measure an angle around a circle with a protractor. If you are at a **latitude** of 0 degrees then you are at the **equator** and if you are at a **latitude** of 90 degrees then you are at the North or South Pole! **Latitude** affects the temperature of the **climate**. This is because there is a shorter distance between the Sun and the Earth's surface at lower **latitudes**, so these areas heat up easily. For example, at **latitudes** close to the **equator** the Earth is warm, while at the poles it is cold.

IN FOCUS

GEOGRAPHICAL ZONES

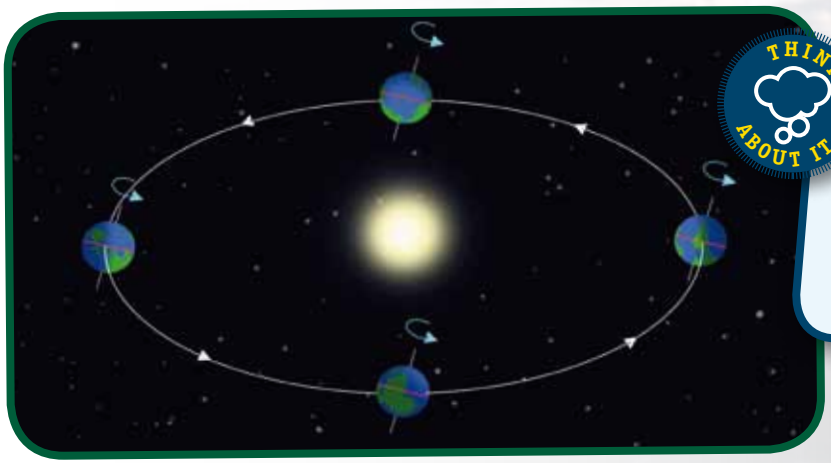
We define the geographical zones that occur across the world using **latitude**. Here are the different zones and where they occur:

- The Arctic Polar Region, north of the Arctic Circle.
- The Northern **Temperate** Zone, between the Arctic Circle and the Tropic of Cancer.
- The **Tropics** (or Torrid Zone), between the Tropic of Cancer and Tropic of Capricorn.
- The South **Temperate** Zone, between the Tropic of Capricorn and the Antarctic Circle.
- The Antarctic Polar Region, south of the Antarctic Circle.



EARTH'S KEY GEOGRAPHICAL ZONES AND THEIR LATITUDES.
© YUNGA, Emily Donegan

The **latitude** also determines the seasons that a place experiences. Seasons are the differences in climatic conditions in a place during the year. These changes occur because at high **latitudes** the distance from the Earth to the Sun differs throughout the year. However, at the **equator** there are very few seasonal changes because this part of the Earth's distance to the Sun always stays the same. The size of the seasonal changes determines how resistant plants and animals must be to differences in temperatures and rainfall. For example, the animals and plants living at very high **latitudes** in the Arctic have to be able to cope with 24 hours of daylight in the summer and 24 hours of darkness and freezing cold conditions in the winter.

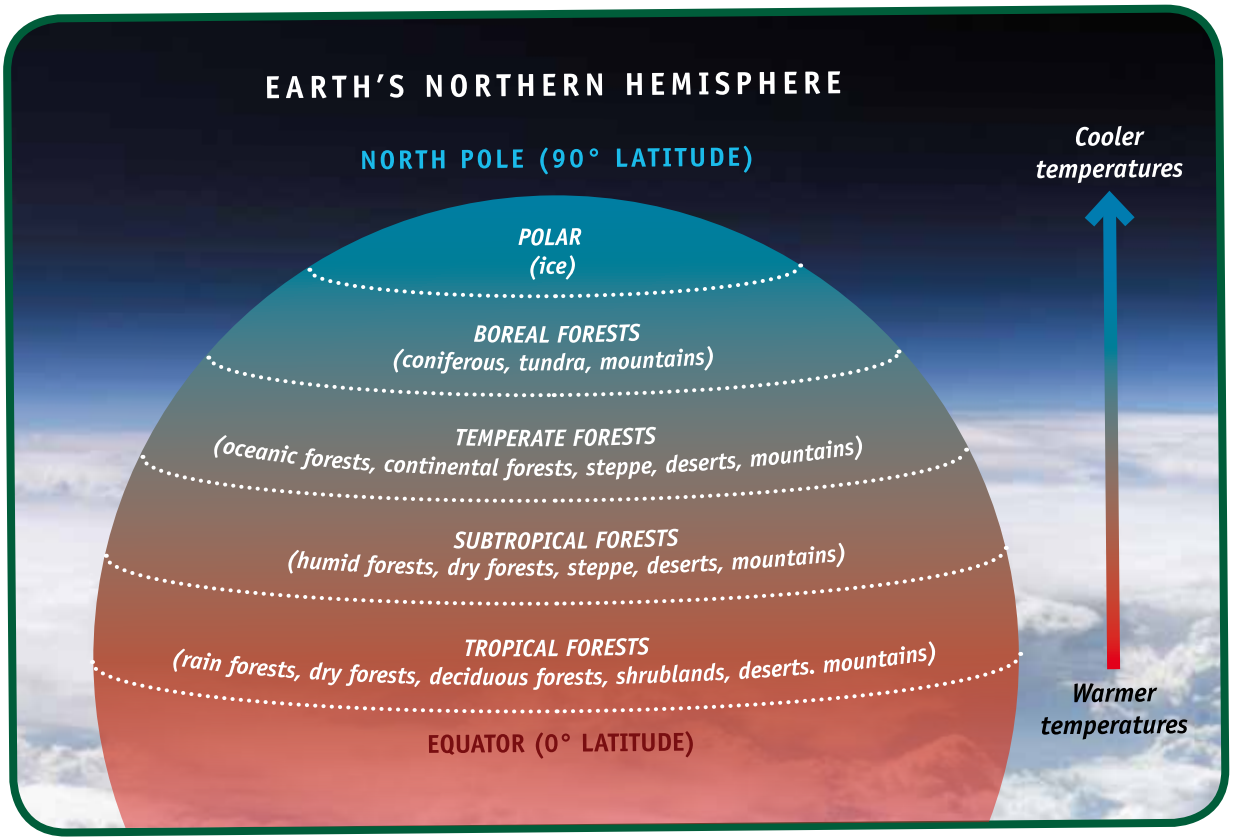


THINK ABOUT IT

How do you think the seasons affect how forests grow?

THE EARTH SPINS ON ITS AXIS AND REVOLVES AROUND THE SUN. BECAUSE OF THE MOVEMENT AROUND THE AXIS, THE SAME PART OF THE EARTH WILL BE CLOSER OR FURTHER AWAY FROM THE SUN THROUGHOUT THE YEAR. THIS IS WHAT CAUSES THE SEASONS.
© YUNGA, Emily Donegan

Because of the differences in temperature at different **latitudes**, you find different types of forest as you move away from the **equator** toward the poles. The diagram on p.23 shows the forests that are found at different **latitudes** in the Northern **hemisphere**.



FOREST TYPES FOUND AT DIFFERENT LATITUDES.
© YUNGA, adapted from The Natural Enquirer 2011

Forests close to the **equator** are generally **tropical**, while those in cold zones lying towards the North Pole are **boreal forests**, made up of **evergreen** **coniferous** (cone-bearing) trees. Between the **boreal forests** and the North Pole, where it is really cold, no forest occurs at all. Instead, stunted bushes, small hardy plants, lichens and mosses grow in an area called **tundra**. Between the cold poles and the hot **tropics** there are **temperate** zones that contain **deciduous** forests and **subtropical** mixed forests.

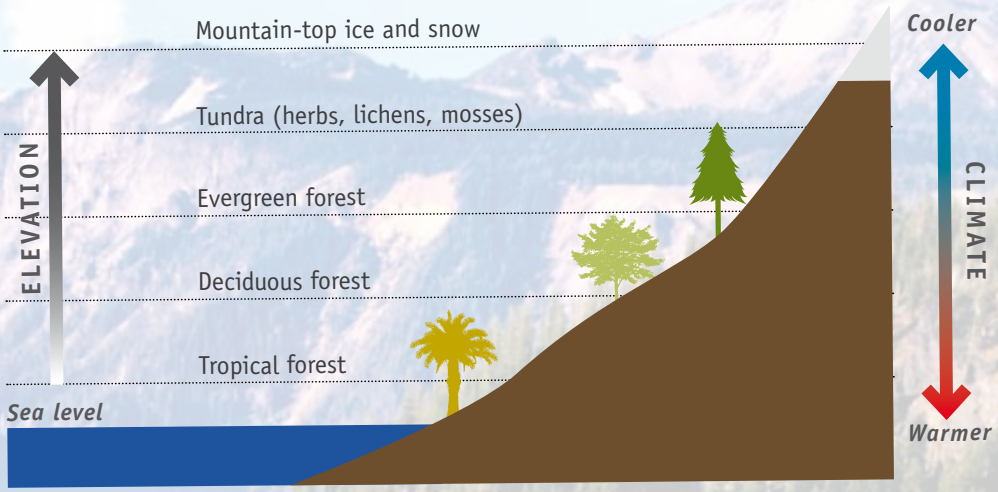
THINK ABOUT IT

Where would you expect to find forest types that prefer warm *temperatures?*

Where would you expect to find forest types that prefer cool *temperatures?*

ALTITUDE

The height of the land above sea level is called its **altitude**. At higher **altitudes** the **climate** is cooler than at lower **altitudes**. Therefore, when you climb a mountain, the temperature decreases. Because different plants and animals like different temperatures, the type of **ecosystem** that you find in a region varies according to **altitude**.



AT THE SAME LATITUDE, THE HIGHER THE ALTITUDE (ELEVATION), THE COOLER THE CLIMATE.

© YUNGA, adapted from The Natural Enquirer 2011

PRECIPITATION

Precipitation is water that falls from the **atmosphere** to the ground, such as rain, snow and hail. Across the Earth, different areas receive different amounts of **precipitation**. As we have seen, this is due to the **altitude** and **latitude** of the area, but also depends on how close the area is to the sea or large mountains.

All plants need water to survive, but plants in different regions have adapted over time to live with the varying amounts of **precipitation**, especially rainfall, that they get. For example, plants living in deserts do not need much water to survive and have adapted to conserve the small amounts of water available. Other plants, however, require a lot of water to survive, so the amount of **precipitation** determines which plants can live in an area and which forests you might find there. In general, drier areas have fewer plants and trees than wetter areas. Some desert areas have no plants or trees at all!





Above
MANGROVES GROWING IN THE SUNDARBANS, BANGLADESH. MANGROVES HAVE SPECIAL ADAPTATIONS TO ALLOW THEM TO PERMANENTLY LIVE IN WATER.
© FAO/G. Grepin

Below
ACACIA FOREST PLANTATION, SENEGAL. ACACIA TREES COPE WELL IN DRY CLIMATES BY STORING WATER BETWEEN THE BARK AND CENTRAL PART OF THE TREE.
© FAO/Selou Diallo

THINK ABOUT IT

In the polar regions there are extensive areas of ice (i.e. lots of solid water) but no forests.

Why do you think this is?

CLIMATE AND FORESTS

All the factors we've discussed (**latitude**, **altitude** and **precipitation**), interact to determine the average weather conditions (or **climate**) of an area. Therefore, forests may also differ from place to place because they grow in these different **climates**. In one part of the world, forests may be dry with little **vegetation**, for example, the forests of the Sahel zone south of the Sahara Desert in Africa. In another part of the world, forests may contain large trees that grow quickly because of high rainfall, such as the forests of the Amazon jungle.



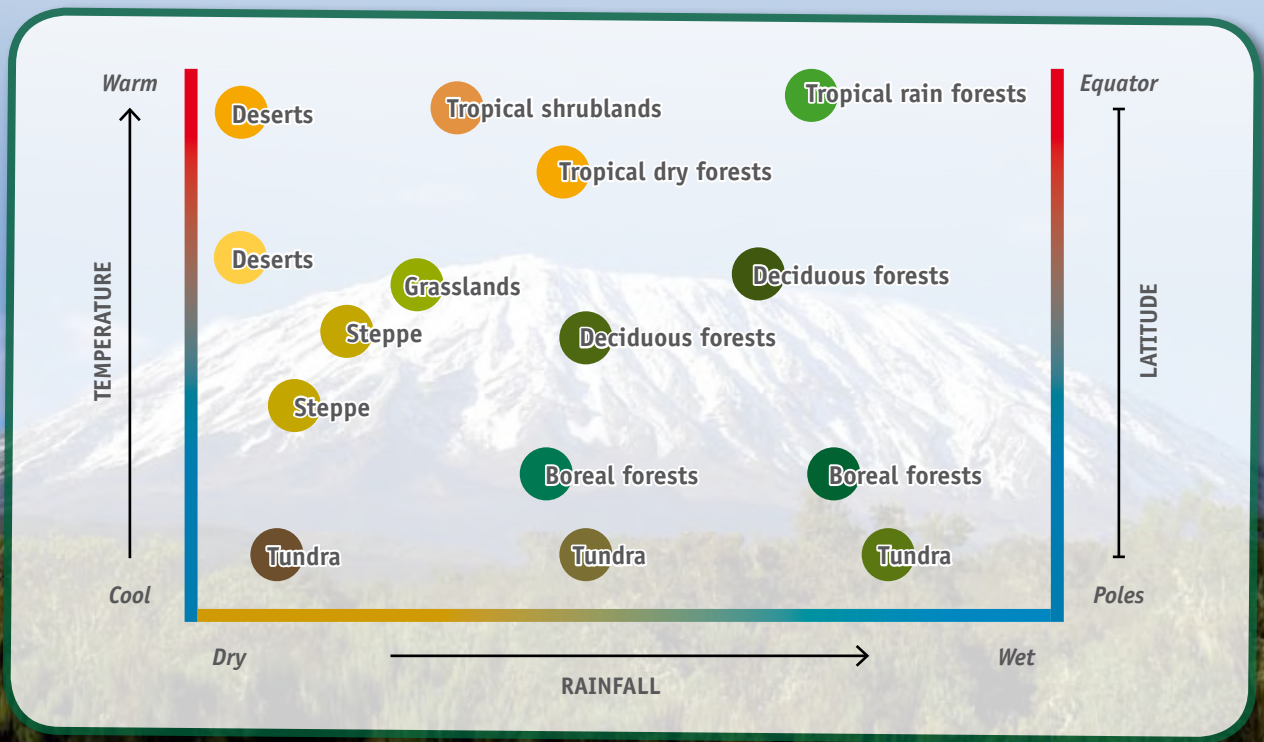


A BAOBAB TREE, *ADANSONIA DIGITATA*, IN THE SAHEL SUB-SAHARAN SAVANNA, AT MAHANGU NATIONAL PARK, NAMIBIA.
© Marco Schmidt

AMAZONIAN RAINFOREST, UPPER AMAZON BASIN, LORETO REGION, PERU.
© Shao

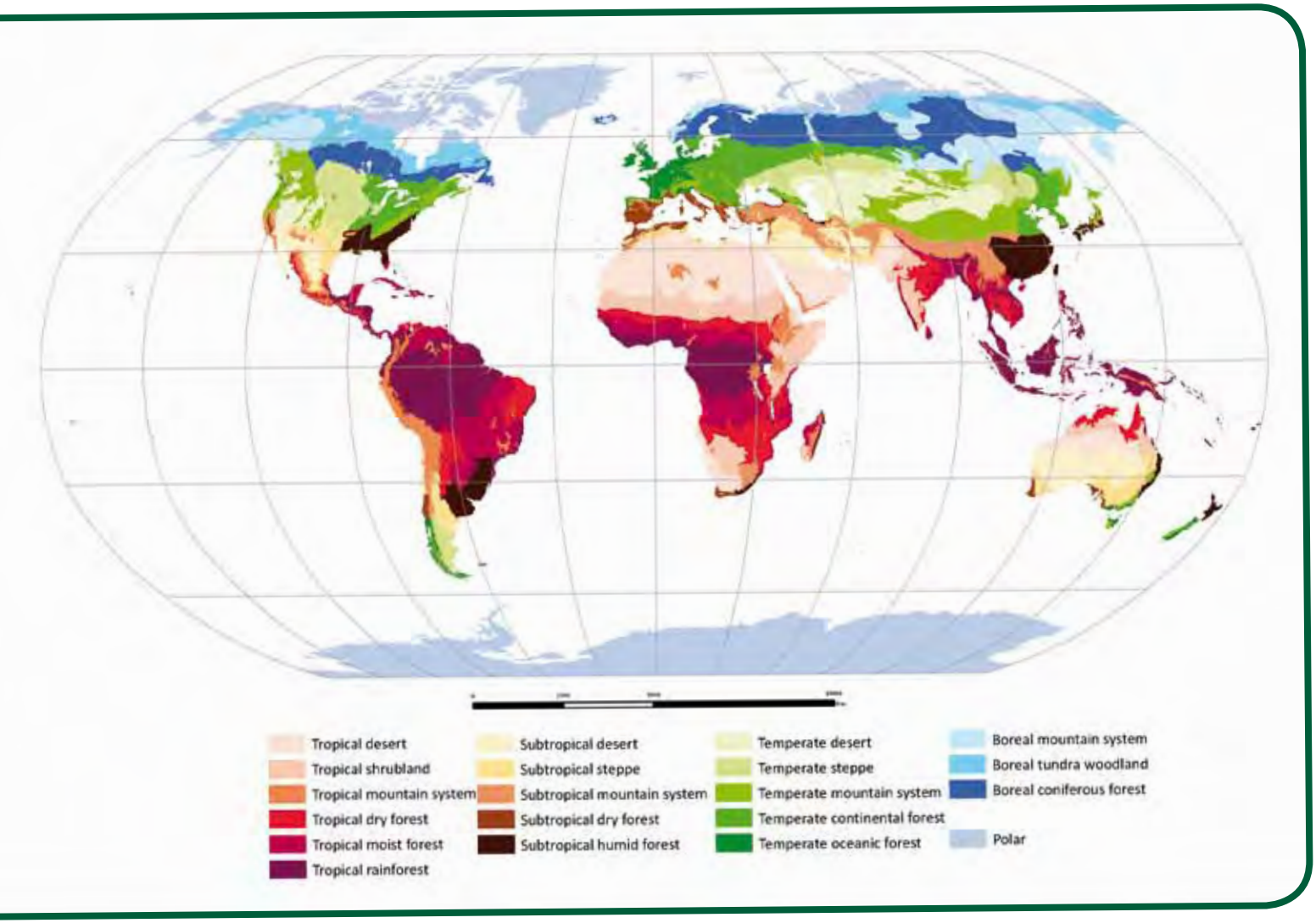
The combination of factors that determine the **climate** of an area can also result in some quite unexpected results. For instance, even places close to the **equator** can be cool at high **altitudes**. So, a mountain like Mt. Kilimanjaro, which lies only three degrees south of the **equator** in Tanzania but is 5 895 metres high, has snow and ice lying at the summit.

If you climb Mt. Kilimanjaro, you will notice many different forest types growing along the mountain's slopes, as well as tussock grasslands and plants adapted to living in mountainous conditions. You can find out more about mountain forests on pp.70-72. The diagram below shows the relationship between **vegetation** types, rainfall, temperature and **latitude** and illustrates how different combinations of factors can result in different **vegetation** types. For example, **tundra** is found in cool temperatures at the poles (at high **latitudes**) under a range of dry and wet rainfall conditions. In contrast, **tropical** shrublands are typically found near the **equator** where there are warm temperatures and moderate amounts of rainfall.



DIFFERENT TYPES OF FORESTS EXIST UNDER A RANGE OF CLIMATIC CONDITIONS THAT OCCUR AT DIFFERENT LATITUDES.
© YUNGA, adapted from the Natural Inquirer 2011

The map below shows where the different forest **biomes** that are determined by these different factors can actually be found on the Earth.



THE FAO GLOBAL ECOLOGICAL ZONES.
APPROXIMATE SCALE 1 : 150 000 000.
© FAO, 2010

CONCLUSION

It is quite amazing to discover how much weather and climate affect the type of forests found in an area, right? Climate, latitude and altitude all play a big part in determining what type of plants and animals will be able to live in an area. As we now know, these specialized geographical areas are known as biomes and vary significantly in different parts of the world. Turn to Section B to find out all about the different forest biomes and the amazing biodiversity that can be found within them!



LEARN MORE

:: FAO Forestry Department: www.fao.org/forestry/en

:: CBD – *Forest Biodiversity: Earth's Living Treasure*: www.cbd.int/idb/doc/2011/idb-2011-booklet-en.pdf

:: UNEP's forest pages: www.unep.org/forests/AboutForests/tabid/29845/Default.aspx

:: World forest biomes: www.worldbiomes.com/biomes_forest.htm

Section B



FORESTS AROUND THE WORLD



Chapter 03

MAJOR FOREST BIOMES



MAJOR FOREST BIOMES

DISCOVER THE MAJOR FOREST TYPES FOUND AROUND THE WORLD AND THE DIFFERENT SPECIES LIVING IN THEM.

3

What kinds of forests grow on the planet?
Where are they found?

Now that we know that climate determines which natural forests are found on Earth, let's take a closer look at some of the major forest biomes.

MOUNTAIN FOREST SLOPES OF MONTEVERDE, COAST RICA.
© Geoff Gallice

TROPICAL RAINFORESTS

Tropical rainforests are mainly found where the climate is hot and humid (wet) throughout the year. This is because they are located near the equator where there are very few seasonal changes. For example, there are major tropical rainforests in the Amazon Basin of South America, the Congo Basin of Central Africa and inland areas of Southeast Asia. We will look at each of these rainforests in this chapter.

Tropical rainforests are the world's most diverse terrestrial ecosystem with many rare, endemic and endangered plant and animal species. The vegetation is rich, with tall, closely set trees that often form a continuous, multi-layered canopy. The tallest trees in the emergent layer can reach a height of 50 to 60 metres! Trees in a rainforest are often so close together that only five percent of the light that hits the canopy manages to reach the forest floor. Tropical rainforests contain many useful resources such as timber, rattan (palms used to weave baskets and other furniture), fruits, nuts, medical plants and rubber. Such forests are also home to a large number of indigenous peoples.



TROPICAL FOREST IN DOMINICA.
© FAO/T. Frisk

IN FOCUS

ENDEMIC SPECIES

What does it mean when someone says that a **species** is '**endemic**' to a region? Well, an **endemic species** in a region (this could be an island, country or **habitat**) is a **species** that is only found there and nowhere else (unless it was transported somewhere else, such as to a zoo).

Islands tend to have lots of **endemic species**. Can you guess why? It's because it is difficult for **organisms** (or at least, the ones that can't fly or swim!) to travel across water from the mainland or from other islands. This means that the **organisms** on islands tend to be very isolated and often **evolve** differently from those on the mainland.

Rainforests also have very high levels of endemism. This makes them important places for **conservation** because if the **habitat** of **endemic** rainforest **species** is destroyed and the **species** dies out, then the **species** is lost for good! This is known as **extinction**.



TROPICAL FOREST TOWARDS CACAO IN FRENCH GUIANA.
© Cayambe

PLANTS OF THE TROPICAL RAINFOREST

Over half of the world's tree **species** can be found in the **tropical rainforests** – that's a lot of trees! Trees can grow fast in the rainforest because it is warm and wet; these are perfect conditions for plant growth. Because so little light reaches below the **canopy**, plants that live in the **understorey** must be able to cope with low light levels or be able to grow up to reach the light above. Let's have a look at some of the amazing plant **species** that live in the **tropical rainforest**.

The Kapok tree and epiphytes

The Kapok tree grows in rainforests around the world. This tree stands out (literally!) because it is so tall. It can grow as high as 60 metres tall and is part of the **emergent layer** of the forest because its crown sticks up above the rest of the forest **canopy**.



KAPOK TREE ON ISLA COLÓN, BOCAS DEL TORO, PANAMA.
© Geoff Gallice

The Kapok is particularly important for a group of plants called **epiphytes** (plants that grow and live on other plants rather than the ground). When **epiphytes** grow on the Kapok branches, they get much more light than they would on the **forest floor**. Without emergent trees like the Kapok, these plants would not survive. But, where are the **epiphytes**' roots, if they grow on branches? Well, these plants have aerial roots that absorb all the water and **nutrients** the plant needs to survive from the air, rain and nearby debris rather than the soil; so these plants are never actually attached to the ground!



EPIPHYTES GROWING ON A TREE IN THE FOREST CANOPY, MONTE VERDE, COSTA RICA.
© Geoff Gallice

DID YOU KNOW?

Epiphytes aren't only found in the **tropics**. You can also find these non-parasitic plants in **temperate** forests. Just look for mosses, lichens, liverworts and **algae** growing on trees. In the **tropics**, the most common types of **epiphytes** are orchids, ferns, cacti and bromeliads.

The meat-eating tropical pitcher plant

The 'tropical pitcher plant' or 'monkey cup', is found in **tropical rainforests** mostly in Southeast Asia. They live near the bottom of the forest in the **understorey**. These plants are not like normal plants that get all their energy from sunlight. Because they typically live in low light conditions, tropical pitcher plants also get energy from another source – animals! That's right, these plants are **carnivorous** and catch their prey in their pitcher-like trap filled with fluid. The animals fall into the pitcher and then can't get out again, drowning in the pitcher's fluid. The usual prey of pitcher plants is insects, but some plants have been known to catch larger prey such as rats and lizards!



A PITCHER PLANT IN SARAWAK, MALAYSIA.
© Richard Sinyem



A MARSUPIAL FROG (*GASTROTHECA RIOBAMBAE*) IN A BROMELIAD AT THE WATER MUSEUM 'YAKU', QUITO, ECUADOR.
© Patomena

Bromeliads

Bromeliads are a family of plants that contain 2 700 different **species**. Some bromeliads have stiff leaves that overlap one another; when it rains (which obviously happens a lot in the rainforest!) these plants catch the water and store it in between their leaves like little lakes. This causes **algae** to grow, which attracts mosquito larvae and other insects, which, in turn, attract larger animals like frogs. Therefore, these highly useful plants can form an **ecosystem** all to themselves and contain their very own **food web**. There is one very well known bromeliad that is eaten by humans – the pineapple!

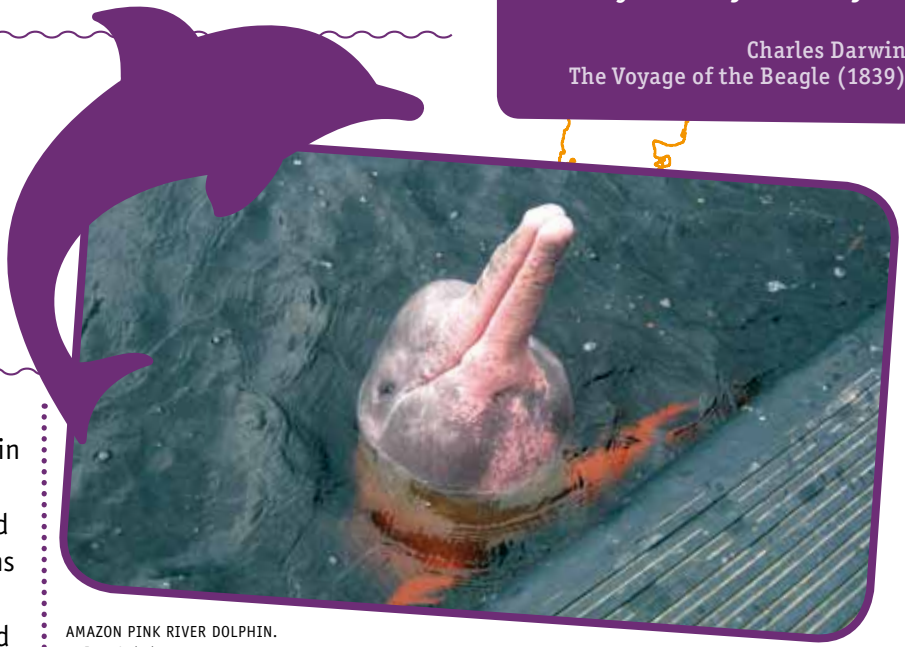
THE AMAZON RAINFOREST



The Amazon rainforest is the largest **tropical rainforest** in the world, stretching over 800 million hectares and spanning nine countries. The Amazon basin sustains the world's richest diversity of birds, freshwater fish and butterflies, and it is estimated that one quarter of all land-based (**terrestrial**) **species** can be found here. It is the **habitat** of rare **species** such as jaguars, harpy eagles and pink river dolphins.

"The land is one great wild, untidy, luxuriant hothouse, made by Nature for herself..."

Charles Darwin
The Voyage of the Beagle (1839)



AMAZON PINK RIVER DOLPHIN.
© Jorge Andrade

Amazon pink river dolphin

The Amazon pink river dolphin is the largest freshwater dolphin in the world. The females can grow up to 2.5 metres long and weigh 100 kilos! These dolphins hunt for fish in the flooded forest. To help them get around the flooded tree trunks they have an amazing **adaptation**; unlike other dolphins who cannot move their heads, these dolphins have special necks that allow them to turn their heads 180 degrees!

In the Amazon basin, the pink river dolphin is also known as the Boto. In traditional folklore, it is thought that Botos have special powers – they are known as shapeshifters that turn into humans at night! Unfortunately, the Boto is under threat because of river pollution and because they get tangled in fishing nets.

Parrots

The parrots of the Amazon are a good example of how **species** are specifically adapted to their forest **habitat**. Parrots usually eat fruit from the rainforest plants – but they also eat dirt! This practice is called 'clay lick'. Now, dirt can't be very tasty, so what could be the reason for this strange habit? Well, these birds don't get all the **nutrients** they need from their staple diet of fruit; specifically, they don't get enough of a mineral called sodium that we find in salt. The clay they eat contains this important mineral, which is why the birds collect in large numbers in order to feast on clay. Without the presence of sodium in the soil, these birds would not be able to survive.



MANY PARROTS AT A CLAY LICK IN ANANGU, YASUNI NATIONAL PARK, ECUADOR. SPECIES SEEN ARE BLUE-HEADED PIONUS (*PIONUS MENSTRUUS*), DUSKY-HEADED PARAKEET (*ARATINGA WEDDELLII*), MEALY AMAZON (*AMAZONA FARINOSA FARINOSA*) AND YELLOW-CROWNED AMAZON (*AMAZONA OCHROCEPHALA*).
© Geoff Gallice

CONGO BASIN

At the heart of the African continent, the **tropical forests** of the Congo basin cover an area of more than 400 million hectares, and provide a mosaic of **ecosystems** – rivers, forests, swamps and flooded forests – which teem with life. It contains more than 600 tree **species** and 10 000 animal **species**! The Congo basin forests provide sanctuary for forest elephants, gorillas and other wildlife living under towering **canopies** of ancient trees.

The Congo rainforest is home to many 'charismatic **species**' – these are animal **species** that are popular among human beings; think of them as animal movie stars! Because lots of people know about these **species**, they can be used to raise awareness about the rainforest as a whole.



Cross River gorilla

The Cross River gorilla (*Gorilla gorilla diehli*), found in the Congo basin rainforests on the border between Nigeria and Cameroon, is one of the most **endangered** primates in the world, with only around 300 individuals surviving in the wild.



CROSS RIVER GORILLA, CAMEROON.
© Julie Langford and the Limbe Wildlife Centre

Forest elephant



These elephants live deep in the rainforest of the Congo basin, usually on their own or in small groups. Even though they live separately, these elephants can communicate miles across the forest using their low frequency rumblings, some of which are so low they can't even be heard by humans. Elephants carry out a very important activity for the plants of the forest: they eat large seeds that other animals can't eat, and then when they do their business they spread the seeds to other areas! This allows plants to spread across the forest. However, these elephants are threatened by poaching because the ivory from their tusks is worth a lot of money.

AFRICAN FOREST ELEPHANTS IN THE MBELI RIVER, NOUABALÉ-NDOKI NATIONAL PARK, CONGO.
© Thomas Breuer



Bonobo

The Bonobo, along with the common chimpanzee, is the closest living relative to humans. It lives in the rainforests of the Democratic Republic of Congo, south of the Congo River. Bonobos are very social animals and live in quite large groups. Some people even think that Bonobos share many human emotions, such as joy, empathy and compassion for others.

FEMALE BONOBO AT LA VALLÉE DE SINGES PRIMATE PARK IN FRANCE.
© Hans Hillewaert

SOUTHEAST ASIAN RAINFOREST



The islands of Borneo and Sumatra are home to some of the world's most diverse rainforests and Southeast Asia's last large-scale **primary forests**. The islands' **tropical climate** and diverse **ecosystems** have created **habitats** for a vast array of life. The forests of Borneo and Sumatra are some of the most biologically diverse **habitats** on Earth, possessing staggeringly high numbers of unique plant and animal **species** that live nowhere else. The forests of Borneo are home to more than 200 **species** of mammals, including elephants, orangutans, leopards and rhinoceros, more than 350 bird **species**, 150 reptile and amphibian **species**, and an astonishing 10 000 plant **species**! That's a whopping 10 700 **species**, and this number doesn't even include all the **species** of insects, **microorganisms** and **fungi** in the forests!



ORANGUTAN.
© Julie Langford

Orangutan

Native to Indonesia and Malaysia, orangutans are currently found only in rainforests on the islands of Borneo and Sumatra. The word 'orangutan' comes from the Malay words 'orang' (man) and '(h)utan' (forest); therefore, the orangutan is known as the 'man of the forest'. There are two **species** of orangutan that live on the two different islands. Both **species** are threatened by **extinction** because people are destroying the rainforest in which they live. According to the **IUCN Red List** (which **classifies** how threatened a **species** is), the Sumatran orangutan is critically **endangered** and the Bornean orangutan is **endangered**.



Sunda clouded leopard

The Sunda clouded leopard is the largest cat in Borneo and Sumatra. This leopard is 'arboreal', which means that it lives in the trees. The widespread human destruction of the rainforests has lead to this beautiful cat being **classified** as vulnerable to **extinction** on the **IUCN Red List**.

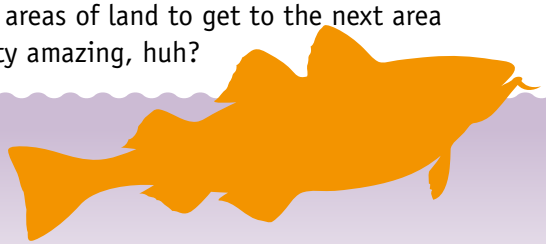
A SUNDA CLOUD LEOPARD (*NEOFELIS DIARDI*) SITS BETWEEN LEAVES AND FERNS IN KALIMANTAN, INDONESIA.
© Spencer Wright



A WALKING CATFISH (*CLARIUS BATRACHUS*) IN CAPTIVITY.
© ШаШатилло Г.В.

The Walking Catfish

Have you ever seen a walking fish? Although it sounds like something out of a fairytale, the walking catfish (*Clarius batrachus*) actually exists in the rainforests of Southeast Asia! This incredible fish uses its front fins (or pectoral fins) to help it wriggle along the ground like a snake. But why does it do this? Well, the fish leaves the water to find food and other bodies of water in which to live. It usually lives in stagnant water, like ponds, rice paddies and small streams; so sometimes it has to cross small areas of land to get to the next area of water. Pretty amazing, huh?



TROPICAL DRY FORESTS

Tropical dry forests and woodlands occur in tropical regions where there are pronounced dry seasons. These forests are most extensive in eastern and southern Africa, where woodlands stretch over large areas. However, tropical dry forests are also found in India, parts of China and parts of South America. The vegetation is relatively open and is typically made up of deciduous trees 10 to 20 metres tall with a grass understorey. Due to frequent fires and tree felling, many of these woodlands have been converted into savannah, where grasses and shrubs dominate. In Africa, in particular, woodlands and savannah are major habitats for wildlife and also provide local people with valuable products and services, such as fuelwood, honey, timber, bushmeat, medicines and grazing for animals.



MOUNT ETNA, AUSTRALIA.
© Mark Marathon

IN FOCUS

SUBTROPICAL DRY FORESTS

Subtropical dry forests occur in areas outside of the strict **equatorial** region but they may border the **tropical** zone. Because they are further from the **equator**, these areas have noticeable seasonal changes. Although temperatures may vary only slightly over a year, rainfall may be distributed unevenly so that wet and dry **seasons** occur. **Subtropical** dry forest is the natural **vegetation** of the Mediterranean **climate** type where there are mild, humid (wet) winters and dry summers. The tree **species** living here typically have small, leathery **evergreen** leaves, and the **vegetation** ranges from tall, open forest to sparse woodland and shrubs. However, much of the historical Mediterranean forest has been cleared and is now dominated by shrubs. Additionally, many Australian eucalypt tracts and parts of Chile have been converted to **plantations** (**planted forests**) – you can find out more about **planted forests** on pp.73-74. The Cape Region of South Africa harbours particularly rich plant life, including many **endemic species**. Important **non-wood forest products** that come from these forests include cork, honey and olives.



A SUBTROPICAL FOREST.
© Geoff Gallice

PLANTS OF THE TROPICAL DRY FOREST

Acacias

Acacias are an important tree in the tropical dry forest **biome**. They are found in both Africa and the Americas. Acacias have long, sharp thorns that deter many **herbivores** (but not giraffes!) from eating their leaves. The plants have another form of defence if the thorns aren't enough – the hollow thorns are also home to colonies of ants that will attack anything that comes near the plant. This relationship is called **symbiosis** because both the ants and the acacia benefit – the plant gains a defence and the ants gain food (they eat the rich nectar produced by the acacia).



ACACIA SENEGAL IN NIGER.
© FAO/Pietro Cenini

CULTURAL STORY

THE BAOBAB TREE

A very long time ago, the first baobab tree sprouted beside a small lake. As it grew taller, it gazed across the lake. The baobab saw many other types of trees – it was amazed by the colourful flowers of the flame tree, the slender and graceful trunks of the palm tree, and the bountiful fruits and large leaves of the magnificent fig tree.

Then one day the wind was quiet, leaving the water on the lake as smooth as a mirror, finally allowing the tree to see itself. The reflected image shocked the baobab so much that it shivered all the way down to its root hairs! Its own flowers were dull, its leaves were tiny, and its trunk and limbs were very, very fat. The baobab complained loudly to the creators of the Earth about the bad deal it had been given. The gods ignored the baobab's whining. Each day, the tree grew more and more jealous of the beauty of all the other trees. Consumed by jealousy, the baobab started to destroy the other trees. This behaviour angered the gods, so they uprooted the baobab and replanted it upside down so that it would stay quiet!

Since that day, the baobab has lived in this upside down position. It continues to pay for its ancient transgression by doing good deeds for people.

African legend



THE BAOBAB (*ADANSONIA DIGITATA*), ONE OF AFRICA'S ANCIENT TREES, IS OFTEN CALLED THE 'UPSIDE DOWN TREE' DUE TO ITS UNIQUE SHAPE. THE BAOBAB OF THE AFRICAN LEGEND DIDN'T REALIZE THE IMPORTANCE OF ITS PECULIAR SHAPE TO LIVE IN THOSE ENVIRONMENTS. WHAT MIGHT BE ONE ADVANTAGE OF THE BAOBAB'S UNUSUAL SHAPE?
© Frank Vassen

IN FOCUS

ADAPTATIONS TO THE DRY SEASON

Plants that live in tropical dry forests must be able to survive very long and intense dry seasons. Therefore, they need to have special **adaptations**. Let's take a look at some:

:: **Deciduousness** – most plants lose their leaves in the dry season. This is so that they do not lose water through **photosynthesis**.

:: **Nyctinasty** – this fantastic-sounding adaptation is the process by which plants close up their leaves at night (when they can't **photosynthesize** anyway) to reduce the surface of the leaf that is exposed to the air. Leaves lose water through little holes on their underside called stomata in a process called **transpiration**. By rolling them up, this water loss can be reduced.

:: **Water storage** – some plants store water during the wet season in swollen roots or stems for use during the long dry season.

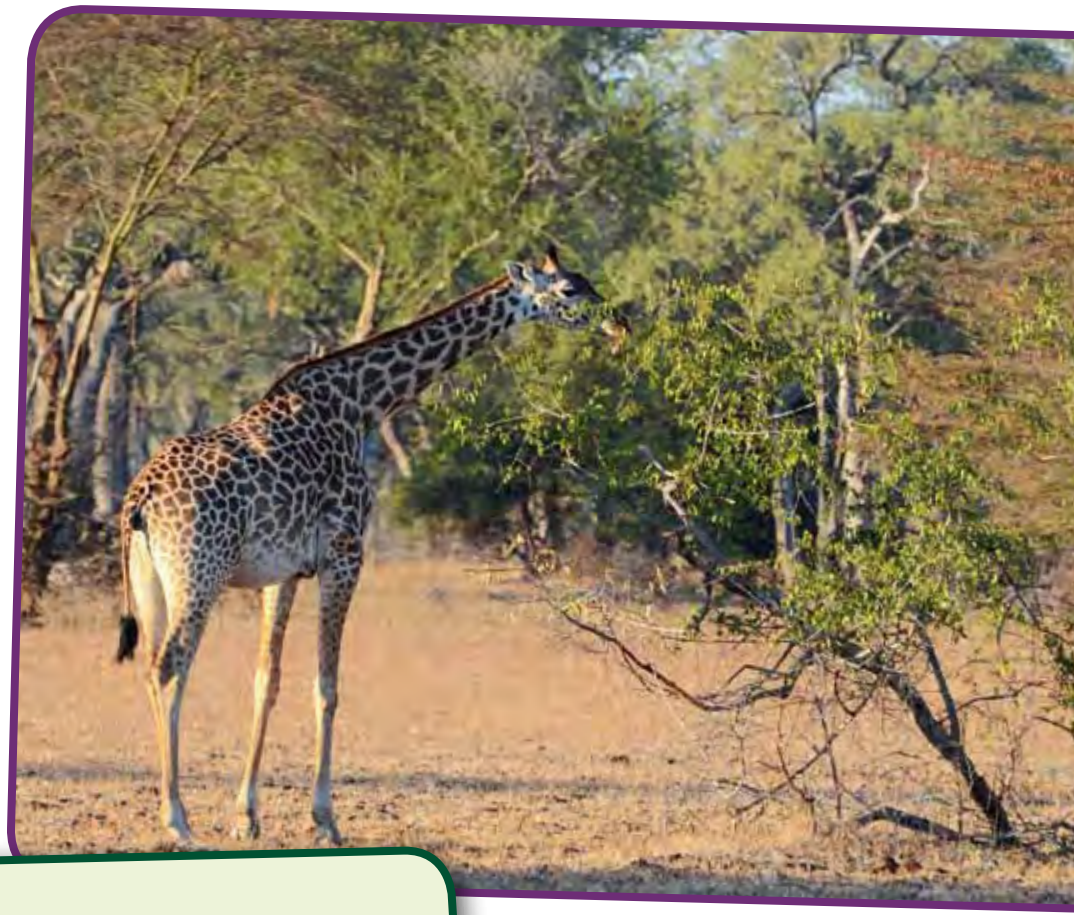
:: **Waxy leaves** – many plants have a thick waxy layer on their leaves so that water cannot escape. Imagine trying to pour water through a piece of cling film and you get the idea!

:: **Green trunks** – when plants drop their leaves and stop **photosynthesizing**, they don't produce the food they need to grow. This means that many plants can't grow during the dry season. However, some plants have green trunks that can **photosynthesize** so they can grow even after they have lost their leaves.

ANIMALS OF THE TROPICAL DRY FOREST

Giraffes

Giraffes are the world's tallest mammals and can grow up to 5.5 metres tall. They mostly feed on the buds of acacias and aren't even put off by their sharp spines. The giraffe uses its long neck and huge tongue to reach the juiciest branches at the top of the tree. Giraffes also have special **adaptations** to deal with dry environments. For example, they don't need to drink very often (only once every few days) because they get most of the water they require from the **vegetation** they eat.



GIRAFFE FEEDING ON SOME LEAVES, ZAMBIA.
© Geoff Gallice

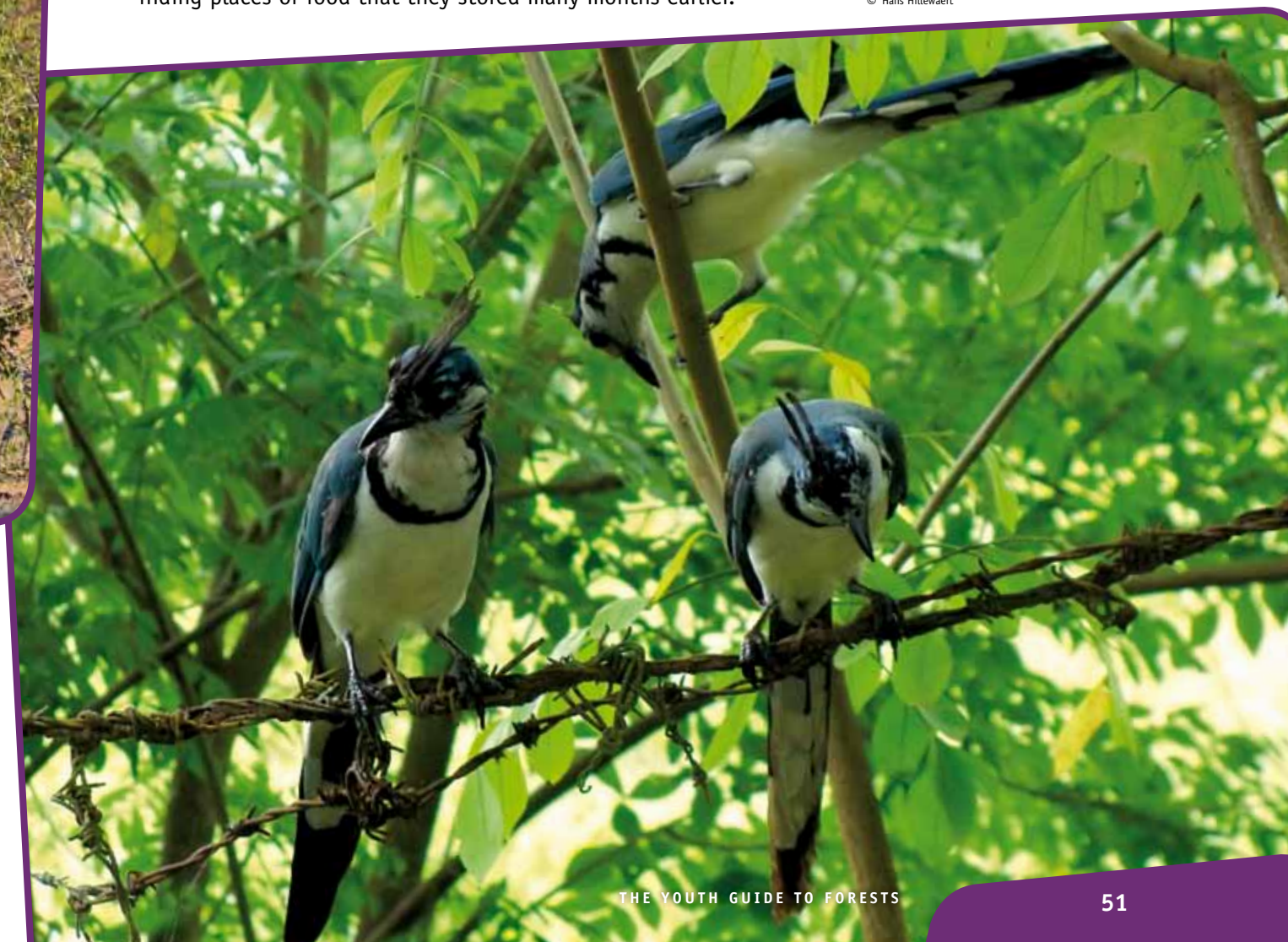
DID YOU KNOW?

In Latin, the giraffe is called *Giraffa camelopardalis* because, when it was discovered by the Greeks and the Romans, they thought it looked like a cross between a camel and a leopard. The lump on its back reminded them of a camel and the pattern on its fur reminded them of a leopard!

Magpie-jays

Tropical dry forests have two very different seasons – the wet season and the dry season. In the wet season there is lots of food but in the dry season there may not be enough food for animals to survive. As a solution to the seasonal food shortage problem, magpie-jays store food that they find in the wet season to eat later in the dry season when there is less food available. But how do they find the food again? Well, these jays have an amazing memory! They remember the hiding places of food that they stored many months earlier.





WHITE-THROATED MAGPIE-JAYS AT CABUYA ON THE NICOYA PENINSULA, COSTA RICA.
© Hans Hillewaert

TEMPERATE FORESTS

Temperate forests grow between the tropics and the polar regions in both the northern and southern hemispheres. With four distinct seasons and a well-defined winter, the climate is moderate. Temperate forests include a mix of trees that belong to three main groups:

:: Deciduous trees that lose their leaves in autumn (such as maples, oaks and beech);

:: Coniferous trees that have seeds that develop in cones and have needles for leaves, also called evergreen because they are green all the time (such as pines, firs and cedars); and

:: Broad-leaved evergreens (such as olive, holly and eucalyptus trees) that have flat leathery leaves that are not shed in winter.



A TEMPERATE FOREST, RUSSIA.
© FAO/Vasily Maksimov

TREES OF THE TEMPERATE FORESTS

Shagbark hickory

The shagbark hickory tree is a tall tree that can grow up to 30 metres high. Its strange name is inspired by its bark, which peels off in long strips and gives the trees a 'shaggy' appearance. The shagbark hickory is a **deciduous** tree that loses its leaves in winter. The picture on the right shows what the trees look like in the winter months, without any leaves.



SHAGBARK HICKORY (*CARYA OVATA*) IN NEW JERSEY, USA.
© John B

Walnut tree

Walnut trees grow in **temperate** forests across the world. They are well-known because they produce the delicious walnuts that humans eat. The wood from walnut trees is also used to make furniture. A typical walnut tree can grow up to 20 metres tall.



WALNUTS ON THE TREE.
© Thesupermat

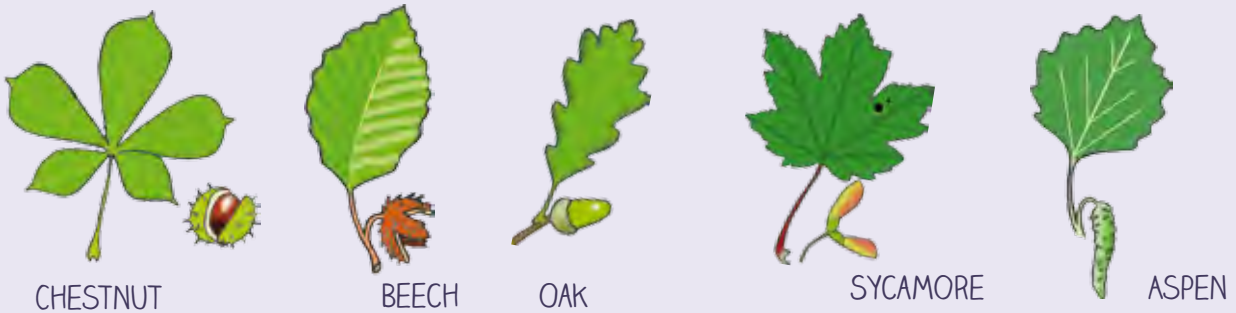
DID YOU KNOW?

In 2010, 2.55 million tonnes of walnuts were produced worldwide for human consumption. That's a lot of nuts!

IN FOCUS

KNOW YOUR TREES!

Have you ever seen a leaf and wondered which tree it belongs to? Now's your chance to learn about the leaves and fruits (or seeds) of some classic **temperate** forests tree **species**!



© YUNGA, Emily Donegan

BIODIVERSITY OF THE TEMPERATE FORESTS

Temperate forests are often made up of broadleaved tree **species** such as oak, maple, beech, and elm. Many well-known animals also live in this kind of forest, such as foxes, deer and boars, as well as large birds of prey such as red-tailed hawks. These animals have unique **adaptations** suited for seasonal life. For example, deer store up fat in spring and summer, which they burn later during the colder winter months when there is little food available. Plants also adapt, for example, **deciduous** trees lose their leaves in autumn, and remain leafless until the next spring. Without leaves, trees cannot **transpire** (as we have seen in the case of leaf-rolling nyctinasty in **tropical** dry forests on p.49), allowing them to retain water during winter.



The oak tree and the gall wasp

Some **deciduous** trees, such as the large oak tree, have an interesting relationship with tiny insects that we can barely see. The gall wasp, for instance, lays its eggs in oak tree flowers. This isn't good for the oak tree because it triggers a change in the growing oak bud – instead of growing into an acorn the bud grows into a gall and the larva inside it feeds on the oak's wood! The galls are shed in autumn, and the next spring, an adult gall wasp emerges from the gall that has been dormant on the ground for the whole winter. The cycle then starts again. Without the oak tree, the gall wasp would not be able to survive.



AN OLD OAK TREE IN HERTFORDSHIRE, ENGLAND.
© Anemone Projectors.





Red deer

Red deer are one of the largest **species** of the deer family. In the breeding season, the male deer (called stags) have harems of female deer (called hinds) that they protect. The stags fight one another and the winner controls the hinds. However, fighting is very dangerous and can cause injury or death. So, stags have a clever way of checking out their competitors before a battle and deciding whether or not they can win: they roar. The stag with the loudest roar is usually the strongest and most likely to win in a fight. These roars are very loud; the sound travels long distances through forests and woodlands.

A RED DEER IN RICHMOND PARK, LONDON, ENGLAND.
© Smudge 9000.



THE TAWNY MILKCAP MUSHROOM.
© Amadej Trnkoczy

Tawny milkcap mushroom

The tawny milkcap mushroom, or Chichitake mushroom as it is known in Japan, is an edible mushroom that is found in North America, Europe and Asia. In Asia, it is one of the most popular mushrooms used in casseroles and sauces. Mushrooms are neither plants nor animals – they are **fungi**. **Fungi** produce food by decomposing (breaking down) other living matter, like dead plants and animals. They are very important parts of any **food web** because they prevent waste matter from building up on the **forest floor**. They very happily live on the dark, damp **forest floor** because they do not need light to grow.

IN FOCUS

A SYRUPY SWEET FOREST

Long ago, the **indigenous peoples** of north-eastern North America discovered a way to produce very sweet and sticky treats from tree sap of the **temperate** forests. In late winter and early spring, when the night temperatures drop below freezing and the day temperatures rise above freezing, the **indigenous peoples** would collect sap from maple trees. By concentrating the sugars, they produced maple syrup and maple butter.

Making maple products is still important to the people living in this part of the world. Many will celebrate the 'sugaring off' period when the sap is running. People celebrate the end of a long cold winter at a 'sugar shack' with lots of traditional dancing and music, and a feast of pancakes, baked beans and sausages drenched in maple syrup.



MAPLE SYRUP FROM QUEBEC, CANADA.
© Miguel Andrade



MAPLE TREES IN QUEBEC, CANADA DURING THE 'SUGARING OFF' PERIOD.
© Christine Gibb

BOREAL CONIFEROUS FORESTS

The boreal forest is named after Boreas, the Greek god of the cold north wind and the bringer of winter. This is because boreal coniferous forests are found at high latitudes, only in the northern hemisphere, where the climate is cold. The boreal forest is the world's largest terrestrial ecosystem and covers parts of Alaska, Canada, Scandinavia, Russia, Kazakhstan, Mongolia, and Japan. These forests are the world's major source of commercial softwood. Spruce and fir trees dominate the forests of North America, northern Europe and western Siberia, while larch trees are common in the forests of central and eastern Siberia. The forest canopy cover is often low, with an understorey of shrubs, bushy vegetation, mosses or lichens. In these forests, biodiversity is low (there are only a few species) but those species that are found there are not found anywhere else (i.e. the level of endemism is high). Wetlands in these forests fill an important ecological function as they are the breeding habitat for many species of waterfowl (swimming birds, such as duck and geese) and shorebirds.

DID YOU KNOW?

Taiga is the Russian word for forest, and is another name for boreal forests. This is because the Siberian taiga constitutes the Earth's largest continuous forest – it makes up nearly one third of the Earth's total forest area! (In case you didn't know, Siberia is a vast, northern part of Russia.) Life in the taiga is tough, the average temperature is below 0°C for six months of the year and winter temperatures can fall as low as -54°C! Brrrr, that's chilly!

A TAIGA LANDSCAPE, SIBERIA.
© Svetlana Ivanova

PLANTS OF THE BOREAL FOREST

Larch

The Siberian larch is the most cold-hardy tree in the world. It can tolerate temperatures down to minus 70 °C (-94 °F), which is necessary, given that it grows on the permafrost in Siberia! (Permafrost refers to soil that is below freezing all year round.) The larch is one of the most widespread gymnosperms **species** (plants with uncovered seeds) in the world – growing the furthest north of any tree. Like other conifers it has a conical shape so that the snow that lands on the tree slides off rather than building up on its branches. That's important, because the weight of snow building up would break its branches.



LARCH TREES IN THE ALTANSUMBER FOREST, MONGOLIA.
© FAO/Sean Gallagher



SPRUCE TREE.
© Jarek Tuszynski

Spruce

There are 35 known **species** of spruce tree that mostly live in **boreal forests**. They are large **evergreen** trees that can reach heights of between 20 to 60 metres.

DID YOU KNOW?

The oldest known living tree is thought to be a spruce tree is growing in Sweden. It is 9 550 years old! Isn't that incredible?



Fir

Firs are **evergreen** **coniferous** trees that live in the **boreal forest**. There are about 50 **species** of fir, some of which are very popular as Christmas trees. The different **species** vary in height from 10 metres to 80 metres when fully grown.

A LARGE FIR TREE AT PITMEDDEN GARDEN, SCOTLAND.
© Bill Harrison

IN FOCUS

HOW TO TELL THE DIFFERENCE BETWEEN A SPRUCE AND A FIR

Spruce and fir grow in similar places and they are both **evergreen** **coniferous** trees, so telling them apart can be a bit tricky. Here are three clues that should help you crack the case:

1. **Needles** – the needles of the spruce tree are hard and square and so can be rolled between your fingers. The needles of the fir, however, are flat and soft and so less easily rolled. Some scientists use the saying "firs are friendly" to help identify conifers - this is because firs generally have rounded needles, so they don't 'poke' when you touch them!
2. **Branches** – the branches of the spruce tree are rough after the needles drop off, those of the fir tree are smooth.
3. **Cones** – the cones of the spruce tree are much more flexible than those of fir trees because the scales are much thinner. Fir cones usually stick up from the branches very stiffly.

Sarracenia

Due to the cold weather and the acidic needles shed by coniferous trees, the soils of the boreal forest are thin and lack nutrients compared with those of the temperate forests further south. So some crafty little plants have found a way to get nutrients from other sources instead. These plants are called Sarracenia, and they are carnivorous! During the short summer, there are lots of insects in the boreal forest. Many migratory bird species drop in to eat them – it is estimated that over 60 percent of the USA and Canada's birds nest in the boreal forest during the summer. Like the birds, the Sarracenia enjoy insect feasts all summer long. These plants lure insects into their trumpet-shaped flowers using attractive colours and scents. Once inside, the insects lose their footing on the slippery, waxy sides. The nectar of some species contains a drug, making the insects even less likely to keep their balance (how sly!). Once the insect has fallen in, downward pointing hairs prevent it from climbing back out, so the insect will slowly be digested by the plant in a sort of insect soup. Yum!



LICHENS.
© Geoff Gallice

Algae, fungi – and caribou

Lichens are composite organisms made up of a fungus and a photosynthetic partner (usually algae) that partner together to have a symbiosis. In a symbiotic relationship both organisms benefit, and couldn't survive without the other. This is what lichens do: the fungus provides a home, water and minerals for the algae, and the algae provides sugars that it makes from solar energy for the fungus in exchange. This successful partnership allows lichens to survive in some of the most extreme environments in the world, including areas north of the boreal forest, known as the barren tundra. Here, lichens provide essential food for herds of caribou (their North American name) or reindeer (their European name) during the winter. The

caribou are also a staple food for other **species** including wolves, wolverines, bears and even humans. Reindeer herding is the way of life for the Sami people, an **indigenous people** living in Scandinavia: they follow and look after the reindeer wherever they go, helping to birth their calves, and using their meat for food and their pelts for clothing. See how lichen and **algae** support a whole **food web**?



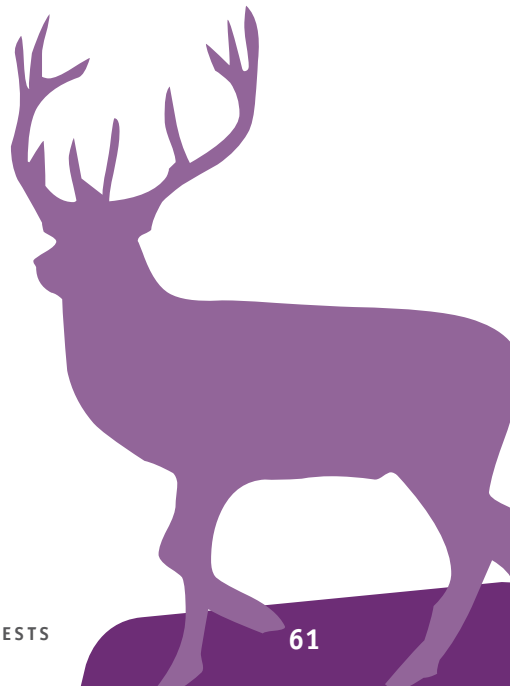
REINDEER (CARIBOU) IN A BOREAL FOREST.

ANIMALS OF THE BOREAL FOREST

The **boreal forest**, supports a large range of animals. For example, Canada's **boreal forest** includes 85 **species** of mammals, 130 **species** of fish, and an estimated 32 000 **species** of insects.

Insects and birds

As we've been hearing, insects are important parts of the **food web**: they play a critical role as **pollinators** and as **decomposers**, and provide a key source of food for many nesting birds. That is why the breeding season of many bird **species** coincides with peak insect season, making sure that there are lots of tasty protein-rich bugs to satisfy hungry, growing baby birds. The **boreal forest** is also home to large **herbivorous** mammals, such as moose and the reindeer/caribou we've just learned about.



The wolverine

The **boreal forest** is home to the greediest animal around: the wolverine. The largest member of the weasel family, the wolverine is a **carnivore** that feeds on other mammals, such as rabbits and rodents and even larger animals like caribou. It is said that the wolverine can eat more in one sitting than any other animal, which is where it gets its nickname: the 'glutton'.



WOLVERINE.
© Steve Hillebrand, US Fish and Wildlife Service

Woodfrogs

Woodfrogs are amphibians that live in the **boreal forest**. Amphibians need water to live on land, so you might wonder how a woodfrog would survive the freezing boreal winter when all the water is frozen solid as ice and snow. Well, this little animal freezes too! The woodfrog hibernates just beneath the soil surface. When in hibernation, its liver converts the frog's energy stores to sugars, which are sent to all the **cells** in its body. The frog also stores urea – normally a main ingredient of urine – in its **cells**. This mix of sugar and urea limits the freezing of the frog's body. As long as at least 65 percent of the frog stays unfrozen, it can survive the boreal winter right under the snow!



WOODFROG.
© Brian Gratwicke

CULTURAL STORY

NORTHERN RAVEN FOLKLORE



RAVEN.
© Michel Juteau

The raven is found in **boreal forests**. It is considered one of the most intelligent birds, and it features in the folklore of many different cultures. In some cultures, the raven is revered as a god. For example, in far East Russia, the raven god Kutkh is credited with creating Kamchatka (a Russian peninsula) by losing a feather, and literally 'dropping' various other islands and rivers down to Earth as he pooped and peed! In other cultures, there are myths explaining how the raven gave humans light, language, fire, water and skills such as net weaving. Do you know any of these stories?

The beaver

Beavers are second only to humans in terms of the scale of their impact on the environment around them. They gnaw through and **fell** trees with their strong, sharp teeth which never stop growing. (In fact, they need to keep gnawing, or their teeth would get uncomfortably long!) They use the trees, branches and mud to create dams to block rivers – turning forests and fields into lakes and ponds where they love to swim. Beavers eat aquatic plants as well as the leaves and bark from the trees they **fell**. Inside their dam, beavers build a home, called a lodge, with an underwater entrance deep enough to stay unfrozen during the cold boreal winter. They have big flat tails they use like a rudder to swim, or to slap on the water surface loudly to warn other beavers of impending danger. But coolest of all: beavers have see-through eyelids that they can use like goggles to see underwater. How useful is that?!



BEAVERS BUILDING A DAM IN OTTAWA, CANADA.
© Mark Round

The snowy owl

The snowy owl is one of the largest owls in the world; it lives and breeds in the **boreal forests** at high northern **latitudes**. The owl's favourite food is lemmings (small rodents) – an adult snowy owl can eat up to 1 600 lemmings a year! As these owls live in the **boreal forest** all year round, they have a number of special **adaptations**. Their plumage (feathers) changes with the seasons so the owls are always camouflaged – in the winter they are as white as the snow and in the spring, when the snow melts, the owls grow new brown feathers to blend in with their surroundings. They also have very thick feathers to keep them warm in winter; even their feet are fluffy!



A SNOWY OWL WITH ITS WINTER PLUMAGE IN QUEBEC, CANADA.
© Michel Juteau

MANGROVE FORESTS

Mangrove forests are a common sight on the mudflats and banks of tropical and subtropical coasts. Some of the largest areas of mangroves are found in Indonesia, Brazil and the Sundarbans of India and Bangladesh. Mangroves are highly productive ecosystems.



MANGROVE TREES AT LOW TIDE ON EAST RAILAY BEACH, THAILAND.
© Christine Gibb

For example, they are important reproduction, nursery and feeding sites for many marine fish and shellfish because their tree roots offer good protection from predators. Local people often use mangrove wood for building materials, fish traps, fuelwood and charcoal, among other uses. Therefore, mangroves are important for both **biodiversity** and human development. Mangroves are also extremely important for coastal protection. Their dense root systems trap sediments flowing down rivers and off the land which helps to stabilize the coastline and prevents **erosion** from waves and storms. In areas where mangroves have been cleared, coastal damage from hurricanes and typhoons is much more severe. By filtering out sediments, the forests also protect coral reefs and seagrass meadows from being covered and trapped in sediment. During recent decades, however, a significant portion of the world's mangroves has been cleared for agriculture, salt ponds or **aquaculture**. FAO estimates that between 1980 and 2005, 20 percent of the world's mangrove forests disappeared.

(*Source*: FAO, The World's Mangroves 1980-2005)

TREES OF THE MANGROVES

Mangrove forests boast very few other **species** of plants because survival in such a salty place requires very special **adaptations**. The plants that can live in this environment, however, have some pretty unique and amazing traits.

Coping with salt

Whenever the **tide** comes in, salty water floods the mudflats on which mangroves grow. This threatens to **dehydrate** and damage plants by drying out their **cells**. Creative as nature is, different salt-tolerant plants (called halophytic plants) have **evolved** different but equally incredible ways to deal with this challenge. Some **species**, like the grey mangrove, can actually secrete (give out) salt from their leaves! If you ever have the opportunity, look at the underside of their leaves: you'll see little salt crystals! Other tree **species** store excess salt in their oldest leaves, that drop from the plant once they're full. That's one neat waste disposal system!

Roots

As mangrove trees grow in **tidal** zones, they need to be really sturdy to be able to withstand the daily movement of the water. Therefore, they tend to have long slim stilt roots (also known as aerial roots) or thick strong buttress roots that extend out of the ground a long way and help hold the plant up in the soft mud. These special roots are also needed so that the plant can take in **oxygen** from the surrounding air. This is because the soil in **tidal** zones doesn't contain much **oxygen**; it is 'anaerobic'.



STILT (AERIAL) ROOTS IN THE SUNDARBAN MANGROVE FOREST, BANGALDESH.

© FAO/G.Grepin

ANIMALS OF THE MANGROVES

Mangrove forests are home to many **species** of fish and other animals which hide among their great roots, especially when they are still young. Read on to find out more.

Mangrove crabs

Mangrove crabs have two getaway options to escape predators: they can burrow into the soil, or they can climb trees. Have you ever seen a crab scaling a tree? These crabs are very important for the whole mangrove **ecosystem**. As part of the **food web**, adult crabs are eaten by many different predators, such as the crab plover (a bird), while young crabs are eaten by young fish, and crab faeces are eaten by other **organisms**. And that's not all! When the crabs burrow into the ground they let air into it, making it easier for plants to grow (remember, there isn't much **oxygen** in mangrove mudflats). Without these little crabs the mangroves would be a very different place! This makes the mangrove crabs a **keystone species**.

THINK ABOUT IT

The mangrove crabs are called a **keystone species** *because if you take them away the* **ecosystem** *could no longer function in the same way. Like the keystone in an arch, they hold the* **ecosystem** *together.*

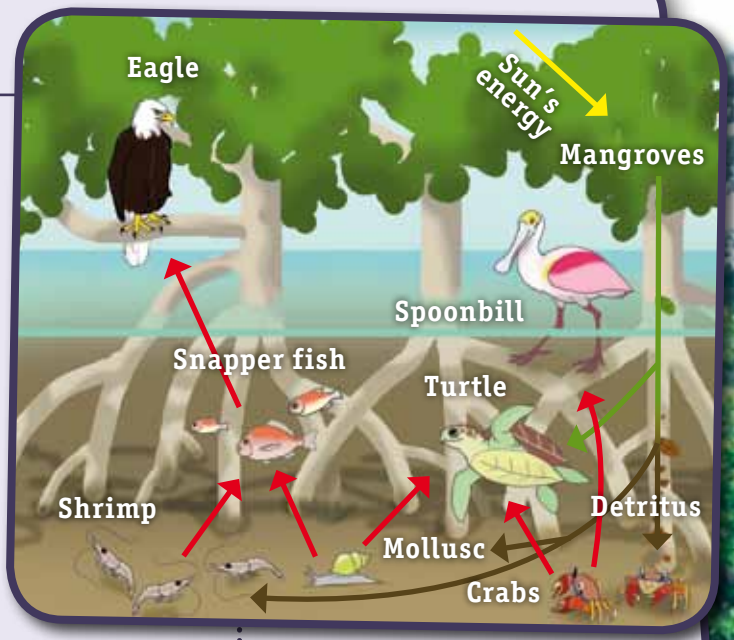
Which **keystone species** *inhabit your area?*



A MANGROVE CRAB IN MANGROVES NEAR QUEPOS, COSTA RICA.
© Charlesjsharp

IN FOCUS

A MANGROVE FOOD WEB



A MANGROVE FOOD WEB. THE ARROWS SHOW THE FLOW OF ENERGY FROM THE SUN TO THE MANGROVE TREES TO THE HERBIVORES TO THE CARNIVORES. WHEN EACH PLANT OR ANIMAL DIES, AND ITS BODY IS BROKEN DOWN BY CRABS, SMALL FISH, FUNGI, BACTERIA, ALGAE AND OTHER DECOMPOSERS, NUTRIENTS AND ENERGY ARE RETURNED TO THE MANGROVE ECOSYSTEM.
© YUNGA, Emily Donegan

Bald eagles are one of the top predators in the mangrove **food web**, feeding on fish and other small prey. They are also scavengers and will eat large dead prey, like deer, if they can find it.

Spoonbills are birds that eat insects, crustaceans (like shrimps) and tiny fish (like young snapper fish). This bird feeds by sweeping its bill from side to side until it feels something touch the inside of its bill, then it snaps it shut and eats whatever is inside. Clearly spoonbills aren't fussy eaters!

Loggerhead turtles are not permanent residents of the mangroves; they spend most of their lives in the open ocean. However, young turtles spend a short, but critical part of their lives in the mangrove 'nursery' away from predators.

Loggerhead turtles eat small marine animals such as crabs, sea urchins and molluscs (e.g. snails) as well as some sea grasses.

Juvenile snapper fish are one of the many kinds of baby fish that take shelter in the mangroves while growing. Snapper fish eat crabs, shrimps and other molluscs.

Shrimps provide food for many of the larger **species** living in the mangroves.

Mangrove crabs (and their faeces) are food for predators big and small. As we've seen, they also help plants grow by aerating the soil when they burrow into it.

Mangrove trees are the basis of the **food web**. Through a process called **photosynthesis**, they convert sunlight into sugars that feed the trees themselves – as well as animals that feed off them. When their leaves fall off, they provide food for crabs, shrimps and **decomposers**.

IN FOCUS

LIFE IN THE SUNDARBANS MANGROVES

The Sundarbans Mangroves make up 140 000 hectares of forest in the Bay of Bengal in India and Bangladesh. They are one of the biggest areas of mangrove forest in the world and are listed as a World Heritage Site due to their importance as a **habitat** (*Source:* http://whc.unesco.org/en/list/798).

Mammals that live there include the **endangered** Royal Bengal tiger: it is estimated that 350 tigers live in the Sundarbans. That may not sound like many, but it's a whole lot better than none! The Sundarbans are also home to around 50 reptile and eight amphibian **species** and that's not to mention all the fish that occupy their network of water channels.

Although the Sundarbans contain lots of different animals, some **species** have already been lost entirely due to human activities, and many other **species**, like the Royal Bengal tiger, are currently threatened with **extinction**.

Since the beginning of the 21st century, at least five spectacular **species** (the Javan rhinoceros, water buffalo, swamp deer, gaur and probably the hog deer) have all become **extinct** from the Sundarban **habitat**.



NASA WORLD WIND SCREENSHOT OF THE GANGES RIVER DELTA, BANGLADESH. THE DARK GREEN AREAS SHOW THE MANGROVE FORESTS.

MOUNTAIN FORESTS

Mountain forests vary considerably depending on their latitude (whether they occur in the tropics, subtropics or temperate zones, see pp.21-23 to refresh your memory). Their unique forest vegetation differs in structure and species composition from surrounding lowland vegetation and the type of vegetation changes gradually as altitude increases. The high mountains in the tropics, such as the Andes in South America and Himalayas in Asia, boast a range of forest types depending on altitude and exposure to the climate. In dry regions, such as the Middle East, natural forests are often confined to the mountains. Overall, mountain forests sustain a great diversity of habitats and are essential for providing water, watershed protection and soil conservation.



MOUNTAIN FOREST, MONTEVERDE, CARRIBEAN.
© Geoff Gallice

IN FOCUS

THE HIMALAYAS

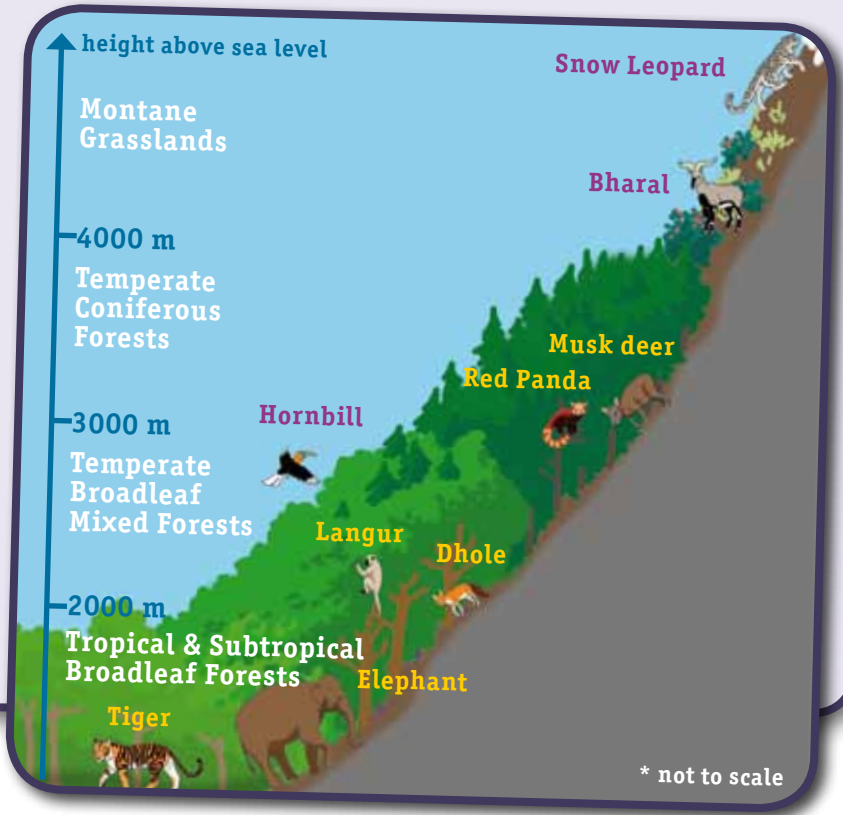
The Himalayas are home to the highest mountain in the world, Mount Everest. It is not surprising that their name comes from the Sanskrit word for 'home of snow' because their highest peaks are covered in snow all year round. However, the Himalayas also contain many different forest **ecosystems** at different **altitudes**. Let's have a look!

Tropical and Subtropical Broadleaf Forests (500 – 1 000 m):
There are more than 340 bird **species** that live in the forests on the lower slopes of the Himalayas, as well as tigers and Asian elephants.

Temperate Broadleaf and Mixed Forests (2 000 – 3 000 m):
In these forests, you find Langur monkeys along with plants like orchids and ferns.

Temperate Coniferous Forest (2 500 – 4 200 m):
Here you find spruce, fir and pine trees. Among the trees you can see red pandas and musk deer.

Montane Grasslands and Shrublands (3 000 – 5 000 m):
At this **altitude**, the conditions are too harsh for trees. However, you do find shrubs, such as Rhododendron. These **ecosystems** are also home to one of the world's most elusive and beautiful big cats: the snow leopard.



© YUNGA, Emily Donegan

ANIMALS OF MOUNTAIN FORESTS

Mountain gorilla

Mountain gorillas (*Gorilla beringei*) live at high **altitudes** of between 2 200 and 4 300 metres in **tropical** mountain forests. Mountain gorillas are critically **endangered** as a result of illegal hunting, the movement of humans onto land where the gorillas live, **habitat** loss and disease. There are only around 880 of these magnificent creatures left. **Conservation** initiatives, such as the International Gorilla Conservation Program aim to protect these apes and the **habitat** where they live. You can find out more about this initiative here: **www.igcp.org**



MALE MOUNTAIN GORILLA.
© FAO/Steve Terrill

Andean condor

The Andean condor is a bird of prey that lives in the South American Andes. It is one of the largest birds in the world, with a wingspan of 3.2 metres! It is also one of the longest-living birds, with birds in **captivity** living to around 70 years. (*Source*: Wildlife Conservation Society).



AN ANDEAN CONDOR SOARS THROUGH THE SKIES ABOVE COLCA CANYON, PERU.
© Geoff Gallice



THE COATS OF ARMS FROM CHILE, ECUADOR, COLOMBIA AND BOLIVIA (LEFT TO RIGHT).

The Andean condor is a very important cultural symbol in many South American cultures and it can be found on the coat of arms of many countries. Can you spot it on these coats of arms?

HUMAN-MADE
FOREST PLANTATIONS

Forest plantations are forests that have been planted by humans. They can occur anywhere in the world and can be made up of any tree species. Plantations are usually a monoculture of a single tree species that are grown over a large area of the land.

Fruit orchards are not usually classified as **plantations** because they are usually cultivated on a smaller scale and the tress are typically smaller than those which fit into the standard tree and forest definitions (see pp.4-5). **Plantations** are an increasingly important source of industrial wood, and can potentially reduce **timber** harvesting from **natural forests**. Forest **plantations** and woodlots also provide fuelwood and building materials for local use. **Planted forests** are often established for environmental purposes such as soil **conservation** because tree roots help to keep soil in place and prevent it from washing away when it rains (**erosion**). The area of the world covered by forest **plantations** is increasing, and this trend is expected to continue.



RUBBER PLANTATION IN UGANDA.
© FAO/Roberto Faidutti

Background
EUCALYPTUS DEGLUPTA (HABIT), MAUI.
© Forest & Kim Starr

PLANTS OF THE PLANTATIONS

There are many different types of **plantations** around the world. A few examples are:

- Pine plantations (for wood)
- Fir plantations (for wood)
- Teak plantations (for wood)
- Banana plantations
- Coffee plantations
- Oil palm plantations (find out more on p.135)



From top to down

RUBBER TREE IN THE DEMOCRATIC REPUBLIC OF CONGO.
© FAO/Guilio Napolitano

VARIOUS TYPES OF DIDGERIDOO.
© Nick Carson

The rubber tree

When you think of products made from rubber do you also think of nature? Most probably not, but in fact, there are quite a few natural rubbers that come from plants. The rubber tree (*Hevea brasiliensis*) is the most commonly used plant for producing rubber. It originally grew in the Amazon rainforest but it is now also commonly found in **plantations** all across the **tropics**.

Softwood plantations

Softwood is wood that comes from **evergreen** trees. **Plantations** of **evergreen** trees are very common in **temperate** and boreal **biomes** because the trees grow quickly, providing a constant, cheap source of **timber**.

Eucalyptus plantations

Eucalyptus trees originally came from Australia but are now grown all over the world. Eucalyptus is used as **timber**, fuelwood, pulpwood and for ornaments. Eucalyptus wood is even used to make the traditional Australian Aboriginal instrument – the didgeridoo. These are good trees for **plantations** because when they are chopped down at the base, they simply grow back again.

Coconut

Coconut **plantations** can be found in 80 countries worldwide, mostly in humid, warm **climates**. Over 61 million tonnes of coconuts are produced each year! Coconuts grow high up, so in many countries farmers climb the trees to harvest them. In other countries, such as Thailand and Malaysia, people train pig-tailed macaque monkeys to climb up the coconut palms, pick a coconut and then drop it down to the people waiting below!

CONCLUSION

It's pretty amazing to learn about the big differences between forest types found in different parts of the world, right? From tropical rainforests and their carnivorous plants to the saltwater-laden mangrove forests, a vast amount of biodiversity lives in forest habitats. One of the most incredible things is how these different species interact with each other in the forest ecosystem, creating food webs, symbiotic relationships and many more ecological wonders. In the next section, we will discover how forest ecosystems provide many benefits to humans, too.



LEARN MORE:

:: Boreal coniferous forests: www.marietta.edu/~biol/biomes/boreal.htm

:: Forest Habitats (you can explore most of those which we discussed in this chapter): http://wwf.panda.org/about_our_earth/ecoregions/about/habitat_types/habitats

:: Mangrove forests: www.habitat.noaa.gov/abouthabitat/mangroves.html

:: Tropical rainforests: www.blueplanetbiomes.org/rainforest.htm and http://kids.mongabay.com

:: Tropical dry forests: www.marietta.edu/~biol/biomes/tropdry.htm

:: Temperate forests: http://test.glossopedia.org/temperate-forest

Section C



FRIENDLY FORESTS





Chapter 4

THE IMPORTANCE OF FORESTS

Chapter 5

FORESTS, CULTURE AND RECREATION



THE IMPORTANCE OF FORESTS

LET'S EXPLORE JUST HOW MANY BENEFITS FORESTS GIVE TO LIFE ON EARTH, ESPECIALLY FOR US HUMANS!

4

You might be surprised to learn just how much of the world relies on trees and forests to meet their healthcare, nutrition, shelter and livelihood needs, not to mention their spiritual well-being. Try thinking for a moment about all the things you use that come from trees and forests.

"A people without children would face a hopeless future; a country without trees is almost as helpless."

Theodore Roosevelt
26th president of the United State of America (1858-1919)

THE BEAUTY AND VITALITY THAT FORESTS PROVIDE FOR OUR LIVES, COSTA RICA.
© Alvaro Vega Cubero

Forests are invaluable to all life on earth



Forests cover 1/3 of the total land area



Forests contain most of the world's terrestrial biodiversity

1.6 billion people

depend on forests for their livelihoods

US$108 billion a year

of medicinal plants from tropical forests



The rate of deforestation, though slowing, is still alarmingly high



5.2 million hectares lost each year; equivalent to the size of a soccer field every second

A sustainable future for forests



Forests must be managed sustainably to help reverse the effects of land degradation and deforestation



Widespread forest restoration and tree-planting are significantly reducing the net loss of forest area



Sound policies are needed to ensure a future for forests

THINK ABOUT IT

What are five things you use on a daily basis that come from trees and forests?

This page:
© FAOSTAT

Facing page:
FOREST MATERIALS.
© FAO/L. Dematteis

A FOREST HABITAT.
© Geoff Gallice

FOREST FOOD.
© FAO/Ishara Kodikara

RECREATION IN FORESTS.
© Geoff Gallice

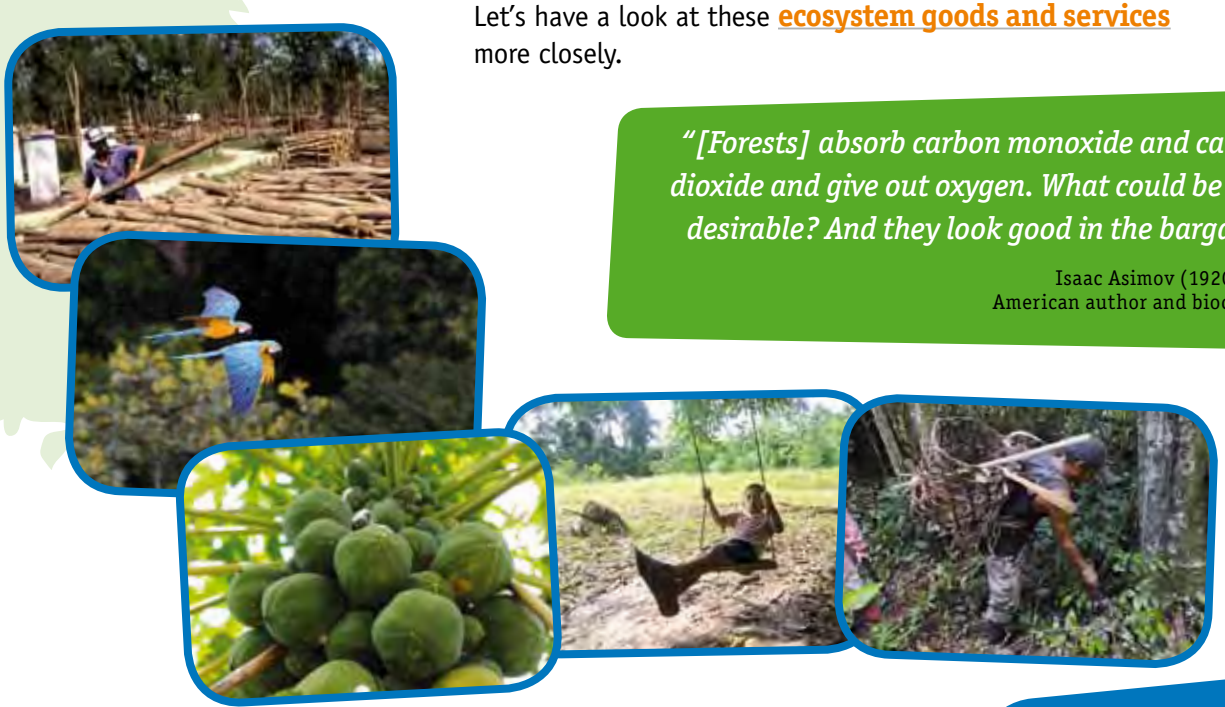
FOREST JOBS – A MAN COLLECTS BRAZIL NUTS FROM THE PERUVIAN RAINFOREST.
© Geoff Gallice

Even if you never set foot in a forest, you still depend directly on forests for many things. Forests are a source of clean air, water, energy, wood and non-wood forest products (NWFPs) such as food and medicine. The benefits that we obtain from forest ecosystems are called ecosystem goods and services.

Here are just a few things that forests do for us:

- Forests provide materials (such as wood for constructing buildings and furniture, or for burning as fuelwood to produce energy) as well as food for people and feed for animals.
- Forests provide a habitat for different kinds of plants and animals, which helps to maintain biodiversity.
- Forests protect the quality of fresh water by filtering out pollutants.
- Forests prevent soils from being washed or worn away (erosion).
- Mangrove forests also support coastal ecosystems and protect shorelines from wave and storm erosion.
- Forests absorb the greenhouse gas carbon dioxide from the atmosphere and produce oxygen through photosynthesis. This gives us clean air to breathe while helping to mitigate the negative effects of climate change.
- Forests provide jobs, which sustain the livelihoods of people working in the forestry sector and their families.
- Forests provide places for people to live, play and relax.

Let's have a look at these ecosystem goods and services more closely.



"[Forests] absorb carbon monoxide and carbon dioxide and give out oxygen. What could be more desirable? And they look good in the bargain."

Isaac Asimov (1920-1992)
American author and biochemist

ECOSYSTEM SERVICES

THE HIDDEN HELP

THE LUNGS OF THE WORLD

You breathed today, didn't you? (Of course you did, or you wouldn't be reading this.) Well, that's just the first of many forest services that you enjoyed today! Without forests, we wouldn't be able to breathe. This is because forests absorb carbon dioxide from the air during photosynthesis, and release oxygen back into the atmosphere as a by-product. This is important considering that we humans (and all other animals) do the opposite: we need oxygen to breathe, and breathe out carbon dioxide. Many types of trees can also absorb pollutants from the air, acting like giant air filters. See how well harmonized life on Earth is?

THE WATER OF LIFE

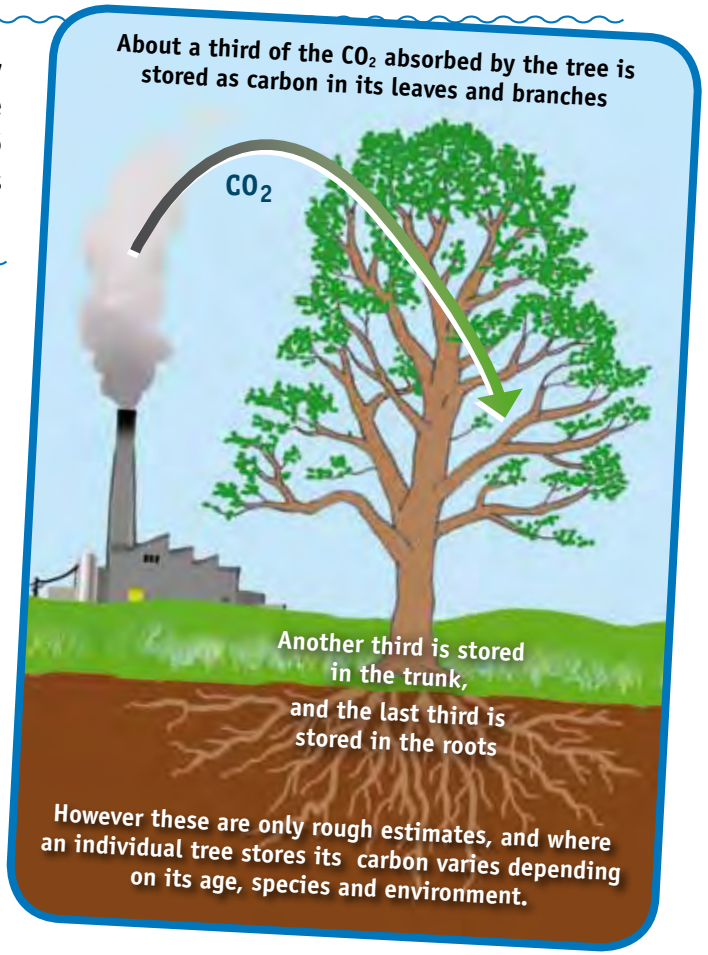
Apart from air, what else can we not live without? You guessed it – water. Like all living creatures, trees need water to survive. But did you know that trees and forests actually make sure that all the rest of the terrestrial living things on the planet have the water that they need to live? This is because forests are an important part of watersheds. Watersheds are areas of land in which all of the water found there (in the soil, or running off the land) ultimately drains to the same place. Above ground, this drainage is visible to us as rivers, streams and other water bodies such as ponds and lakes (and underground it is known as groundwater). Just as trees filter the air we breathe, making it clean and safe for us, trees and forests also play a key role in filtering the water we drink.

Forests also help to regulate local weather systems, which can impact how much rain and snow fall across an area. Trees capture rain and snow in their leaves, serving as a buffer and helping to regulate how quickly rain and snow are absorbed into the ground, acting as a natural control for floods, avalanches, rockslides and erosion. Without forests and their rich vegetation, desertification is also more likely to occur in some parts of the world, meaning that land areas dry up and become deserts.

CLIMATE CHANGE MITIGATION

As we discovered earlier, trees absorb **carbon dioxide** and release **oxygen** through **photosynthesis**. As well as filtering and cleaning the air and producing **oxygen** for us to breathe, there is another reason why this process is relevant to us today. **Carbon dioxide** is a **greenhouse gas** that causes the Earth to heat up and accelerates global **climate change** (find out more about forests and **climate change** on pp.132-133). So when trees use **carbon dioxide** for **photosynthesis**, they actually remove **carbon dioxide** from the **atmosphere**, helping to reduce **climate change**.

Trees are in fact called **carbon sinks** as they convert **carbon dioxide** in its gas form and store it as a solid form (wood). Take a look at Chapter 6 for more information about **climate change** and its effects on forests.



© YUNGA, Emily Donegan

"The answer is simple. If we lose the world's forests, we lose the fight against climate change. Rainforests are our Earth's greatest utility – our planet's lungs, thermostat and air-conditioning system."

Michael Somare (1936 -)
Prime Minister of Papua New Guinea
from 1975–1980, 1982–1985 and 2002–2011.



SUNRISE AT APALACHICOLA NATIONAL FOREST, FLORIDA, USA.
© Geoff Gallice

TEMPERATURE CONTROL

Trees are natural air conditioners! They cool down the air around them through **transpiration**, harnessing the Sun's energy to make the water in their leaves **evaporate**. Also, the shade that they provide cools the surrounding air and ground, which ultimately helps cool the Earth's temperature overall. In other cases, especially in **boreal forests** and forests in cold **climates**, forests act as insulators by blocking strong winds and trapping warmth within the forest **vegetation**, creating a local greenhouse effect. This allows numerous plant, animal, bird and insect **species** to survive in what would otherwise be too cold conditions.

POLLINATION

Pollination is an essential part of a healthy forest **ecosystem**. While some plants are self-pollinated or wind-pollinated, many trees need help from **pollinators** so that they can produce fruit and seeds. Over 100 000 invertebrate **species** (such as bees, moths, butterflies, beetles, flies, etc.) and more than 1 000 birds, mammals, and reptile **species** serve as **pollinators** worldwide. In turn, these **pollinators** depend on the existence of a wide variety of **habitat** types (including many forest **habitats**) to feed, breed, and complete their life cycles. Wild **pollinators** are crucial in assisting agricultural processes, and more often than not they are **species** that live in **natural forest habitats** next to farmlands. So next time you are enjoying a delicious meal, you can thank the birds, bees, insects and animals – and the forests that support them – for kick-starting the food production cycle!



BUTTERFLIES, SUCH AS THIS MENELAUS BLUE MORPHO BUTTERFLY ARE IMPORTANT POLLINATORS.
© Derkarts

NATURAL PEST CONTROL

An estimated 99 percent of potential pests that can destroy crops are controlled by natural enemies, including many birds, spiders, parasitic wasps and flies, lady bugs, **fungi**, bacteria, and numerous other types of **organisms**. These **organisms** often live in forest **habitats**. These natural pest controllers save farmers billions of dollars each year by protecting crops and reducing the need for chemical pesticides. Scientists have reported that the cost to U.S. agriculture of replacing natural pest control services with chemical pesticides would be about $54 billion each year. In Costa Rica, a citrus **plantation** pays the forested **conservation** area next to it $1 per hectare every year to provide natural pest control services. See how useful forests are?



THE RED TAILED HAWK IS A COMMON NATURAL PEST CONTROLLER IN NORTH AMERICA.
© Michel Juteau

GROUND RULES

The very ground you stand on is likely to have been influenced by forests. Forests have played an important geological role throughout time, particularly in the creation of soil. Air and water can cause the **weathering** and **erosion** of rock, making them break apart over time. Trees can also cause **weathering** as their roots grow into small cracks in rocks and widen them, causing the rock to wear down more quickly than it otherwise would. Think about the trees in your neighbourhood. Have you ever seen the concrete or tarmac cracked around the base of the tree? That's **weathering**. In nature, when enough time passes, the rock will eventually break down and become soil. So, as you can see, trees quite literally contribute to the creation of Earth!



WEATHERING CAUSED BY TREE GROWTH THROUGH A ROCK, IN SALINA, ITALY.
© Heidi Soosalu

SOIL QUALITY

Forests play an essential role in the **nutrient** cycling process by providing organic components to the soil. All plants and living things need organic compounds to grow, so without forests helping to cycle these compounds, the soils can become less **nutrient**-rich. Here's how it works: leaves, bark and branches fall to the **forest floor**, where **decomposers** (**microorganisms** like **fungi** and bacteria) break them down into small particles that make up soil organic matter (SOM). SOM rich soils are super healthy, allowing plants and trees to absorb the **nutrients** that they need to grow. When forests are cleared, the soil usually becomes **degraded** as there is less **vegetation** to provide organic matter.



FUNGI DECOMPOSING A LEAF ON THE FOREST FLOOR, YASUNI NATIONAL PARK, ECUADOR.
© Geoff Gallice



CULTURE AND RECREATION

It's time to zoom in and look at the trees and forests close to home. When was the last time you visited a forest? When last did you pass by a nice tree in your neighbourhood? Did you notice how trees seem to make things prettier and more peaceful? Well, if you did, you aren't alone. A lot of people find forests and trees beautiful and enjoy visiting their favourite hiking trails and parks near their homes. In fact, outdoor activities form the basis of a multi-billion dollar industry. What's more, for many people around the world, forests are an essential part of religious ceremonies and spiritual belief systems. All this is to say that forests have an important role in many people's lives, and for some, they are important simply because they exist. You can find out more in Chapter 5.

HIKING IN FOREST, CANYON CREEK LAKES, CALIFORNIA, USA.
© Jeffrey Pang

IN FOCUS

PAYMENT FOR ECOSYSTEM SERVICES

Let's check in for a moment. We've discussed an assortment of ways in which we benefit from forests – clean air and water, weather regulation and so on. All of these are incredibly important for the survival and well-being of human beings and other living creatures. They are also all **intangibles**. In other words, you can't hold air in your hands or directly watch the water filtering through the soil to become the stream that will provide your village, town or city with water. You can take a photo of your favourite forest vista, but a photo just isn't the same as seeing the real thing. These kinds of **intangible** forest benefits are often referred to as 'forest **ecosystem services**'.

Stop and think about it for a minute. When someone spends time doing something for you, such as tutoring you in math, you aren't given something you can hold in your hand; instead, they are giving you a service. This is precisely what forests do when they give us **intangible** benefits. It's difficult to put a price on **intangible** benefits (exactly how much should a lung-full of forest-cleaned air be worth? Who should be paid? Unlike your maths tutor, forests don't need money, after all!). Without a price, these **intangible** benefits may be valued less highly than **tangible** forest benefits (like **timber**) that have an actual price tag.

That's why a concept called 'payment for **ecosystem services**' has been developed: the idea is to encourage people to conserve **intangible** environmental benefits by giving them a monetary value. Usually this works on the basis that local communities will be paid to protect a **natural resource**, rather than making money from its **over-exploitation**. (Skip to pp.171-172 for an international example of payment for **ecosystem services**: the **REDD+** programme.)

Talk about payment for **ecosystem services** with your friends and family. For example, how much do you think a breath of fresh air should be worth? Discuss your thoughts – do you think it's a good idea? What might be tricky about giving **intangibles** a price? Who should decide this price?

GREEN CONIFEROUS FOREST.
© Petr Kratochvil

ECOSYSTEM GOODS – THE GENEROUS TREES

WOOD FOREST PRODUCTS

Of course, forests provide a lot of really important physical resources as well as the ecosystem services that we discussed earlier. One familiar forest resource is timber. Timber comes from the wood part of trees and is used to create all sorts of products, such as building materials for homes and furniture. What other products can you think of that come from wood? Think of things you use every day - like pencils. The paper you write on also comes from trees. Broadly speaking, forest products that are derived from wood are referred to as wood forest products.



COLOURED PAPER.
© Michael Maggs.

"Ultimately, literature is nothing but carpentry. With both you are working with reality, a material just as hard as wood."

Gabriel García Márquez (1927-2014)
Colombian novelist



COLOURED PENCILS.

IN FOCUS

WHICH WOOD?



A FURNITURE SHOP IN HANOI, VIET NAM. DO YOU THINK THESE ARE HARDWOODS OR SOFTWOODS?
© FAO/Joan Manuel Baliellas

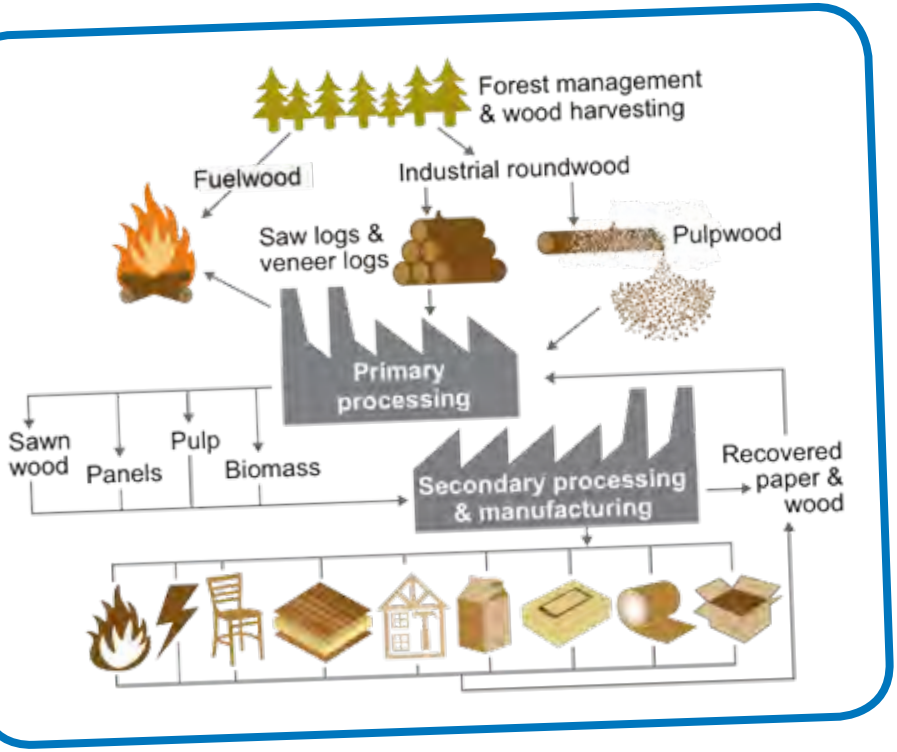
As we have discussed, wood, as well as being used to produce **timber**, goes into making many other products. But which types of wood are best for which product?

There are two main types of wood: **hardwoods** and **softwoods**. You would think that **softwoods** would be soft and **hardwoods** would be hard, right? Well, this isn't necessarily true, some **hardwoods** are actually the softest woods (e.g. balsa wood, the movie-star of woods that is often used in films when characters crash through doors or break furniture, is extremely soft!). The difference between the two woods actually depends on the type of tree that they come from. **Hardwoods** come from **deciduous** trees that lose their leaves and **softwoods** come from **evergreen** trees that have leaves all year round.

Some examples of **softwoods** are pine, spruce, cedar, fir and larch. Some examples of **hardwoods** are mahogany, teak, walnut, oak, ash and elm.

Softwood is more widely used for furniture and buildings because **evergreen** trees grow faster than **deciduous** trees and so more **timber** can be harvested. Therefore, **hardwood** is usually more expensive than **softwood** because you have to wait longer before you can harvest the wood and it is usually a darker, heavier wood. **Softwoods** are therefore considered to be more **sustainable** because they grow faster and are thus more readily renewable.

STACK OF FUELWOOD.
© Petr Kratochvil



HOW WOOD IS PROCESSED TO PRODUCE PRODUCTS THAT WE USE EVERY DAY.
© WWF

"When you plant a tree, never plant only one. Plant three – one for shade, one for fruit, one for beauty."

African proverb

NON-WOOD FOREST PRODUCTS

The term '**non-wood forest products**' refers to all the goods forests give us apart from wood, including berries, nuts, leaves, insects, wild animals (**bushmeat**) and fruits, all of which may be used in foods, medicines or beauty products. For many people around the world, especially in **developing countries**, food derived from trees and forests makes up a critical part of their diet. Again, even if you don't live anywhere near a forest, you rely on them: for example, if you have ever used a hand lotion containing shea butter (see the 'In Focus' box on p.92), then you have used a **non-wood forest product**.

THINK ABOUT IT

Have you ever thought about where your food comes from? Take a second to think about the foods you ate today. Do they grow in your country or somewhere else? Were they harvested in a rainforest? Rainforests provide foods (such as bananas, pineapples, brazil nuts, cocoa beans, mangos and star fruit) not just for the people who live in them but to people all over the world.







Clockwise

A FARMER TRANSPORTING BANANAS TO THE MARKET IN TANZANIA.
© FAO/Simon Maina

A FARMER SHOWS US A PINEAPPLE FROM HIS FARM IN KENYA.
© FAO/Christena Dowsett

BRAZIL NUTS IN BRAZIL.
© FAO/Giuseppe Bizzarri

IN FOCUS

SHEA BUTTER

Producing shea butter is a long process. It comes from the fruits of the shea tree.



SHEA TREE (*VITELLARIA PARADOXA*), EASTERN BURKINA FASO.
© Marco Schmidt



FRUITS OF THE SHEA TREE, MT. MBATI, CAMEROON.
© Marco Schmidt.

The fruits are then ground to make a paste.



WOMAN PROCESSING SHEA NUTS IN BURKINA FASO.
© TREEAID.

To produce the shea butter that you might buy in a shop, the fruits are treated and other compounds are added. It is then packaged to keep it fresh and clean.



UNREFINED SHEA BUTTER.
© Hopkinsuniv

Pharmaceutical Plants

Did you know that forests are literally *growing* with medicine? More than 70 000 plant **species** are used as medicine. From insect repellents to painkillers, forest life offers many kinds of health benefits, which humans have been using for thousands of years. The National Cancer Institute estimates that more than two-thirds of all cancer-fighting drugs come from rainforest plants, and in China alone, 5 000 plant **species** are used as drugs in Chinese traditional medicine. Additionally, more than a quarter of modern medicines, worth an estimated US$ 108 billion a year, originate from **tropical** forest plants. Think of the potential that lies with the undiscovered effects of many forest **species** to treat illnesses such as AIDS, cancer, diabetes, arthritis and Alzheimer's. Many health secrets and untold treasures still await discovery…

THINK ABOUT IT

What forest products can be harvested in the forests near you?

What kinds of jobs and workers are needed to transform these forest products into items that people can use?



NON-WOOD FOREST PRODUCTS - MUSHROOMS AND BERRIES, PICKED IN NEARBY WOODS, ARE SOLD ON A ROADSIDE NEAR VARENA, LITHUANIA. THE REGION IS FAMOUS FOR ITS FORESTS, MUSHROOMS, AND BERRIES.
© Phillip Capper

Money grows on trees

You've perhaps heard the saying 'money doesn't grow on trees'. That may technically be true, but given the wide array of resources that we have seen that forests offer us, it is obvious that they do provide financial benefits by creating many jobs! A lot of people, in both **developing** and **developed countries**, make their living by processing wood and **non-wood forest resources** into useful products. The shea butter hand lotion we just talked about couldn't have been produced without someone harvesting the shea fruit and processing it into a form that is useful to the beauty industry. Another example is the wooden furniture in your house; it didn't magically appear. Someone had to cut the trees, allowing for someone else to process the wood into **timber** for yet another person to craft the furniture. When you think of all the forest products out there, it's easy to see that forests and trees provide an important source of employment for a huge number of people around the world.

IN FOCUS

FORESTS AND CIVILIZATIONS

It's not just recently that forests have become important parts of human lives. Forests have had important roles in civilization throughout history. In the past, many great civilizations lived in rainforests. We can still see some of their ruins today.



LA DANTA PYRAMID.
© Dennis Jarvis

The Mayas

Remains of the Mayan civilization of El Mirador, which can be found deep in the Guatemalan rainforest, still astound people today. The civilization flourished around 600 – 700 BC, and at its height, the centre of the settlement was ten miles square. This is a view of the tallest Mayan temple ever built, La Danta pyramid. The temple is 79 metres high and has a volume of 2.8 million cubic metres!

The Aztecs

The Aztecs were the major civilization in Mexico for many centuries until 16th Century. Below is a photo of an Aztec temple in the rainforest in Malinalco, Mexico.

However, civilizations like the Mayas and Aztecs obviously had to cut down large parts of the forest to build their temples and cities. As these civilizations grew, they used many **natural resources**, which ultimately lead to their collapse because their environment (the forest) was no longer able to sustain them. Let's hope that today we can learn from their mistakes and use our resources more **sustainably**!



AZTEC TEMPLE, MALINALCO, MEXICO.
© Eneas de Troya

CONCLUSION

Home to over 80 percent of land-based biodiversity, forests have amazing benefits for people. They provide us with a large number of products and services, from tangible things such as timber and food products, to intangible services like cleaning our air and water supplies. Forests produce a large amount of the world's oxygen and also serve to prevent soil erosion. They are a major source of timber, pulpwood, fuelwood, fodder, meat, cash crops, fish, and medicinal plants that provide jobs to hundreds of millions of people worldwide.

However, there are even more reasons why forests are special. Move on to Chapter 5...



LEARN MORE:

:: Encyclopaedia of Earth: Forest environmental services: www.eoearth.org/view/article/152818

:: Forests in our daily lives: www.rainforest-alliance.org/kids/facts/daily-lives

:: Forests in the economy: www.fao.org/docrep/w4345e/w4345e05.htm

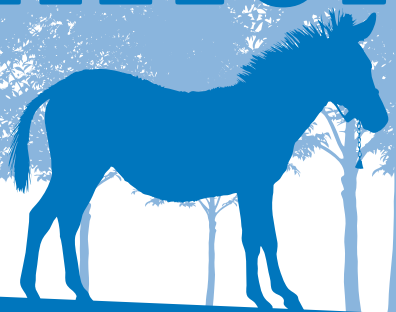
:: *The Value of Forest Ecosystems*, CBD Technical Series No. 4: www.cbd.int/doc/publications/cbd-ts-04.pdf

:: Valuing Forest Goods and Services: http://wwf.panda.org/what_we_do/how_we_work/conservation/forests/forestfinance



FORESTS & CULTURE & RECREATION









FORESTS ARE A PLACE FOR MANY ENJOYABLE RECREATIONAL ACTIVITIES, AS WELL AS A SOURCE FOR SPIRITUAL REFLECTION AND WORSHIP FOR MANY PEOPLE AROUND THE WORLD.

5

People have always been drawn to forests. Their main attractions include the amazing wildlife found there, alongside the sheer amount of foliage they boast – trees, creepers, bushes and herbs. For many people, forests hold an air of mystery that appeals to their sense of adventure; whilst others see forests as serene refuges away from worldly chaos.



A MOTHER AND HER DAUGHTER TAKE A QUICK BREAK FROM BREWING ORGANIC COCONUT OIL IN BALI, INDONESIA.
© Altaire Cambata

CULTURAL STORY

TANE MAHUTA – THE MIGHTY KAURI TREE OF NEW ZEALAND



TANE MAHUTA.
© Gadfium 2007

The mighty Tane Mahuta is the world's largest living kauri tree (*Agathis australis*). It is named after the Maori god of the forest, and is estimated to be over 2 000 years old. With a diameter of 13.8 metres and height of 51.5 metres, Tane Mahuta dominates the Waipuoa Forest in the Hokianga region of New Zealand. It's as tall as a 15 story building!

Many religions, cultures and **indigenous peoples** around the world have creation myths that explain how the world began and how the first people came to live here. Creation myths often describe symbols, practices and events that are important to the culture that tells them, so they reveal a lot about the identity, beliefs and values of that culture. So what does the following Maori creation myth tell you about the importance of the kauri tree to the Maori people in New Zealand?

In the beginning, there was nothing but darkness. After some time passed, two beings appeared: the Earth mother named Papatuanuku and the Sky father named Ranginui. In the darkness, the Earth mother and the Sky father came together in a tight embrace, and eventually produced 70 sons.

Unfortunately for Papatuanuku and Ranginui's

children, their parents' tight embrace shrouded them in complete darkness. The boys really wanted to escape the dark and to experience light. So, they held a meeting to figure out how to loosen their parents' embrace. The children decided that they only had two options: either to kill Rangi and Papa or to separate them.

One of the boys, whose name was Tane Mahuta, spoke up. He wanted to separate his parents, instead of killing them. He thought that his Sky father Ranginui should go high up into the sky, and his Earth mother Papatuanuku should go deep down below, into the ground. The other children agreed with him.

So, one by one, each of the boys tried to separate their parents with all his might, but none was strong enough. Lastly, it was Tane Mahuta's turn. He was as strong as the great kauri tree. He lay down on his back, placing his shoulders against his mother and his feet against his father. Tane Mahuta pushed, heaved and strained for a very, very long time. Finally, he succeeded in separating Papa and Rangi – the Earth from the Sky.

For the first time in their lives, Tane and his brothers saw daylight and they were delighted! Tane then began clothing his mother with **vegetation**, *tall* **canopy** *trees with long reaching limbs, smaller* **understorey** *trees, shrubs, lianas (vines) and* **epiphytes**.

Today, Tane is revered by the Maori people as the god of humans, forests and all things inhabiting the forests. All the birds and the trees of the forest are treated as Tane's children. As for Tane's 69 brothers, well, they later became the other gods of the Maori people.

KAHURANGI NATIONAL PARK, NEW ZEALAND.
© Pseudopanax



AN OLD GROWTH TREE IN THE NKULA FOREST, DEMOCRATIC REPUBLIC OF THE CONGO.
© FAO/Guilio Napolitano

DID YOU KNOW?

One of the oldest living trees is 4 765 years old, and has been called Methuselah (after the oldest person ever to have lived according to the Hebrew Bible). It is found in California and is just one of many, many amazingly ancient trees that have been around for over a 1 000 years. Just imagine all that they've seen in their lifetimes! Some had already started their lives when the Prophet Muhammad was preaching in Mecca, da Vinci was painting the Mona Lisa, the Wright Brothers took flight, World War I broke out, and ... you get the idea. Perhaps it is because they have seen so much that trees seem to hold a silent wisdom, which may partly explain our fascination with them.

Forests are unique places on Earth, where ancient trees reign over a world of dancing light and shade, scurrying wildlife and mysterious rustlings. Yet, while teeming with life, forests have an amazing stillness deep inside them that is rarely found anywhere else.

Fascinated by forests, people have used them as the settings for magical stories and tales of adventure for thousands of years. It is usually in the forest where heroes come across enchanted castles with imprisoned princesses, wicked ogres with strange powers, and dwarves who ask riddles. Poets speak eloquently about the beauty of forests and their hidden mysteries. Hermits and yogis seek refuge deep within their shade. Some people worship at the roots of ancient trees, and others dance around them in celebration of festivities. Forests have always played an important role in the lives of those fortunate enough to live near them.

ENJOYING A CANOPY WALK AT KAKUM NATIONAL FOREST NEAR CAPE COAST, GHANA.
© World Bank, Jonathan Ernst



"That each day I may walk unceasingly on the banks of my water, that my soul may repose on the branches of the trees which I planted, that I may refresh myself under the shadow of my sycamore."

Egyptian tomb inscription
(circa 1400 BC)

THINK ABOUT IT

Have you ever spent time in a forest?

How did you like it?

Did the majesty of the trees and the stillness of being deep within nature inspire you?

FUN IN FORESTS

Forests provide a wonderful world of possibilities. Buddha reached enlightenment sitting under a Banyan tree, and legend has it that Sir Isaac Newton discovered gravity when an apple fell on his head as he sat under a tree. Bottom line: with trees around, who knows what might happen?

Although not everyone will change the world by visiting a forest, people visit them for all sorts of fun activities, too. Lovers of animals, birds, and insects delve into forests to see these creatures first hand. People often mix these expeditions with other fun activities, such as rafting, kayaking or canoeing down rivers through the forest, hiking along trails, and perhaps doing a spot of camping. When this kind of tourism follows the principles below, it is known as **ecotourism**.

Ecotourism:

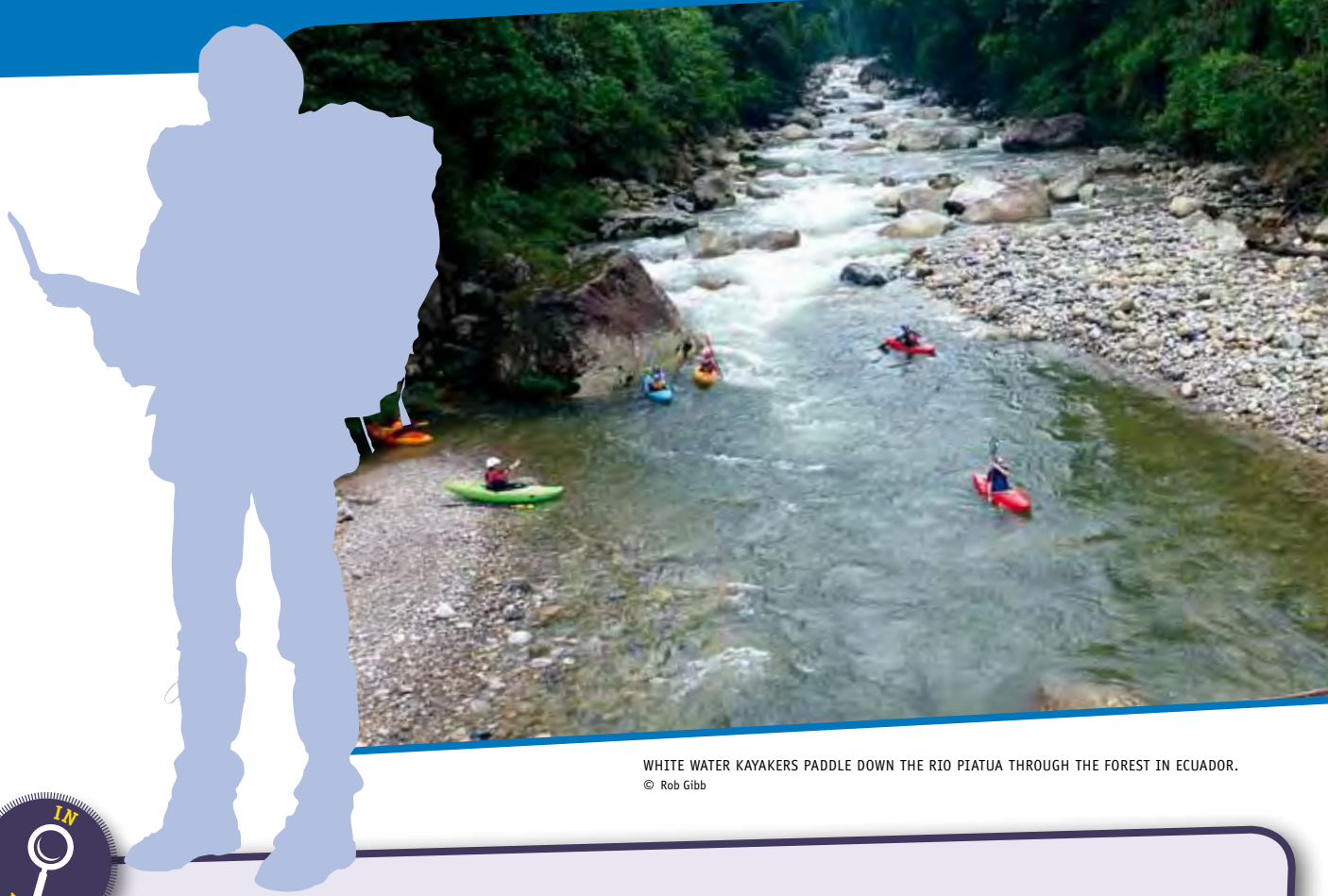
- promotes **conservation**;
- includes and respects local communities;
- gives people a chance to explore nature while learning; and
- introduces people to local cultures.

Why not try it for yourself? If you live near a forest, you can go for a hike, a jog, or a leisurely nature walk. You can prepare a scrumptious picnic and have a feast under a ceiling of leaves with your friends and family. You can go camping with your friends and spook yourselves out telling ghost stories around a fire... Or maybe stick to singing songs. Perhaps you just feel like dreaming or reading a book at the foot of a big tree, or collecting unusual leaves that have fallen. If you are leaning towards something a bit more on the wild side, some forest authorities offer organized recreational activities, such as the high wire adventure of the person in the photo on the left.



ZIP-LINING THROUGH A FOREST IN SLOVENIA.
© Soča rafting d.o.o.

! Whatever fun forest activity you choose, be sure to take safety precautions and to do the activities under qualified supervision and with the permission of a parent or guardian!



WHITE WATER KAYAKERS PADDLE DOWN THE RIO PIATUA THROUGH THE FOREST IN ECUADOR.
© Rob Gibb

IN FOCUS

UNESCO WORLD HERITAGE SITES

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) set up the World Heritage convention in 1972 in order to help protect the world's natural and cultural heritage. What's heritage? '*Heritage is our legacy from the past, what we live with today, and what we pass on to future generations*' (*Source*: http://whc.unesco.org/en/about). It is something that we pass on from generation to generation, like a tradition.

Therefore, World Heritage Sites are areas that have specific value to humanity because of their natural beauty and cultural significance. World Heritage forest sites now have a total surface area of over 75 million hectares.

Find out more about World Heritage forest sites in your region here: **http://whc.unesco.org/en/forests**.

INDIGENOUS PEOPLE
AND FORESTS: A SPECIAL BOND

We may think of a forest as just a place to visit, but for about 300 million people around the world, forests are their home (*Source*: www.un.org/forests)**. Many of these forest dwellers are indigenous peoples. Indigenous people are usually defined as the people who were the original or oldest known inhabitants of a particular area (also known as native peoples, First Nations peoples or aboriginals). In many countries, indigenous peoples often depend on forests for food, clothing, medicines and income. But often their ties to the forest run much deeper than that. Forests may hold a sacred significance, a special relation that has existed since their ancestors first hunted and gathered food in those same lands. Many indigenous communities hold important rituals in forests, raise their children to cherish and protect them, and feel connected to their ancestors through the ancient trees and land.**

"Indigenous forest people see themselves as inseparably linked to the forest and everything in it – trees, plants, rivers, animals and mountains…These ideas are expressed through mythology, religious practices, and systems of social regulation, including management of the environment and systems of production and exchange."

UNEP

Because of their deep respect for forests, **indigenous people** around the world have often played a major role in protecting forests in their area.



IN FOCUS

THE LIVES OF INDIGENOUS PEOPLES

Here are some examples of the different ways in which forests influence the lives of **indigenous people** around the world:

- The Waimiri Atroari of the Brazilian Amazon use 32 plant **species** just to construct hunting equipment! They specially choose each plant for its individual physical and chemical properties.
- The next time your parents or a teacher tells you to stop whistling, you can tell them you're actually communicating in el silbo. That's right, el silbo is a whistle language (how cool is that?!) that originated in the forests of Garajonay National Park, Spain as a way for people to communicate across the deep valleys.
- Almost all the ceremonies and rituals of the indigenous Maasai people in East Africa – including naming, marriage and death ceremonies – take place in the forest, or use plants and trees from the forest.
- The Efe, commonly known as 'pygmies', have lived in the Ituri Forest in the Democratic Republic of Congo for thousands of years. The forest has inspired them to create amazing music. 'Summoning Tore (God) with trumpet-like calls that imitate the sounds of animals, washing clothes to the accompaniment of the likembi, and often chanting continuously through the evening, the Efe are world-renowned for their songs – songs of love for the forest that is their home.'

(*Source:* Cultural Survival)



INDIGENOUS MEN IN BRAZIL PADDLE THROUGH THE FOREST.
© World Bank

"Many of the last remaining tropical forests in the world today are found in indigenous peoples' territories. The main reason for this is that forest-dwelling and forest-dependent indigenous peoples regard forests not only as the source of sustenance and livelihoods but the very basis of their identities, cultures and their social organizations. Thus, they continue to sustainably use, conserve and protect these forests which are home to them."

UNFCCC

DEPICTIONS OF THE FOREST IN THE ARTS, LITERATURE, AND MUSIC



REPLICA TOTEM POLES OF ORIGINALS CARVED BY FIRST NATIONS PEOPLE (THE HAIDI) IN BRITISH COLOMBIA, CANADA.
© Peter Graham

ARTS

Forests and forest resources can be a key source of inspiration for many artistic and creative projects. Many of these artistic ventures have important historical and cultural elements. For example, have you ever seen or heard about totem poles? These are large posts carved out of giant cedar tree trunks in North West America and Canada. First Nations peoples (the term used for North American **indigenous peoples**) carve figures and stories into the wooden posts for a number of reasons: for example, to preserve a common ancestral legend; to commemorate notable community events; or to celebrate cultural symbols. Why don't you try carving your own mini totem pole?

Many a painter has attempted to capture the beauty of forests on canvas. The French artist Henri Rousseau often painted forest related images and claimed to have "no teacher other than nature". Claude Monet, Vincent van Gogh and Rembrandt also enjoyed painting trees and forest scenes too. What other art forms and artists can you think of who have been inspired by forests?

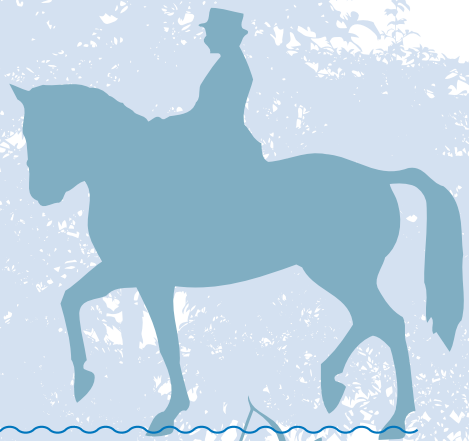
MUSIC

Forests have also inspired many musicians who have created fantastic compositions reflecting the beauty and awe of trees and the forest environment. For example, Italian composer Antonio Vivaldi's *The Four Seasons* skillfully reflects spring birdsong in the woods as well as the icy advance of winter frosts through his four famous violin concertos. The Finish composer Jean Sibelius also drew inspiration from forests for his piece titled *Tapiola*. He wrote this preface to the score: "widespread they stand, the Northland's dusky forests, Ancient, mysterious, brooding savage dreams; Within them dwells the forest's mighty god, And wood-sprites in the gloom weave magic secrets". More recently, American indie rock artist Bon Iver recorded the entire album *For Emma* whilst seeking winter solace in a cabin deep within the Wisconsin forest. Can you think of any forest inspired musicians from your culture?

LITERATURE

Writers and poets love writing about forests. However, in books, forests often take on a sinister and scary role. Still, whether described as scary or safe, they almost always have a magical quality that draws the characters in the stories to them. It's just like the way we are drawn to forests in real life.

Perhaps the most forest-obsessed stories are fairy tales, where unsuspecting characters encounter weird and wild adventures as they walk through the forest. There's Little Red Riding Hood who meets the cunning wolf, while Hansel and Gretel meet a creepy witch who lives in a house made of gingerbread! Let's not forget Snow White, who meets the seven dwarves in the forest.



It is not just fairy tales that depict forests: Robin Hood and his 'merry men' spent most of their time in Sherwood Forest in England, which provided a safe haven as well as the perfect setting for many adventures.





A LIVING SCULPTURE OF THE MAN WHO PLANTED TREES IN MONTREAL, CANADA.
© Christine Gibb

Forests even appear in the works of Shakespeare, perhaps most memorably as the magical forest in a *Midsummer Night's Dream*. There are also many horror stories written about forests. For example, the *Legend of Sleepy Hollow* is about a headless horseman who rides through the woods carrying his severed head in his hands. Scary stuff!

There is also the story of *The Man Who Planted Trees*, a tale about a shepherd who single-handedly re-forested a barren valley by planting acorns that he had collected on his travels with his sheep. The shepherd continues to plant trees and care for the forest over 30 years or so, and soon he has transformed to valley into a beautiful, vibrant place where more than 10 000 people make their home. Find out about a similar real-life version of this story on p.200.

A lot of modern literature is also set in forests. Harry, Ron and Hermione in the *Harry Potter* books have hair-raising adventures in the Forbidden Forest. In the *Hunger Games,* Katniss, the protagonist, is not only at her happiest and most peaceful in the forest, but also relies on it for food and survival.

Forests star in poetry too; for example, the "lovely, dark and deep" woods of Robert Frost. Some songs also feature forests – can you think of any?

THINK ABOUT IT

The literary examples described here mostly relate to Western culture, but in fact forests hold important roles in cultures all around the world.

Can you think of any forest-y stories, poetry or songs from yours or other cultures?

How about getting creative and writing your own?

CONCLUSION

For centuries, forests have influenced our imaginations, and therefore our collective consciousness and cultures. From ancient tribes singing songs, beating drums and carrying out important rites, to philosophers seeking wisdom and inner peace, to modern day campers, explorers, and adventurers – forests are a favourite setting for all types of cultural, spiritual and recreational pursuits. Get involved; go and explore a forest near you! Help your friends and family to see the cultural value of your local forests – can you inspire them to protect and conserve these enchanting places?

LEARN MORE:

:: Cultural Survival – Information about indigenous people around the world: www.culturalsurvival.org

:: Forests for People Factsheet: www.un.org/esa/forests/pdf/session_documents/unff9/Fact_Sheet_ForestsandPeople.pdf

:: Forest Peoples: Numbers Across the World: www.forestpeoples.org/sites/fpp/files/publication/2012/05/forest-peoples-numbers-across-world-final_0.pdf

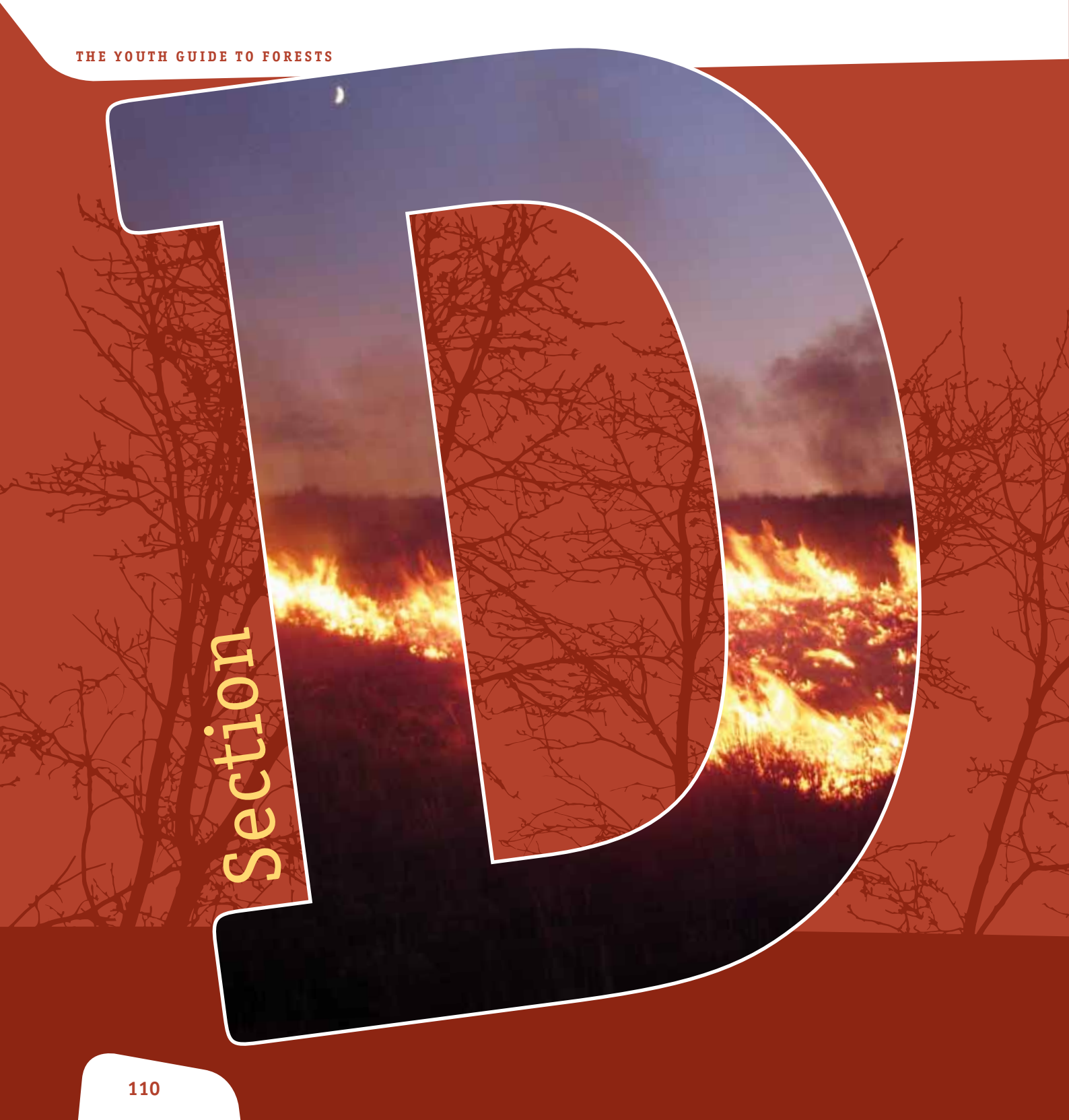
:: Greenpeace – Information on people of the Amazon: www.greenpeace.org/international/en/campaigns/forests/amazon/people-of-the-amazon

:: TEBTEBBA, Sustaining and Enhancing Forests Through Traditional Resource Management – Report explaining how indigenous people are helping to save forests: www.tebtebba.org/index.php/content/276-sustaining-a-enhancing-forests-through-traditional-resource-management-volume-2

:: UNEP, The Relationship Between Indigenous People and Forests: www.unep.org/vitalforest/Report/VFG-03-The-relationship-between-indigenous-people-and-forests.pdf

:: UNESCO, Use of the knowledge of indigenous people for environmental conservation: www.unesco.org/new/en/indigenous-peoples/sustainable-development-and-environmental-change

Section D



FORESTS UNDER ATTACK



Chapter 6

FORESTS FACING THREATS



FORESTS FACING THREATS

MANY FACTORS ARE PUTTING THE WORLD'S FORESTS AT RISK. PROTECTING FORESTS BEGINS WITH UNDERSTANDING THE THREATS THEY FACE.

6

Organisms living in a forest ecosystem have always had to be tough in order to survive in an environment that experiences many natural hazards.

Today, however, new threats posed by humans are pushing forest ecosystems to the limit; meaning that ecosystems are disappearing and species are dying out.

DANAO, PHILIPPINES. A PORTION OF A HILL CLEARED RECENTLY BY SLASH AND BURN METHODS STILL USED BY SOME FARMERS IN THE REGION.
© FAO/Noel Celis

Although at first glance forests may seem to be a permanent part of the landscape, the reality is that they are very dynamic and change continuously, in both shape and composition. Most changes occur very slowly and on a small scale, and can therefore be difficult to see. Do you remember the last time you saw a dry branch falling or a seed **germinating**? (It's a trick question; seeds **germinate** underground so you can't actually *see* this important **ecological process**.) Bigger events are more visible; forest fires, windstorms, pest infestations or human activities can rapidly and completely alter a forest's appearance.

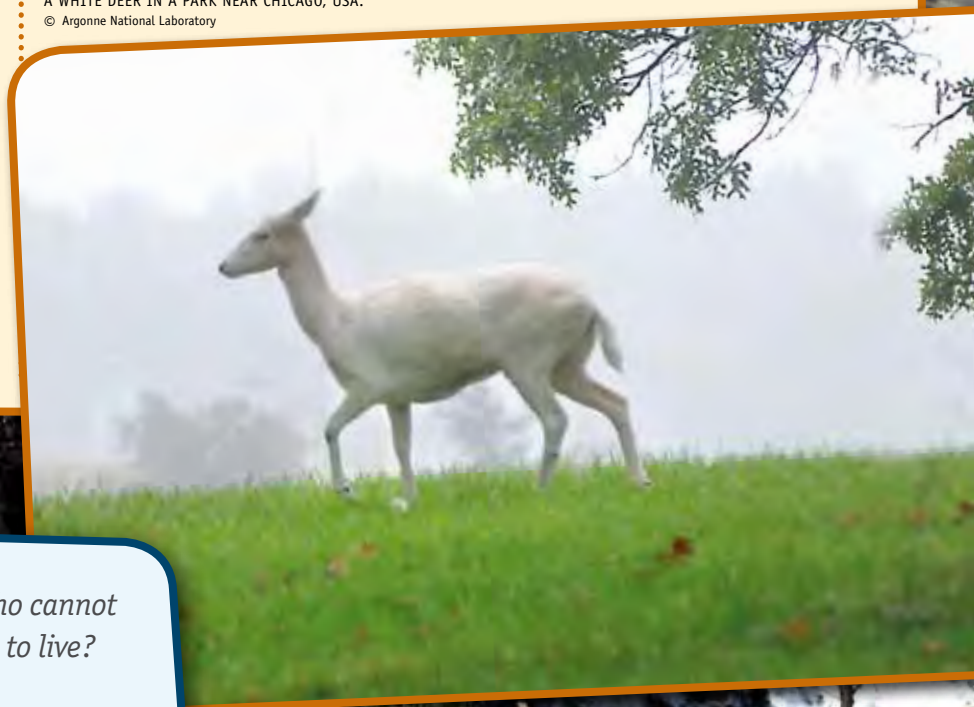
AVALANCHE DAMAGE.
© Walter Siegmund



CULTURAL STORY

THE ANIMALS OF FARTHING WOOD

The Animals of Farthing Wood is a fictional book written by Colin Dann about a group of animals who have to leave their home, Farthing Wood, when it is destroyed by humans to make way for the building of human homes. The humans fill in the pond in the wood and cut down all the trees, leaving no **habitat** for the animals foxes, badgers, weasels, voles, mice, owls and toads that live there. The situation is made worse because there is a **drought**; the animals have nothing to drink because the stream has dried up! The book follows the adventures of a group of animals who choose to journey to White Deer Park, a fictional nature reserve where they hope that they will be safe. The animals have lots of misadventures as they journey across dangerous roads, towns, rivers and fields full of **pesticides**. Although the animals undergo many struggles, the story has a happy ending when the animals arrive at White Deer Park. There, they celebrate their arrival and remember all the animals who lost their lives along the way.



A WHITE DEER IN A PARK NEAR CHICAGO, USA.
© Argonne National Laboratory

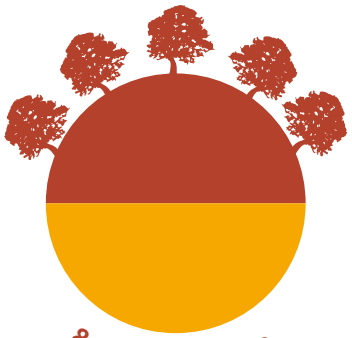
THINK ABOUT IT

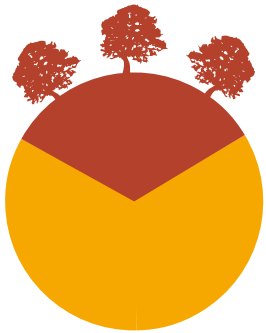
What about the animals who cannot travel to find a better place to live?

And what about plants who cannot move at all?

THE STATE OF THE WORLD'S FORESTS

Eight thousand years ago, half of the Earth's land surface was covered by forests or wooded areas. Today, these areas represent less than one third. Trees have always had natural enemies, such as animals; and competitors, such as other tree species. Similarly, forests have always been shaped by natural forces, such as climate, natural hazards and water availability; all of these forces can change forest size and composition. Unfortunately, the current rate of forest loss, scientifically called the deforestation rate, far exceeds the normal historical rate that existed before humans got so good at clearing and exploiting forests. It is frightening: an area equivalent to five football pitches disappears *every minute*! FAO estimates that a forested area roughly equal to the size of Greece is lost every year.





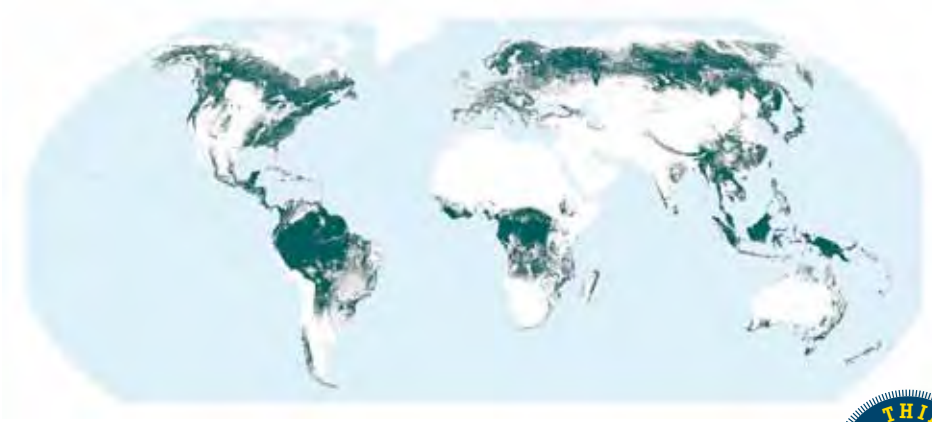
Different parts of the world have experienced different amounts of forest loss. In developed countries, forest area has remained stable or even increased over the past 100 years. This is largely due to the fact that many developed countries deforested large areas of their land centuries ago to use the land for agriculture and other activities. Today however, in developing countries, the amount of forested areas continues to diminish.

DID YOU KNOW?

Since 2000, about 13 million hectares of forest have been lost each year. This is not good news! However, the rate of deforestation in the last decade is less than the rate of deforestation in the previous 10 years – let's hope it continues to decrease!

(*Source:* 2010 Global Forest Resources Assessment, FAO)

THE WORLD'S FORESTS



Forest (>10 percent tree cover)

Other land

Water

Note: Tree cover derived from MODIS VCF* 250 meter pixels for year 2005.
* Moderate-resolution Imaging Spectroradiometer Vegetation Continous Fields (Hansen *et al.* 2010).

THIS MAP SHOWS THE STATE OF THE WORLD'S FORESTS IN 2005. WHAT DO YOU NOTICE ABOUT FOREST COVER IN DIFFERENT PARTS OF THE WORLD?

© FAO Forest Resources Assessment

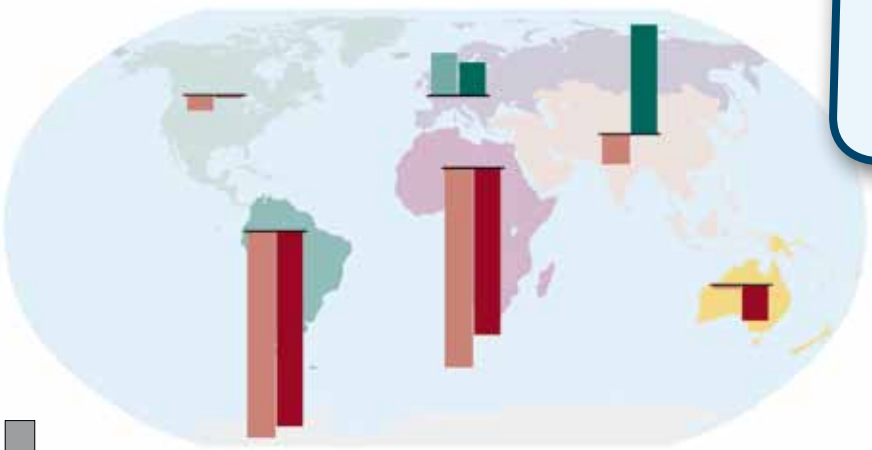
THINK ABOUT IT

Where are the areas with major forest losses?

What kind of forests do you find there?

Who, or what, are the main causes of these changes?

ANNUAL CHANGE IN FOREST AREA BY REGION, 1990–2010



scale: 1 million ha (million ha/yr)

NET LOSS	NET GAIN
1990–2000	1990–2000
2000–2010	2000–2010

Africa	North and Central America
Asia	Oceania
Europe	South America

THIS MAP SHOWS THE ANNUAL CHANGE IN FOREST AREA BY REGION BETWEEN 1990 AND 2010. WHAT DO YOU NOTICE ABOUT FOREST LOSSES AND GAINS IN DIFFERENT PARTS OF THE WORLD?

© FAO Forest Resources Assessment

WHAT CAUSES FOREST LOSS?

Events that change the forest and the trees that grow within it are called **forest disturbances**. For millions of years, disturbances have been shaping forests in different ways. These can be **classified** depending on their:

DURATION



from seconds to months

IMPACT LEVEL



from leaf damage through to tree death

ORIGIN



natural or human

Whether the origin of the **forest disturbance** is human or natural can have major consequences on the future of the affected forest. Many human activities permanently convert forest land into land that can be used for other purposes, such as agriculture.

Permanent removal and the decrease in the area of a forest is called **deforestation**. For example, **deforestation** happens when people cut down trees to build roads or houses, or to clear areas for agricultural production. When the forest is lost, many of the other life forms that lived and depended upon the forest disappear too. Some **species** can adapt to the new environment, but many others cannot and need to find new **habitats** in which to live. In addition, we also lose many of the **ecosystem goods and services** that forests provide us with (as discussed in Chapter 4), which are difficult to measure but provide many **intangible** benefits to the environment and our human wellbeing.

Another type of **forest disturbance** is **degradation**. **Degradation** is defined as a decrease in the quality of the condition of a forest, although the forest area remains the same size. A decrease in the quality of the forest could mean a less healthy forest, a forest with fewer **species**, or a forest with fewer useful goods and services for humans to use or sell. Forest **degradation** can be caused by natural forces such as **wildfires** and landslides, which are explained in more detail on pp.120-125.

Forest **degradation** can also occur when humans overuse or **over-exploit** forest resources. For example, damaging or removing **organisms** and wildlife (e.g. by killing animals for **bushmeat** or collecting **understorey** plants for fuelwood) in large numbers changes the balance of the **ecosystem**, meaning it can no longer function as it should. If a forest is heavily **degraded**, the trees will die off and **deforestation** will occur. **Degradation** is a complex issue, and much more difficult to observe and measure in comparison to **deforestation**.

Natural and human **forest disturbances**, although different, are also linked. Many natural **forest disturbances** are becoming more intense due to humans actions. For example, **climate change** is causing an increase in the number and strength of extreme weather events, such as **droughts**, that can put severe stress on forests, which can't adapt quickly enough, and cause the loss of **species**.

...So what are the main threats to forests?



FOREST DISTURBANCE IN THE TARTASTAN REPUBLIC, RUSSIA.
© FAO / Vasily Maksimov

THINK ABOUT IT

What are some examples of **forest disturbances**? *Are any of them occurring in forests near you?*

Describe their effects on the forest.

EXTREME EVENTS

EARTH
not always as stable as you think!



LANDSLIDE IN CALIFORNIA, USA.
© Mark Reid, U.S. Geological Survey

Tree roots perform an important service by keeping the soil in place (try to imagine the network of roots as a kind of net that holds the soil together). Where forests are cleared or **degraded**, and there is no **vegetation** cover, heavy rains can wash away the soil. This slow but continuous process is called **erosion**, and can be a key threat inhibiting the re-growth of forests. In fact, once the **topsoil** (the top fertile layer) is eroded, all plants have a hard time growing again, causing the land to stay bare for long periods of time. Under these conditions landslides are likely to occur in sloped areas. Landslides are triggered by natural causes, such as rains or earthquakes, but the likelihood of their occurrence can be increased by human activities, such as forest clearing. In major landslides, the **topsoil** of an entire mountainside may be carried downhill. Landslides uproot the trees and other **vegetation** in their path and sweep them away, together with rocks, earth, mud and debris.

As well as destroying any natural **ecosystems** in their path, landslides can also be dangerous for people who live and work in the area; extreme landslides can even sweep away houses and entire **livelihoods**.

IN FOCUS

HEROIC PLANTS THAT CAN GROW IN CHALLENGING SOIL CONDITIONS

Some **alpine** plants found on the steep rocky slopes of mountains belong to a group called **cushion plants**, named so because of the grow in clustered groups that look a bit like cushions. They are low-growing **species** that have relatively large and deep roots. These features allow them to grow in eroded soil, or nutrient-poor environments.

Honey mesquite, the common name of *Prosopis juliflora*, is a typical plant found in dry areas. It can grow in very sandy soil. Thanks to its root system and its ability to colonize areas by sending out new shoots, honey mesquite trees have been successfully used in Mauritania to create forest belts that stabilize the soil and limit the spread of sand dunes.



CUSHION PLANTS IN PERU.
© Emilie Hardman



HONEY MESQUITE PLANTS IN MAURITANIA.
© FAO / T. Fenyes

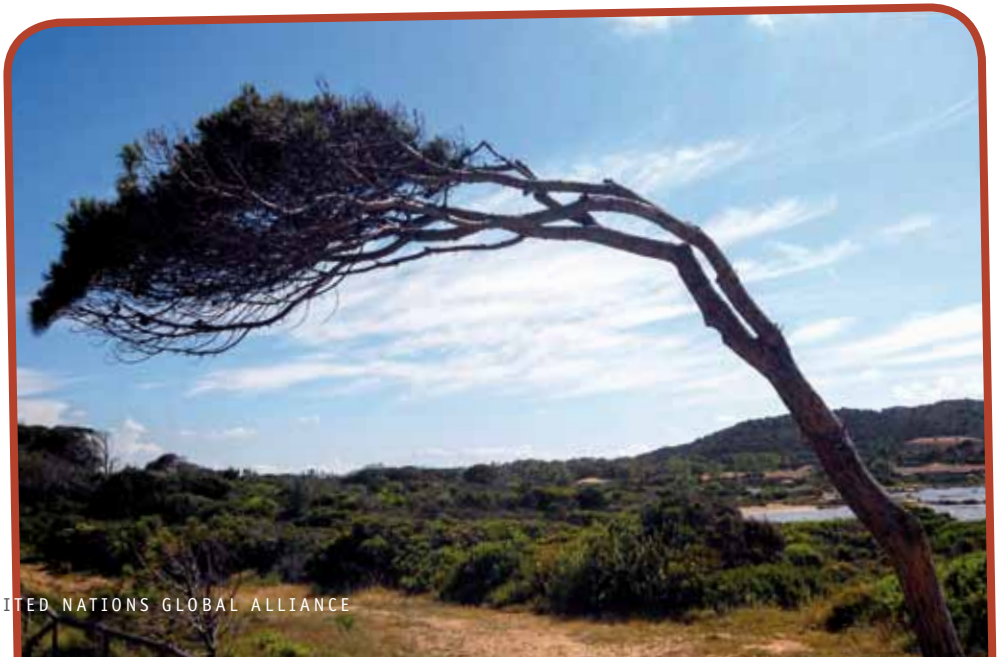
AIR
the invisible danger

Tornadoes, cyclones and windstorms are the most impressive forms of wind. Winds can blow up to 400 km/h (250 mph) and cause enormous damage to human **infrastructure** and forests. Wind can carry snow, ice, sand, dust, hail, debris or a combination of these things, becoming even more devastating. During a windstorm, trees can become bent, twisted, uprooted or broken as well as having their bark and leaves or needles stripped off. Such damage obviously makes them more vulnerable to other harmful forces, too. Chain reactions are also common. For example, when a big tree falls, dozens of other neighbouring trees may be brought down with it. However, the wind doesn't need to be strong to affect trees – just being exposed to a constant sea breezecan be enough to make a tree grow crooked!



STRONG WINDS CAN AFFECT FORESTS.
© Rafik K.

Constant exposure to wind (e.g. in mountains, semi-arid regions or along the coast) dries the soil and **vegetation**, and even erodes the ground on which **vegetation** grows.



TREE BENT BY CONSTANT SEA WINDS IN SARDINIA, ITALY.
© Arcalino

FIRE
friend and foe

Did you know that fire is both a friend and a foe of forests? Although fires can destroy vast areas of forests, they can also contribute to the overall health of forests and even to the survival and reproduction of some tree **species**!

Forest fires have always been pretty common. In the ancient past, forest fires were ignited by natural forces such as lightning, volcanic eruptions or sparks from rock falls. Later on (but still thousands of years ago), humans took over as the main fire starters. Today, 90 percent of forest fires are caused by human activities, such as deliberate fires set for clearing land for agriculture, or accidental fires set by a stray cigarette or an unattended campfire. Fire can easily and unintentionally get way out of control. These uncontrolled **wildfires** do not only damage forests, but also endanger wild animals, people and sometimes



SLASH AND BURN AGRICULTURE IN GUINEA. LAND THAT HAS BEEN CLEARED BY FIRE IN ORDER TO PLANT FONIO CROPS.
© FAO/Marzio Marzot

DID YOU KNOW?

Fires are sometimes used by humans to clear spaces in the forest in order to make space for agricultural land. This **unsustainable** practice is called 'slash and burn agriculture' and is very damaging, not only to the forest around but also to people's health because it creates bad air pollution that can travel thousands of miles.

entire villages. In these cases, fire suppression is a matter of life or death.

During the last few centuries humans have made enormous efforts to suppress fires. Ironically, these efforts sometimes harm the forest. Regular, small-scale, low ground fires can be beneficial to forest **ecosystems** that are adapted to regularly occurring fires. They control pests, create space for the strongest trees to grow, and most importantly, prevent dry leaves and branches from piling up on the **forest floor**. Forests with extra high levels of dead leaves and branches are like ticking time bombs: when a fire finally does eventually start, the leaves and branches provide lots of fuel for the fire, allowing it to grow into a giant and destructive fire.

The trick is to limit the severity of fires. Community or professional fire managers light low intensity fires on a regular basis – in a controlled manner. This is called a prescribed fire.



A WILDFIRE IN THE BITTERROOT NATIONAL FOREST IN MONTANA, USA.
© John McColgan, Bureau of Land Management, Alaska Fire Service



A PRESCRIBED FIRE.
© FAO/Simon Maina

IN FOCUS

HEROIC PLANTS THAT LIVE WITH FIRE

Some plants actually need fires to reproduce; for example, the **jack pine** (*Pinus banksiana*), a **coniferous** tree **native** to North America. Its seeds are housed in extremely tough cones that stay closed until an intense heat source, such as a forest fire, causes them to open. Because the forest fire also clears the **understorey** and forest debris, the released jack pine seed benefits from a freshly prepared nutrient-rich ash bed without competitors.

The **eucalyptus** is sometimes called a 'dirty tree' because it produces large quantity of litter (leaves, bark) that can pile up on the soil. Eucalyptus litter is easily flammable. Some eucalyptus **species** also produce oils that are highly flammable. Eucalyptus trees can **regenerate** quickly after a fire, while other tree **species** cannot. Hence, the spread of fires actually prevents other tree **species** from invading eucalyptus territory!

© William D. Boyer, USDA Forest Service, Bugwood.org



A EUCALYPTUS TREE SHEDDING ITS BARK.
© fir0002



WATER
too much, too little; too hard, too dirty

Water is a vital source of life. Every living **organism** on Earth needs it. So, how could such a precious thing harm forests?

THINK ABOUT IT

Under what conditions can water harm a forest?



TOO MUCH WATER CAN HARM FORESTS, LIKE THE AFTER-EFFECTS OF THE 2004 TSUNAMI IN INDONESIA.
© FAO/Jim Holmes

Whether water helps or harms a forest and its inhabitants depends on its *quantity* and *state*. Let's explore this idea:

- **Too much water:** There are many ways that large amounts of water can enter a forest in a short period of time. For example, powerful **tsunamis** and flooded rivers and lakes can bring enormous waves that strike **vegetation** with terrific force. Slow but continuously heavy rains can be dangerous too. Wet soil is heavy, and may even give way to create a landslide, like we saw earlier in the chapter. Too much water, in the form of excess standing water, is also dangerous: it fills the spaces between the soil particles previously occupied by **oxygen**, preventing the submerged roots from exchanging gases that they need to survive. However, there are some types of tree that can survive (and even thrive) in standing water. The mangrove forest is a key example (see pp.65-69).
- **Not enough water:** Water may be unavailable due to hot and dry weather conditions (rapid **evaporation** or no rain at all). If this situation is prolonged, it is called a **drought**. The lack of water causes plants to suffer; they wither and eventually dry out. They become more vulnerable to other threats, including diseases, pests, extreme



SNOW AND ICE DAMAGE TO A FOREST IN CZECHIA.
© Petr Kapitola, State Phytosanitary Administration, Bugwood.org

temperatures and strong winds. A long **drought** can also increase the possibility of forest fires.

- **Solid water:** Melting snow and ice are important sources of water for forest **vegetation** in some parts of the world. However, when the snow and ice come down from a mountain too fast, they can be very destructive. In a matter of seconds snow can turn into a high-speed **avalanche** hurtling down a steep slope and destroying everything in its path, including houses and large trees. Snow and ice can also damage trees on a smaller scale, for example by piling up on a tree's branches. While beautiful to look at, the heavy weight of snow and ice is often enough to break branches.
- **Polluted water:** Water can be pure and drinkable, or contaminated with toxic substances harmful to the health of living creatures. Humans release many of these toxins into our planet's waterways. For example, when we burn **fossil fuels** in our cars and factories, or use fertilizers and pesticides to increase agricultural yields, we release toxic substances. When these toxic substances mix with water in the **atmosphere** (producing **acid rain**) or in the soil, they can travel for hundreds of kilometres with the help of wind currents or rivers. The effects of these substances vary greatly. Along their journey, some of these substances may dissolve and/or leach (suck out) **nutrients** and minerals from the soil before plants can use them. At the same time, substances can modify other usually harmless soil particles, making them dangerous for trees. Leaves and needles are particularly affected: when exposed to some substances leaves may turn brown and fall off (a phenomenon called 'forest dieback'), making it harder for trees to withstand the cold or other stress factors.



AVALANCHE DAMAGE TO A FOREST IN FRANCE.
© F. Parrel

IN FOCUS

HEROIC PLANTS THAT EVOLVED WITH WATER THREATS

A bit like mangroves (remember pp.65-69), **cypresses** can survive in flooded areas. They have developed funny-looking projections from their roots that are nicknamed 'knees' (because they look knobbly!). These 'knees' stick up to 30 cm out of the soil in which cypresses roots are anchored. Most scientists agree that they help the roots get enough oxygen, as they break through the surface of the water into the air while the rest of the root is submerged. Some mangroves have 'knees' too by the way!

Baobab trees are part of some beautiful African landscapes, where it is hot and dry for long periods. Their fatness (which the first baobab was apparently so upset about, remember p.48) is actually the key to their survival during long dry periods: their thick trunks store water during the rainy season which they can access and use during the following dry season.



CYPRESS 'KNEES' STICKING OUT OF A SWAMP.
© Natalie K

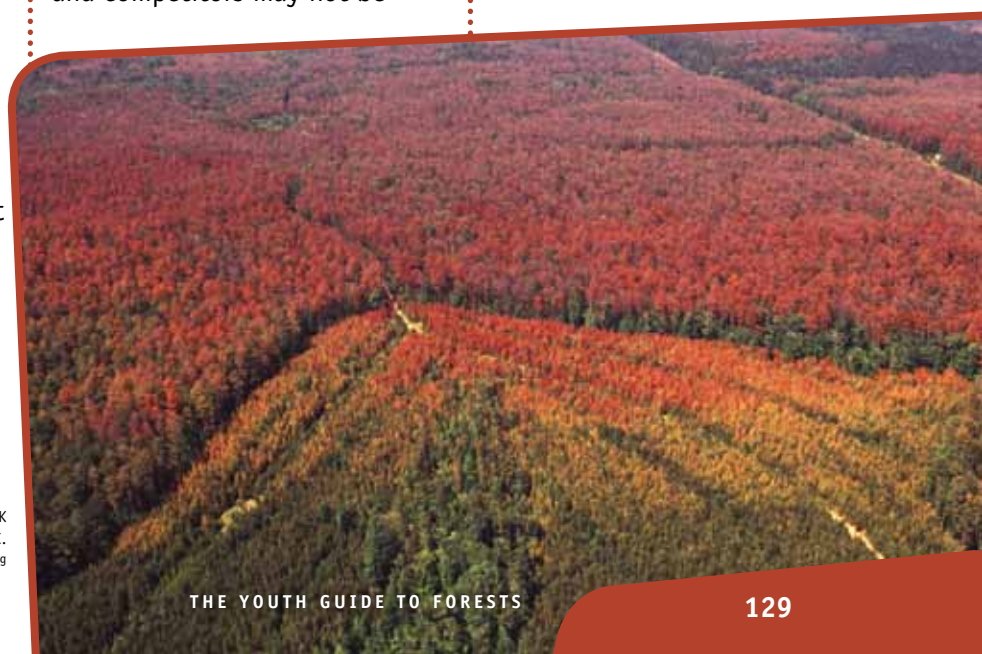


A 'FAT', WATERY BAOBAB IN MADAGASCAR.
© Cilibul

Pesky pests

Insects, **fungi** and wild animals are natural and essential inhabitants of healthy forests. They perform many different and useful tasks. For example, they speed up the decomposition process of dead plants and animals, they pollinate plants, they transport seeds, and they are prey (food) for other animals. At the same time, insects, **fungi** and wild animals are constantly challenging trees: pests and **fungi** can kill or injure trees, browsing (grazing) animals can slow the growth of new seedlings, and diseases caused by **microorganisms** can kill many trees. Such occurrences are usually very limited and only the weakest trees die (e.g. young, stressed or unhealthy trees). However, under certain conditions, insect or pest populations expand to the point where they become a serious threat to forests. This is called a pest outbreak.

Some **species** are particularly inclined to wreak havoc in certain environments. These **species** usually come from somewhere else in the world. These **non-native** (or **exotic**) **species** may have been introduced by humans by mistake; for example, when transporting wood and wood products, food or animal and plant products. On the other hand, some **species** may have migrated (due to changes in **climate**) when their previous **habitat** was no longer able to support them. If they can survive in their new environment, **exotic species** can often spread more quickly than at 'home', because their natural predators and competitors may not be there to keep their numbers in check. As **native species** have never encountered the newcomers before, they might not have effective defenses to protect themselves from new competition or predation posed by the **non-native species**. Therefore, harmful newcomers are called **invasive species**: they are nasty competitors for space and **nutrients** and may even replace unique or **endemic** plants and animals previously living there. If these **native species** disappear, then the other animal and plant **species** that depend on them are in trouble. The **invasive**



A FOREST IN TEXAS, USA SUFFERING FROM A BARK BEETLE ATTACK.
© Ronald F. Billings, Texas Forest Service, Bugwood.org

species may not offer the same **habitat** or **nutrient** quality as the **native species**.

If you see a group of rusty red trees and it isn't autumn, you may be seeing trees under a bark beetle attack. The picture on the previous page was taken in Indian Mounds Wilderness, Texas, USA. (Don't jump to conclusions though; some trees show similar symptoms even though they are affected by different stresses, including pests and air pollutants.)

Mile-a-minute weed (*Mikania micrantha*) is a perennial vine from Central and South America. It was originally introduced in India to camouflage airfields during the Second World War. Today it has spread uncontrolled (its shoots grow up to three centimetres per day!) throughout large areas of southern Asia, overrunning forests and crops, cutting out the light and smothering life under a green blanket.

The problem of **invasive species** is getting worse as more and more people and products move around the world. **Climate change** amplifies the problem because **species** are migrating to new areas in order to stay in the **climate** to which they are most suited.

MILE-MINUTE-WEED COVERING TREES IN THE USA.
© USDA APHIS PPQ Archive, USDA APHIS PPQ, Bugwood.org



IN FOCUS

HEROIC PLANTS WITH SPECIAL DEFENCES AGAINST PESTS

To protect themselves from unwanted guests, conifers produce a sticky substance called resin. When they are damaged, the resin keeps insects out and kills other **microorganisms** that could infect the wounded bark. (This is similar to how your own body produces scabs to protect cut or scraped skin from letting in harmful germs.)

Some trees, like this **babool** (*Acacia nilotica*) in India, are covered with mean spikes that offer prickly protection against **herbivores** who want to eat the tree's leaves. Ouch!

© J.M. Garg



Climate change

We have seen that there are many different natural processes that affect forests. When these processes occur naturally and occasionally, the forest is generally able to recover. However, one global process is increasing how often these events occur and is making the forest very vulnerable to threats. This silent killer is the increasing amount of **greenhouse gases** in the **atmosphere**.

Here's how it works: like the glass in a greenhouse, **greenhouse gases** in the **atmosphere** create a layer that prevents the Sun's heat from escaping the **atmosphere** again, making the Earth heat up. This isn't a bad thing in itself; without the 'greenhouse effect' Earth would actually be too cold for us to live on. We also know that plants need **carbon dioxide** for **photosynthesis** - so what is all the fuss about? The problem occurs when the levels of **carbon dioxide** and other (**greenhouse gases**) in the atmosphere get too high. And levels have been rising rapidly since the late 18th Century, when human industrial activities began to flourish on a large scale. Especially by burning **fossil fuels**, we have hugely increased the naturally occurring levels of **carbon dioxide** in the **atmosphere**.

You can work the next step out for yourself: higher **carbon dioxide** levels means more of the Sun's heat stays trapped in our **atmosphere**. This leads to a slow but steady increase of the Earth's average (overall) temperature, accelerating what is known as **climate change**. As we've seen in Chapter 4 (remember p.83), trees play a vital role in helping to **mitigate climate change** (slow it down) by acting as **carbon sinks**.

We also learnt in Chapter 2 that the **climate** is very important in determining which **species** live in which locations, so as the **climate** changes, **species** are forced to migrate (move) or **adapt** to the new conditions. If they can't do either, they are threatened with **extinction**. **Climate change** is highly likely to affect the frequency with which extreme events occur, such as **droughts** and fires, or pest outbreaks. As the **climate changes**, so too do many aspects of the forest and our lives (find out more in the box on pp. 132-133).



IN FOCUS

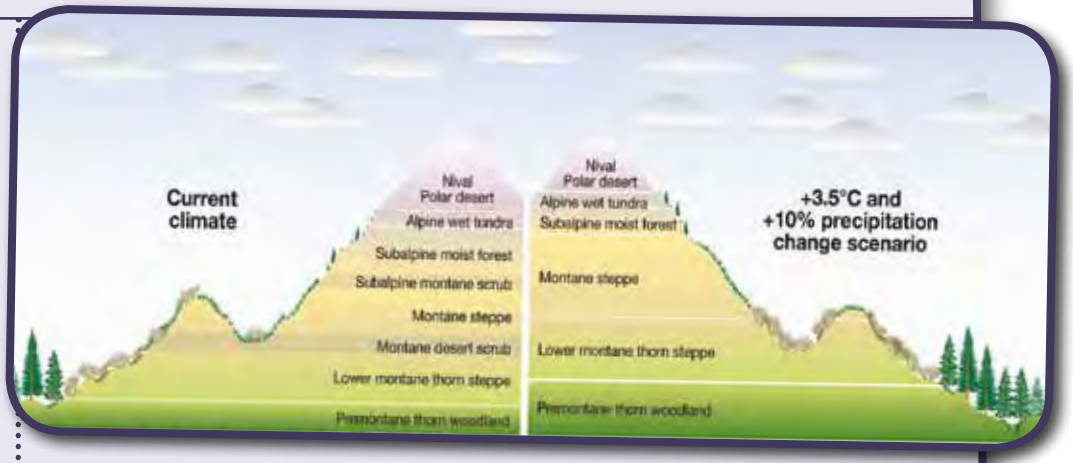
IMPACTS OF CLIMATE CHANGE ON FORESTS

Susan Braatz, FAO Forests and Climate Change

Forests are sensitive to **climate change**. Even a small change in the average temperature can have severe consequences on forest features. According to international **climate** experts, the average temperature of our planet is likely to increase by 1°C to 6°C by the end of the 2100. Changes linked to **climate change** in the world's forests have already been observed. Here are some examples:

:: **Changes in the type of forests and wildlife**: Some **species** are expanding their geographic range and colonizing (taking over) new areas, whereas other **species** are disappearing from ranges that they previously occupied.

:: **Changes in the amount and location of forests:** Forests are on the move.



IMPACT OF CLIMATE CHANGE ON MOUNTAIN VEGETATION ZONES.
© Philippe Rekacewicz, UNEP/GRID-Arenda, www.grida.no/publications/vg/forest

To find more favourable conditions, many forests are migrating northward or southward towards the poles or to higher altitudes. In areas that are already very dry, forests that cannot migrate are at risk of disappearing altogether. Wet areas are also affected: rising sea levels threaten forests located on the coast, especially mangroves.

:: **Changes in the health of forests:** Depending on region, **climate change** can either increase or decrease forest growth. In most cases, however, forests become more vulnerable to **disturbances**. Changes in temperature can cause changes in the timing of life cycle events. For example, spring events like blossoming or flowering occur earlier than usual, which can increase the risk of damage from events such as spring frost. Furthermore, different **organisms** within the

forest **ecosystem** may react differently to the changes in **climate**, and this can disrupt the functioning of the **ecosystem**.

In addition to these direct effects of **climate change** on forests, there are also indirect consequences. **Climate change** is affecting the frequency, intensity and timing of **forest disturbances**. This means forests experience:

:: **More extreme weather events** (storms, wind, rain, **drought**, heat waves, etc.);
:: **More frequent and more extreme attacks** by pest, diseases and invasion by new **non-native species**; and
:: **Increased forest fires** due to drier and warmer conditions and lightning storms.

Have a look at the diagram on the right. It shows the relationship between **climate**, **disturbance** and forest **degradation**. It is a closed circle. It's a vicious cycle, in which every process causes the following process to increase. This is known as positive feedback (though it has decidedly negative consequences in this case!). In this way, **climate change** is self-enforced by its own effects on forests!

DISTURBANCES > FOREST DEGRADATION: The more **disturbances** there are, the more the forests are **degraded** or destroyed.

FOREST DEGRADATION > CLIMATE CHANGE: If forests are destroyed, the **carbon** that was stored in their wood and in the soils that were protected beneath them is released back into the **atmosphere**. The fewer forests there are, the less **carbon dioxide** is soaked up from the **atmosphere** and stored in the trees. Increased concentration of this gas in the **atmosphere** increases the risk of **climate change**.



CLIMATE CHANGE, DISTURBANCE AND DEGRADATION CIRCLE.
© YUNGA, Emily Donegan

CLIMATE CHANGE > DISTURBANCE: **Climate change**, in turn, increases the frequency of **forest disturbances**.

... And the cycle starts again.

Human actions

As with natural threats to forests, human actions have both direct and indirect impacts on forests. The **direct impacts** are:

- The use of forest resources, such as wood and **non-wood forest products**;
- The conversion of forested land for farming;
- The expansion of cities and towns into forests;
- The building of **infrastructure**, such as roads.

All of these impacts can cause **degradation** and **deforestation**.

Humans also have **indirect impacts** on the functioning and overall health of forest **ecosystems**. The most important indirect impact is, as discussed, our contribution to **climate change**. However, we can also influence forests through pollution that enters our waterways and **atmosphere**, through changes in **watersheds** due to river management systems such as dams, and through soil **erosion** near forests due to farming or the development of cities.



THE LAST BATCH OF SAWNWOOD FROM THE PEAT FOREST IN INDRAGIRI HULU, INDONESIA. THE FOREST HAS BEEN CLEARED TO MAKE WAY FOR AN OIL PALM PLANTATION.
© wakx

IN FOCUS

PALM OIL – WHAT'S THE FUSS?

Without knowing it, you probably eat palm oil almost every day because it is an ingredient in many processed foods. (The average person who lives in a **developed country** eats 10 kilos of palm oil a year.) Palm oil is produced from the fruit of the oil palms, which grow in the **tropics**. As well as being used for food, palm oil is also burnt as a **biofuel**, a type of renewable energy. It is very popular because the plants produce lots of oil at very low cost.

So, if palm oil is a cheap source of oil and **renewable energy**, why are people concerned about how much of it is produced?

Well, the problem is that palm oil is too popular and creates so much money for those who grow it that oil palm **plantations** are worth more than healthy rainforests. Therefore, rainforests are being cut down to make way for oil palm **plantations**. In Indonesia and Malaysia, an area of forest the size of six football pitches is destroyed every minute to make way for oil palms! (*Source*: www.saynotopalmoil.com)

This **deforestation** contributes to **climate change** and creates air pollution that endangers animal and human health. Not only that, but **deforestation** is destroying rainforests that are home to the many amazing **species** that we have learnt about in earlier chapters. For example, the Sumatran orangutan has lost 90 percent of its **habitat** in the last 20 years largely due to oil palm **plantations**, and is now an **endangered species**.



A FARMER HOLDS A RIPE DATE PALM FRUIT BUNCH READY TO BE PROCESSED INTO PALM OIL.
© FAO/Ami Vitale

FOREST BIODIVERSITY UNDER THREAT

As a consequence of **deforestation**, forest **biodiversity** is being lost at an alarming rate: up to 100 forest animal and plant **species** are lost (go **extinct**) every day, and many of these **species** are ones that we don't have much knowledge about yet – and will now never know about.

Thirty-six percent of the world's total forest area is covered by **primary forests** (remember: those are forests comprised of **native species** where natural **ecological processes** have not been significantly disturbed by human activity). **Primary forests** include some of the world's most **species**-rich and diverse **ecosystems**. Due to the threats mentioned earlier, they have shrunk over the last ten years by more than 40 million hectares.

The International Union for the Conservation of Nature (IUCN) is the association that measures the population (number of animals) and distribution (where they live) of **species** and decides whether a **species** is under threat. This project is called the 'Red List' – see the in focus box on p.137 to learn more. There are currently 28 235 identified forest **species** on the **IUCN Red List** and of those, 7 599 are threatened; in other words, more than a quarter of all forest **species** are threatened with **extinction**! Furthermore, 22 of these **species** are **extinct** in the wild (they are only found in zoos or **captivity**) and 166 are **extinct** altogether (*Source*: IUCN Red List).



Is the forest **biodiversity** *nearest you threatened?*

If so, what are the major threats?

DEFORESTATION

IN FOCUS

WHAT IS THE RED LIST?

The **IUCN Red List** is the world's most comprehensive information source on the global **conservation** status of **species**; it currently holds information about more than 48 000 different **species**, covering **species taxonomy**, geographic ranges, population numbers and threats. These data are collected by thousands of experts worldwide and are an extremely useful tool for influencing **conservation** decisions, informing **species**-based **conservation** actions, andmonitoring **species**' progress.





CONSEQUENCES OF FOREST LOSS

Forest **degradation** and **deforestation** can cause loss of **biodiversity** and the destruction of natural **ecosystems** which isn't just bad for nature: damage to forests can have severe consequences for the people who depend on them, too. As we learnt in earlier chapters, we rely on forest **ecosystem services** and forest products for our well-being, and even our survival! Some groups of people, including some **indigenous peoples**, are especially dependent on forest resources for building their houses and finding fuelwood or food. In summary, the loss or **degradation** of a forest can have significant negative effects on:

- people's well-being,
- people's income,
- the environment.

However, healthy forests can be very resilient, recovering from stressful situations or damages over time. Forest **regeneration** can actually increase plant and animal diversity, and enable **species** best adapted to that particular environment to become established. Thus the temporary loss of trees is not always a bad thing from an **ecological** point of view. However, continued **degradation** by humans over a long time reduces the resilience of forests to natural threats and makes them more vulnerable to irreversible damage. In the next chapter we are going to learn about what groups around the world are doing to help forests **regenerate** and remain strong in the face of changes.

FOREST REGENERATION USING AN ASSISTED NATURAL REGENERATION (ANR) APPROACH IN THIS FOREST IN THE PHILIPPINES.
© FAO/Noel Celis



CONCLUSION

There are many factors that contribute to forest loss and degradation. From natural hazards such as drought, avalanches, fire and flooding – to human induced pollution, climate change and introducing invasive species, forests certainly have a lot to deal with. It may seem like it is all a bit overwhelming and that our planet's forests are doomed. But that's not the case! It is in our hands to change human practices to better conserve the Earth's forests. Let's delve into what we can do to help protect forests in Section E.



LEARN MORE:

:: Forests and Climate Change: www.fao.org/forestry/climatechange/en

:: Problems with palm oil: www.saynotopalmoil.com

:: Review of the Status and Trends of, and major Threats to, Forest Biological Diversity: www.cbd.int/doc/publications/cbd-ts-07.pdf

:: Threatened species: www.iucnredlist.org

:: Wildfires: www.smokeybear.com



Section

ACTIONS TO PROTECT FORESTS



Chapter 7
FOREST MANAGEMENT

Chapter 8
THE FUTURE OF FORESTS

Chapter 9
FORESTS AND YOU!





FORESTS MANAGEMENT

HOW CAN WE BETTER LOOK AFTER ONE OF EARTH'S MOST VALUABLE HABITATS AND SUPPLY OF NATURAL RESOURCES? HOW CAN FORESTS BE MANAGED SUSTAINABLY?

7

Given that forests are so important for our survival and that they are under attack from both natural and human-made forces, we need to think about how we can manage and protect forests. It is important to properly manage the forest because it provides so many valuable ecosystem goods and services. This chapter investigates the best way to manage forests sustainably for the future, including different forest management techniques.

OXBOW LAKE, YASUNI NATIONAL PARK, ECUADOR.
© Geoff Gallice

CULTURAL STORY

WHY HUMAN DEATH IS LIKE THE BANANA TREE

Here is an ancient creation story from Madagascar:



A BANANA TREE, LIKE ALL OTHER PLANTS, IS NOT IMMORTAL, BUT THANKS TO THE NEW GENERATIONS ITS PRESENCE REMAINS ON THE LANDSCAPE.
© FAO/M.Bleich

Birth and death can take many forms. Many years ago, God asked the first man and woman on Earth about death. He posed an unusual question, "Do you want to die like the moon or like the banana tree?"

The woman and the man did not understand, so God explained, "The moon leads a cyclical life: each month it fades away and dies, then it slowly revives back to life. The banana tree is different. When it dies, it does not come back to life. But before it dies, it sends out green shoots, and its offspring live on in its place. Would you prefer to revive every month like the moon, or have your children replace you like the banana tree?"

The man and the woman spent a long time thinking about their decision.

If they wanted to live forever, like the moon, they would be childless. It would be a lonely life and there would be nobody else to teach, to love or to help them with their work. In the end, they decided to be fruitful like the banana tree. During their lives, the woman and man had lots of wonderful children and were very happy.

All generations of humans who lived after the first man and woman have spread lots of love and life around the planet. But the time that each individual spends on Earth is brief, according to the wishes of the first woman and man. In death, the human body dies like the banana tree.

(*Source:* http://spiritoftrees.org/why-death-is-like-the-banana-tree)

MANAGING FORESTS

WHY IS FOREST MANAGEMENT IMPORTANT?

Some of the particularities of trees, forests and forest management make planning the future of a forest especially challenging and important:

- **Trees and people have very different lifespans.** Trees grow more slowly and live two to ten times longer than us. This means forest managers must consider (very) long-term needs, and not just immediate ones.
- **Forests are mainly public goods that belong to everyone.** Most of the world's forests (80 percent) are publically owned. This is an advantage because it allows many people to benefit from them, but it is also a challenge when decisions need to be made because many diverse actors have the right to assert their interests or needs. See the box on p.146 to find out more about forest rights.
- **Forest management operations cost money.** Managing forests can be expensive. Some of the costs can be offset by selling **timber** or other forest products, or by allowing people to use forests and their resources for a fee, such as when people park their cars, camp or hike in a national park.



FAMILY MEMBERS GATHER COFFEE BERRIES IN UGANDA. THE GOVERNMENT HAVE INTRODUCED SUSTAINABLE FOREST MANAGEMENT, GIVING LOCAL COMMUNITIES ACCESS TO FOREST RESOURCES.
© FAO/Roberto Faidutti



How would you feel if the land you lived on or your house got taken away from you?

How do you think people who depend on forests for their entire **livelihoods** *feel when the forest is taken away from them?*

IN FOCUS

WHAT DOES IT MEAN TO HAVE RIGHTS TO THE FOREST?

All human beings have rights. Rights are principles of entitlement, which means that the person who holds the right is entitled to something.

If you have a right to forest land or forest resources then you are allowed to use or make decisions about that land or those resources.

When it comes to forests, lots of different people have different rights. Some people may have **ownership rights** to the forest, which allow them to sell it and its products to whomever they want. Other people may have **use rights**, which permit them to use and harvest the forest resources. These different rights may be in conflict.

Rights that are recognized by the law are known as '**statutory rights**', and are usually easier to uphold than rights that are not recognized by formal, legal systems. This is because if a statutory right is disrespected, the legal system to evaluate and settle disputes is already in place. However, most **indigenous peoples** only have informal, non-legal '**customary rights**' to use it because they have lived on the land longer than anyone else. Therefore, if the land is legally sold to someone else who starts using up the forest's resources or clears it altogether, **indigenous people** will lose the resources they require to survive, or may even lose their homes.

To prevent this problem, it is important that both types of rights (customary and statutory) are recognized in the management of forest resources.

HUMAN IMPACTS ON FORESTS

The impact we, as humans, have on a forest depends on the *type* of management methods used and *how much* we manage the forest.

To help forest managers (and anyone else intrigued by forests) to easily communicate, FAO's Forestry Resources Assessment uses the following five forest categories to **classify** forests (also remember the original forest classifications on pp.18-19). They are based on increasing degrees of human impact:



1. Primary forest

A forest that doesn't show any sign of modification by human activities.

© ganmed64



2. Modified natural forest

A forest with plants that occur naturally in an area modified by *limited* human activities (mainly natural **regeneration** and single tree logging).

© Andy Arthur



3. Semi-natural forest

A forest with plants that occur naturally in an area modified by *intensive* human activities (e.g. assisted **regeneration**, logging, thinning).

© CIAT, Neil Palmer



4. Forest plantation

A forest with plants that occur naturally or that have been artificially introduced and that present a very geometrical pattern (trees of the same age planted at regular distance).

© USDA Forest Service, Steven Katovich



5. Other land

Land with very degraded vegetation that is not considered forest anymore (but that still has scattered trees).

© Dirk van der Made

1
the most natural

We can also think of these categories as degree scale of a forest's 'naturalness'

5
the least natural

IN FOCUS

EXTENT OF FOREST TYPES

Using the categories described on p.147, scientists have made some interesting discoveries about the extent of different types of forests. The 2010 Global Forest Resources Assessment notes that:

- Forests cover about 31 percent of the Earth's land area. This is a little bit more than four billion hectares. More than half of the world's forests (by area) are found in just five countries (the Russian Federation, Brazil, Canada, the United States of America and China – to be fair, those are all pretty big countries!).
- **Primary forests** make up 36 percent of the world's forests. **Primary forests**, particularly wet **tropical forests**, are the world's most diverse forests with the greatest variety of plant and animal **species**.
- **Planted forests** make up seven percent of the world's forests. The number of hectares of planted forests has increased between 2000 and 2010, and is expected to increase in the future.
- Most of the world's forests (57 percent) are modified natural forests, which grow naturally without human assistance but show some signs of human activities.

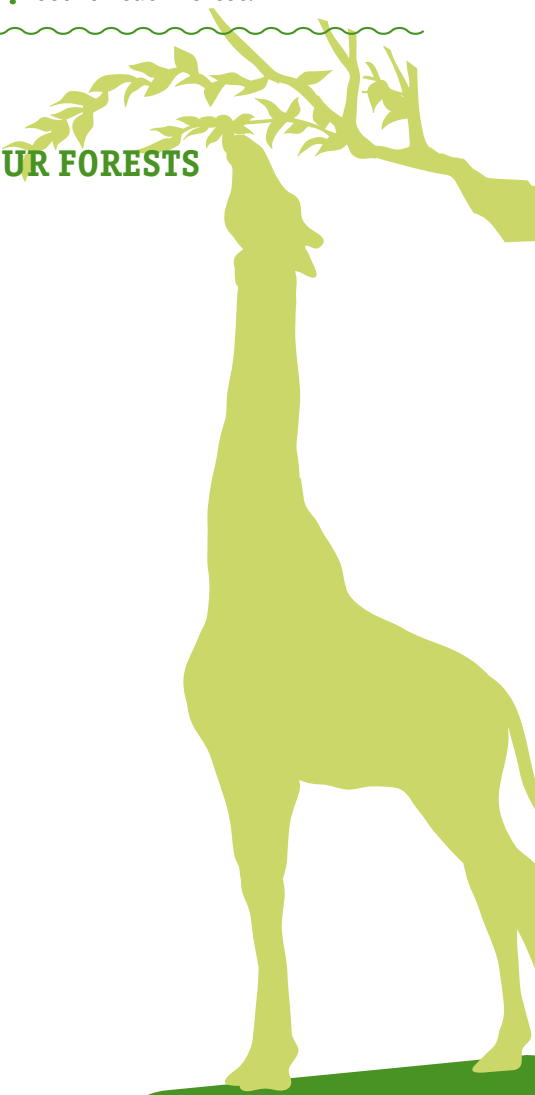


We can use these categories to help us make management decisions. For instance, we can decide that we would like to keep a certain forest at a specific degree of naturalness, and then manage it accordingly. It is even possible to protect a forest or a certain area according to one of these categories. For example, we can decide that we want to maintain the untouched character of a forest and ensure that any kind of human activity is forbidden (category 1). Another area could be open to the public for recreation, but the exploitation of its **natural resources** is strictly forbidden or restricted to a greater or lesser degree (categories 2-3). The naturalness of a forest may also determine the **priority** we set for each forest.

PLANNING: PRIORITIZING WHAT WE WANT FROM OUR FORESTS

There are many different ways in which the important resources forests give us can be used, depending on different people's needs.

Sometimes forest areas can be managed to meet these different people's needs simultaneously. For example, protecting a **watershed** is usually compatible with conserving wildlife. In other cases, however, managing a forest according to multiple interests is impossible. For example, preserving the **biodiversity** is hardly compatible with maximizing the amount of **timber** extracted from the same location! The best alternative could then be to assign a **priority** to different parts of the forest. Priorities (sometimes also called the 'forest management objectives') usually reflect one of the functions listed on pp.150-151. *(You can also see the percentage of forests worldwide that are protected for that particular reason. The percentages given don't add up to 100 percent because some forests are prioritized for other reasons.)*



Forests prioritized for:



© Christian Ziegler

Conservation

These forests are managed with the aim of protecting their unique environments so that many different plants and animals can find a **habitat** that meets their **ecological** needs and so the **biodiversity** within the **ecosystem** is preserved.



© FAO/L. Dematteis

Production

Production forests are used by people for the production of commodities including wood and/or **non-wood forest products**.

With all the different ways we can use forests, the many types of resources present, and the huge number of people involved, making a decision is never easy, especially if some options are incompatible with others.



© FAO/Rosetta Messori

Protection

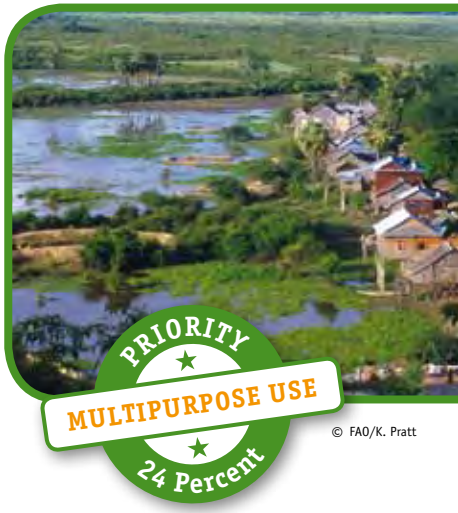
Protective forests are important for preserving soils, **watersheds** and human **infrastructure** (such as roads and houses) from **erosion**, air pollution and **natural hazards**.



© Augapfel

Socio-economic benefits

These forests offer benefits to the people who use them for outdoor recreation, tourism and education, or for people who simply appreciate their cultural or spiritual value. Other people may be employed in a forest-related industry and rely directly on forests for their economic well-being.



© FAO/K. Pratt

Multipurpose use

Multipurpose forests are managed to fulfil multiple uses and values, combining two or more of the functions described above.

For example, choosing to cut down trees can provide benefits such as local jobs, wood for construction and perhaps even new land for agriculture. However, this same activity can also destroy hunting grounds and habitats used by local wildlife. It may also cause soil erosion that will prevent crops from growing or destroy a forest area that is used by indigenous people as a basis for their livelihoods.

IN FOCUS

LOGGING

There are important economic reasons why people cut down trees in forests; logging usually occurs when the land is more valuable when it is cleared and used for other purposes, such as for growing crops or grazing animals. When logging is done **sustainably**, it provides important benefits such as jobs for people, and resources such as **timber** for building houses.

When logging is not done **sustainably**, **deforestation** can occur. This photo illustrates **deforestation** in the Philippines.



LABOURERS STRIP OFF BARK AND SQUARE FELLED TREES IN PREPARATION FOR THEIR TRANSPORT TO A MILL IN HONDURAS.
© FAO/L. Dematteis

A PORTION OF THE FOREST IS REMOVED USING SLASH AND BURN TECHNIQUES.
© FAO/Noel Celis



The good news is that forests are home to **renewable resources**. **Renewable resources** have the remarkable ability of replacing themselves once they have been used. Wood, in the form of **timber**, fuelwood and **biofuel**, is one example of a **renewable resource**. Take Christmas trees as a simple example. Each year, millions of Christmas trees are **felled**, usually from specially managed **plantations**. Yet, because new trees are also planted to replace the ones that are cut down, we can continue to use Christmas trees for holiday celebrations year after year. Therefore, the basis of forest management is making sure that we use the forest resources in such a way that they are renewable: if we didn't plant as many Christmas trees as we cut down then eventually they would run out.

Though our survival doesn't depend on having a decorated tree at Christmas, it does depend on many other forest resources. The Christmas tree example applies to every other kind of forest resource usage: think ahead to needs in years to come, work with the forest's natural ability to renew itself, and let those considerations influence your forest management activities today.



CHRISTMAS TREE PLANTATION IN THE USA.
© USDA Natural Resources Conservation Service

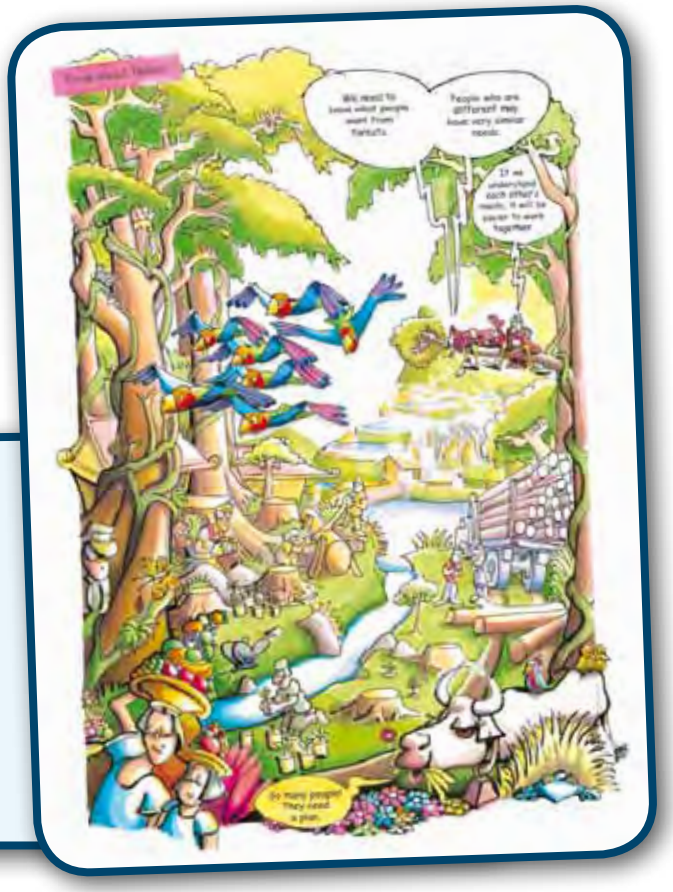
SUSTAINABLE FOREST MANAGEMENT

ONE FOREST, MANY INTERESTS

THINK ABOUT IT

Look at the picture. It illustrates many activities that forests can support.

What are these activities? Whose needs can be met by forest products? Who decides which activities are pursued and which ones are not? How are these decision made?



FOREST DILEMMA.
© FAO/Jared C. Crawford with Louise E. Buck

No matter which priority is chosen for a forest, it is important that the forest is managed sustainably.

This principle is called sustainable forest management.

To be '**sustainable**' means to be able to maintain something over a long period of time. So, **sustainable forest management** can be described as a management system that aims to keep all the parts of a forest **ecosystem** healthy, including the **vegetation**, soil, water and wildlife – both now and into the future. **Sustainable forest management** balances the protection of the forest with their use. It ensures that the goods and services that come from forests meet the needs of people today, while at the same time the availability of forest resources should be secured for long term future development. It's important that future generations can enjoy all the benefits from forests that we get from them today.

But how can forest managers know whether or not a forest is healthy and **sustainable**? They use a set of criteria that have been established at the regional and global levels. FAO identifies seven broad criteria that should be used when answering questions about forest health and **sustainability**. Each one of these criteria also has indicators that can be used to measure how well the forest management in each country or region is in line with the criteria.

They are:

1. **Extent of forest resources** – what the forest contains.
2. **Biological diversity** – the number of **species** in the forest.
3. **Forest health and vitality** – whether the forest **ecosystem** is functioning like it should.
4. **Productive functions of forest resources** – the amount of wood and **non-wood forest products** that the forest offers (**ecosystem goods**).
5. **Protective functions of forest resources** – the **ecosystem services** the forest provides.
6. **Socio-economic benefits** – the benefits that people can enjoy, such as jobs and recreation.
7. **Legal, policy and institutional framework** – how the forest land and resources are governed.

Individual countries have **sustainable forest management** programmes and monitor their own progress towards achieving **sustainable forest management**. They report the results on specific criteria to international processes, such as the FAO's Global Forest Resources Assessment and the Convention on Biological Diversity (CBD). You can find out more about these two international organizations here: **www.fao.org** and **www.cbd.int**.

By balancing social, economic and environmental objectives, global forest organizations help countries to manage their forests in a **sustainable** way so that both present and future generations can enjoy the benefits of the Earth's forest resources.
These organizations aim to improve the knowledge on **sustainable** forest and wildlife management, in order to:

- Maintain the capacity of forests to produce wood and **non-wood forest products**;
- Sustain wildlife populations;
- Conserve **biodiversity**;
- Safeguard wildlife **habitats**;
- **Mitigate climate change**; and
- Protect soils and **watersheds**.

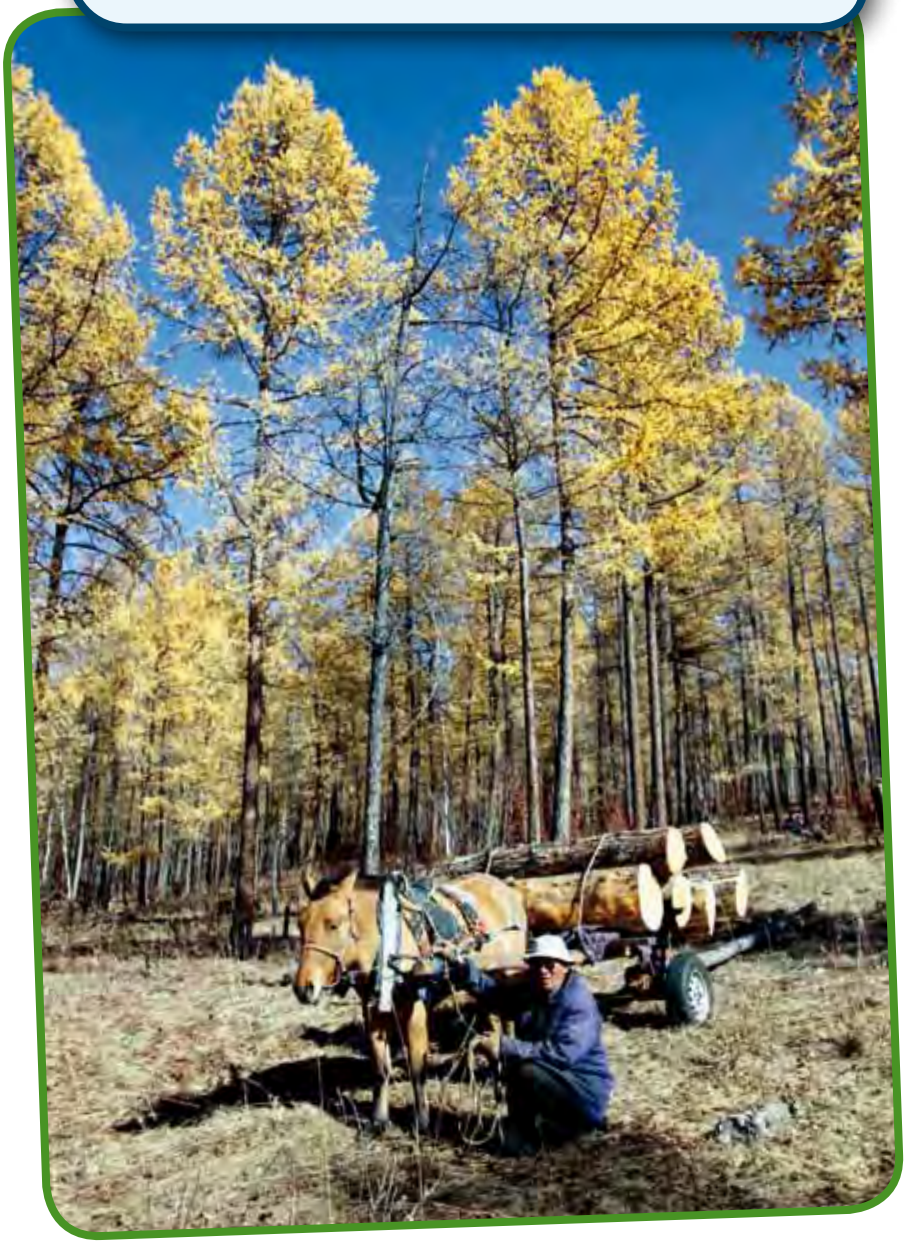
For more details about these criteria and their indicators, you can read the 'World's Forests Edition' of the *Natural Inquirer* (number 15). It's available online at **www.fao.org/forestry/29094-01972c285fac04157a542a1fbe2310a6a.pdf**

REACHING THE DESIRED STATE

After agreeing on and setting clear objectives like the ones mentioned earlier, it's time to explore different options to reach and maintain the desired state of a forest. One possibility is to act indirectly, by promoting or discouraging some practices (e.g. through raising awareness of the importance of forest **ecosystems**, or introducing a new law that prevents the cutting down of trees). Another option is to directly and physically modify the forest structure and composition. The scale of these interventions varies; it can be very minimal, involving only a few trees, or drastic, involving large areas within a forest. Let's take a look at some of the techniques used by foresters to manage forests.

THINK ABOUT IT

*What other things (apart from forests) need to be managed in a **sustainable** way?*



SUSTAINABLE FOREST MANAGEMENT CONSIDERS SOCIAL, CULTURAL, SPIRITUAL, ECONOMIC AND ECOLOGICAL ASPECTS.
© FAO/Sean Gallagher

FORESTRY TECHNIQUES

Forests are managed by forest experts who gain expertise by studying a science called 'forestry' (also called silviculture) at school or university. Forestry students learn about forest ecology, or how a forest grows and interacts with its surroundings, and about the art and business of establishing, tending, using and conserving forests. Silvicultural principles can be applied to manage forests wisely and consider many interests with the ultimate aim of maintaining forests so that they will continue to provide multiple benefits in the future.



FOREST PLANNING.
© FAO/Ch. Errath

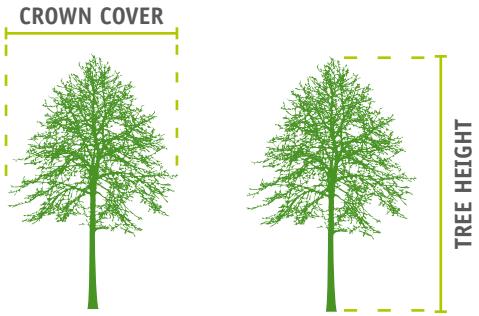
To be able to manage forests properly, forest experts require lots of information about the forest:

- The approximate numbers of trees and how old they are;
- Which tree species are present;
- The number of other species of plants and animals living in the forest;
- The extent of human influence;
- The best options available for harvesting and/or conserving the forest.

Let's look at some of the techniques foresters use to gather this information.

PROPERTIES OF TREES

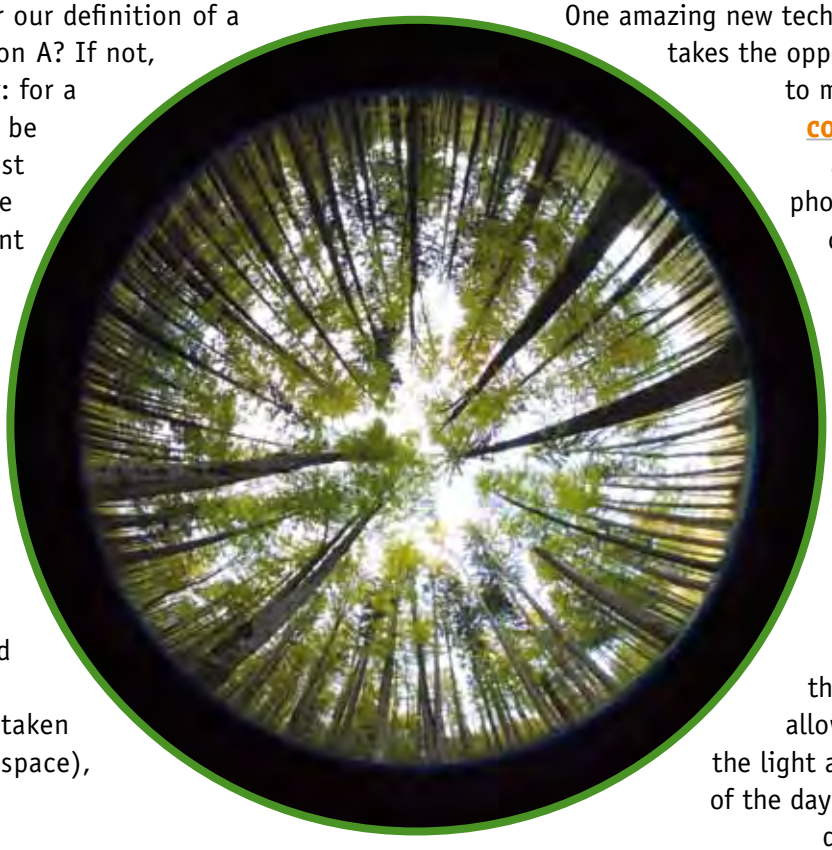
Foresters study the following properties to better understand the state of a forest.



Crown Cover

Do you remember our definition of a forest from Section A? If not, here's a reminder: for a group of trees to be considered a forest they have to have at least 10 percent **crown cover**.

But how do we measure **crown cover**? One way is to use aerial photographs to calculate how much of the ground is covered by trees. These photographs are taken from the sky (or space), looking down on the forest.



One amazing new technology, however, takes the opposite perspective to measuring **crown cover**. It is known as 'hemispherical photography', and is created when the forest manager stands on the **forest floor**, looks up, and takes a fish eye photo of the **canopy**. The photograph shows how much light reaches down to the ground! It also allows us to measure the light at different times of the day and through the different seasons.

HEMISPHERICAL (OR FISH EYE) PHOTO IN THE BAVARIAN FOREST, GERMANY.
© Wegmann

Tree height

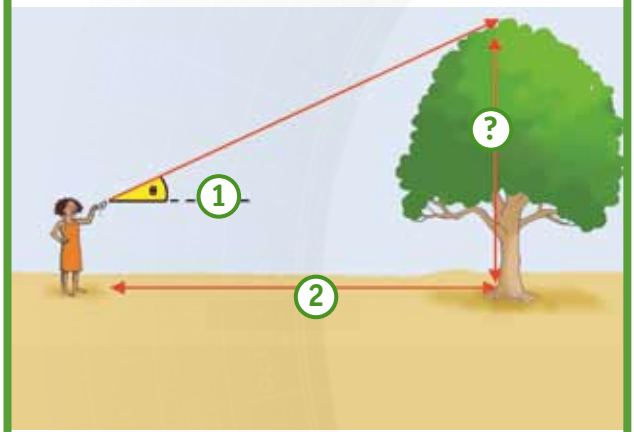
For a group of trees to be considered a forest, the average tree height must be at least five metres. However, trees can grow as tall as 100 metres! That's usually too high to use a ruler, so how do we measure the height of a really tall tree? Well, foresters use a mathematical trick called trigonometry which allows them to measure trees without having to climb all the way up to the treetop with a giant ruler. The only tools you need to calculate tree height are a stick or a ruler, a protractor to measure angles, and a scientific calculator that has trigonometric functions (or you can use an online calculator like this one: **http://web2.0calc.com**). Why not check out the diagram to see how it works and give it a go yourself!

THE TRIGONOMETRIC EQUATION TO WORK OUT THE HEIGHT IS:

$$x(\tan\theta) = y$$

? Want to find out this height 'y'

1 **MEASURE ANGLE 'Θ' WITH PROTRACTOR**
Example answer: Θ = 30°



2 **MEASURE THIS LENGHT 'X' WITH RULER**
Example answer: x= 9 m

So, using a scientific calculator and the trigonometric equation from above:
9(tan30°) = 5 m
So, the height of the tree in the example is 5 m!

TREE HEIGHT MEASUREMENT.
© YUNGA, Emily Donegan

Tree width

It is often important to know the widths of trees to know which trees should be **felled** and which should be left to grow. Sometimes, there are rules about the size of tree that can be cut down in a particular area; these rules usually include a minimum tree width.



MEASURING TREE WIDTH.
© FAO/Guilio Napolitano

Measuring tree width is actually more difficult than you might think because all trees have different trunk shapes. Different trunk shapes means that tree widths vary widely. Therefore, tree width is measured at a specific height every time, in order to try and make sure that measurements are consistent. This height is 1.3 metres above the ground and is called 'diameter at breast height' (DBH for short) because this is the average chest height for adults. DBH can be found by taking a measuring tape and measuring all around the tree trunk 1.3 metres from the ground. To find the diameter you then have to divide the number by the number π (which, rounded, comes to 3.14). Why not try it out yourself?

Tree rings

No, tree rings aren't woody pieces of jewellery to wear on your fingers! In fact, tree rings are the circles we see in the trunk of a tree. Have you ever noticed them before? Each year, when the tree grows, it adds a new ring to its trunk. That means we can use tree rings to tell us how old a tree is. Tree rings also give us lots of other information about the life of the tree. Let's look at the different properties of tree rings:

Width – the width of the tree ring tells us how much the tree grew in that year. A wide ring means that the tree grew a lot, and a thin ring means that the tree grew hardly at all. Why do trees grow different amounts in different years? Well, it's mostly due to the weather that year; if the tree gets enough water and sunlight then it will be able to grow lots but if there is a **drought** or the tree was in the shade then it will grow less. Pests can also influence tree growth; in a year when lots of bugs attack the tree, the tree uses its energy and resources for fighting the invaders instead of for growth, which means that the tree ring for a bad pest year will be small.

Scars – scarring in the rings indicate that the tree was under some stress; this could be due to pests or even fire.

Shape – are the rings circular, are they oval, or are they off-centre? Different shapes may represent the tree bending or being pushed by another tree, rock, or even a fence.



TREE RINGS SEEN IN A CROSS SECTION OF A TREE TRUNK.
© Arnoldius

Note that some trees, such as those growing in **tropical** and **subtropical climates**, can develop more than one ring per year (even as many as 20 very thin rings each year!), therefore it can be difficult to tell the age of the tree using this method alone. However, in **temperate climates** which have distinct seasons, the rings form much more clearly (the tree grows more in the summer season and then growth halts in the winter), giving distinct annual rings.

THINK ABOUT IT

Try it for yourself! Next time you see a tree stump, try counting the tree rings! How old was the tree when it was cut down? What else can you discover about this tree's life from its rings? Why not draw a picture?

FOREST BIODIVERSITY

To know how to look after the organisms in a forest – the trees, other plants, animals and fungi, it is necessary to know what is actually there! How do we measure biodiversity in a forest?



RAINFOREST CANOPY SAMPLE, MADRE DE DIOS, PERU.
© Geoff Gallice

Taking a sample

If we asked you to count every single tree in the Amazon rainforest what would you say? Probably 'No!' Just imagine how long it would take you to count the 500 billion trees there! Counting every single individual tree takes too much time. A more realistic, and still scientifically accurate, alternative is a technique that scientists and forest experts call 'sampling'. They count trees in a small area that is assumed to represent the rest of the forest. You can use sampling for any of the techniques described above. For example, you can measure the crown cover in a certain area and assume that similar areas have similar crown cover. Sampling helps save time and means that foresters can cover a larger area. However, you have to be careful that you only generalize your findings from your sample to areas that are very similar... otherwise you will get misleading results! In order to make their results more accurate, scientists almost always sample several areas of a forest and calculate their average values to reach an overall result that is more representative of the whole forest.

Background
FOREST AUTUMN COLOURS, WEST VIRGINIA, USA.
© ForestWander

IN FOCUS

COUNTING INSECTS

Insects are small, secretive creatures. Counting the number of different **species** in an area is very difficult. One way to measure all the insect diversity on one tree is called 'fogging'.

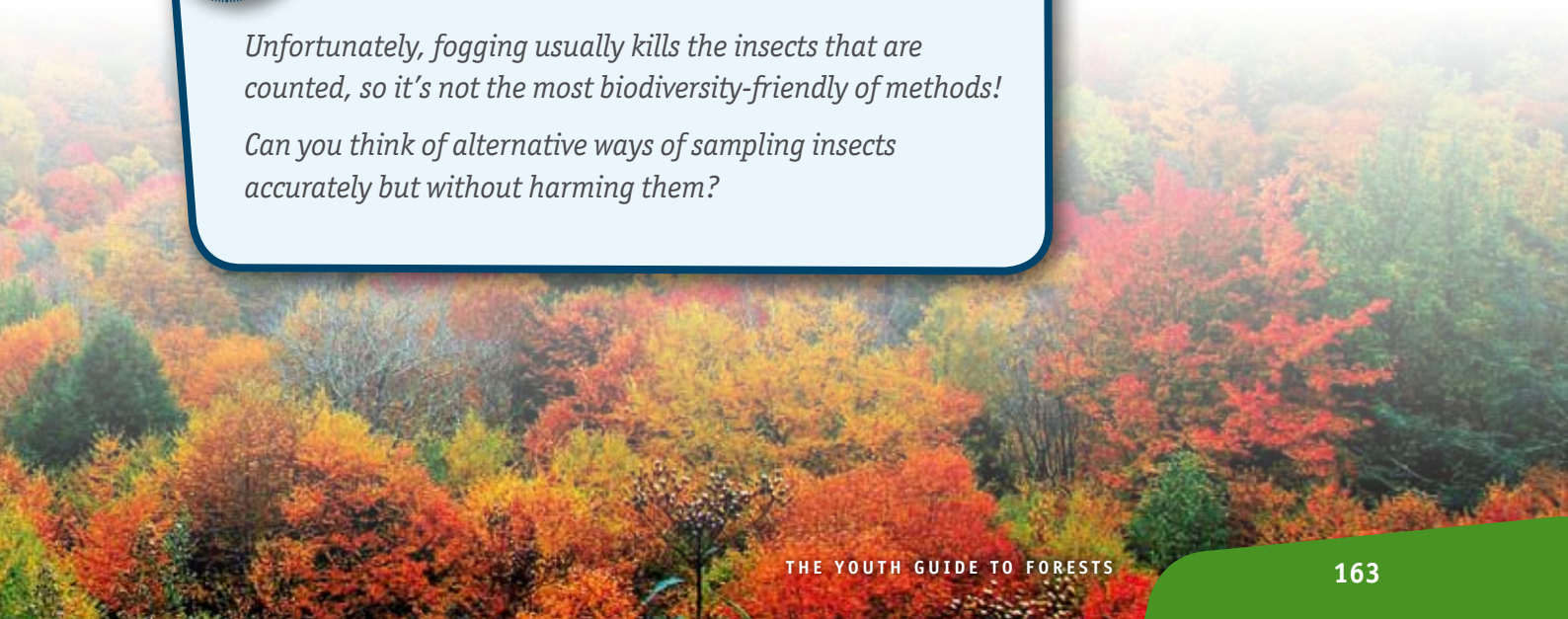
Foresters place a very large sheet underneath a tree and spray a fog of an insecticide into the tree **canopy**, which causes all the insects to fall out of the tree and land on the sheet. Afterwards, foresters count the number of insects and identify all the different **species**. Sometimes they even identify new **species** using this method.

Fogging is used as a sampling technique – it is done on one or several trees and then it assumed that trees of the same **species** contain similar numbers and **species** of insects.

THINK ABOUT IT

Unfortunately, fogging usually kills the insects that are counted, so it's not the most biodiversity-friendly of methods!

Can you think of alternative ways of sampling insects accurately but without harming them?



FOREST OPERATIONS

Forests are naturally very dynamic, meaning that they are constantly changing. A wildfire or a storm can create large openings, allowing new plants to colonize these areas. The death of a tree (caused by old age, illness or competition for nutrients, space and sunlight) can create small openings. Sometimes, foresters attempt to mimic the result of these major and minor events through forest management operations. Here are some techniques used to modify the forest appearance and character:



© Doug Waldron

Clear-cutting

All trees in a certain area are removed in one operation. It results in a large open area, similar to the effect of a forest fire. In many countries, clear-cutting is restricted by laws because it can have a drastic effect on the ecosystem.



© USDA Forest Service, Brian Lockhart

Selection cut (group/single)

In this technique, individual or small groups of trees are strategically removed. Usually lesser quality trees are felled to give more space to the larger and more commercially valuable trees. When these latter trees grow large enough, they may be harvested.



© Eli Sagor

Shelterwood

This cut is designed to remove old trees over a period of several years to make way for younger trees. Tree reproduction is encouraged and some old trees are kept to provide initial protection and shade to the sensitive new seedlings until they are strong enough to grow independently.



© FAO/F. McDougall

Assisted regeneration

This technique ensures that temporarily bare land is covered by vegetation again. Human interventions promote and accelerate the establishment of vegetation (through seeds from mother trees or by planting new species).

CONCLUSION

In the previous chapters we have learnt all about forests and their many uses. Now we understand why we need good forest management – in particular sustainable forest management – and the benefits that this method can bring to both present and future generations.

Good forest management relies on having accurate data available about the state or condition of a forest. For this reason, foresters use a range of techniques to measure the forest's properties. This information is then used to guide a range of forest operations. With good data and using the appropriate forest operations to suit different forest, forest management becomes better and more sustainable, ultimately leading to healthier forests.

LEARN MORE

:: Human impacts on forests in the FAO Forestry Resources Assessments: www.fao.org/forestry/fra/en

:: Forestry management techniques: www.irlenvirothon.org/uploads/08_Forest_Management_Techniques%5B1%5D

:: Greenworks forest management: www.greenworks.tv/rough_terrain/sustainableforests/whatis.htm

:: Silvicultural methods: www.state.tn.us/agriculture/publications/forestry/silviculture.pdf

:: Sustainable forest management: www.fao.org/forestry/sfm/en

:: Sustainable Forest Management, Biodiversity and Livelihoods: www.cbd.int/development/doc/cbd-good-practice-guide-forestry-booklet-web-en.pdf

:: Why not test out how much you know about tree rings with this quiz? http://forestry.usu.edu/htm/kids-and-teachers/tree-cookie-game





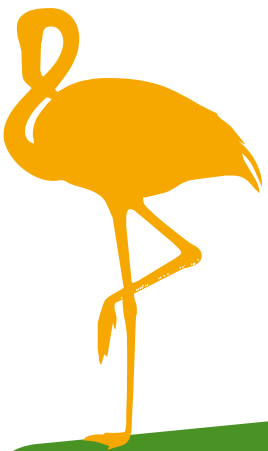
THE FUTURE OF FORESTS



MANY INTERNATIONAL AND LOCAL INITIATIVES ARE WORKING TO PROTECT AND CONSERVE FORESTS. LET'S GET INSPIRED!

8

Forests are under attack. Deforestation and loss of forest species are occurring at an alarming rate. What are people around the world doing to make sure that there are forests for future generations to enjoy?



NINJA-POSING NIÑOS, LAGUNA KUMPAK, SOUTHERN ECUADOR.
© Geoff Gallice

CULTURAL STORY

THE LORAX BY DR. SEUSS

The story of the Lorax teaches us that we must protect the forests while we still can.

A young boy living in a poor, run-down town visits a strange man called the Once-ler. The boy asks him why the town is so desolate. The Once-ler recounts that the town wasn't always this way. When he first arrived there, the Once-ler saw a beautiful, pristine valley containing happy, playful animals who spent their days frolicking in a forest of 'Truffula trees'. These Truffula trees have lots of resources that the Once-ler wanted to use to knit 'Thneeds'. These Thneeds could be used as a shirt, a sock, a glove, a hat, a carpet, a pillow, a sheet, a curtain, a seat cover, and countless other things – a pretty amazing invention! So the Once-ler cut down one of the trees.

When he cut down the first tree, a Lorax appeared from the stump of the Truffula tree. The Lorax told the Once-ler that he 'speaks for the trees, for the trees have no tongues', and then warned him of the consequences of cutting them down. But the Once-ler foolishly ignored him, and instead called all his relatives to come and work in the factory knitting Thneeds.

As the Thneed industry expanded, more and more Truffula trees were **felled** *and the once beautiful area became choked with pollution. The forest became uninhabitable so the Lorax sent away the animals to find better habitats elsewhere. Eventually, the Once-ler cut down the last tree. When the trees were gone, the Lorax left, too. Without raw materials, the factory shut down; without the factory, all the Once-ler's relatives left and he was left alone.*

Before moving, the Lorax left a message for the Once-ler: the word 'Unless' etched on a stone slab. The Once-ler pondered the message and then realized that the Lorax was saying that unless someone cared about the land, the situation would not improve.

The Once-ler gives the boy the last Truffula seed and tells him to plant it, hoping that if the boy can grow a whole forest of Truffula trees, 'the Lorax, and all of his friends may come back.'

You can watch the cartoon adaptation here: **www.youtube.com/watch?v=8V06Z0Quo0k**

As we've learnt in earlier sections, forests provide many benefits to people and other **organisms**. Even if forests are left untouched they will not remain exactly as they are today. Instead, they will change in character, coverage and **species** composition. What we do today to take care of the world's forests has important implications for the future of forests and for our ability (and that of future generations) to continue to enjoy and use them.

In this chapter, we'll learn about some of the ways in which various groups of people around the world are caring for forests and what they are doing to protect precious forest resources. Forest **conservation** is difficult because there are many people competing for the use of forests and who require their resources to survive. However, when groups at all levels get involved – from international organizations to individuals – the results can be very positive. Let's see what is happening at each of these levels.



WILL THERE STILL BE FORESTS IN THE FUTURE?
© Kyle Pearce

INTERNATIONAL INITIATIVES

Forests exist in nearly every country in the world and so it is important that the things that we do to protect them are also global. That is why countries and international organizations work together to carry out forest conservation efforts.



MANY VALUABLE TREE SPECIES ARE AT RISK OF EXTINCTION, SUCH AS THE COAST REDWOOD (*SEQUOIA SEMPERVIRENS*).
© Brian Gratwicke

CONSERVATION OF TREE SPECIES

Many people know about the threats to well-known forest-dwelling animal species such as grizzly bears, tigers or gorillas. Fewer people are aware of the dangerous situation faced by some of the world's trees. The World List of Threatened Trees (1998) indicates that more than 8 000 tree species, ten percent of the world's total, are currently threatened with extinction.

Many economically important tree species, including some species of pine, oak, fir, cedar, mahogany and meranti, are threatened due to unsustainable use. More than one in six mangrove species worldwide are on the IUCN Red List of Threatened Species. They are in danger of extinction because of factors such as coastal development, climate change, logging, agriculture and aquaculture.

To promote the conservation of tree species, the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) initiated a Global Tree Conservation Atlas in 2003, which profiles threatened tree species around the world in a map-based format (you can take a look here: **www.unep-wcmc.org**).

HELPING TO STORE CARBON

As we've seen, forests are an important tool to help to **mitigate climate change** because they are important **carbon sinks**. Making sure that **carbon** continues to be stored in forests (rather entering the **atmosphere** as **carbon dioxide**), helps to prevent harmful **climate change**.

Therefore, governments all over the world are trying to ensure that forests are used effectively in the fight against **climate change**. They have joined forces to undertake the challenge to develop a system that could promote better protection, use and management of forests. This initiative is called 'Reducing emissions from **deforestation** and forest **degradation** and the role of **conservation**, **sustainable** management of forests and enhancement of forest **carbon** stocks in **developing countries**'. That's a bit of a tongue twister, so it's called '**REDD+**' for short.

Through **REDD+**, **developing countries** receive financial incentives to:

Reduce the **E**missions from **D**eforestation (the 'RED');

Reduce the emissions from forest **D**egradation (the second 'D')

REDD+

:: Conserve the carbon contained in forests (included in the '**+**')
:: Manage forests in a sustainable way (included in the '**+**')
:: Enhance the carbon stock sequestered (taken in and stored) by forests (also included in the '**+**')

Those **developing countries** that successfully protect their trees by completing one or more of these actions (and thereby reduce their **carbon** emissions) are meant to be paid for their efforts (revisit p.87 to refresh your memory about payment for **ecosystem services**). This money is provided by **developed countries** because they recognize that consumption of wood and **non-wood forest products** in their countries directly contributes towards the threats to forests in **developing countries**, as well as producing high amounts of **carbon** emissions. **Indigenous peoples** and other forest-dependent communities are intended to benefit from the prevented forest loss or **degradation**.

Although some details of **REDD+** are still under negotiation, **REDD+** projects are already underway and the first experiences are positive.

Watch a video about **REDD+** here: **www.b-movies.co.uk/films/united-nations.htm**



TAKING CARBON MEASUREMENTS IN AN AREA OF TROPICAL FOREST NEAR PALMIRA, COLOMBIA, AS PART OF A CIAT-HOSTED WORKSHOP ON REDD+.
© CIAT, Neil Palmer

IN FOCUS

INTERNATIONAL INSTITUTIONS WORKING TO CONSERVE FORESTS

As well as IUCN, UNEP-WCMC and REDD+, there are many other international organizations working on **sustainable forest management** and **conservation** initiatives:

The Food and Agriculture Organization of the United Nations (FAO) Forestry programme

The FAO Forestry Department works on balancing social, economic and environmental objectives so that present generations can reap the benefits of the Earth's forest resources while conserving them to meet the needs of future generations. FAO serves as a neutral forum for policy discussions, and as a reliable source of information on forests and trees through scientific monitoring. FAO also provides expert technical assistance and advice to help countries develop and implement effective national forest programmes.

www.fao.org/forestry/en

www.fao.org/docrep/014/am859e/am859e08.pdf

The United Nations Forum on Forests (UNFF)

UNFF was established to promote the management, **conservation** and **sustainable** development of all types of forests and to strengthen long-term political commitments. UNFF serves to facilitate the implementation of forest related agreements between all UN member states and foster a common understanding of **sustainable forest management**. This involves enhancing the contribution of forests toward international agreements, such as the Millennium Development Goals (MDGs) and World Summit on Sustainable Development.

www.un.org/esa/forests

INTERNATIONAL ORGANIZATIONS WORKING TO CONSERVE FORESTS

IN FOCUS

International Tropical Timber Organization (ITTO)
ITTO is an intergovernmental organization committed to the preservation of **tropical** forest resources by monitoring and promoting their **sustainable** management, use, and trade. ITTO collects, analyzes and shares information about the **tropical timber** trade, and develops internationally agreed policy documents to promote the **sustainable** management and **conservation** of tropical forests, supporting member countries in the implementation of related projects.
www.itto.int

The Convention on Biological Diversity (CBD)
CBD is an international agreement to promote **sustainable development**. The Convention recognizes that biological diversity is about more than plants, animals and **microorganisms** and their **ecosystems** – it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live. The Convention has three main objectives: the **conservation** of biological diversity, the **sustainable** use of the components of biological diversity and the fair and equitable sharing of the benefits arising out of the use of genetic resources.

The Convention covers several cross-cutting issues and programmes of work, including a specific **Programme of Work on Forest Biodiversity.** In 2010, the CBD Conference of the Parties adopted a global, overarching framework for **biodiversity conservation**, the **Strategic Plan for Biodiversity 2011-2020**.

INTERNATIONAL ORGANIZATIONS WORKING TO CONSERVE FORESTS

IN FOCUS

Four of its 20 Aichi Biodiversity Targets address forest **biodiversity**. The Strategic Plan is supported by the **Global Strategy for Plant Conservation (GSPC)**.
www.cbd.int
www.cbd.int/forest/pow.shtml
www.cbd.int/gspc/strategy.shtml
www.cbd.int/sp

Other biodiversity-related conventions:
Apart from the CBD, there are five other important conventions that promote the **conservation** and **sustainable** use of **biodiversity** (including forest **biodiversity**):

:: **The Convention on International Trade in Endangered Species of Wild Fauna and Flora** (CITES):
www.cites.org
:: **The Convention on the Conservation of Migratory Species of Wild Animals** (CMS):
www.cms.int
:: **The International Treaty on Plant Genetic Resources for Food and Agriculture**:
www.planttreaty.org
:: **The Ramsar Convention on Wetlands**:
www.ramsar.org; and
:: **The World Heritage Convention** (WHC):
www.whc.unesco.org

Based on their names, what do you think each of them focuses on? Take a look at their Web sites and see if you were right.

CIVIL SOCIETY INITIATIVES

Many people care deeply about protecting forests and the resources that they provide, especially people in countries where forest products are vital for survival and livelihoods.

Many charitable organizations (also known as non-governmental organizations and civil society organizations) aim to help protect forests and the people who live in them.

WWF – ZERO NET DEFORESTATION AND FOREST DEGRADATION

WWF recognizes the important role that forests play in protecting biodiversity and supporting human well-being. Its goal is to achieve Zero Net Deforestation and Forest Degradation (ZNDD) by 2020. This isn't the same as 'zero deforestation', which would mean no deforestation anywhere. People need to use forest resources, and if managed properly, forests can provide renewable resources indefinitely. ZNDD means we can use forest resources, as long as the overall quality and quantity of trees remains the same.

WWF identifies five key issues that are crucial to achieving ZNDD and avoiding negative consequences:

1. **Biodiversity:** Biodiversity is a precious resource and should be prioritized! If a forest has particularly high biodiversity, this forest's protection should be prioritized. If, however, another highly biodiverse ecosystem would have to be destroyed in order to protect a forest with less biodiversity, we should reconsider. We must consider what is best for the whole Earth and not just forests on their own.

2. **Governance:** ZNDD is only possible under good governance (see the *In focus* box on *What is forest governance?*). People's rights must be respected and laws must be made and followed.

3 **Market demand:** Each of us help to determine market demand every time we buy something. When we buy **sustainably** produced forest products, we are telling companies that we value forests. Similarly, if we stop buying products that are not produced **sustainably**, we are telling companies to shape up and use forests and their resources wisely.

4 **Lifestyle and consumption:** We help forests by adopting **sustainable** consumption habits. We can reduce food waste, eat less meat and reduce how much energy we use.

5 **Local livelihoods:** Forest **conservation** must take into account the millions of people who depend on forests. ZNDD is possible, but it will take different strategies in different places to meet the needs of both people and nature.





WHAT IS FOREST GOVERNANCE?

Governance describes how something is managed or ruled.

Governance answers three important questions:
- How do we decide **who** makes the rules?
- **How** are the rules made?
- What are the **consequences** if we don't follow the rules?

If people do not obey forest protection laws, then these laws are useless.

For example, a law that prohibits logging in a forest will be worthless if the law is not enforced and illegal logging is allowed to continue.

YOUTH ORGANIZATIONS

The **International Forestry Students' Association** (IFSA) is a global network of students interested in forest sciences. Roughly 3 000 students from around 73 member associations located in more than 54 countries are members of IFSA. IFSA is a non-profit organization entirely run by students for students. One of IFSA's major activity is the International Forestry Students' Symposium (more information in Chapter 9, p.196).

For more information see:
www.ifsa.net/main.php

The **Global Youth Biodiversity Network (GYBN)** is an international network of youth organisations and individuals who share a common objective: to halt the loss of **biodiversity**. The network seeks to inspire global youth to work together for **sustainable** use and **conservation** of **biodiversity**, and to bring their opinions and positions into the global negotiations and decision-making processes related to **biodiversity**, including under the Convention on Biological Diversity. Youth are invited to take part in the discussions, get involved in the working groups or join the network.

Find out more: **www.gybn.net**
or **www.facebook.com/thegybn**



PRIVATE SECTOR INITIATIVES

It makes good business sense to protect and support the key resources required for your product. For example, if you make chocolate, two of your key resources are the cocoa trees and the farmers who grow them.

NESTLÉ

Have you ever eaten a Kit Kat, a Milky Bar or a Lion Bar? Nestlé produces many of the world's most famous chocolate treats – chances are, you've sampled one. The Nestlé Cocoa Plan aims to support cocoa trees and farmers. As part of the plan, Nestlé's research centres in France and Côte d'Ivoire are working to improve the yield and quality of cocoa trees through a process called 'accelerated propagation'. This process means that trees bear fruit earlier, produce higher yields, are more **drought**-tolerant, and more likely to survive disease attacks than regular cocoa trees. Another part of the plan is the farmer field school programme, in which cocoa farmers learn about pruning trees, controlling pests, and harvesting and processing cocoa beans. Not only do farmers learn about **sustainable** farming practices, but the classes are also used as an opportunity to address other subjects such as child labour, education for children, HIV/AIDS and environmental issues. Nestlé works with local non-governmental partners to create and deliver these programmes.

Learn more: **www.nestlecocoaplan.com**



A WORKER SPLITS OPEN NEWLY HARVESTED CACAO FRUITS TO COLLECT THE COCOA BEANS, BRAZIL.
© FAO/K. Boldt

COMMUNITY INITIATIVES

Local communities can do a lot to protect the forests in their area. The first step is to raise awareness of the importance of forests for the local community and get everybody thinking about forest issues. This is exactly what the radio programme from St. Vincent and the Grenadines has done. Check it out below! Why don't you try writing your own radio show to raise awareness about forest issues near you?

IN FOCUS

BUSH MELÉE: CARIBBEAN FORESTS, FRIENDS AND FOES

CELESTE CHARIANDY, CARIBBEAN NATURAL RESOURCES INSTITUTE (CANARI)

Bush Melée is a mini radio drama developed by stakeholders on issues of forest **livelihoods** and **sustainability** in St. Vincent and the Grenadines. It was featured once a week for a month on the English-language radio programme 'Bush Talk', part of an innovative public education and outreach programme. The feature helped people to understand some of the issues that forests on the island face.

The summary of the story is given over the next couple of pages. A few questions are posed at the end of the story to help you consider forest management issues. How would you answer?

Mavis is a single parent. She tries her best to make ends meet, making jewellery using seeds from the forest. While collecting seeds one day, she was trapped by a forest fire and injured her ankle. Brian, a Forest Officer, came to her rescue.

Selwyn lives in a shack near the river in the forest. His faithful dog, Poopsy, was recently chopped to death by a hunter. He bumps into Reginald, the man who killed Poopsy. Tempers flare and



Selwyn goes to a local bar to drown his sorrows, while Reginald laughs.

Mavis checks on her ankle at the Health Centre. Nurse Pat is the Head Forest Officer's wife and is helping to organize a 'community caravan'. This community event will highlight the work of agencies that manage forests and the **livelihoods** *of people who use forest resources* **sustainably**. *Pat encourages Mavis to participate.*

Meanwhile, Brian investigates the fire. He sees Selwyn's small garden and cautions Selwyn about polluting the river. Selwyn is a **subsistence farmer**. *Brian realizes that the fire was set by a hunter trying to get wild animals to leave their holes. Selwyn suspects that Reginald set it. He says that Reginald thinks he could get away with it because the Head Forest Officer is his brother-in-law.*

Reginald visits Pat and laughs about the caravan. Pat tells him to stop senselessly slaughtering wildlife. Reginald says that as long as he has customers he will keep on supplying them. Pat says his attitude gives her more motivation to make the community caravan a success. People must realize they have to manage forests for the future.

Later on, Brian visits Reginald. Reginald's attitude gets him in trouble: he boldly admits to setting the forest fire. Brian shocks Reginald by arresting him.

The community caravan takes place. Mavis is happy that she took part. People say that the work of the Forestry Department and others now makes a lot of sense. Selwyn is sorry Pat's brother was arrested, but Reginald did a lot of harm and didn't care. Pat is pleased about the turnout and that the caravan's message that people's **sustainable** *use of forests sustains* **livelihoods** *has been well received.*

Which characters in this story have strong, positive attitudes towards the forest and which have strong, negative attitudes? Which characters seem to be in the middle? Do you think that those in the middle could adopt a positive attitude in the future and if so, how?

IN FOCUS

Whose character do you connect with the most?

Bush Melée was produced by the Caribbean Natural Resources Institute (CANARI) in conjunction with civil society stakeholders and the Forestry Department in St. Vincent and the Grenadines and PCI Media Impact. This project was funded by the Food and Agricultural Organization of the United Nations (FAO) National Forest Programme Facility. Visit their Web site: **http://mediaimpact.org/production/bush-melee**



THE RADIO DRAMA PARTICIPANTS DEVELOP THE STRUCTURE OF THE MAGAZINE, DISCUSS CHARACTER PROFILES, AND COMPARE NOTES.
© Caribbean Natural Resources Institute (CANARI)

CONCLUSION

Forestry issues were once viewed as distant and technical, but more recently they have begun attracting more public interest. Encouragingly, public awareness about the importance of forests in supporting local and global ecosystem services is on the rise. You, too, now know that forests are not only required for local livelihoods and national resources but also for international climate regulation. Therefore, forestry services increasingly need to address issues across different sectors (such industry and environmental groups) and to better integrate local needs and national plans within the international context. Whether or not there are strong, healthy forests in the future will largely depend upon the ability of the international community to strengthen political, financial, scientific and technical support for sustainable forest management. This involves engaging local communities, non-governmental organizations, international organizations and groups in the private sector.

We can be optimistic about the future of forests. Many people around the world are working at different levels and with various approaches to ensure a positive future for forests – and the plant, animal and human life they support. Let's join in!



LEARN MORE

:: Centre of International Forestry Research (CIFOR): www.cifor.org

:: The Centre for People and Forests (RECOFTC): www.recoftc.org

:: The Forest Peoples Programme: www.forestpeoples.org/topics/responsible-finance/private-sector



FORESTS AND YOU!

WHY DON'T YOU START A PROJECT TO HELP PROTECT FORESTS?

9

Having learned about the importance of forests to life on Earth while reading this Guide, it's time to take action to help protect our planet's forests! Think about the threats forests are facing – which is the most important to you? Young people around the world are already leading successful projects to help protect and conserve forest ecosystems and the biodiversity found within them. Now it's your turn to take action: read on to learn the six simple steps to start forest action project!

STUDENTS FROM KISANGANI UNIVERSITY, DRC, REVIEW THEIR STUDY NOTES IN THE BOTANICAL GARDENS.
© FAO/Giulio Napolitano

CULTURAL STORY

THE ROAD NOT TAKEN

By Robert Frost 1874-1963

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveller, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim
Because it was grassy and wanted wear,
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I –
I took the one less travelled by,
And that has made all the difference.



A FOREST TRAIL IN WEST VIRGINIA, USA.
© www.ForestWander.com

Just like Robert Frost in the wood, we all have decisions to make in our lives. Our decisions will change the future and we won't be able to go back in time and make a different decision or take a different road! So, let's look at the choices we can all make in our lives to help look after our forests for the future.

Background
FOREST PATH IN POLAND.
© Dariusz Dembinski

BE SAFE AND SOUND

You can start a forest action project wherever you live. However, make sure you take a few precautions for your own safety, as well as making sure that you don't hurt the forest ecosystem. Remember: "take only pictures and leave only footprints".

Please consider the general precautions below and carefully evaluate which other safety issues need to be taken into consideration before you get started.

- Wash your hands after every activity.
- Treat nature with respect.
- Don't pick and eat any plants because some poisonous plants look very similar to non-poisonous ones.
- It is better to leave nature as you found it. Never pick protected species. Before collecting plants or picking flowers, get permission. Only take what you really need and make sure you leave at least one third of anything you find in the wild.
- Don't collect living creatures; draw a picture instead.
- Only build campfires in places where it is specifically allowed (e.g. in campfire pits at campsites, never in the wild). Have a bucket of sand to hand in case you need to contain or extinguish the fire.
- Be careful if you are working with animals. Wear protection if necessary. Be gentle. Make sure they have appropriate food, water, shelter and air. When you're done, return them to where you found them.
- Recycle or reuse the materials used in your project as much as possible.
- You may want to upload pictures or videos to the internet on Web sites such as YouTube. Always make sure that everyone in the pictures or video, and/or their parents, have given their permission before you post anything online.

SIX SIMPLE STEPS TOWARDS CHANGE

These *Six Simple Steps Towards Change* have been adapted from the Guide to Action created by TakingItGlobal, in consultation with young leaders around the world.

You can use these steps to help you plan and execute your own forest project:

1. REFLECT AND GET INSPIRED
2. IDENTIFY AND GET INFORMED
3. LEAD AND GET OTHERS INVOLVED
4. GET CONNECTED
5. PLAN AND GET MOVING
6. HAVE A LASTING IMPACT



CLOWN TREEFROG FOUND IN YASUNÍ NATIONAL PARK, ECUADOR.
© G. Gallice

REFLECT & GET INSPIRED

Think about the changes you would like to see, whether they are in yourself, your school, your community, your country or even across the whole world. Also think about who or what inspires you to take action. Seeking out sources of inspiration can give you great ideas and help you find the strength to turn your vision into a reality.

IDENTIFY & GET INFORMED

Which issues are you most passionate about? Learn more about them by gathering information about the things that interest you. By informing yourself, you are preparing yourself to tackle the challenges that lie ahead.

LEAD & GET OTHERS INVOLVED

Being a good leader is about building on the skills you have and knowing how to leverage the strengths of others. Write down the skills that you and your team members bring to your action project and see how each of you can use your strengths to lead in different ways. Remember that good leadership includes great teamwork!

GET CONNECTED

Networking can give you ideas, access to knowledge, experience and help in gaining support for your project. What are you waiting for? Create a map of your networks and start tracking your contacts!

PLAN & GET MOVING

Now that you are equipped to take action, it's time to begin the serious planning... You already have an idea of the issue or issues you'd like to work on: now identify a particular goal you can work towards. When you have your plan, stay positive and focused. If you encounter obstacles, don't worry, that's completely normal! You will learn a great deal from overcoming challenges.

HAVE A LASTING IMPACT

Monitoring and evaluation are important parts of project management. Throughout your project, you'll want to identify the obstacles you are facing and the lessons you are learning. Remember, even if you don't achieve all of your expectations, you most probably influenced others and experienced personal growth! At the end of your project, you can revisit your notes and think about how you can benefit from this experience in your NEXT project... Encouraging other youth to get involved in the issues you care about is also a great way to sustain your efforts, even after your own project has ended.



1. REFLECT AND GET INSPIRED
Reflect on the issues you are passionate about

Take a moment to **REFLECT** on the threats facing forests that matter most to you. Imagine how it would be if we humans lived in harmony with our beautiful planet and its natural systems. *What would that world look like?*

Think about which forest plant or animal **species**, **habitats** or **ecosystems** (see Chapter 3) you want to **conserve**, **protect** and **restore** locally and globally.

ASK YOURSELF

Are there threatened forest plant or animal species you want to protect? Are there certain habitats or ecosystems you would like to conserve or restore? Which threats to forests worry you most? Do you know anyone who is being affected by threats to forests? How about communities in other countries?

Conserve – **Conservation** means to preserve the natural functions of forest **ecosystems** and biological communities, as well as their resilience (their ability to recover from shocks). This can be done by limiting the use and extraction of the **natural resources** that forests provide.

Protect – You can help protect an **ecosystem** or **species** by campaigning to have it protected by your government's laws or international policies.

Restore – Restoration helps 'repair' **degraded ecosystems** or **habitats** to a more natural, less damaged state so they can function better again.

THINK ABOUT IT

Why not use the **IUCN Red List** to find out whether there are any **endangered species** near you.

What can you do to help to protect them?

Go to:
www.iucnredlist.org

Get inspired

GET INSPIRED by learning about local and international forest champions – reading the case studies of youth-led forest projects in this chapter is a good place to start! You can also start to identify local forest champions in your family, neighbourhood, school or city.

Join TakingITGlobal's network of youth engaged in global issues and connect with youth leaders, organizations and projects from all over the world at **www.takingitglobal.org**

CASE STUDY: **RHIANNON TOMTISHEN AND MADISON VORVA**

18, Michigan, USA, www.projectorangs.org

In 2007, Madison and Rhiannon began the process of earning their Girl Scout Bronze Award by raising awareness about the **endangered** orangutan. While doing research, they learned that the orangutans' **habitat** (the **tropical rainforest** in Indonesia and Malaysia) was being destroyed at alarming rates to make way for oil palm **plantations**. As you'll remember from p.135, palm oil is used in everything from candy bars to cosmetics. After making the shocking discovery that palm oil was an ingredient in Girl Scout Cookies, Madison and Rhiannon launched a campaign to make Girl Scout Cookies rainforest-safe. They launched Project ORANGS (Orangutans Really Appreciate and Need Girl Scouts).

Seven years on, the girls have created numerous campaigns through Project ORANGS to raise awareness about this issue, including a petition (which has been signed by Dr. Jane Goodall, the famous primatologist); a letter-writing campaign; and a campaign that allows past and present Girl Scouts to decorate puzzle pieces with why they believe it is important for Girl Scout Cookies to be rainforest-safe. Working with the Rainforest Action Network and Philadelphia Zoo, Rhiannon and Madison also designed the Rainforest Heroes Badge which has allowed girls of all ages to show their support and take action on this issue.

As a result of their grassroots organizing and appearances in national media outlets including the Wall Street Journal, ABC World News and NPR, Madison and Rhiannon were able to secure a meeting with Girl Scouts USA. In 2011, the Girl Scouts USA announced a palm oil policy that is a step forward but does not do enough to protect forests or people. However, Kellogg's, a baker of Girl Scout Cookies, adopted a deforestation-free palm oil policy for their entire product line in 2014. Madison and Rhiannon are still working towards their goal of deforestation-free Girl Scout cookies by educating consumers nationwide about the global impacts of their daily purchasing decisions. As youth, the girls have fought to make their voices heard and show their peers the tremendous power they have to make a difference within their local and international communities.



MADISON AND RHIANNON, PROJECT ORANGS FOUNDERS.
© http://projectorangs.org

Find out more:
http://projectorangs.org

2. IDENTIFY AND GET INFORMED
Identify the issues you are going to take action on

Referring to your reflections on the forest resources that you would like to conserve, protect or restore, **IDENTIFY** and narrow down the issues that are most important to you.

Develop a set of question that you want to answer. Here are some ideas:

- What makes this issue unique and important?
- Who is most affected by the issue, and why?
- How does this issue differ locally, nationally, regionally and globally?
- What different approaches have been taken to understand and tackle the issue?
- Which groups are currently working to address the issue? (Consider different sectors such as governments, corporations, non-profit organizations, youth groups, United Nations agencies, etc.)

Make a list of all the key resources you have found (organizations, publications, Web sites):

1.....

2.....

3.....

4.....

Get informed

GET INFORMED by finding resources on the issues you are interested in. Be sure to check out the links listed at the end of each section of this Guide! You can also visit TakingITGlobal's Issues pages to find further organizations, online resources and publications for inspiration:

www.tigweb.org/understand/issues

ASK YOURSELF
What more can I learn about the issues I care about?

CASE STUDY: **ROBERT MASSICOTT**

12, Connecticut, USA

Robert Massicott began studying rainforest **ecosystems** as part of a geography class at school. He quickly became captivated by what he saw. "The vibrant colors, the **exotic** animals – especially the snakes – really interested me. My favorite part of the world became the rainforests", Robert explained. However, just studying the rainforest wasn't enough for Robert. After learning about the numerous threats facing these areas he wanted to take action.

Robert created a project to help protect **endangered** species. His project, which raised money through donations and the sale of rainforest bracelets, was a huge success and resulted in a US$ 1 200 donation to the Rainforest Trust to protect **endangered** rainforests in Colombia.



ROBERT SHOWCASES HIS PROJECT.
© www.rainforesttrust.org

SMOOTH MACHETE SAVANE, EASTERN ECUADOR.
© G. Gallice

3. LEAD AND GET OTHERS INVOLVED
Lead your project to success

Identifying your skills and characteristics will help you **LEAD** your project to success. Start by understanding your own strengths and needs, and then consider how creating a team could help you to better achieve your goals. Helping your team members identify and leverage their own strengths and talents for the project is an important part of leadership. It is also important to ensure that all those involved are able to share in the vision of what you are trying to achieve. Think of someone who shows strong leadership. What makes that person a good leader? Create a list of leadership qualities. Some examples are:

- **Accountability**
- **Compassion**
- **Dedication**
- **Fairness**
- **Honesty**
- **Innovativeness**
- **Being motivational**
- **Open-mindedness**
- **Responsiveness**
- **Being visionary**

Build a team and get others involved

Once you have reflected on your personal leadership assets and goals, you are ready to develop a team and **GET OTHERS INVOLVED**. Start with people you know, and then expand the project to people they know and so on – your team will grow quite quickly! When you feel ready, you can call for participation from the wider community, too. How can you encourage them to take part in your project to address forests issues you are most concerned about?

List skills the leadership skills that you possess:

1 .....
2 .....
3 .....
4 .....

List the leadership skills that you want to develop:

1 .....
2 .....
3 .....
4 .....

Name some people you already know who would want to be part of your team:

1 .....
2 .....
3 .....
4 .....

What are some of the skills that your team members can contribute?

1 .....
2 .....
3 .....
4 .....

CASE STUDY: **SYLVESTER CHISIKA**

Kenya

'Better teach a young man how to fish than to give him fish' – this wise saying has been quoted all around the world by men and women as a means to challenge those who intend to provide help, guidance or support to others, and instead re-energize or propel them to new horizons in life. In my opinion, the Commonwealth Forestry Association (CFA) has mastered the hidden meaning of this saying through its Young Forester Award programme and I am a living proof of the fact that the Young Forester Award is an amazing opportunity!

In 2011 I won the CFA Young Forester Award, and I was assigned to the Sawlog Production Grant Scheme (SPGS), Uganda, as an intern for three months. I was given the task of developing the commercial forestry sector in Uganda by promoting investment incentive initiatives. I learnt a lot of things at SPGS: I learnt the art of how to plan forestry **plantations**; I attended and participated actively in community resource mobilization and community exchange tours all over Uganda; and I further developed my research skills in the process.

The new fire that had been lit by CFA and this professional forestry opportunity did not only stop at excellent work performance, but also inspired me to make a difference in my community. I mobilized a group of young people in my home village and we came up with a project called 'the trees again project', whose mandate is to encourage private farm owners to establish tree **plantations** on their **degraded** farmlands and to provide technical assistance and training. Only a few months after the project had started, the local community development fund had more than US$ 5 700 to use for the project activities and upscale the involvement of more young people.

Find out more:
www.cfa-international.org/youth/yfa.php

4. GET CONNECTED

You can also develop a team by networking and **GETTING CONNECTED** to people you have not yet met, but would like to work with. They might be associated with people whom you already know; alternatively, why not connect with a network that works on issues that matter to you?

You can start by attending events and conferences about forest conservation. Do a little bit of research and find out what opportunities there are in your area.

List at least one event in your area that you would like to attend:

.....

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FOREST INITIATIVES: **BRINGING YOUNG ACTIVISTS TOGETHER**

There are many initiatives for you to join or get inspired by! Here are just a few examples:

:: The **International Forestry Students' Symposium** is the biggest annual International Forestry Students' Association meeting and provides young people with an opportunity to exchange knowledge and share interest in forestry matters.

Find out more about the IFSA here: **www.ifsa.net/main.php**

:: The **Forests Asia Summit** is holding a youth session in an effort to involve young people in policy and research projects in the forestry sector: **http://www.cifor.org/ForestsAsia/wp-content/uploads/2014/documents/Youth-session-at-the-Forests-Asia-Summit-Key-recommendations.pdf**

:: The **Economist World Forest Summit** held its inaugural event in 2013 and is set to become an annual event with many interesting speakers discussing key topics: **www.economistinsights.com/sustainability-resources/event/world-forests-summit-2014**

What other initiatives can you find? Which ones would you like to get involved in?

CASE STUDY: **DeforestACTION –** Take action with students around the world!

DeforestACTION is a global movement of youth and schools working together to stop **deforestation** and create a permanent **habitat** for orangutans and other **species** that depend on forest **ecosystems**.

Through online tools, webinars and educational resources developed by TakingITGlobal, students from around the world are working collaboratively to learn about and share ideas on how to address **deforestation**. From here, individual schools teams plan and lead local action projects to raise awareness and funds to support rainforest protection and restoration efforts in Borneo, Indonesia.

Youth, students and concerned citizens alike also use Earthwatchers, an online forest monitoring tool that provides high-resolution satellite imagery and mapping tools. Through the program, participants monitor and identify any changes in land patterns in the project's target area of Borneo. Land pattern changes may indicate illegal logging, thus providing another set of eyes to support the local authorities surveillance efforts.

Through DeforestACTION, students have been able to develop meaningful dialogue on the global problem of **deforestation**, its' relationship to **climate change** and **biodiversity** loss, and the parallel impact on local communities.

Learn more and join the movement at **http://dfa.tigweb.org**



DeforestACTION.
© TakingITGlobal

5. PLAN AND GET MOVING

Develop an action plan

By now, you have identified key threats to forests, you've learned more about them and have a good idea of your skills as well as those of your team. You have also learned about the importance of networking and connecting with people who can help you to achieve your goals. This means you are now ready to develop and implement your action **PLAN**!

Keeping in mind the main issue you have identified, which goal or desirable outcome would you like to work towards in your action plan? Here are some possible examples to get you thinking:

Conserve

- Campaign to prevent the **deforestation** of a particular forest **habitat**.
- Raise awareness about a product, leisure activity or industrial activity that threatens forests.

Protect

- Campaign to have a forest **ecosystem** recognized as a United Nations Educational Scientific and Cultural Organization (UNESCO) Biosphere Reserve or World Heritage Site.
- Advocate for an at-risk plant or animal **species** to be included in the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species.

Restore

- Organize or participate in a community tree planting day in an effort to replant a **degraded** or damaged forest.
- Spend some time helping a local forest **conservation** organization.

Write your goals:

Brainstorm five possible actions related to a forest issue you have identified. Actions are activities that will help you achieve your goals:

1 .....

2 .....

3 .....

4 .....

5 .....

Develop a mission statement

Project mission

Clarify what you want your project to achieve and write it down in the form of a mission statement: a short, clear sentence about your purpose. For example: *Restore endangered bird habitats in a local forest.*

Project activities

What actions can you take to work towards achieving your project mission? For example: *Plant native plant and shrub species that make up the forest understorey.*

Break it down

You know your mission. Now, use the sample chart below to break your project down into specific activities, resources, responsibilities and deadlines. Planning these activities in detail will ensure your project is a success. If your goal is to *restore endangered bird habitats in a local forest*, your chart might look similar to this example:

ACTIVITY	RESOURCES	RESPONSIBILITIES	DEADLINE
Restore endangered bird habitats in a local forest	:: Local conservation groups :: Local council :: Native plant nursery :: Keen friends and family members :: ...and many more!	*I will:* consult local conservation groups to find out about which native species to plant. *Grandma will:* help me write a newspaper article about forest regeneration activities for our local newspaper. *Luke and Lucy will:* design posters and leaflets for our campaign. ...and so on!	21st March, International Day of Forests

Implement

Once you have finalized your plan, it's time to **GET MOVING** and actually implement your project! Take time to chart your progress so that you can appreciate and assess the impact of your actions. Document your project with pictures and videos. It is also a good idea to keep a project journal or blog!

Try to refer to your plan along the way, but don't be surprised if not everything goes according to it. Circumstances may be unpredictable, so it's important that you are flexible while staying organized: you may need to revise your plan as you encounter challenges. So, remember to enjoy the entire experience as a learning process.

Raise awareness

Create promotional materials, such as press releases and flyers, to get publicity and to let people know about your project! Word of mouth is one of the strongest marketing tools. Be enthusiastic and stay positive when you let others know how and why they should get involved. One way to promote your project is to create a project page on *TakingITGlobal* (**www.takingitglobal.org**) or add it to The Green Wave Web site (**www.greenwave.cbd.int**).

Stay motivated

Be sure to stay motivated, especially if you find yourself facing obstacles. Remember: every challenge is an opportunity to learn. Use your creativity to come up with innovative solutions to each challenge: that's problem-solving in action!

CASE STUDY: **JADAV PAYENG - 'The forest man of India'**

Assam, India



"My efforts haven't gone in vain, I may live a very lowly life, but I feel satisfied that I have been able to stir up a lot of people who love nature."

Jadav Payeng - 'The forest man of India'

JADAV PAYENG, AKA THE FOREST MAN.
© Bijit Dutta

Jadav 'Molai' Payeng lives by the Brahmaputra River in Assam, India. In 1979, when he was still a teenager, he saw snakes washed up on the river bank near his house after a flood. Because there was no shade from trees, the snakes overheated and died. He was very upset and decided that he would begin to plant his own forest. He sowed every seed by hand and watered every tree that grew. After 35 years, he has grown 550 hectares of forest that is home to lots of different wildlife. The forest, which came to be known as 'Molai forest' in his name, now houses Bengal tigers, Indian rhinoceros, over 100 deer and rabbits, as well as apes and several varieties of birds, including a large number of vultures. Around 100 elephants visit the forest each year and make it their home for roughly six months. Isn't it amazing that one man has single-handedly created an **ecosystem** and **habitat** for all this wildlife? Pretty inspirational stuff!

6. HAVE A LASTING IMPACT

Monitoring your project throughout each stage will help you to best respond to changes that occur along the way and **HAVE A LASTING IMPACT**. It is helpful to set out indicators or measures of success to make sure you stay on track. The more specific your indicator, the easier it will be to evaluate your achievements. For example:

OBJECTIVE	INDICATORS OF SUCCESS
Restore endangered bird habitats in a local forest.	:: Number of people (and/or communities) engaged in project. :: Number of **native species** planted. :: Number of materials created and distributed as part of the project. :: Number of bird nests in the forest a little time after the main campaign. (Make sure a conservationist shows you how to count these carefully without disturbing the birds!)



THE SHOLA GRASSLANDS AND FORESTS IN THE KUDREMUKH NATIONAL PARK, INDIA. THE PARK IS ABOUT 600 SQ. KM IN AREA AND IS ONE OF THE 25 BIODIVERSITY HOT SPOTS IN THE WORLD.
© Karunakar Rayker

CASE STUDY: **THE GREEN WAVE: WORLDWIDE**

The Green Wave provides tools for people to learn and take action to protect **biodiversity**. *The Green Wave* is a fun project to help children and youth, their parents, teachers and friends learn about **biodiversity** together with hundreds of groups from around the world. In a special event each year, the mark the International Day for Biological Diversity on 22 May, *Green Wave* participants join hands to celebrate life on Earth. At 10 a.m. local time, young people in schools and groups hold an event to learn about **biodiversity** and/or plant a single tree at or near their school: creating a green wave of action across time zones around the world. Participants upload photos and stories of the event to *The Green Wave* Web site that go live on the online map at 20:20 local time, creating a virtual green wave starting in the far east and travelling west around the world. Since 2008 6 000 groups and schools from at least 72 countries have taken part in *The Green Wave* and have shared their exciting stories. They have planted hundreds of thousands of trees, have learned about tree **biodiversity** and how to care for trees and for the life that surrounds them. For youth and children in urban areas, *The Green Wave* provides a simple way to connect with and learn about nature. *The Green Wave* transmits an important message from the young generation: "We want a healthy, biodiverse future; we will unite and take action for biodiversity; we are working towards reducing biodiversity loss."



CHILDREN AND YOUNG PEOPLE AROUND THE WORLD PARTICIPATE IN GREEN WAVE FESTIVITIES.
© The Green Wave

Here are some stories from around of the world of groups of young people taking part in *The Green Wave*. Get involved!

"Our *Green Wave* tree name is *Cultivate the Future*. Mangroves have good survival and the seeds are buoyant, therefore suited to water dispersal. An increase in mangrove trees has been suggested for climate change mitigation."

Organization for Industrial Spiritual & Cultural Advancement, OISCA-International, and Anislagan Elementary School, Quezon City, Philippines.

"We are planting *Edible Trees for the Future* for the 2013 *Green Wave*. This year, we will focus on planting about 25 to 30 edible trees that will provide food for both humans and wildlife. We want to attract more birds, bees, butterflies and other insects to create a healthier and diverse schoolyard habitat. Our graduate students will each plan a Guanábana tree, this will be part of their legacy for future generations of the school."

Caguas, Select, Puerto Rico.

"Our *Green Wave* tree name is *Capturing Carbon*. This tree was chosen as a species that is particularly favoured by large herbivores, the pods have a high nutritional value and the leaves are valuable browse. It is a resilient species, resistant to frost damage that grows well in arid conditions."

Falcon College, Esigodini, Zimbabwe.

"Our *Green Wave* tree species is *Syzygium samarangens*. The tree is grown for its fruit. It has a cooling effect which makes it useful as a summertime fruit especially for the birds in our campus."

The Green Wave 2013 in Chengannur, Keralam, India.

"We planted Sea Teak, a small tree with thick, glossy, bright green leaves. It is listed as 'critically endangered' in the **IUCN Red List** of threatened plants in Singapore. This once common plant is becoming increasingly rare but the tree is now widely planted in many of our coastal parks."

Temasek JC School, Singapore.

THE GREEN WAVE

PLANT FOR THE PLANET: THE BILLION TREE CAMPAIGN

The Billion Tree Campaign was inspired by Wangari Maathai, a Nobel Peace Prize laureate and founder of the Greenbelt movement, which has so far planted 30 million trees across Africa.
Ms. Maathai was told that a group of people wanted to launch a campaign to plant a million trees. Her reply? "That's great, but what we really need is to plant a billion trees." And with that the Billion Tree Campaign began! In fact, so far, over 12 billion trees have been planted as part of the campaign, which is pretty awesome. Check it out: **www.plant-for-the-planet-billiontreecampaign.org**

"It's the little things citizens do. That's what will make the difference. My little thing is planting trees."

Wangari Maathai (1940–2011)
Kenyan environmental and political activist
2004 Nobel Peace Prize winner



CHILDREN AT KIROKA PRIMARY SCHOOL IN TANZANIA PLANTS TREES AND JOIN THE CAMPAIGN.
© FAO/Daniel Hayduk

CONCLUSION

Now that you have read through the *Six Simple Steps Towards Change*, you are ready to lead your own forest action project to success! Remember that these steps are only guidelines and you may want to set your own path. There is no perfect recipe for success because each situation is unique. Every action project you start is a learning process that will challenge you to solve problems and develop your own skills and talents.

Don't forget to take the time to document and reflect on your progress. Keeping good records will help you learn from your experience and will make it easier to share what you have learnt with other people at home and abroad. As a young forest champion, you can help other youth to reflect, get inspired and start their own action projects!



Use the activity-packed
Forests Challenge Badge
to inspire you to take action:
www.fao.org/docrep/018/i3479e/i3479e.pdf

LEARN MORE

:: The Green Wave: www.greenwave.cbd.int
:: Guide to Action: Simple Steps Towards Change, TakingITGlobal (2006): www.tigweb.org/action-tools/guide/online.html
:: International Day of Forests: www.un.org/en/events/forestsday
:: TakingITGlobal: www.takingITglobal.org
:: TakingItGlobal for Educators (TIGed): www.tigweb.org/tiged
:: WAGGGS: www.wagggs.org
:: WOSM: www.scout.org





CONTRIBUTORS & ORGANIZATIONS

ANNEX A

LEARN MORE ABOUT THE PEOPLE WHO WROTE AND HELPED DEVELOP THIS BOOK AND ABOUT THE INSTITUTIONS WHICH HAVE BEEN INVOLVED IN ITS PREPARATION.

The following annex contains information on the people and institutions which contributed to this Guide, who hope that you have found the Guide interesting and useful, but most of all, that you are now passionate about forests and will now undertake your own actions to safeguard the world's fantastic FORESTS.

SCARLET MACAW, MADRE DE DIOS, PERU.
© Geoff Gallice

Susan Braatz is a Senior Forestry Officer at FAO leading the Forests and Climate Change team. Susan has over 30 years of experience in international forestry and sustainable development. Her expertise includes forest policy, forest ecology, climate change, agroforestry, community forestry and urban forestry.

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Geoff Gallice is a graduate research fellow at the Department of Entomology and Nematology at the University of Florida. Geoff is studying the ecology and conservation of Neotropical butterflies found in the 'biodiversity hotspot' region of the Andes and the western Amazon, and taking some fantastic photos at the same time.

Christine Gibb has worked as a consultant for the Secretariat of the Convention on Biological Diversity (CBD) and FAO on youth and biodiversity issues. She is currently completing her PhD on environmental migration in the Philippines.



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Victoria Heymell is a freelance forestry and communications consultant. Victoria previously worked in the Forestry Department of FAO on issues of forest degradation and forests and water, as well as assisting with communications and liaisons with various outside partners and organizations.

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Neil Pratt is the Senior Environmental Affairs Officer in the Mainstreaming, Partnerships and Outreach (MPO) division of the Secretariat of the Convention on Biological Diversity (CBD). He oversees partnership, outreach, communication and education issues with each of the major stakeholders, including children and young people.

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Rosalaura Romeo is a Programme Officer for the Mountain Partnership Secretariat, hosted by FAO. She promotes collaborations among the Mountain Partnership members and works on advocacy for mountains, to ensure that mountain issues are included in the main international processes.

Laura Schweitzer Meins is a forester, originally from the USA. Her areas of expertise include community-based forestry and forest policy. She is currently working for the U.S. Department of Agriculture within the U.S. Mission to the UN Agencies in Rome.

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Isabel Sloman works for YUNGA coordinating and editing various publications and managing social media and communication activities. She holds a MA in Sustainable Development from the University of St Andrews and is passionate about education for sustainability and inspiring young people to take action to protect our planet.

Johannes Stahl works for the Secretariat of the Convention on the Conservation of Migratory Species (CMS). Prior to joining the CMS he was a Junior Professional Officer for forest biodiversity at the Secretariat of the Convention on Biological Diversity (CBD).





www.canari.org

The Caribbean Natural Resources Institute (CANARI) is a regional technical non-profit organization which has been working in the islands of the Caribbean for more than 20 years. CANARI's mission is to promote and facilitate equitable participation and effective collaboration in the management of natural resources critical to development in the Caribbean islands, so that people will have a better quality of life and natural resources will be conserved, through action-based learning and research, capacity building, communication and fostering partnerships.



www.cbd.int

The Convention on Biological Diversity (CBD) is an international agreement that commits governments to maintain the world's ecological sustainability through biodiversity conservation, the sustainable use of its components, and the fair and equitable sharing of the benefits arising from the use of genetic resources.



www.fao.org

The Food and Agriculture Organization of the United Nations (FAO) leads international efforts to defeat hunger. FAO acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information, helping countries to modernize and improve agriculture, forestry and fisheries practices and promoting good nutrition for all. FAO's Forestry Department in particular aims to strengthen global governance and the managerial and technical capacities of FAO's member states to improve the conservation and utilization of forest resources, hereby contributing to human wellbeing, food security, poverty alleviation and environmental sustainability.



www.tigweb.org

TakingITGlobal is a non-profit organization with the aim of fostering cross-cultural dialogue, strengthening the capacity of youth as leaders, and increasing awareness and involvement in global issues through the use of technology.



www.unesco.org/education/desd

The United Nations Educational, Scientific and Cultural Organization (UNESCO) was founded on November 16, 1945. UNESCO's mission is to contribute to the building of peace, the eradication of poverty, sustainable development and intercultural dialogue through education, the sciences, culture, communication and information. It strives to do

so by building networks among nations, mobilizing for education, building intercultural understanding, pursuing scientific cooperation, and protecting freedom of expression. It is also the lead agency for the United Nations Decade of Education for Sustainable Development (2005-2014).

www.wagggsworld.org

The World Association of Girl Guides and Girl Scouts (WAGGGS) is a worldwide movement providing non-formal education where girls and young women develop leadership and life skills through self-development, challenge and adventure. Girl Guides and Girl Scouts learn by doing. The association brings together Girl Guiding and Girl Scouting associations from 145 countries, reaching 10 million members around the globe.

www.scout.org

The World Organization of the Scout Movement (WOSM) is an independent, worldwide, non-profit and non-partisan organization which serves the Scout Movement. Its purpose is to promote unity and the understanding of Scouting's purpose and principles while facilitating its expansion and development.

wwf.panda.org

WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global Network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

www.yunga-un.org

The Youth and United Nations Global Alliance (YUNGA) was created to allow children and young people to be involved and make a difference. Numerous partners, including UN agencies and civil society organizations, collaborate to develop initiatives, resources and opportunities for children and young people. YUNGA also acts as a gateway to allow children and youth to be involved in UN-related activities, such as the Millennium Development Goals (MDGs), food security, climate change, biodiversity and environmental sustainability.

PLEASE NOTE THAT THE INVOLVEMENT OF AN INSTITUTION OR INDIVIDUAL DOES NOT IMPLY ITS OR THEIR ENDORSEMENT OR AGREEMENT WITH THE CONTENT OF THIS GUIDE.


A
G
N

GLOSSARY



Acid rain: Any type of precipitation that contains nitric and sulphuric acids, resulting from the burning of fossil fuels.

Adaptation: A special characteristic that helps an organism to survive and reproduce under specific conditions in a particular place. Adaptations evolve over time, making some species better at surviving in a given area than others.

Agro-forestry: A type of farming that integrates the growing of trees.

Algae: Simple organisms that can photosynthesize. They live on land and in both fresh and salt water.

Altitude: The height of the land above sea level.

Aquaculture: The farming of aquatic organisms including fish, shellfish or seaweed, usually in cages, ponds or, in the case of bivalves (like clams and mussels), on ropes or racks.

Atmosphere: The atmosphere is a layer of gases around the Earth and it is held in place by gravity. The gases in the atmosphere include oxygen (which humans and animals need to breathe) and carbon dioxide (which plants need to respire, like breathing). Also see greenhouse gases.

Atom: Everything in the world is made up of miniscule particles called 'atoms'. These particles are like small 'building blocks'. Different atoms combine to make up molecules of different substances.

Avalanche: A large amount of snow, often mixed with earth and rocks, that comes loose from the side of a mountain and quickly falls down to the valley below. Avalanches are natural hazards which can cause a lot of damage to affected ecosystems.

Biodiversity: The variety of all the different kinds of plant and animal life on Earth, and the relationships between them.

Biofuel: Plant material and animal waste that is used as a fuel or energy source.

Biome: A biome is an area of the planet that can be classified according to the plants and animals that live in it. A biome is different from an ecosystem, because an ecosystem is the interaction of living and non-living things in an environment, while a biome is a specific geographic area defined by the species living there. There are many different types of forest biomes including: tropical rainforest, mangrove forest, boreal coniferous forest and deciduous forest biomes.

Boreal forest: An evergreen coniferous forest in the northern hemisphere located just south of the tundra and dominated by firs and spruces. It is the world's largest terrestrial ecosystem, covering parts of Alaska, Canada, Scandinavia, Russia, Kazakhstan, Mongolia, and Japan.

Bushmeat: Wild meat from animals that have been hunted or caught, not farmed.

Canopy: The top layer of a forest, including treetops and plant species that reach above the canopy.

Captivity: The state of being kept in a place (such as a cage or a zoo) and not being able to leave or be free. Some endangered species are bred in captivity to help them survive and prevent total extinction.

Carbon: A very important substance that all life on Earth depends on. It is in nearly every biological compound that makes up our bodies, systems, organs and cells. All plants have carbon as their most important element. Carbon is also found in charcoal, petroleum, plastics, and the lead of a pencil.

Carbon dioxide (CO_2): A gas made up of carbon and oxygen, which makes up less than one percent of the air. A carbon dioxide molecule is made up of one carbon atom (C) and two oxygen atoms (O_2). CO_2 is produced by animals and used by plants and trees. It can also be produced by human industrial processes such as burning fossil fuels. CO_2 is a greenhouse gas and can speed up climate change.

Carbon sink: A 'reservoir' in which carbon can be stored in a harmless solid form, instead of in the harmful gaseous form that can speed up climate change. A tree is an example of a carbon sink, because it converts carbon dioxide into carbon which it uses in its cells. The four major sinks, which are regions of the Earth within which carbon behaves in a systematic manner, are the atmosphere, the land-based biosphere (usually including forests and fresh water systems), the ocean, and sediments (including fossil fuels).

Carnivore, carnivorous: These are animals that gain all (or the vast majority) of their nutritional needs from eating other animals. Carnivore literally means meat eater.

Cell: The basic building block of life. All organisms are made up of one or more cells.

Classify: To put something into a group or a category. For example, forests are classified according to their type (natural, planted or primary forests).

Climate: This is the long-term average, or overall picture, of the everyday weather experienced in a location.

Climate change: A change in the overall state of the Earth's climate (such as temperature and rainfall) caused by both natural processes and human activities. The build-up of greenhouse gases, such as carbon dioxide, in the Earth's atmosphere is an example of how some human activities (e.g. energy production, transportation, farming and the manufacturing of goods) can accelerate climate change.

Coniferous: Tree species that bear cones as their seed source. Coniferous trees are mainly found in the Northern hemisphere.

Conservation: Maintaining the health of the natural world (including land, water, biodiversity, and energy) by changing human needs or habits.

Crown cover: The amount of forest canopy covering and shading the forest floor.

Deciduous: Deciduous plants lose their leaves in winter. This type of forest is associated with a humid climate that includes tree species such as oak, beech, birch, hickory, walnut, maple, elm and ash.

Decomposer: An organism that breaks down dead plants and animals. Decomposers include mushrooms, bacteria and worms.

Deforestation: Removing a forest or part of a forest (e.g. by cutting it down or burning it) to use the wood (e.g. to make paper or furniture) or to use the land for something else (e.g. farming or building on it).

Degraded, degradation: Degradation takes place when parts of an ecosystem (e.g. a forest) is damaged (e.g. because some of it is cut down) but the ecosystem is not yet lost. This may only be temporary, in which case a damaged forest could grow back into a healthy one over time.

Desertification: The degradation of land in arid (dry), semi-arid, and dry sub-humid areas resulting from various factors, including climatic variations and human activities. Desertification causes the degradation of the natural ecosystem and reduces agricultural productivity.

Developed country: A socially and economically well-off country, with high levels of industry, technology, infrastructure, and so on.

Developing country: A poor country that is trying to become more economically advanced. Developing countries tend to rely heavily on subsistence farming or fishing (where farmers or fishers grow, raise or catch enough food only to feed their families, and rarely produce enough to sell on to earn a living).

Drought: A long period of unusually low rainfall, leading to a shortage of water. Droughts may lead to desertification.

Ecological process: An activity carried out by organisms living in an ecosystem. Two examples of ecological processes are filtering water or air, and decomposing dead organisms.

Ecology, ecological: Of, involving, or relating to the relationships between and among organisms and their environment.

Ecosystem: The combined physical and biological components of an environment, and their interactions. An ecosystem is relatively self-contained and is defined by the types of **organisms** found there and their interactions (e.g. forest, lake). Ultimately, the whole world is one big, very complex ecosystem.

Ecosystem goods and services: The benefits that humans and the natural environment can obtain from natural **ecosystems**. There are four types of **ecosystem services**: provisioning (e.g. providing food and water), regulating (e.g. healthy tree roots in the ground help with flood control), cultural (e.g. people enjoy spending time in nature; some cultures worship nature or parts of it) and supporting (e.g. the natural water cycle helps maintain life on Earth).

Ecotourism: Ecotourism is a kind of tourism that has a low impact on the environment and supports local **livelihoods**. Ecotourists often like going to areas of natural beauty to enjoy nature.

Emergent layer: The tallest layer of trees in a forest; the layer that sticks out above the **canopy**.

Endangered: If a plant or animal **species** is in danger of becoming **extinct**, it is said to be 'endangered'.

Endemic: A **species** that is **native** to a particular area or environment and not found naturally anywhere else.

Epiphyte: A plant that grows on and lives off other plants without roots of its own in the ground. For this reason, epiphytes are sometimes also known as 'air plants'.

Equator: The equator is the line around the Earth at 0° **Latitude**. The equator is equally distant from the two poles and divides the Earth's surface into the northern and southern **hemispheres**.

Erosion: Erosion means 'wearing down'. Rocks and soils are eroded when they are picked up or moved by rain, running water, waves, ice, wind, gravity or other natural or human agents. Also see **weathering**.

Evaporation: The process by which heat turns a liquid substance into gas or vapour.

Evergreen: A tree, shrub, or plant that keeps its leaves or needles all year round (unlike **deciduous** plants).

Evolve: To be transformed from one form into another by a process of gradual changes over time. For example, an **organism** may evolve through a series of **adaptations** to better suit its changing environment.

Exotic: Living or growing in a particular region outside its normal range (also see **non-native**).

Extinct, extinction: The state in which a plant or animal **species** no longer lives on Earth.

F

Fell: To cut down.

Food web: A system of interdependent food chains. Food chains show us the links between **organisms** based what eats what. As some **organisms** eat the same things, these chains cross over, forming complex food webs.

Forest disturbance: An event (e.g. a **drought**, fire or **deforestation**) that changes the forest and the trees that grow within it. Forest disturbances can occur as part of a natural process or as the result of human activities.

Forest floor: The bottommost layer of a forest.

Fossil fuels: Fossil fuels form over millions of years from prehistoric plant or animal remains. Three examples of fossil fuels are coal, oil and natural gas. When we burn fossil fuels to fuel vehicles or generate energy, the **greenhouse gas carbon dioxide** is released into the **atmosphere**, contributing to **climate change**.

Fungus (plural: Fungi): An **organism** that grows in the soil, on dead matter or on other fungi by decomposing organic matter. This process means **nutrients** are reused ('nutrient recycling'). Mushrooms, for example, are the fruits of specific kinds of fungi.

G

Gene: A chemical structure inside a **cell** that contains information about the characteristics of the **organism**; it is passed down from parent to offspring.

Germinate: The process by which plants begin to sprout and start growing into plants.

Greenhouse gases: These are gases in the atmosphere that can absorb and emit (or radiate) heat. They include water vapour, carbon dioxide, methane, nitrous oxides and ozone. Human activities like industrial production, energy production and transportation have increased the levels of greenhouse gases in the atmosphere to such an extent, that the Earth's temperature is starting to rise: this is known as climate change. Also see mitigation of climate change and REDD+.

Habitat: The local environment within an ecosystem in which an organism usually lives.

Hardwood: The wood from 'angiosperm' trees, which means their seeds have some sort of covering. Hardwoods are used for construction, furniture, flooring, and containers, among other things.

Hemisphere: Hemisphere means 'half a sphere'. The Earth is divided into two hemispheres which are split at the equator into the 'northern hemisphere' and 'southern hemisphere'.

Herbivore: Animals that only eat plants, algae and photosynthesizing bacteria.

Indigenous people: The people who were the original or oldest known inhabitants of a particular area (also known as native peoples, First Nations peoples or aboriginals). These communities often have a strong cultural, and sometimes spiritual, connection to the forests in which they live.

Infrastructure: The basic facilities and services needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions including schools and post offices.

Intangible: Something that cannot be touched or imagined easily. For example, many forest services such as filtering water and the air are important intangible benefits.

Invasive species: Animals, plants and other species that have been introduced to an area from elsewhere, either by accident or on purpose, and negatively affect the native habitat by out-competing native species.

IUCN Red List: An inventory of the global conservation status of species, based on data collected by thousands of experts worldwide. The Red List tells us how many species are endangered with extinction and to what extent they are endangered using the following categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient and not evaluated.

Keystone species: A species that has a major influence on an ecosystem, especially when other species depend on them for their survival. (Fun fact: the term 'keystone' comes from the way in which a semi-circular arch is built: it's held up by a wedge-shaped stone at the top, in the middle of the arch's bend. If you remove this 'key' component, the whole arch collapses.)

Latitude: A measure of the distance north or south of the equator.

Livelihood: A way of supporting yourself, either through a paying job or by growing, producing and/or gathering everything you need to survive.

Microorganism: A creature too small to be seen with the human eye alone, but which can be seen through a microscope. In ecosystems, they help in recycling nutrients.

Mitigate, mitigation of climate change: Decreasing the amount of greenhouse gases in the atmosphere. There are different ways in which greenhouse gases can be removed from the atmosphere. Trees, for example, need carbon dioxide to respire – which is why REDD+, an international mechanism for climate change mitigation, supports the planting and protection of trees and forests. Also see climate change.

Molecule: When individual **atoms** stick together, they make up small clusters are called 'molecules'. Different molecules make up different substances. For example, a **carbon dioxide** molecule is made up of one **carbon atom** (C) and two **oxygen atoms** (O_2), which is why its scientific name is CO_2.

Native: Something that is original to a place and occurs naturally there.

Natural forest: A forest composed of indigenous trees and not classified as forest **plantation**.

Natural hazard: **Droughts**, floods, hurricanes and **tsunamis** are all examples of natural disasters that can harm people and/or the environment. Natural disasters such as these are becoming more threatening as they become more severe and more frequent with due to **climate change**.

Natural resource: Natural resources are useful materials found in the natural environment around us. Water, soil, wood or rocks are examples of natural resources we rely on to survive. We need water for drinking, water and soil for growing food, wood for making paper and furniture or and wood and rocks for building materials. And those are only a few of the uses we can put those resources to! Can you think of more?

Non-native: Living or growing in a particular region outside its normal range. Also see **invasive species**.

Non-wood forest products: All forest products except **timber** are non-wood forest products (NWFPs). NWFPs includes resins, oils, leaves, bark, **fungi**, animals or animal products and plants other than trees.

Nutrients: Chemicals which animals and plants need to live and grow.

Organism: A living creature, like a plant, animal or **microorganism**.

Over-exploitation: The overuse of a **species** or **ecosystem** that can lead to the inability of a natural area to renew itself. In severe cases, over-exploitation may lead to the **extinction** of a **species**.

Oxygen (O_2): A gas produced by plants and trees during **photosynthesis**, and used by humans and animals who need it to breathe. An oxygen **molecule** is made up of two oxygen **atoms** (O_2).

Photosynthesis, photosynthesize: A biological process found in plants and **algae** that uses light as an energy source to convert **carbon dioxide** and water into a source of food (sugars and other useful chemicals). Photosynthesis breaks **carbon dioxide molecules** down so that the plant can use the **carbon** (C). The left over **oxygen** (O_2) **molecules** are released back into the air, which is very important for life on Earth!

Planted forest, plantation: A forest established by planting and/or seeding new trees in cultivated land. Plantations often cultivate introduced **species** though in some cases indigenous **species** are also used.

Pollinator: An animal that carries pollen from one seed plant to another, unwittingly helping the plant to reproduce. Common pollinators include bees, butterflies, moths, bats and birds.

Precipitation: The process whereby water vapour in the **atmosphere** condenses and falls in the form of rain, sleet, snow or hail.

Primary forest: Forest with **native** tree **species** and mostly undisturbed **ecosystem** processes, without visible impact of human activity.

REDD+: An international mechanism aiming to reduce **greenhouse gases** in the **atmosphere** and to mitigate **climate change**. It rewards governments, local authorities and forest owners in **developing countries** for leaving their forests intact instead of cutting them down. It is called 'Reducing emissions from **deforestation** and forest **degradation** and the role of **conservation**, **sustainable** management of forests and enhancement of forest **carbon** stocks in **developing countries**' or 'REDD+' for short.

Regenerate, regeneration: To renew or restore something that is damaged. For example, a forest may need to regenerate after a **wildfire**, or after an **invasive species** has been removed.

Renewable energy: Energy powered by **renewable resources** which can be replaced or replenished, either by natural processes or human action. Wind, water and solar energy are examples of renewable forms of energy.

Renewable resource: A resource that can be replaced or replenished, either by the Earth's natural processes or by human action. Air, water, and forests are often considered to be example of renewable resources.

S

Savannah: Open grasslands, usually with scattered bushes or trees, characteristic of much of **tropical** Africa where rainfall is seasonal.

Silviculture: The process of developing and caring for a forest wisely so that forests will continue to provide multiple benefits in the future.

Socio-economic benefits: Things that contribute to the social and economic well-being of an individual or a community. Benefits could include public services, good nutrition, jobs and equality between men and women.

Softwood: Wood from trees known as 'gymnosperm' trees, which means their seeds do not have a covering. Softwood trees are found in the global north and their wood tends to be light, both in colour and weight.

Species: A group of similar **organisms** which are able to breed together and produce healthy offspring that are able to produce young themselves.

Subtropical: Of the **subtropics** (see **subtropics**).

Subtropics: The regions between the **tropics** and the **temperate** zones.

Sustainable, sustainability: The state in which we humans use the natural environment to meet our needs without damaging it so that it can no longer be productive (i.e. can no longer support plant, animal or human life). Making sure that our actions are sustainable means that future generations will be able to live well, too.

Sustainable forest management: A way to use and to take care of forests that tries to keep all the parts of a forest healthy, including the **vegetation**, soil, water and wildlife, both now and in the future. It balances the protection of a forest with its use. It is a forward-looking form of management that considers the social, cultural, spiritual, economic and **ecological** values of a forest.

Symbiosis: The relationship between two different **organisms** (usually two plants, or an animal and a plant) in which are both are attached to one another, or in which one lives off the other. Symbiotic **organisms** support each other in a mutually beneficial way.

T

Tangible: Easily seen, touched and felt. The opposite of '**intangible**'.

Temperate: The type of **climate** that can be found between Earth's **tropics** and its polar regions where the temperatures are relatively moderate with few extremes in summer and winter. For example, the Mediterranean **climate** is a temperate **climate**.

Terrestrial: Relating to the land or Earth as a whole ('terra' means 'earth' in Latin).

Tide, tidal: The rise and fall of the sea due to the gravitational pull of the moon and sun and the turning of the Earth. Most places see two high and low tides per day.

Timber: Wood that is used for construction, furniture or other uses. Timber does not include wood that is used as fuelwood.

Topsoil: The top layer of soil, from which plants obtain most of their **nutrients**.

Transpiration: A process where moisture is released from tiny holes called 'stomata' (meaning 'little mouths' in Greek!) on the underside of plant leaves.

Tropical: See **tropics**.

Tropical forest: A forest in a region near the **equator**.

Tropical rainforest: Dense forest of **evergreen** trees growing in regions with heavy year-round rainfall in **tropical latitudes** (near the **equator**) and warm, **temperate climates**.

Tropics: The areas around the **equator**, which have a very warm **climate** and about 12 hours of daylight (and 12 hours of darkness) throughout the year. The tropics extend north to the Tropic of Cancer (the line on which the sun directly overhead at noon on 21 June) and south to the Tropic of Capricorn (the line on which the sun directly overhead at noon on 21 December).

Tsunami: Tsunamis are extremely powerful waves caused by movements at the seabed including earthquakes, volcanic eruptions and underwater landslides.

Tundra: An area of flat land in the Northern **hemisphere** where it the ground is always frozen and no forest occurs at all.

Understorey: The layer of **vegetation** beneath the main **canopy** of a forest.

Unsustainable: The opposite of **sustainable**.

Vegetation: The plants and trees in an area.

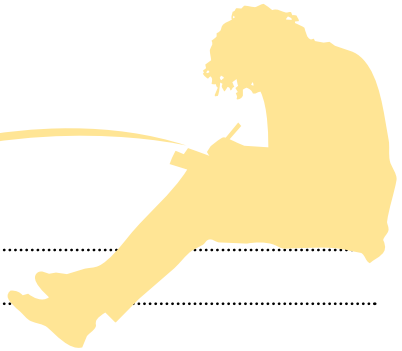
Watershed: An area of land that catches rain and snow, and drains into a larger body of water such as a marsh, stream, river, lake, ocean or groundwater. A watershed (sometimes called a drainage basin) can be as small as a few hectares or as large as thousands of square kilometers.

Weathering: The wearing away of a material or substance such as rock or soil due to natural factors (like wind, rain, the tides, or growing tree roots) or human factors (like chemical pollution). Unlike **erosion**, weathering takes place without the material being moved.

Wildfire: A large, destructive fire that spreads easily.

Wood forest product: Any product produced from the stems and branches of trees and other woody plants.

YOUR NOTES





THE YOUTH GUIDE TO FORESTS

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THIS PUBLICATION HAS BEEN PRINTED USING SELECTED PRODUCTS AND PROCESSES SO AS TO ENSURE MINIMAL ENVIRONMENTAL IMPACT AND TO PROMOTE SUSTAINABLE FOREST MANAGEMENT

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TAKE ACTION FOR FORESTS!



YOUTH AND UNITED NATIONS GLOBAL ALLIANCE LEARNING AND ACTION SERIES

THE YOUTHGUIDE TO FORESTS

The Youth and United Nations Global Alliance (YUNGA) is a partnership between United Nations agencies, civil society organizations and other groups working with children and young people. YUNGA aims to empower children and young people to play an important role in society, encouraging them to become active agents of change. It does so by creating engaging educational resources, activities and opportunities for participation in areas of key environmental and social concern at the local to the international level. The Youth Guide to Forests is part of YUNGA's *Learning and Action Series* which seeks to raise awareness, educate and inspire young people to take action. The series also includes other educational resources and initiatives such as the United Nations Challenge Badges.

This Forest Guide was jointly developed by CBD and FAO, with contributions and support from many other institutions and individuals. It is designed as an educational resource for schools, youth groups and other curious young learners. This fact-filled Guide explores forests from the equator to the frozen poles, the depths of the rainforest to the mountain forests at high altitudes. It also demonstrates the many benefits that forests provide us with, discusses the negative impacts that humans unfortunately have on forests and explains how good management can help protect and conserve forests and forest biodiversity. At the end of the Guide, inspiring examples of youth-led initiatives are provided, and an easy-to-follow action plan aims to help YOU develop your own forest conservation activities and projects.



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