

ECOSYSTEMS & ECOSYSTEM SERVICES



ECOSYSTEMS GIVE US FOOD, CLEAN WATER, CLEAN AIR, BALANCED HABITATS AND MUCH, MUCH MORE!

5

Nadine Azzu, FAO

An **ecosystem** can be considered the house where **biodiversity** lives – in terms of the physical location and the interactions that occur within this space. An ecosystem is made up of physical and chemical (abiotic) and living (biotic) factors – for example, rocks, air and water are physical/chemical factors, while plants, animals and micro-organisms are living factors.

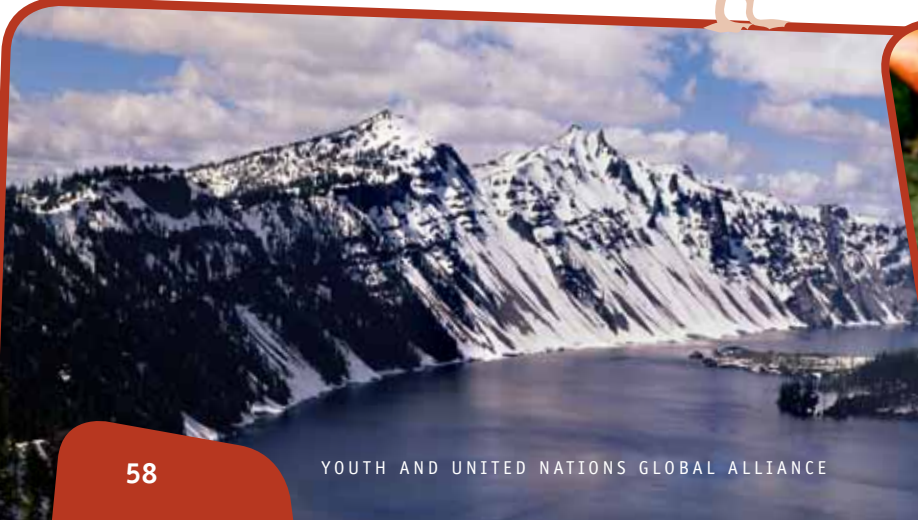
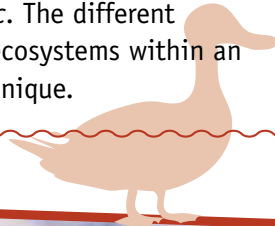


An ecosystem is a **system** which contains **biodiversity at all levels – including species diversity and genetic diversity – and encompasses the interactions and dependencies of biodiversity.**

There are many reasons why different ecosystems are so fascinating – and one of those reasons is that a single ecosystem can contain many small ones. Let's take the case of a simple garden. In a garden, there can be grasses, flowers, bushes, maybe a tree or two, and if we want to be fancy, even a little pond. Of course, there is also the soil, and animals such as ants, worms and bees. But within that garden, there are what we can think of as microecosystems. For example, in the soil there are millions of tiny **micro-organisms** of all types. These micro-organisms are part of an intricate food chain, both under and above the ground. They also provide ecosystem services that keep the soil healthy, regulate water and capture carbon.

Ecosystems can be classified in various ways. Some ecosystems are *natural*, whereas others are *modified and managed by humans*. Ecosystems can be either *terrestrial* or *aquatic*. The different combinations of **genes, species** and microecosystems within an ecosystem are part of what makes each one unique.

One wonderful quality of ecosystems is their delicate balance. The abiotic and biotic factors interact with each other in such a way that all components of the ecosystem give and take just enough from each other, and in just the right way, to keep the ecosystem healthy. This “giving and taking” also allows for the ecosystem to provide different types of services (called ecosystem services) to the environment – including to humans.



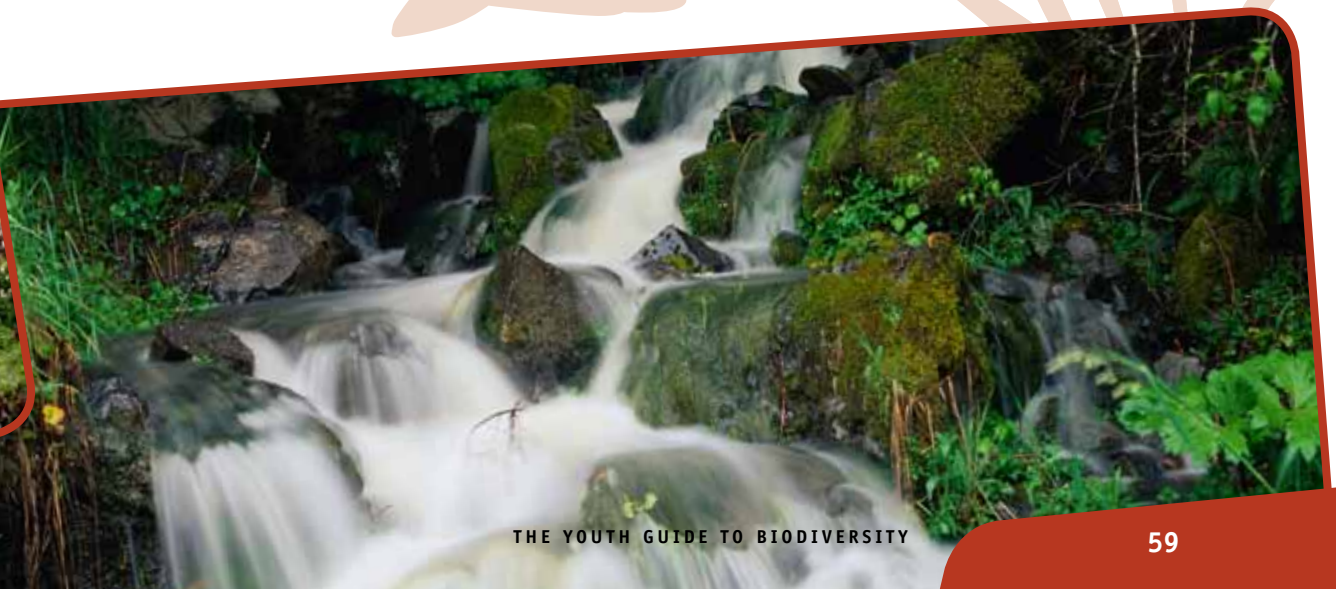
TYPES OF ECOSYSTEMS

Terrestrial ecosystems are found on land, and include tropical forests and deserts. The biodiversity found in tropical rainforests is famous for its variety – birds of all types, shapes and colours, different and abundant tree species, and even spiders, snakes and monkeys.

Natural aquatic ecosystems can be inland or marine. Examples of natural freshwater ecosystems are ponds, rivers and lakes. The biodiversity found in a pond is very different from the biodiversity found, let's say, in a river. In a river, you could see salmon struggling and swimming upstream through the rushing waters to reach their breeding grounds. In a smaller, calmer pond, however, you might see ducks and fish swimming, water lilies floating along the surface of the water, insects flying overhead or frogs hiding in the shallows. Learn more about examples of freshwater biodiversity in Chapter 7.

Similarly, different marine ecosystems, such as seas, oceans and coral reefs, each contain their own unique biodiversity. Sharks, for example, can live in the open oceans, whereas corals, sponges and molluscs are more often found around sheltered coral reefs.

An **agro-ecosystem** is an example of an ecosystem that is dependent on human activities for its existence and maintenance. The biodiversity in agro-ecosystems provides food, fibre, medicine and other benefits for people. Examples of agro-ecosystems include rice paddies, pastures, agroforestry systems, wheat fields, orchards and even backyards with a homegarden or chickens (see the box: “The Rice Paddy Agro-ecosystem”). Read more about agricultural biodiversity in Chapter 9.





THE RICE PADDY AGRO-ECOSYSTEM

A rice paddy is an aquatic ecosystem that houses different types of fish, frogs, plants, insects and soil. For more than 5 000 years, humans have actively managed rice paddies to produce high yields of rice; these rice paddies are called flooded rice agro-ecosystems. In some countries, fish are kept in the rice paddy, so that farmers can harvest both rice *and* fish, which they eat and sell at the market. Similar to other ecosystems, a rice paddy *gives and takes*: when insects that come to eat the rice crop fall into the water, they become food for fish.



RICE TERRACES IN INDONESIA.
© FAO/Roberto Faidutti

WHAT ARE ECOSYSTEM SERVICES, AND WHY DO WE NEED THEM?

Ecosystem services (sometimes called ecosystem goods and services) are the benefits that the environment, of which humans are a part, obtains from ecosystems. Boxes: “The dirt on healthy soils” and “How our health and safety depend on biodiversity” take a closer look at some of the vital ecosystem services provided by biodiversity. There are four types of ecosystem services. They are:

1. PROVISIONING SERVICES: these services are products obtained from ecosystems, such as food, fresh water and genetic resources.

2. REGULATING SERVICES: regulating services are involved in climate regulation, disease control, erosion control, pollination and regulation of natural processes, such as floods and forest fires.

3. CULTURAL SERVICES: ecosystem services not only provide concrete things like food, or essential services such as water filtration, but they also provide us with spiritual, recreational and cultural benefits. For example, ecosystems provide a rich source of inspiration for art, folklore, national symbols, architecture and even advertising.

4. SUPPORTING SERVICES: these services maintain the conditions for life on Earth. They are necessary for the production of all other ecosystem services. Their impacts on people are either indirect or occur over a very long time. In contrast, changes in the other three categories have relatively direct and short-term impacts on people. Examples of supporting services are nutrient cycling, soil formation and retention and **habitat provision**.



1

FRESH FISH SOLD IN A MARKET IN CAMBODIA.

© World Bank/Masaru Goto



2

POLLINATION IS AN ECOSYSTEM SERVICE THAT DEPENDS TO A LARGE EXTENT ON THE COOPERATION, OR SYMBIOSIS, BETWEEN SPECIES - THE POLLINATED (THE PLANT) AND THE POLLINATOR (THE BEE). BEES PROVIDE VITAL POLLINATION SERVICES TO THOUSANDS OF PLANT SPECIES.

From Wikimedia Commons

3

BIODIVERSITY INSPIRED THESE ADVERTISEMENTS IN BONN, GERMANY DURING THE BONN INTERNATIONAL CONFERENCE ON BIODIVERSITY IN 2008.

© Christine Gibb



4

FORESTS PROVIDE VITAL HABITATS FOR MANY SPECIES.





THE DIRT ON HEALTHY SOILS

Enhancing the provision of ecosystem services can result from a collective effort. For example, creating and maintaining healthy soil in an agro-ecosystem requires farmers and worms to work together. Small **organisms** such as worms burrow through the soil and make it porous, so water can seep through, reaching the roots of plants. Worms also digest

old leaves and plant material, recycling them into nutrients that nourish existing plants. In doing so, worms provide a very important ecosystem service – but they can't provide this service unless there is organic matter (old leaves and plant material) available. Humans also play a role in ensuring that soil is kept healthy and fertile. Farmers must decide carefully

about which types of farming practices they use, so that the environment continues to provide ecosystem services. In an agro-ecosystem such as a crop field, farmers' practices such as **mulching**, leaving organic matter on the ground instead of collecting and disposing of it, provide the worms with the organic matter they will transform into nutrients to feed the farmers' crops.



CLOSE-UP OF WORM CULTURE. WORMS ARE USED TO IMPROVE SOIL QUALITY.
© FAO/A. Odoul



HOW OUR HEALTH AND SAFETY DEPEND ON BIODIVERSITY

Conor Kretsch, COHAB Initiative Secretariat

Biodiversity sustains our health in many ways. In addition to providing us with sources of fresh water and food, it provides important medicines and resources for medical research.

Biodiversity also plays a role in the control of pests and infectious diseases, and by supporting healthy ecosystems it can help to protect us against the worst effects of natural disasters.

For around 80 percent of the world's people, healthcare is based on traditional medicines using wild flora and fauna. Many modern medicines are also based on chemical compounds from wildlife. The important anti-cancer drug Taxol comes from the Pacific yew tree and some types of fungus. The anti-malaria drug quinine comes from the cinchona tree, while the drug exanitide, which

helps to treat diabetes, was developed from the venom of the gila monster lizard.

Modern medicine also has much to learn from studying animals in the wild. For example, wild bears eat large amounts of fatty and sugar-rich foods before hibernating for several months. In humans, eating fatty foods and sugars and not exercising for prolonged periods can lead to diabetes, obesity, heart problems and bone weakness; however, bears can sleep for

100 days or more without suffering from any of these problems!

So scientists studying bears hope to learn new ways of understanding and treating these diseases in people. Other species we are learning from include primates, crabs, sharks and whales. We still know very little about most of the biodiversity on Earth, but we know that when a species disappears, anything we might have been able to learn from that species disappears too.



A GILA MONSTER.
© Blueag9/Wikimedia Commons



A MOSQUITO RESTS ON FOLIAGE IN NAKHONRATCHASIMA PROVINCE, THAILAND.
© Muhammad Mahdi Karim/Wikimedia Commons



TSUNAMI HAZARD ZONE NOTICE ON A BEACH IN KOH PODA/ KRABI, THAILAND.
© Juergen Sack



Just as animals and plants have their own place and part to play in a healthy ecosystem, so too do organisms which can cause disease (e.g. certain viruses, bacteria, fungi and parasites). When human activity damages an ecosystem in which these organisms live, we risk creating new disease outbreaks. For example, the parasite that causes malaria is spread to people by the bite of some types of mosquito, which breed in pools of water. Changes to ecosystems – through deforestation, dam building or urbanisation – can provide new areas for mosquitoes to breed, and this can lead to an increase in malaria risk for people nearby.

Many other diseases have been linked to human impacts on biodiversity and ecosystems, including HIV/AIDS, SARS, hantavirus and some types of avian influenza.

Biodiversity also helps improve human safety and security. It can protect communities against the impacts of disasters, by supporting ecosystems that provide shelter against floods and storms, prevent erosion or avalanches on hillsides, or help provide food security for people faced with drought or famine. So, conserving biodiversity is a way of supporting communities and protecting our health and that of our children.



WHY SHOULD WE PAY ATTENTION TO ECOSYSTEM SERVICES?

As we have seen, balanced and healthy ecosystems provide important ecosystem services. They are important, not only for giving us clean air, water, soil and food, and for protecting us from floods and diseases, but also for providing us with beautiful landscapes in which to live. Ecosystem services are also vital to the short- and long-term survival and health of ecosystems. What other ecosystem services are there? What are some practical examples of why they are vital to humans and nature?

Human activity is putting ecosystems in danger, which in turn, means that these ecosystems cannot provide us (or any other part of biodiversity) with ecosystem services. But what exactly does this mean for us? And what can we do to help? Let's explore these questions using the ecosystem service of pollination as an example.

HONEYCOMB.
© Kriss Szkulatowski



AN EXAMPLE OF AN ECOSYSTEM SERVICE: **POLLINATION**

Pollination is an ecosystem service that depends to a large extent on cooperation, or **sympiosis**, between species – the pollinated (the plant) and the **pollinator**. Some pollinators only pollinate specific types of flowers. At least one-third of the world’s agricultural crops (especially many fruits and vegetables) depend upon pollination provided by insects and other animals. Pollinators are essential for **orchard**, **horticultural** and **forage** production, as well as for the production of seeds for many root and fibre crops. Some examples of pollinators are moths, butterflies, flies, beetles and vertebrates (such as bats, squirrels and birds). Most animal pollination is done by bees. That means that bees are responsible for making sure many of the fruits and vegetables that we eat actually exist!



Bees visit flowers to drink nectar and to collect pollen grains. When a bee lands on the flower, pollen grains from the **anther** of the flower get stuck on the bee’s body. Then, the bee flies off to another flower. Some of the pollen on the bee’s body gets transferred to the **stigma** of this new flower – and in this way, the new flower is pollinated. Once a flower is pollinated, it produces a seed, and this seed can grow into a new plant.

A BEE COLLECTING POLLEN GRAINS.
© Laurence Packer/Cory Sheffield

Unfortunately, bee populations are declining around the world. Many human practices kill bees, often by accident. For example, the uncontrolled spraying of pesticides kills both “bad” and “good” insects. The destruction of valuable bee habitats leaves fewer places for bees to live. Different bee species need different types of habitats for foraging and for shelter. The clearing of forest land harms species that live in hives or inside fallen logs. The ploughing of fields destroys the homes of ground-nesting bees.



Although scientists do not yet know all the reasons why bee populations are declining, they do know that the decline will have a huge impact on ecosystems and on our food. If pollinator populations fall, it will be difficult to grow crops that provide us with important vitamins and nutrients, such as our fruits and vegetables. Without diverse nutritious fruits and vegetables, we would end up having unbalanced diets and health problems.

Often, bees have a bad reputation – they are seen by people as being dangerous and irritating, and are generally not welcome. Instead, we should learn to appreciate the importance of pollination, and maybe help give bees a better reputation! So next time you are in a garden and see bees buzzing around, try to notice if there are any fruit trees around. Tell your family and friends that bees should not be seen as harmful insects, because if they ate a piece of fruit this morning for breakfast, it was thanks to the bees who pollinated the trees!



AN EXHIBIT AT THE EXPO OF DIVERSITY IN BONN, GERMANY SHOWS THE IMPORTANCE OF BEES IN PRODUCING FOOD. WITH BEES, WE HAVE ALL THE FOODS ON THE LEFT TABLE. WITHOUT BEES (RIGHT TABLE), WE HAVE MUCH LESS FOOD!
© Christine Gibb



CONCLUSION

In a sense, nature is made up of “big life” and “small life”. The big life cannot survive if small life is not taken care of, or if it is not managed properly. The bits and pieces of small life – and just as importantly, the interactions between them – are what sustain the big life. The small life consists of the species that can be found on the ground, in the skies, in the water and underground – for example, mammals, birds, fish and insects. The big life is the wider ecosystem. As we have seen in this chapter through examples such as rice paddy ecosystems, pollination and soil fertility, it is the small life (species) that not only sustains the ecosystem but also the ecosystem services that ensure a healthy and functioning planet.



LADYBIRD INVASION.
© Tobias Abrahamsen (age 16)

We can draw an important lesson from these examples: in nature, we must look at both the individual “small life” and the “big life”. In practical terms, this means that if we were doctors, and we saw a population of any given species suffering, we would not just prescribe a specific medicine to target the apparent illness – instead, we should find out why the species population is sick. Maybe the answer doesn’t lie within the species itself, but is caused by a series of events found in the wider ecosystem. Can you give an example of how a natural or human-made impact on “small life” affects “big life”?

Together, we can take many actions to raise our own awareness, and that of others, of the importance of healthy ecosystems. We can start by taking small, but significant, actions. Begin, for example, by building a terrarium (small container with soil for plants) to learn firsthand how an ecosystem works. Monitor and record the activities that you observe in your terrarium. Take the terrarium to school and share your observations with your classmates. Whatever you decide to do, make sure you apply your learning about healthy ecosystems to your daily actions.