Conservation

Native = A native plant occurs naturally in a particular region. A plant can be native to multiple regions.

Endemic = Endemic plant species are only found in one particular region. Endemic species are often endangered.

Endangered = Any species that is in danger of extinction throughout all or a significant portion of its range.

Threatened = Any species that is likely to become an endangered species within the foreseeable future.

Biodiversity

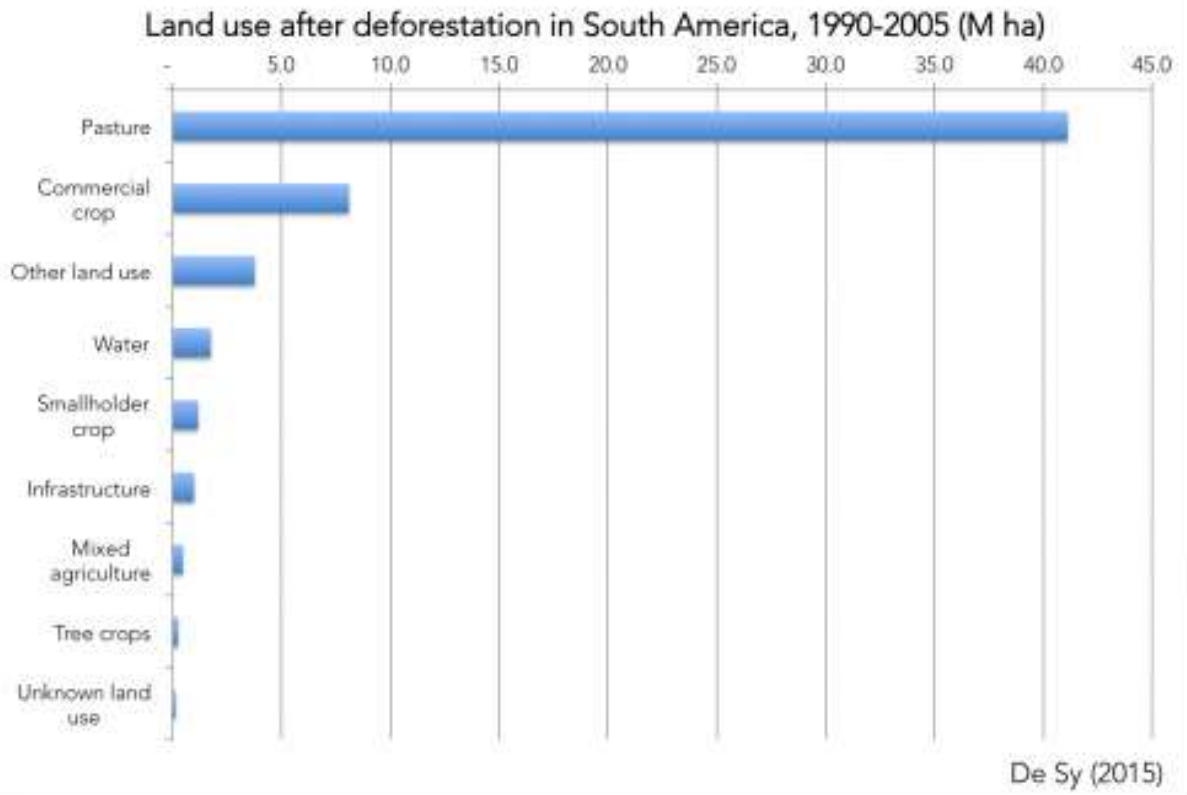
Fifty percent of the world's plants and animals can be found in the worlds rainforests. Rainforests once covered 14% of the earth's land surface; now they cover a mere 6%. Most experts agree that we are losing upwards of 80,000 acres of tropical rainforest daily, and significantly degrading another 80,000 acres every day on top of that. Along with this loss and degradation, we are losing some 135 plant, animal and insect species every day—or some 50,000 species a year—as the forests fall.

Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play. For example, a larger number of plant species means a greater variety of crops. Greater species diversity ensures natural sustainability for all life forms. Biodiversity benefits human kind for many reasons - the richer the diversity of life, the greater the opportunity for medical discoveries, economic development, and adaptive responses to such new challenges as climate change. They help maintain the climate by regulating atmospheric gases and stabilizing rainfall, and provide many other important ecological functions. A quarter of our modern pharmaceuticals are derived from rainforest ingredients, but less than one percent of the trees and plants in the tropics have been tested for curative properties.

What is hurting our tropical forests?

- Pasture land for cattle.
- Oil extraction in the rainforest areas of Colombia, Ecuador, Peru, Bolivia and Nigeria – destroys habitat and pollutes.
- Mining for gold and other minerals – destroys or degrades habitat and pollutes waterways and soils.
- Paper mills and logging – destroys habitat, erodes the land and pollutes waterways.

- Farming (Palm Oil plantations, soybean fields, cattle ranching) – destroys habitat and erodes the land.
- Collectors/Poachers – upset delicately balanced food webs, contribute to species extinction (cycads are sought after by poachers).
- Fragmentation of habitat (roads, dams, urban creep, resorts, golf courses) – destabilizes the forest interior, prevents natural movement of plants and animals, often cannot support larger species, plants can lose pollinators, and diversity decreases.



Success Stories

TECHNOLOGY

In the early 2000s, Brazil was losing forest in the Amazon at a rate of 23,000 square kilometers — an area larger than Belize or the state of New Jersey — annually. In 2004, the South American country implemented a satellite-based deforestation monitoring system that enabled authorities to see where forest was being cleared on a monthly basis. Since then, the annual rate of clearing in the Brazilian Amazon has fallen 80 percent. Analysis suggests that the biggest factor in driving deforestation downwards was the satellite system, which increased transparency around forest use.

Google Earth has been used for years by conservationists who compare maps of the same forest over weeks and months. Someone in San Francisco can discover illegal deforestation happening thousands of miles away. An online platform called Global Forest Watch (GFW) was developed to allow users to access data on tree cover loss – but it took a year for that data to become available. Today, however, GFW has unveiled a new dataset for 2015, one that tracks forest impacts in near real time. And it is revealing some big issues unfolding in the world's forests. Analysts say this data could help governments, NGOs, and communities better monitor their forests, as well as more quickly and effectively address deforestation.

Other technologies include monitoring drones, tree tagging to track flow of timber products from the forest to buyers and identify discrepancies in volumes, species and products reported. The internet has also aided with advocacy. A smartphone video or a call to action from a citizen journalist or activist can spread globally in days or hours.

CORPORATE ACTION

In response to environmental groups — and increasingly shareholders and local governments — companies are changing their practices. Since 2010, scores of companies have adopted "zero deforestation" policies that set social and environmental safeguards for their commodity sourcing. Deforestation for palm oil plantations has dropped significantly in recent years. Unilever, the world's largest corporate buyer of palm oil, was caught up in a scandal in 2008 when Greenpeace claimed the company's supplier was involved in forest destruction in Borneo. Unilever learned that the palm oil supplier was indeed clearing rainforests and carbon-dense peatlands. Unilever suspended buying from the company. Since then, Nestle, Kraft, Burger King, and General Mills have followed suit. McDonald's will combat deforestation across its main commodity supply chains, including palm oil, beef, paper and packaging, coffee, and poultry. The commitment is the most comprehensive of any major restaurant chain. The policy also establishes labor and human rights safeguards and requires suppliers to verify the origin of raw materials.

GOVERNMENT ACTION

Governments seem to be taking forest issues more seriously than they did in the past. For example, the Norwegian government has committed billions toward tropical forest protection and even announced a zero deforestation procurement policy, while the U.S., European Union, and Australia have passed laws governing timber imports, attempting to close some of the loopholes that allow illegal timber imports. The crackdown on the ivory trade could help protect species with an important role in forest ecosystems: African and Asian elephants. In Indonesia, the government announced the palm oil permit and coal mining freeze in2016. Both sectors are vital to Indonesia's economy, but lead the way in damaging the environment. Rapid oil palm expansion is decimating the country's

rainforests and was a prime cause of last year's fire and haze crisis, which sickened half a million people, polluted the air of neighboring countries, pumped an incredible amount of carbon into the atmosphere and, according to the World Bank, cost Indonesia $16 billion.

INDIGENOUS CONTROL OF LAND

Two of the biggest trends in forest conservation in the past five years have been at opposite ends of the spectrum: corporate "zero deforestation" commitments and increasing recognition of the conservation value of securing land rights for forest-dependent communities, including indigenous peoples. The reason for the latter? A growing body of evidence indicating that locals do a better job of stewarding natural resources when their traditional management rights are recognized: deforestation in indigenous territories is often lower than in national parks. This recognition is now starting to happen in countries ranging from Mexico (an early leader) to Indonesia, where millions of hectares of state-owned land could potentially be turned over to indigenous control.

What can I do to help?

TREES – is a great way to teach elementary school students how to help the rainforest.

- **T**each others about the importance of the environment and how they can help save rainforests.
- **R**estore damaged ecosystems by planting trees on land where forests have been cut down.
- **E**ncourage people to live in a way that doesn't hurt the environment.
- **E**stablish parks to protect rainforests and wildlife.
- **S**upport companies that try to minimize their damage to the environment.

Some more specific examples:

- Buy only tropical wood products that are certified as sustainably harvested.
- At stores and restaurants ask where your meat comes from. Much of the red meat in fast food, frozen foods and pet food comes from ranches carved out of tropical ecosystems.
- Buy shade-grown coffee and chocolate. These plantations generally grow coffee and chocolate under the existing canopy trees, rather than clearing the rainforest..
- Recycle, re-use and re-purpose as much as you can. Aluminum cans, paper, wood, even gold and diamonds for jewelry.
- Donate money to organizations that protect rainforest and other environments.
- Learn all you can about tropical environments and help educate others on your tours at the Conservatory. One great resource is Mongabay.com.

Nutrient Cycling in the Rainforest

Understanding the basic composition of forest soils helps explain the concept of nutrient cycling in the rainforest; why there are problems with clearing rainforest lands for agriculture; and how soils are an important factor influencing forest complexity.

SOIL COMPOSITION

Over two-thirds of the world's rainforests, and three-fourths of the Amazonian rainforest can be considered "wet-deserts" in that they grow on red and yellow clay-like laterite soils which are acidic and low in nutrients. Many tropical forest soils are very old and impoverished, especially in regions—like the Amazon basin—where there has been no recent volcanic activity to bring up new nutrients. Amazonian soils are so weathered that they are largely devoid of minerals like phosphorus, potassium, calcium, and magnesium, which come from "rock" sources, but are rich with aluminum oxide and iron oxide, which give tropical soils their distinctive reddish or yellowish coloration and are toxic in high amounts. Under such conditions, one wonders how these poor soils can appear to support such vigorous growth.

Rainforests are tremendously vegetated. Early European settlers in the tropics were convinced (and even assured by scientists at the time) that the lushness of the "jungle" was due to the rich soils, so they cut down large patches of forest to create croplands. The cleared land supported vigorous agricultural growth, but only for one to four years, when mysteriously, plant growth declined to a point where copious amounts of fertilizer were required for any growth. Settlers wondered why their crops perished and how such poor soil could support the luxuriant growth of tropical rainforest. The answer lies in the rapid nutrient cycling in the rainforest.

NUTRIENT CYCLING

The colonial settlers did not realize that they were dealing with an entirely different ecosystem from their temperate forests where most of the nutrients exist in the soil. In the rainforest, most of the carbon and essential nutrients are locked up in the living vegetation, dead wood, and decaying leaves. As organic material decays, it is recycled so quickly that few nutrients ever reach the soil, leaving it nearly sterile.

Decaying matter (dead wood and leaf litter) is processed so efficiently because of the abundance of decomposers including bacteria, fungi, and termites. These organisms take up nutrients, which are released as wastes when organisms die. Virtually all organic matter is rapidly processed, even fecal matter and perspiration. It is only a matter of minutes, in many rainforests, before dung is discovered and utilized by various insects. Excrement can be covered with brightly colored butterflies, beetles, and flies, while dung beetles feverishly roll portions of the waste into balls for use later as larval food. Insects are not only attracted to dung for the energy value, but often for the presence of nutrients like calcium salts. Human sweat is a treasure for several species of butterflies, which gather on the necks and hats of tourists, and for annoying sweat bees, which can cover seemingly every inch of exposed skin in some forests.

DUNG MIMICS
The attractiveness of dung to small rainforest insects has led to the development of dung-mimics both among predators and prey. These animals, generally insects and spiders, sit motionless for hours at a time trying to look as dung-like as possible to avoid detection.

As vegetation dies, the nutrients are rapidly broken down and almost immediately returned to the system as they are taken up by living plants. Uptake of nutrients by plant roots is facilitated by a unique relationship between the roots and the fungi, mycorrhizae. The mycorrhizae attach to plant roots and are specialized to increase the efficiency of nutrient uptake nutrient from the soil. In return, plants provide the fungi with sugars and shelter among their roots. Studies have also shown that mycorrhizae can help a tree resist drought and disease.

TREE ROOT SYSTEMS

Tropical rainforest trees are well-adapted to their environment and have mastered the problem of poor soils. Since the first six to eight inches (15-20 cm) of soil is a compost of decaying leaves, wood, and other organic matter, it is the richest source of nutrients on the ground. To tap this resource, canopy trees are shallow rooted, whereas most temperate tree roots extend more than 5 feet (1.5 m) deep. Many tropical species have roots that actually grow out of the ground to form a mat on the forest floor in order to more efficiently collect nutrients. These tiny roots form a network that, along with the mycorrhizae fungi, rapidly absorb nutrients.

The configuration of shallow roots and great height causes a great deal of instability for rainforest trees, especially with wet soils and strong winds of the upper canopy that can accompany tropical storms. To counter this, many tree species have extensive root systems that in some cases may run for over 325 feet (100 m). Other trees, especially tall emergent species, have evolved buttress roots—large, thin extensions of the trunk that begin some 20 feet from the ground. These structures are thought to also aid in water uptake and storage,

increase surface area for gas exchange, and collect leaf litter for additional nutrition. Some trees, especially palms, have stilt roots for support.

Thus when colonists cut the forest and burned the vegetation, they were destroying the delicate rainforest system which allows vigorous growth on such poor soil. Burning the dead wood and vegetation released enough nutrients into the soil to allow crops to grow for several years, but without the mycorrhizae, and other soil organisms to fix nutrients, soils were rapidly leached by the harsh tropical sun or washed away by heavy rains. Essential minerals were not replaced by new decaying matter since there was no longer forest above to drop leaves and wood. Within a few years, the soil becomes nutrient deficient and can no longer support productive yields of conventional crops. Essentially, the colonists destroyed several links in the semi-closed nutrient system of the rainforest and had to abandon the site for another forested patch. While this seems similar to the "slash-and-burn" technique of native indigenous peoples, the difference is in the scale and form of the cleared sites. By clearing large areas, the colonists created a major break in the rainforest nutrient cycling system; something which takes generations to recover. In the smaller patches cleared by traditional forest dwellers, forest can quickly recolonize after agriculture is abandoned, especially if the patch is left surrounded by forest. Within 20 years, relatively well-developed secondary forest can reclaim such an agricultural plot.

Not all rainforest soils are so poor; some rainforests grow on nutrient-rich floodplain and volcanic soils. Some of the best soils are found on steep slopes because minerals are released when the exhausted topsoils erode. Such rich soils are found in the Amazonian floodplains, Andean foothills, and volcanic areas of Southeast Asia (Java), Africa, Central America, and the Caribbean. However, without proper management, these soils as well can be rapidly leached of nutrients by heavy rains and the sun. For example, a hectare of tropical rainforest rarely loses more than 1 ton of soil annually. However, when the forest is leveled and planted with various crops, the erosion increases drastically. If the forest is replaced with dense vegetation like a coffee plantation, the hectare loses between 20 and 160 tons, whereas if it is replaced with field crops, the patch can lose more than 1,000 tons annually.

REGROWTH AFTER CLEARING

When Europeans cleared the rainforest for agriculture, they probably assumed that the forests would regrow relatively quickly like the temperate forests of Europe and North America. But rainforest will not readily return on lands with agricultural monocultures that have been devoid of forest for several years and have highly degraded soils. Tropical soils rapidly become inhospitable to growth due to swift leaching of nutrients caused by heavy rains and intense sunlight. In addition, many tropical hardwood trees are dependent on certain animal species

for pollination, seed dispersal, and seed processing. The seeds of many tropical rainforest species are large (since they germinate in the shade of the canopy and must have enough food reserves to grow in the low light conditions of the forest floor) and require animal dispersers (wind or other mechanical means often are not sufficient for dispersing seeds of this size). The loss of these dispersal species when forest is leveled, means tree seeds are unlikely to be dispersed into cleared areas. Therefore these important forest tree species will not return.

The seeds and seedlings of those tree species not limited by animal dispersal and pollination agents are often specifically adapted to the light and climate conditions of the shaded rainforest floor. These seeds usually will not germinate in the hot, arid conditions of clearings, and those that do sprout rapidly succumb to the sun and poor soils. Tropical rainforest plants are accustomed to the stability of the rainforest, where they are robust. When they and their seeds are confronted with the entirely different set of conditions presented by forest clearing, they do not fare well. Their seeds have little or no capacity to remain dormant since they have no need under normal forest conditions.

The dry air of the forest clearing also dessicates the leaf litter causing the mycorrhizae to die. The elimination of the symbiotic mycorrhizae reduces the capacity of trees to take up nutrients from the soil. The fungi are especially difficult to replace since each species of tree may have its own symbiotic species of mycorrhizae. Regeneration is further stunted by the rapid encroachment of tough grasses and shrubs after the clearing of forest.

The situation is different when a cleared area is left surrounded by forest and the soils have not been decimated. Under these conditions, forest may rapidly reclaim the barren patch as fast-growing, weedy pioneer plants like forest grasses, bananas, gingers, and vines move into the clearing. Pioneer tree species—which require such conditions of bright sunlight and lower humidity for growth—like cecropia (neotropics) and macaranga (Asia) quickly colonize forest gaps. After several years, the small number of pioneer plants and trees like kapok and cecropia are gradually replaced with diverse species more characteristic of older-growth primary forest. The necessary mycorrhizae fungi can recolonize from the surrounding forest and facilitate nutrient uptake. After 20 years the formerly cleared land may again support vigorous growth, although this forest is only a shadow of the original primary forest. The new secondary forest, is far less diverse, has a less developed canopy, fewer animals, and thicker ground vegetation. It is unknown how long it takes for secondary forest to return to the complexity of primary forest, but the estimates range from hundreds to thousands of years.

– Rhett Butler. “Soils and Nutrient Cycling” *Mongabay.com / A Place Out of Time: Tropical Rainforests and the Perils They Face*.