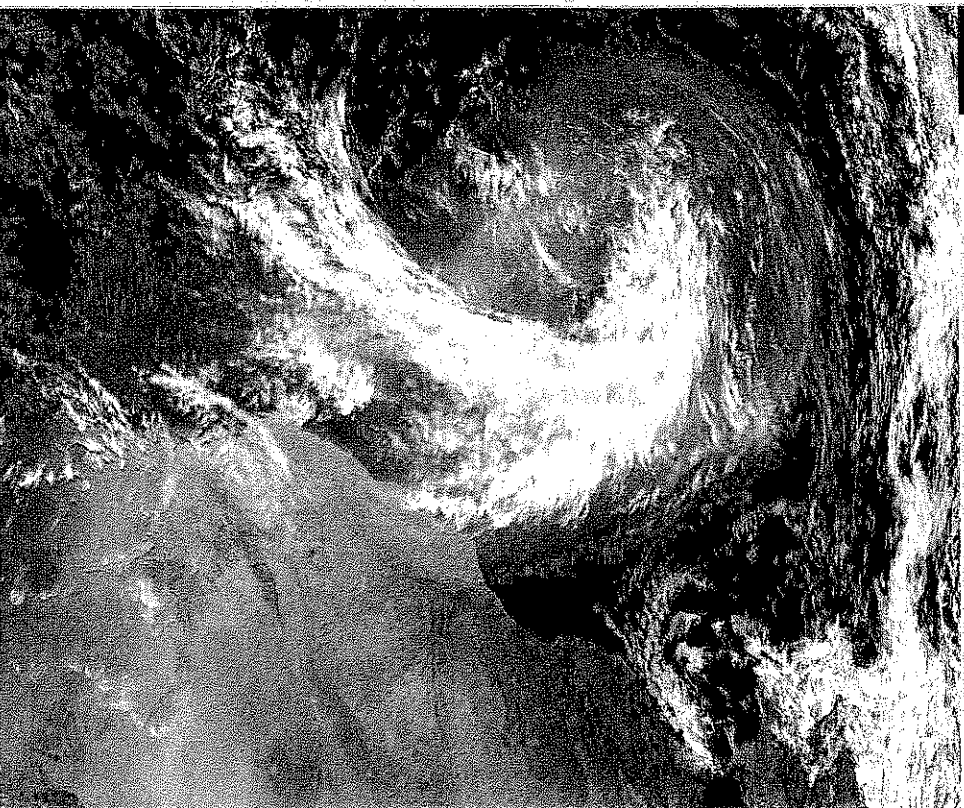


# 7 Climate and Terrestrial Biodiversity

## CORE CASE STUDY

### Blowing in the Wind: Connections between Wind, Climate, and Biomes

Terrestrial biomes such as deserts, grasslands, and forests make up one of the components of the earth's biodiversity (Figure 4-2, p. 79). Why is one area of the earth's land surface a desert, another a grassland, and another a forest? The general answer lies in differences in *climate*, resulting mostly from long-term differences in average temperature and precipitation caused by global air circulation, which we discuss in this chapter.



SeaWiifs Project/Nasa/GSFC, Nasa

**Figure 7-1** Some of the dust blown from West Africa, shown here, can end up as soil nutrients in Amazonian rain forests and toxic air pollutants in the U.S. state of Florida and in the Caribbean. It may also help to suppress hurricanes in the western Atlantic.

Wind—an indirect form of solar energy—is an important factor in the earth's climate. It is part of the planet's circulatory system for heat, moisture, plant nutrients, soil particles, and long-lived air pollutants. Without wind, the tropics would be unbearably hot and most of the rest of the planet would freeze.

Winds transport nutrients from one place to another. For example, winds carry dust that is rich in phosphates and iron across the Atlantic Ocean from the Sahara Desert in West Africa (Figure 7-1). These deposits help to build agricultural soils in the Bahamas and to supply nutrients for plants in the upper canopies of rain forests in Brazil. A 2007 study indicated that in 2006, such dust might have helped to reduce hurricane frequency in the southwestern North Atlantic and Caribbean by blocking some energizing sunlight. Dust blown from China's Gobi Desert deposits iron into the Pacific Ocean between Hawaii and Alaska. The iron stimulates the growth of phytoplankton, the minute producers that support ocean food webs. Wind is also a rapidly growing source of renewable energy, as discussed in Chapter 16.

Winds also have a downside. They transport harmful substances. Particles of reddish-brown soil and pesticides banned in the United States are blown from Africa's deserts and eroding farmlands into the sky over the U.S. state of Florida. Some types of fungi in this dust may play a role in degrading or killing corals reefs in the Florida Keys and in the Caribbean.

Particles of iron-rich dust from Africa also enhance the productivity of algae, and have been linked to outbreaks of toxic algal blooms—referred to as *red tides*—in Florida's coastal waters. People who eat shellfish contaminated by a toxin produced in red tides can become paralyzed or can even die. These red tides can also cause fish kills.

Dust, soot, and other long-lived air pollutants from rapidly industrializing China and central Asia are blown across the Pacific Ocean and degrade air quality over parts of the western United States. Asian pollution makes up as much as 10% of West Coast smog—a problem that is expected to get worse as China continues to industrialize. A 2007 study, led by Reryl Zhang, linked such Asian air pollution to intensified storms over the North Pacific Ocean and to increased warming in the polar regions.

The ecological lesson: *Everything we do affects some other part of the biosphere because everything is connected.* In this chapter, we examine the key role that climate, including winds, plays in the formation and location of the deserts, grasslands, and forests that make up an important part of the earth's terrestrial biodiversity.

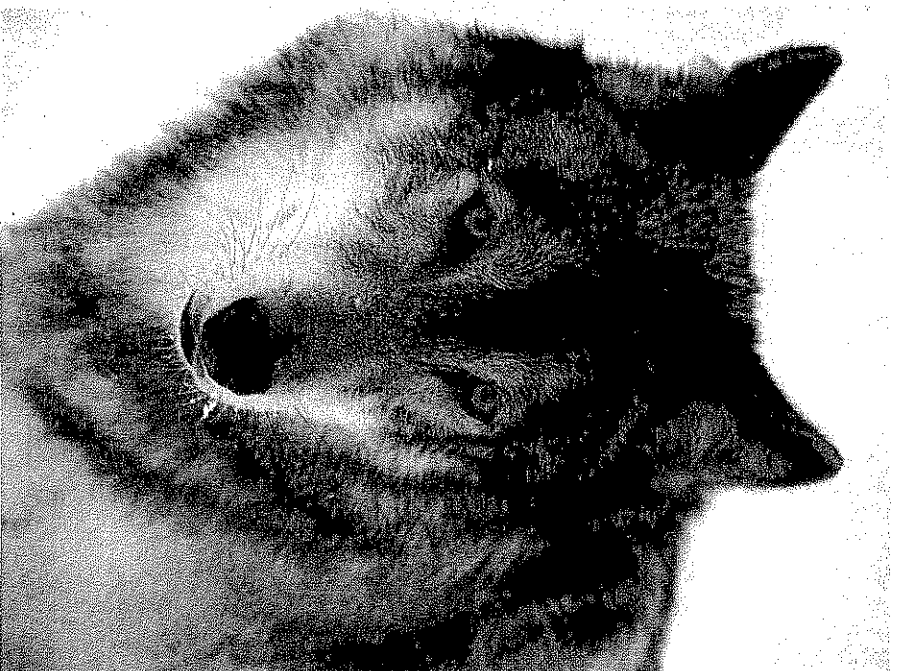
# 10

## Sustaining Terrestrial Biodiversity: The Ecosystem Approach

### CORE CASE STUDY

#### Reintroducing Gray Wolves to Yellowstone

Around 1800 at least 350,000 gray wolves (Figure 10-1), roamed over the lower 48 states, especially in the West, and survived mostly by preying on bison, elk, caribou, and mule deer. But between 1850 and 1900, most of them were shot, trapped, and poisoned by ranchers, hunters, and government employees. When Congress passed the U.S. Endangered Species Act in 1973, only a few hundred gray wolves remained outside of Alaska, primarily in Minnesota and Michigan. In 1974,



Tom Kitchin/Tom Stack & Associates

**Figure 10-1** Natural capital restoration: the gray wolf. After becoming almost extinct in much of the western United States, in 1974 the gray wolf was listed and protected as an endangered species. Despite intense opposition by ranchers, hunters, miners, and loggers 41 members of this keystone species were reintroduced to their former habitat in the Yellowstone National Park and central Idaho in 1995 and 1996. By 2007, there were about 171 gray wolves in the park.

the gray wolf was listed as an endangered species in the lower 48 states.

Ecologists recognize the important role this keystone predator species once played in parts of the West, especially in the northern Rocky Mountain states of Montana, Wyoming, and Idaho where Yellowstone National Park is located. The wolf-culled herds of bison, elk, caribou, and mule deer, and kept down coyote populations. They also provided uneaten meat scavengers such as ravens, bald eagles, ermines, grizzly bear and foxes. When wolves declined, herds of plant-browsing moose, and mule deer expanded and devastated vegetation as willow and aspen trees often found growing near stream and rivers. This increased soil erosion and threatened habitat other wildlife species such as beavers, which, as foundation species (p. 96), helped to maintain wetlands.

In 1987, the U.S. Fish and Wildlife Service (USFWS) proposed reintroducing gray wolves into the Yellowstone National Park ecosystem to help restore and sustain its biodiversity. The proposal brought angry protests, some from area ranchers who feared the wolves would leave the park and attack their cattle and sheep. Other objections came from hunters who feared wolves would kill too many big-game animals, and from mining and logging companies fearing that the government would their operations on wolf-populated federal lands.

In 1995 and 1996, federal wildlife officials caught gray wolves in Canada and relocated 41 of them in Yellowstone National Park. Scientists estimate that the long-term carrying capacity of the park is 110 to 150 gray wolves. In 2007, there had 171 gray wolves. Overall, this experiment in ecosystem restoration has helped to re-establish and sustain some of the biodiversity that the Yellowstone ecosystem once had, as discussed later in this chapter.

In 2008, the USFWS decided to remove the gray wolf protection under the Endangered Species Act in the states of Montana, Wyoming, and Utah. Several conservation groups suits to have the courts overturn this decision. The wolves in park will remain protected. But 6 of the park's 11 wolf packs travel outside of the park boundaries during part of every year. If the courts allow removing the wolves from the endangered species list, it will be legal to kill any of these packs' individuals found outside the park.

Biologists warn that human population growth, economic development, and poverty are exerting increasing pressure on ecosystems and the services they provide to sustain biodiversity. This chapter is devoted to helping us understand and sustain earth's forests, grasslands, and other storehouses of terrestrial biodiversity.

# INDIVIDUALS MATTER

## Wangari Maathai and Kenya's Green Belt Movement

In the mid-1970s, Wangari Maathai (Figure 10-B) took stock of environmental conditions in her native Kenya. Tree-lined streams she had known as a child had dried up. Farms and plantations that were draining the watersheds and degrading the soil had replaced vast areas of forest. The Sahara Desert was encroaching from the north.

Something inside her told Maathai she had to do something about this degradation. Starting with a small tree nursery in her backyard, she founded the Green Belt Movement in 1977. The main goal of this highly regarded women's self-help group is to organize poor women in rural Kenya to plant and protect millions of trees in order to combat deforestation and provide fuelwood. By 2004, the 50,000 members of this grassroots group had established 6,000 village nurseries and planted and protected more than 30 million trees.

The women are paid a small amount for each seedling they plant that survives. This gives them an income to help break the cycle of poverty. It also improves the environment because trees reduce soil erosion and provide fruits, fuel, building materials, fodder for livestock, shade, and beauty. Having more trees also reduces the distances women and children have to walk to get fuelwood for cooking and heating. The success of this project has sparked the creation of similar programs in more than 30 other African countries.



Charlotte Thege/Peter Arnold, Inc.

Figure 10-B Wangari Maathai was the first Kenyan woman to earn a Ph.D. and to head an academic department at the University of Nairobi. In 1977, she organized the internationally acclaimed Green Belt Movement. For her work in protecting the environment, she has received many honors, including the Goldman Prize, the Right Livelihood Award, the U.N. Africa Prize for Leadership, and the 2004 Nobel Peace Prize. After years of being harassed, beaten, and jailed for opposing government policies, she was elected to Kenya's parliament as a member of the Green Party in 2002. In 2003, she was appointed Assistant Minister for Environment, Natural Resources, and Wildlife.

In 2006, she launched a project to plant a billion trees worldwide in 2007 to help fight poverty and climate change. The project greatly exceeded expectations with the planting of 2 billion trees in 55 countries. In 2008, the UNEP set a goal of planting an additional 5 billion trees.

Wangari tells her story in her book *The Green Belt Movement: Sharing the Approach and the Experience*, published by Lantern Books in 2003.

This in turn would help to slow global warming, as more trees would remove more of the carbon dioxide that we are adding to the atmosphere.

### Governments and Individuals Can Act to Reduce Tropical Deforestation

In addition to reducing fuelwood demand, analysts have suggested other ways to protect tropical forests and use them more sustainably. One way is to help new settlers in tropical forests to learn how to practice small-scale sustainable agriculture and forestry. Another is to harvest some of the renewable resources

such as fruits and nuts in rain forests on a sustainable basis. And strip cutting (Figure 10-6c) can be used to harvest tropical trees for lumber.

In Africa's northern Congo Republic, some nomadic forest-dwelling pygmies go into the forests carrying hand-held satellite tracking devices in addition to the traditional spears and bows. They use these Global Positioning System (GPS) devices to identify their hunting grounds, burial grounds, water holes, sacred areas and areas rich in medicinal plants. They then download such information on computers to provide a map of areas that need to be protected from logging, mining, and other destructive activities.

*Debt-for-nature swaps* can make it financially attractive for countries to protect their tropical forests. Such swaps, participating countries act as custodians

## **BLOWING IN THE WIND**

1. Why is wind an important factor in the earth's climate?
2. What nutrients are transported by wind and give two benefits.
3. Explain how coral reefs are affected by the wind?
4. What is red tide and how can it affect people?
5. What are three changes in your lifestyle that would take place if there were no winds where you live?
6. Winds play important roles in creating and sustaining the world's deserts, grasslands, and forests. Identify and explain the scientific principles of sustainability that focus on winds.

## **REINTRODUCING GRAY WOLVES TO YELLOWSTONE**

1. How do you think protecting wolves, in part by reintroducing them to areas such as Yellowstone National Park, helps to protect the forest areas where they live?
2. Do you support the reintroduction of the gray wolf into the Yellowstone ecosystem? Explain. Do you think the reintroduction of wolves should be expanded to areas outside the park? Explain
3. Identify and explain the scientific principles of sustainability that applies to the gray wolf.

## **WANGARI MAATHAI AND KENYA'S GREEN BELT MOVEMENT**

1. Describe the Green Belt Movement. What is its main goal?
2. How did the Green Belt Movement benefit women in Kenya?
3. How did the Green Belt Movement help the environment? List five factors.
4. In her acceptance speech of the 2004 Nobel Peace Prize, what did Maathai say the purpose of the Green Belt program was?