Lesson 5: Biomes

Gro Torsethaugen, PhD

Penn State Biology - BISC 003: Environmental Science
As you work through this lesson about biomes, remember the natural human tendency for cultural replication, the desire to replicate the familiar in new surroundings. If we are able to keep an open mind and adjust our landscaping accordingly, we can greatly reduce our environmental impact. Landscaping can be described as artificial arrangements of assorted plant life that is pleasing to the eye. One of the simplest rules of thumb for landscaping is to use plants that thrive in the conditions that are common to a given area, or in other words, native plants. If one looks at natural ecosystems, general patterns of vegetation become obvious. Throughout the globe, there are repeated patterns of vegetation. These can be classified into several different biomes, which are life zones with similar climates and soil types and thus similar community members.

Thinking back to lesson 3, what determines who lives where? Plants, of course! The factors that have the strongest influence on plant life are temperature, rainfall, and soil type. From dry to wet in the temperate zone, deserts, grasslands, scrub lands, forests, and even temperate rainforests occur. In the tropics, deserts, thorn scrubs, tropical seasonal forests, and tropical rainforests would be found. Farther north in the colder regions of the world, temperate forests are replaced by taiga, or boreal forests, and then by the cold desert of the tundra. Figures 5.3 and 5.4 in your textbook illustrates this nicely.
Biomes and Cultural Replication

Cultural replication – the desire to replicate the familiar in new surroundings.

Landscaping – artificial arrangement of plants, use native plants

Biome: Life zones with similar climate, soil types and vegetation.

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Temperate: deserts, grasslands, scrub lands, forests
Tropics: deserts, thorn scrubs, tropical seasonal and rain forest
Tundra, taiga and boreal forests further north

Let’s go on a virtual road trip and explore the various biomes of North America, for each we’ll look at climate, plant and animal adaptations and how human activities are affecting each biome. Let’s start in New York City and follow route 80 to San Francisco. As we move from one region to another, think about how the vegetation changes; also, think about how well the classic “homestead” with a manicured lawn and mature landscape with trees and shrubs fits with the described native plant life in each region.
As we start from the Eastern seaboard, we travel for two days through the Eastern deciduous forest. Across the Eastern U.S., the most common type of forest is the oak hickory with its robust nut food source and equally robust fauna. Other forest communities are found, with each region having its own mix of primarily hardwood or broad leaf deciduous trees, which are trees that change color and shed their leaves during the fall. Moderate to heavy rainfall, seasonal variations in temperature and layered growth characterizes such regions. All forests have several distinct layers of vegetation. In the deciduous forests, a host of spring wildflowers would greet you, straining to complete their lifecycle before the tree canopy closes over, along with understory of low light adapted plants such as ferns growing beneath the tree canopy. When the Europeans first arrived it was said that the canopy of the Eastern forests was so dense that a squirrel could make it to the Mississippi without touching the ground. The temperate forest regions of the world are areas of dense human occupation, both in Europe, the Eastern U.S., and the eastern coast of Asia. In the U.S., the Eastern forests have been making a comeback as agriculture moves west. Still, the biggest threat to these ecosystems today is uncontrolled human development of cities, roads, industry and mining for natural resources.
As we continue on our journey into Indiana and Illinois and certainly Iowa, we enter the first grasslands, the tall grass prairies of the Midwest. This is the realm of the large grazing herbivores, fires, and the richest soils in the world. There is insufficient rainfall to sustain tree growth but the grasses thrive. This is a land of extremes, where temperatures can soar to above 100°F in the summer to well below 0°F in the winter. The grasslands persist through Nebraska and into Wyoming, gradually replacing the tall grass with the short grass prairie as annual rainfall decreases. The short grass prairie of the Western states might deceive you for desert if you fly by, but if you take time to stop and look, you will notice that the land is covered by perennial grass, perfectly adapted to the conditions. The tall grass prairies of the U.S. are nearly gone and replaced by crops. The remaining areas are found along railroad tracks, where the fires from sparks keep the plant communities close to the natural fire-maintained composition. More of the short grass prairies remain but the once dominant large grazing herbivores, such as deer, antelope and bison, have been replaced by domesticated cattle.
At the edge of Wyoming you begin your descent into the deserts of Utah. Past the Great Salt Lake, you will travel by the salt flats and deserts of the Colorado Plateau. As deserts are areas of extremely low rainfall, vegetation is very sparse. Plants need an "absolute minimum" of 1 inch of rain per year. Desert plants are xerophytes, adapted to drought conditions. They may have thick succulent stems to hold water and leaves reduced to spines like the cactus, or they may have thick leathery leaves with waxy coverings to conserve water, like the succulents. Many desert plant have a modified version of photosynthesis that allows them to limit water loss during the day. Desert animals are also adapted to drought, many being active at night to conserve water. The kangaroo rat is said to never drink water, relying instead on incredibly efficient kidneys, a nocturnal, moderate lifestyle, and only water in its food to meet its needs. The deserts are particularly sensitive to human disturbance. Succession in the desert takes a very long time and once damaged, sometimes deserts can become nearly lifeless. Within the U.S., the desert regions are also areas of tremendous population growth. The boomtowns of the turn of this century are Las Vegas, Reno and even Salt Lake City, all in the middle of deserts. The cities of the Southwest such as Phoenix and Tucson have come to grips with their desert environment and embraced xeriscaping, which is the use of drought adapted plants, to replace traditional eastern landscapes and imposing strict water conservation measures. Unfortunately, such conservation ideas have not caught on in Las Vegas where water usage continues to explode.
As we cross the Sierra through the Donner Pass, some would say that we are descending into paradise. In the summers, the daily forecast remains the same: early morning haze giving way to sunshine with highs in the 70s and 80s and lows in the 60s with next to no humidity. The early Spanish explorers must have felt right at home in the chaparral of the West coast. If the grasslands are the lands of extremes, the chaparral is the land of moderation, seasonal rains and periodic drought. From October to May is the rainy season, though some years, insufficient rainfalls can be problematic for human inhabitants. From May to October, it rarely rains. Humans love the Mediterranean climate of the chaparral and this can lead to problems. If this is your dreamland, remember those periodic droughts are part of life and should be expected. Also be aware that like the grasslands, fires are essential for maintaining this ecosystem.
During our trip along route 80, we hit just about all the biomes of the United States with a few exceptions. If we had turned south in Wyoming, north in Indiana or headed for Maine at the beginning, we would have passed through coniferous forest, dominated by evergreen needle trees. Such forests dominate the colder regions of the world that have sufficient rainfall to support tree growth, but short growing seasons unsuitable for deciduous trees. These are areas where it is a distinct advantage to be able to "leap into photosynthesis in a single bound" with evergreen leaves, taking complete advantage of the short growing season.

If we drove north from the chaparral on the west coast we would find the temperature rain forests of Northern California and Oregon, with its moderate temperatures, heavy rainfall and lush vegetation, including the giant red wood trees.
Coniferous Forests

Climate
- Colder temperatures
- Moderate to heavy rainfall

Plant adaptations
- Evergreen leaves
- “leap into photosynthesis” in short growing season

Temperature Rain Forests

Climate
- Moderate temperatures
- Heavy rainfall

By expanding our travel route to Alaska and Canada in the north and Mexico in the south we would also find tundra, taiga and tropical forests. Read about the climate, plant and animal adaptations and how human activities affect these biomes in the text book.

Which biome do you live in? For those of you that live outside of the United States, check figure 5.4 in the text book to see which biome you live in. Keep this in mind when you prepare your response to this lesson’s discussion forum.
If we had turned south at the beginning of our drive, we would ended up in Florida where we could have explored several aquatic ecosystems. The fresh water and marine ecosystems of the world are tremendously productive in ecological terms and serve humans in ways, including aesthetic and recreational value.

The Everglades in Florida is a highly productive marshland. Where do humans like to live? Look at a map of any country, and you will see a concentration of human habitation along the coastlines and river ways. Wetlands were once viewed as useless swamps and marshes but we now realize their importance in flood control, water purification and they also provide habitat for many different species. If more of the wetlands around New Orleans had been left intact it is likely that the effects of hurricane Katrina would have been less devastating.

In the Florida Keys we could go snorkeling or scuba diving to explore one of the most diverse ecosystems on the planet, the coral reefs. Coral reefs are also one of the most threatened ecosystems, negatively affected by coastal development and farming, pollution that runs into the ocean, as well as unsustainable fishing and tourism. Coral reefs are very sensitive to changes in nutrient levels, pH and temperature, which can lead to coral bleaching. The potential loss of the world’s coral reefs is a big concern in regard to global climate change.

If we had taken our time on our imaginary road trip, we would have seen a tiny fraction of the diversity of life found in the United States. Biodiversity is a significant resource, often undervalued
by humans until it is lost. Unlike other resources that we may overuse, biodiversity is the one resource that we will never be able to replace. Extinction is forever and even with advances in molecular biology and cloning techniques, it is not possible to replace a species once it is lost. As mentioned earlier, only a small fraction of the total biodiversity on earth has even been described and catalogued.

Aquatic Ecosystems

**Wetlands**
- Land surface saturated or submerged with water
- Swamp, marsh and bog
- Flood control and water purification
- Wild life refuge
- Draining and development

**Coral Reefs**
- Biodiversity
- Coastal development
- Pollution
- Unsustainable fishing and tourism
- Change in temperature -> coral bleaching

OK, so that song is a little absurd, but let’s consider exactly what good biodiversity is to humans. We can take one step back and think about pandas in purely aesthetic terms. Depending on your worldview, you may feel that biodiversity has an intrinsic right to exist.

Even if you have a more pragmatic worldview, you can still see the value of wild species. We benefit from living organisms by the many products we harvest; food, remember all crop plants and domesticated animals started as wild species, medicines – a large percentage of modern pharmaceuticals are based on natural products and the bulk of the world still relies on traditional herbal medicine. Check out the Coral Reefs saved my life” video in the course video library as an example. We also rely on many natural materials from wood, fibers, linoleum to turpentine, you never know when you might run across a natural product. And finally, for the ecological services provided by biodiversity and intact ecosystems. Ecological services include pollination provided by bees and other insects, climate regulation by trees, flood protection by wetlands and soil formation by decomposers.
Pandas Must Die!

White and black, the friendly bears of China, white and black, they rarely reproduce
What shall be done about these Chinese bears? What shall be done about these friendly bears?
Die, they must die, the pandas must die
Die, they must die, the pandas must die

Why should we save them? What good do they do? Have you ever seen a panda do something good for you?
They can’t wear t-shirts, they can’t bounce basketballs, they can’t walk tightropes over Niagara Falls
Die, they must die, the pandas must die
Die, they must die, the pandas must die

All endangered species leave endangered feces. If you knew how bad they smelled you would gladly take their pelt.
If we kill them all, we can have more parking lots. We can have small couches made of little ocelots
Die, they must die, the pandas must die
Die, they must die, the pandas must die

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The Value of Biodiversity

- Intrinsic right to exist
- Products
  - Food
  - Medicines
  - Wood, fibers, linoleum, turpentine
- Recreation and tourism
- Ecological Services
  - Pollination
  - Climate regulation
  - Flood protection
  - Soil formation

You might be tempted to ask "why should we worry, since extinction is the fate of all species eventually?" That is a valid question. Extinction IS the fate of all species and in the past, there have been mass extinction events that would make your eyes pop. In the Permian mass extinction for example over 90% of species disappeared. The problem with the current extinction event is that it is not due to some uncontrollable natural event. It can be attributed to human activities that are well within our power to control. So what are the causes of this current extinction crisis? We can use the handy acronym "HIPPCO" to explain the human causes of species extinction:

**Habitat Loss and Land Use:** Humans alter their landscape in such a way that it is no longer suitable for use by other species; the number one cause of species extinction today. Not only have we invaded every corner of the world, we alter the landscape to suit our needs. What little habitat remains is often fragmented and not suitable to support the maximum diversity of an area.

**Introduced or invasive Species:** Accidental or intentional introduction of non-native species to a new ecosystem can lead to a reduced population of native species and in some cases, the loss of native species.

**Pollution:** By introducing substances in excess into an established ecosystem, human activities can again make the environment unsuitable for other species. Pollution comes in many different forms. A pollutant is sort of the chemical equivalent of a weed, a compound out of place. It can be toxic like
mercury, lead, or other heavy metals; overwhelming like sediments, which is eroded soil out of place, and biomagnified like DDT and other persistent organic compounds.

**Population Growth:** As the human population continues to grow, our basic needs for food, shelter and clothing grow as well as our desire for luxury items. We are in competition for resources with all the other species on earth.

The original acronym was HIPPO, still used by the text book, but some has suggested that we should add a C for *climate change*. Historically, changes in climate has played an important part in the evolution and extinction of species. The current and future change in climate, caused by human activities, may lead to the pre-mature extinction of many species. The polar bear was the first species to be put on the list of threatened species because of climate change and has become a poster child for global climate change.

And the last letter in the acronym is **Over-Consumption:** As residents of a developed nation, our demand for goods, and the resulting waste, has a tremendous impact on the world around us. Examples include the early settlers hunting the American bison almost to extinction, harvesting of plants and animals for medical purposes, particularly popular in Asia, and over-fishing around the world. The trade in endangered and threatened species continues today. This trade is driven by demand so as consumers we have a responsibility to investigate where our goods are coming from.

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**Species Extinction**

**HIPPCO** - human causes of species extinction:

- Habitat Loss and Land Use
- Introduced or Invasive Species
- Pollution
- Population Growth
- Climate Change
- Over-Consumption
Introduced species have wreaked havoc on native species around the globe. A newly introduced species has several possible fates: it may die out (no tropical species have successfully invaded the temperate zone for example), it may have no apparent impact (it may become "naturalized" and part of the landscape, though some argue that this is a fallacy) or it may cause the demise of native species. Either by out competing native species, like the rapidly growing plant Kudzu or *Multiflora rose* from my own "backyard"; Bald Eagle State park in central PA. Other invasive species may cause trouble by preying on native species, like the cane toad of Australia that was introduced to control cane beetles, a pest that eats sugar cane. The cane toad ended up eating nearly everything else in the ecosystem. Or by causing disease, an example of this is the once mighty chestnut of the eastern forests that has been reduced to the role of understory tree due to an introduced pathogen, the chestnut blight fungus.

**Invasive Species**

What happens when a non-native species is introduced to an ecosystem?

- die out (tropical plants in temperate regions)
- no apparent impact (become part of ecosystem without causing negative effects)
- outcompeting native species (*Kudzu, Multiflora rose*)
- preying on native species (cane toad in Australia, intentionally introduced to consume cane beetles, a sugarcane pest)
- cause disease (chestnut blight fungus)

Autumn Olive is an invasive species that had taken over large parts of Bald Eagle State park, as seen to the right in the top left picture. The park employees have been clearing out the Olive Autumn, and reintroduced native grasses and other plants. The result is an ecosystem that not only is aesthetically more pleasing and more versatile in terms of human recreation, but the wide range of native plants provides food and shelter for native animal species.

Restoring ecosystems is costly, time consuming and not always successful. As with many other environmental problems, preventing invasive species from spreading in the first place make more sense than cleaning up after the fact.
So, what can we as individuals do to reduce our environmental impact with respect to preserving biodiversity? You can start by being willing to share your habitat with other organisms. The National Wildlife Federation has a backyard habitat certification program. To create a backyard habitat you need provide the necessities of life: food, water, cover, and a place to raise young. If you meet all the requirements, you can even go online and certify your habitat.

You should respect plant and animal quarantines to limit the influx of potentially problematic invasive species. When you travel and they ask you if you are carrying any plant products, confess and surrender them in the interest of preserving the environment. The USDA operates inspection stations both at points of entry to the country as well as at the borders to agriculturally important states like California and Florida. If you are transporting material to these states, be sure to check with your local agricultural extension agent to get your plants inspected. Having the paperwork in order will save you hassle and protect domesticated and wild populations.

You can do your part to limit the pollutants you produce that may have a negative impact on the wildlife in your immediate and not so immediate areas. Dispose of hazardous chemicals properly. Do your best to limit your use of pesticides in the home so they are not introduced into local food chains.

Limit the trade in endangered species and remember it is not just big, attractive furry mammals that are worth protecting. Be an educated consumer. Know fish products and avoid consuming...
species that are at risk. The Monterey Bay Aquarium has a handy wallet card that you can download as a guide; you may even install a SeaFoodWatch app on your smart phone. Be wary of exotic plants-check to see that they are cultured and not harvested from the wild. Ask about the source when you purchase orchids, cacti and carnivorous plants like Venus fly trap. Though they can be and are cultured from seed in a sustainable way, some are still needlessly harvested from the wild. Be wary of herbal remedies. Many popular herbal plants are still primarily harvested from the wild, leading to localized extinctions. Finally, support consumption of sustainably produced products. An easy step is to purchase free trade and shade grown coffee, which is grown without the use of pesticides and more of the profits go to the grower rather than the middle men. Shade grown coffees also support more local biodiversity, particularly birds, compared to coffee plantations out in the sun.

What Can We Do?

- Create backyard habitats
- Use native plants
- Respect plant and animal quarantines
- Limit pollutants (including pesticides)
- Avoid products from endangered species
  - Fish and seafood (SeaFood Watch)
  - Orchids, cacti, Venus fly trap, herbal remedies
- Buy sustainable products
  - Shadegrown coffee
  - Brazil nuts

Let us end on a positive note: individual and governmental actions can and do make a difference. Consider the return of the American alligator and the rebound of the bald eagle as success stories of species that experienced a turnaround in our lifetimes. Let us hope that such successes can continue so the beauty and biodiversity that surrounds us will be shared by our grandchildren and beyond.