Mangrove Forests

Intermediate contestants should study the following description to prepare for the Ecosystem Quiz station in the annual Florida 4-H Forest Ecology Contest

Figure 1. Mangrove Forest Ecosystem in the Florida Keys National Marine Sanctuary. Source: Michael Schilling, NOAA

Contents

General Description

Florida's estimated 600,000 acres of mangrove forests are found in flat coastal and estuarine areas, where freshwater rivers meet saltwater from the ocean. These forests are unique because they include four special tree species: red mangrove, black mangrove, white mangrove, and buttonwood. These trees are famous for their dense tangle of roots and branches and are adapted to live in salty water and tidal floods, where most other trees can't survive. Mangrove forests are covered by water during high tides, and the soil can range from sand, mud, or limestone rock. This soil is always wet and often flooded or underwater, leading to very low oxygen levels, known as anaerobic conditions. Mangrove trees have special adaptations to help them bring oxygen from the surface to their roots despite these conditions.

Mangrove forests are crucial for marine life. The leaves that fall into the water create a base for a complex food web that supports young fish, shrimp, and other sea creatures. The large roots of mangrove trees provide safe hiding spots for young marine animals and stabilize the sediment, which helps protect shorelines from waves and storm surges.

These ecosystems are found along Florida's southern coastlines. Mangroves are sensitive to freezing temperatures, so they usually only grow as far north as Cedar Key on the west coast and Cape Canaveral on the east coast. The largest mangrove forest in Florida is found in the Ten Thousand Islands National Wildlife Refuge.

Environmental Factors

Mangrove forests grow in harsh conditions. They are flooded with saltwater from the tides twice a day, which leaves the soil with very little oxygen. This means that only a few types of plants can survive here.

Temperature is one of the most restrictive factors for mangroves. They need warm temperatures all year to survive, typically above 66°F. In warmer areas with ideal conditions, these forests can grow over 80 feet tall, but usually, they are between 10 and 20 feet tall. In cooler northern areas of Florida, like Cedar Key, mangroves are shorter and might even be killed by cold spells and freeze events.

Salinity, or the measure of salt dissolved in water, also determines which plants grow in mangrove forests. Mangroves have special adaptations to prevent excessive amounts of salt from damaging their tissues. They restrict the amount of salt that can enter through the roots, expel salt crystals through transpiration, grow a thick cuticle to limit salt absorption, or use salt-excreting glands. They can live in both saltwater or brackish water (a mix of saltwater and freshwater). While they can survive in freshwater environments, they are most often outcompeted by other plants there.

Tides are essential for maintaining mangrove forests. They remove toxic compounds like hydrogen sulfide (H_2S) that build up in flooded soils. Hydrogen sulfide is responsible for a

rotten egg-like smell that can sometimes be detected at low tide in mangroves. Tides also prevent the buildup of salt and replenish the system with oxygen-rich water.

Mangroves play a significant role in protecting coastlines by trapping and holding sediment, which helps prevent erosion and reduces damage from storm surges, which are floods caused by rising sea levels during major storms and hurricanes. Fine sediment brought into mangroves with the tide can be trapped by their root systems. Over time, this sediment buildup may result in the formation of land islands around the trees. For this reason, some people describe mangroves as "land builders." Mangrove trees depend on these sediments to provide a place to reproduce and regenerate new trees. However, they need to be in sheltered areas with low wave energy, such as bays and tidal rivers, because strong waves can uproot their shallow roots.

Figure 2. Mangroves growing on the coastline. Source: National Geographic

Flora & Fauna

Plants

While the diversity of plants is low compared to other ecosystems, mangrove forests are home to a few specialized tree species that thrive in their unique coastal environment. In Florida, three main types of mangroves are found: red, black, and white mangroves, along with the buttonwood tree, which is often seen alongside mangroves but is not a true mangrove.

Red mangroves are the most tolerant of flooding and are found closest to the water. They are easily recognizable by their tall, arching roots, known as prop roots, which give them the appearance of walking on water at high tide. Besides providing stability, these roots are covered in lenticels (pores) that help supply the plant with oxygen.

Figure 3. Young red mangrove. Source: Cathleen Bester, Florida Museum

Figure 4. Red mangrove illustration with prop roots. Source: NOAA

Black mangroves are usually found further inland from the red mangroves. They are known for their woody, pencil-like projections called pneumatophores that stick up from the mud. Like the prop roots of the red mangrove, the pneumatophores act as snorkels, supplying the roots with oxygen during high tide. Black mangroves also excrete salt through their leaves, which often appear coated with salt crystals.

Figure 5. Black mangrove.
Source: Cathleen Bester, Florida Museum

Figure 6. Salt on black mangrove leaves. Source: UF

Figure 7. Black mangrove illustration with pneumatophores. Source: NOAA

White mangroves grow even further inland and are the least flood-tolerant of the three. They typically do not have prop roots or pneumatophores. However, their lower trunk has tiny lenticels along the bark to help bring in extra oxygen when water levels are high. White mangroves are the most sensitive to cold and are found further south compared to the red and black mangroves.

Figure 8. White mangrove. Source: iNaturalist

Figure 9. White mangrove illustration. Source: NOAA

One thing that all three mangroves have in common is how their seeds develop. Coastal conditions are rough on seeds trying to establish themselves. To increase their chances of survival, mangroves have an adaptation called vivipary. In this process, seeds begin germinating while still attached to the parent tree. The seeds are housed in pods called propagules. When the propagules detach from the tree, they float in the water until they find a suitable place to establish themselves. Propagules can float for over 12 months and remain viable.

Buttonwood trees are sometimes found in the transition zone between mangrove forests and other coastal habitats, such as tropical hammocks. While not true mangroves, they share some adaptations with mangroves, such as salt-excreting glands on their leaves. Buttonwoods often grow further inland and are recognized by their dense, rounded flower heads and cone-like fruit.

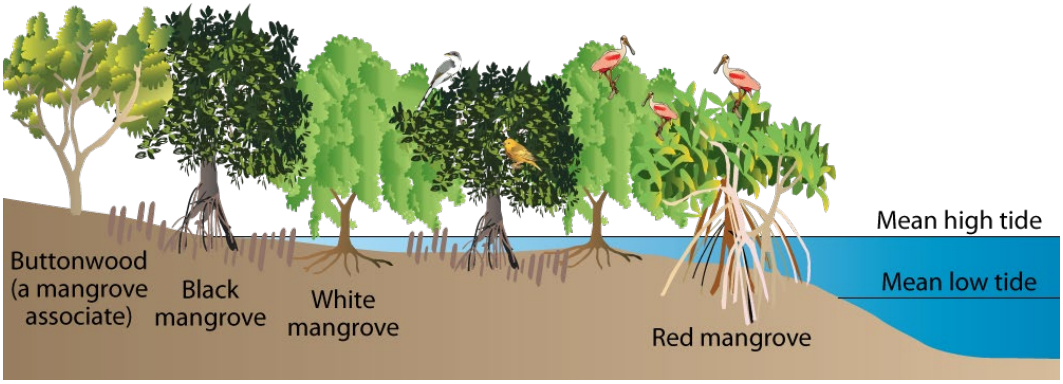

Figure 10. Diagram illustrating the dominant mangrove species and their distribution within the ecosystem. Source: University of Maryland

Due to the harsh conditions, tangled roots, and limited sunlight in mangrove forests, it is rare for there to be understory plants. Occasionally, plants like seaside oxeye, saltwort, or giant leather fern can be found in openings or along the edges. Epiphytes, such as the powdery catopsis, are also present. These plants live on the branches of mangroves and have adapted to the environment by trapping insects for nutrients.

Animals

The conditions in mangrove forests may be harsh for plants, but these ecosystems harbor an incredible diversity of wildlife. Mangroves are teeming with invertebrates, including crabs, clams, snails, and insects. Mangrove tree crabs, for example, scuttle along the branches and shred red mangrove leaves as they feed. Clams and oysters attach themselves to mangrove roots and filter the water as the tide goes in and out, keeping it clean.

Figure 11. Mangrove tree crab. Source: Bob Peterson

Mangrove forests are important nurseries for many fish species. Young fish, like jacks, sheepshead, and schoolmasters find protection among the mangrove roots. These forests also support species popular among Florida anglers, such as red drum, snapper, and snook. This concentration of fish attracts larger predators like redfish and Florida gar.

Figure 12. American crocodile. Source: National Geographic

Reptiles like the mangrove water snake, Florida banded water snake, and American alligator swim and feed in the water. Anoles crawl along the branches as they hunt for insects. Young sea turtles use mangrove forests to feed and evade predators. The largest reptile in North America, the American crocodile, is making its last stand in the mangroves of South Florida. The crocodile is a threatened species. Hunting practices in the past reduced their numbers, and now habitat loss threatens to eliminate them altogether. They may live over 70 years and reach lengths of over 20 feet. Crocodiles mostly eat crabs, turtles, fish, raccoons, and water birds. Interestingly, red mangrove seedlings have also been found in their stomachs. Amphibians rarely use mangrove forests, and only a few species, such as the giant toad, squirrel treefrog, and Cuban treefrog, are known to inhabit them. Because amphibians breathe through their skin, they are generally intolerant of saltwater.

Mangroves provide the most elevated natural structure along much of the South Florida coast and attract over 200 species of birds. Wading birds such as ibis, stilts, and egrets search for food in the shallow waters. Other birds, like the brown pelican, roseate spoonbill, tricolored heron, and great blue heron, rely on mangroves for critical nesting grounds. Birds of prey like the bald eagle, osprey, and peregrine falcon live in mangroves, where they hunt fish, nest, and rest in the trees.

Mangrove forests are also important for mammals. The Key deer, a federally endangered subspecies of white-tailed deer, relies on red mangroves for food. Another endangered mammal that is not seen very often but is frequently observed near mangroves in the Everglades is the Florida panther. More common inhabitants include the bobcat, skunk, raccoon, and river otter. Additionally, Florida manatees pass through these ecosystems on their way to seagrass beds.

Figure 13. Key dear doe swimming by red mangroves. Source: Kristie Killam, USFWS

Human Impacts

Historically, about 20% of Florida's mangrove habitat has been lost due to human activities, with this number exceeding 50% in certain areas of the state. Coastal development has directly destroyed mangrove ecosystems, and alterations to water flow, such as dikes and drainage for mosquito control, have had devastating effects. Dikes that increase water levels can drown mangroves, while draining wetlands often allows upland plants to outcompete them.

Additionally, pollutants like oils and sediments, as well as boat waves, can clog the vital lenticels on mangrove roots, disrupting the oxygen supply and leading to widespread die-offs. Restoration efforts are costly and challenging, often exceeding $50,000 per acre and taking decades to complete.

Today, mangrove ecosystems are recognized for the immense benefits they provide to both wildlife and people and are protected under the law. Government agencies such as the National Park Service and the U.S. Fish and Wildlife Service safeguard several areas of mangrove forest throughout Florida and the United States. However, climate change poses new threats. Rising global temperatures may cause mangroves to expand their range northward, while increasing sea levels could push them inland. The continued protection and restoration of mangrove forests remain crucial to preserving their ecological benefits for generations to come.

Places to see examples of mangrove forests:

- Everglades National Park
- Ten Thousand Islands National Wildlife Refuge
- Charlotte Harbor Preserve State Park
- Florida Keys Wildlife and Environmental Area

Links to learn more:

- Florida Natural Areas Inventory
- Florida Department of Environmental Protection
- Florida Museum of Natural History