CHAPTER 2

Florida Land Use and Land Cover Change in the Past 100 Years

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This chapter provides an overview of land use and land cover change in Florida over the past 100 years and a summary of how it may change in the future. We begin by providing a baseline description of Florida's pre-1900 land cover, natural resource distribution, and biodiversity. This is followed by a description of major land use changes and trends related to transportation, agriculture, mining, urbanization, tourism, disruption of natural processes, and conservation from 1900 to the present. We also describe changes in land use and land cover caused by climate change. The chapter concludes with a discussion of current land use and land cover patterns, and the potential impacts of climate change and continued human population growth on the remaining natural and rural landscapes in Florida. Much has changed in Florida over the last century due to a combination of wetland draining, agriculture conversion, urban development, and establishment of several dominant exotic plant species, as well as accelerating sea level rise and shifting climate zones due to climate change.

Key Messages

- Land cover and land use within Florida have changed dramatically since pre-settlement times, primarily due to human activities, with significant impacts on ecosystems and biodiversity.
- Climate-related impacts on land cover, resulting from human-caused climate change, have also been documented in Florida.
- Patterns of historic land use and land cover change are important to quantify and visualize so that we can assess the degree to which natural systems have been impacted and changed by human activities.
- Florida still has highly significant cultural and natural landscapes, which provide important services to people, in addition to possessing intrinsic values separate from their value to humans.
- As future changes continue to occur as a result of climate change and population growth, it will be more important than ever to conduct careful land use planning and management so that we can preserve natural and cultural resources, and maintain the qualities that make Florida the special place that it is today.

Keywords

Land use; Land cover; Climate change; Transportation; Tourism; Agriculture; Mining; Urbanization; Population growth; Natural processes; Conservation

Historical Overview

Florida has a diverse history of land use and human settlement, coupled with a wide range of natural communities, high biodiversity, and abundant natural resources. Land use trends throughout the state's history have been directly influenced by the natural resources, geomorphology, and climate that exist within the state. In turn land use change caused by human populations has altered the natural features that existed prior to human settlement. In this chapter we define land cover as simply the physical characteristics of the earth's surface including natural communities and altered land cover types (e.g., rocks, water, ice, forest, wetlands, rangeland, desert, etc.) whereas land use refers to specific ways that humans are using land (e.g., pastures, crops, residential, commercial, industrial, mining, transportation, utilities, etc.). (NOAA 2015).

Since 1900, Florida has seen substantial changes in land use patterns and land cover. Even though people had lived in Florida for thousands of years prior to 1900, their overall impact had been minimal. The Native Americans altered the land by building settlements, cultivating fields, building mounds, establishing transportation routes, grading causeways, and digging canals and fishponds (Derr 1998). European explorers and settlers arrived in the 1500s, but much of Florida, particularly the central and southern regions, remained relatively undeveloped until the last decades of the 19th century. Significant increases in population and tourism were coincident with new development, facilitated by new railroads and highways, and inspired by an aggressive marketing campaign for new residents and visitors to come to the state (Derr 1998). In creating the ideal Florida community, destination, or attraction, developers directly and indirectly caused significant changes to the natural landscape and resources of the state, fragmenting and degrading natural landscapes, introducing invasive species, and exploiting natural resources.

In addition to development and tourism, Florida's agriculture and extraction industries also led to land cover changes. Agriculture, Florida's second largest industry, led to land clearing, drainage projects, the introduction of invasive species, and pollution. By the early 20th century, the lumber industry had cleared most of North Florida's old growth forests (Florida Natural Areas Inventory 2005). Mining removed natural land cover, altered soil composition, and often left behind large abandoned excavations in the landscape (Shukla et. al. n.d.). Large-scale crop farming operations significantly altered drainage patterns and impacted water resources, particularly in South Florida (Stone and Legg 1992). In response to the environmental degradation that was occurring, Florida started to implement more environmental protection and growth management policies beginning in the 1970s and 1980s (Davis 2009). Efforts were also made to set aside conservation areas and to create wildlife corridors (Florida Department of Environmental Protection 2015; Hoctor et al. 2015). In recent years (as of 2016), state support for these efforts has weakened, but many people and organizations are still actively working to maintain the natural heritage and resources that remain in Florida. The history of land use change and development within the state is particularly important to understand when making future land use decisions and choices about how to adapt to climate change. The land use decisions that we make today will affect the ability for natural systems to adapt to climate change tomorrow.

Pre-1900 Conditions

Much of Florida was sparsely developed until the late 1800s, and settlers built many of the state's early towns along the coasts and rivers in areas with natural ports. In 1900, four cities in Florida had populations greater than 10,000. These were Jacksonville, Pensacola, Key West, and Tampa (U.S. Census 1910). Jacksonville was a well-established port town. Despite having two yellow fever epidemics in the 1880s that drove away nearly half the population, Jacksonville still had a population of more than 28,000 in 1900 (U.S. Census 1910). Pensacola, initially settled by the Spanish in the 1600s, was a thriving town due to its lumber industry and harbor. Key West was briefly settled in the 1500s and resettled in the 1800s. The town was a major source of salt during the first half of the 1800s. Other important industries included salvage, fishing, and turtling. Tampa rapidly grew to more than 15,000 people as the result of a development boom that began in the 1880s with the arrival of Henry Plant's railroad (U.S. Census 1910). The phosphate industry, cigar industry, and the influx of Spanish, Cuban, and Italian immigrants contributed to the growth of Tampa and neighboring Ybor City and West Tampa.

Orlando and Miami, which are now both major metropolitan areas and tourist destinations, were relatively small in 1900. Orlando had a population of less than 2,500, which still ranked it as one of the top 15 largest cities in Florida (U.S. Census 1910). Orlando had been the hub of the citrus industry in the late 1800s, but the Great Freeze of 1895-1896 caused many citrus growers to move further south. Miami was just beginning to boom at the turn of the century. It had been a small frontier town with a population of about 400 when Henry Flagler's railroad reached the area in the 1896 (City of Miami 2016).

Forests, including longleaf pine (*Pinus palustris*) forests, covered much of North and Central Florida prior to development. Longleaf pine forests are characterized by widely spaced trees, a wiregrass understory (*Aristida stricta*), and a very high level of biodiversity (Myers and Ewel 1990). These forests were logged extensively and used for naval stores. Sawmills operated in North Florida as early as the 1830s, and the industry was well-established by the 1850s although old growth forests remained in North Florida until the 1920s.

In 1900, South Florida remained relatively natural. Native Americans and early settlers had been in the area, but they had minimal impact as they lived primarily on subsistence farming and small-scale extraction. The Everglades dominate this region, and it contains seven ecosystems: cypress, freshwater marl prairie, freshwater slough, coastal lowlands, mangrove, pinelands, and hardwood hammock (National Park Service 2016). Attempts to drain the Everglades began in the 19th century, but these efforts had not yet made a significant impact.

Florida was (and still is) a biologically diverse state, though loss and fragmentation of habitat, introduction of non-native species, overexploitation of resources, pollution, and disease have reduced biodiversity. Since development had been limited, few species were lost prior to 1900. The four vertebrate species lost were the Passenger Pigeon (*Ectopistes migratorius*), Carolina Parakeet (*Conuropsis carolinensis*), Red Wolf (*Canis rufus*), and Plains Bison (*Bison bison bison*) (Endries et al. 2009). One major impact to the state's biodiversity prior to 1900 was plume hunting, which devastated bird populations during the last decades of the 1800s. During the Victorian era, hats adorned with feathered plumes were fashionable and the high price of feathers led to millions of bird deaths each year. In Florida, the decimation of bird populations occurred first in the northern areas of the state and later in the Everglades. By the turn of the century, 95% of the state's shore birds had been killed (Burns 2009). This led to legislation in 1891 and 1901 to protect plume birds, and other bird and wildlife protection laws passed in the early 20th century that greatly reduced the impact of market hunting on birds and other species (Palmer 1902).

Major Post-1900 Land Use Changes

Not much of Florida's growth occurred during the last decades of the 19th century and the 20th century (Mohl 1996). New transportation infrastructure, land development, and tourism partnered to bring people to Florida. The major railroads and highways followed the Atlantic Coast, traversed the Panhandle from east to west, and ran north-south through the center of the state before curving to Tampa (Derr 1998). Early development typically followed transportation, so it primarily occurred along the Atlantic Coast and in the Tampa Bay region. Later development occurred in the Orlando region, the southern Gulf Coast, and along new transportation corridors. Land booms during the early and mid-20th century resulted in the development of new communities and the expansion of low-density suburbia across many parts of the state. Automobiles, window screens, the yellow fever vaccine, ice factories and refrigerators contributed to the first major boom in the 1920s (Derr 1998). The next major boom occurred in the 1950s following World War II. Affordable financing options and new construction techniques made homes more affordable for the middle class contributing to a nationwide housing boom (Jackson 1995; Rome 2001). In Florida, the increasing use of air conditioning provided more year-round comfort. Even though they were not extensively used in residential homes until the late 1960s, the use of air conditioning in hotels, apartments, and commercial buildings increased in the 1950s (Derr 1998).

Agricultural and extraction activities played a major role in shaping the state's current remaining natural land cover and resources. Major agricultural crops included tung oil, citrus (*Citrus spp.*), and sugarcane (*Saccharum spp.*) in addition to row crops such as strawberries and tomatoes. Drainage projects were used to dry up wetlands in an effort to create new agricultural land. The cattle industry is also important in Florida and led to land clearing to create pastureland as well as using (with some conversion to improved pasture) the natural prairies of South Central

Florida for cattle production. The lumber industry removed most of the old growth forest, including the longleaf pine forests and cypress (*Taxodium spp.*), though people replanted some pineland areas with weaker species of slash (*Pinus elliottii*) and loblolly pines (*Pinus taeda*). Cypress was logged out later because it was spread through much of the state and was harder to reach (Harris 1999). Mining operations cleared large tracts of land and altered the terrain and soil composition. In response to these changes, subsequent growth management policies have attempted to more carefully guide and manage development and protect the state's natural resources, though persistent urban and suburban development continues to convert rural lands across the state.

Transportation Development

Transportation networks helped drive the development and growth patterns in the state. Until the late 1800s and early 1900s, inland transportation through the state was difficult and many areas were accessible primarily by boat. However, shipping and travel by water could be unreliable due to weather conditions. Just prior to the Civil War, David Yulee completed the first cross-state railroad from Fernandina (now Fernandina Beach) to Cedar Key, two of the state's major ports at the time. Yet, further railroad developments were delayed until after Reconstruction (Turner 2003).

Beginning in the 1880s, two men developed extensive railroad lines throughout the state. Henry Flagler constructed the East Coast Railroad along the Atlantic Coast with his line reaching the Florida Keys in 1912 (Willing 1957). Henry Plant's extensive railroad system primarily connected northeast Florida to the state's West Coast (Johnson 1966). Railroads improved transportation for people, produce, and goods because it was faster and more reliable than transportation by water (Derr 1998).

In the early 1900s, automobile travel was increasing, but roadways were limited. Trail associations formed to select, improve, and promote interstate roadways, creating two major trails in Florida. The Old Spanish Trail connected St. Augustine to San Diego. The Dixie Highway, promoted heavily by Carl Fisher of Miami, ran north-south from Michigan to Miami. These named trails posed challenges to travelers because some trails, like the Dixie Highway, were a series of roads, all with the same name, that allowed travelers to take alternate routes through the state. To alleviate the problem, the government adopted the U.S. Highway numbering system in 1926 (Weingroff 2015).

Since the mid-20th century, turnpikes and interstate highways have been constructed throughout the state. Florida's Turnpike system began in the mid-1950s and is comprised of a number of toll roads. The main line runs from Wildwood through Orlando to Miami. Another line, the Suncoast Parkway runs north-south through Hernando and Pasco counties into Tampa. Shorter routes are located near Ft. Lauderdale, Orlando, Lakeland, and Tampa. Florida is still considering additional toll road projects including a new highway between Orlando and Melbourne, Tampa to Jacksonville, and across parts of the Florida Panhandle. However, these projects are controversial as development patterns begin to change, transportation infrastructure costs increase, and the social and environmental impacts are considered (Warren 2016).

The Federal-Aid Highway Act of 1956 legislated a federal-state partnership to build interstate highways. These highways followed transportation corridors in the state similar to those of earlier highways and railways. I-95 runs along the East Coast. I-75 enters Florida near Jasper and runs north-south through the center of the state before turning westward to Tampa. Tampa was the initial terminus for I-75, but the route was extended down the Gulf Coast and across the Everglades to Miami. I-4 connects Tampa to Daytona Beach, and I-10 traverses east-west along the Panhandle to Jacksonville. The Interstate System connected Florida's major cities and facilitated development along its corridors. These multi-lane, high-speed roads also created barriers for wildlife and fragmented habitat, though some recent wildlife crossing structure projects have attempted to mitigate these impacts (Buford 2015; Land and Lotz n.d.). One of the last sections to be completed was the I-75 extension across the Everglades. This section of highway was designed with extensive bridges to provide for hydrologic flow through the Everglades, and it included wildlife underpasses in an attempt to reduce the number of animals killed, particularly the Florida Panther.

Tourism

Tourism in Florida began growing in the 1870s and remained strong until the Great Depression (Youngs 2005). Early tourists were often invalids that came to Florida for the salubrious climate and springs. The state's natural attractions also drew tourists to hunt, fish, and stroll. Steam boating along the rivers was one of the main modes of travel and a favorite pastime until the 1890s, and tourists often killed native wildlife from the boats (Noll 2004).

At the turn of the century, Henry Flagler and Henry Plant built luxury hotels along their railroad lines that drew wealthy tourists to Florida to spend the winter season. Flagler's eight hotels were located along the East Coast in Atlantic Beach, St. Augustine, Ormond Beach, Palm Beach, and Miami (Braden 2002). Plant built or acquired nine hotels in the center of the state and near the West Coast. His two main luxury hotels were the Tampa Bay Hotel (now part of the University of Tampa) and the Bellview-Biltmore in Clearwater, of which only a small portion remains (Braden 2002).

As the Depression waned in the late 1930s, developers built roadside attractions to draw visitors back to the state. Many early attractions focused on the state's 'natural' elements. These attractions entertained visitors with water shows, animal acts, and lush gardens. Some of the earlier parks included Cypress Gardens in Winter Haven, Jungle Gardens in Sarasota, and Marineland near St. Augustine. While some attractions retained more natural features, others made significant changes to the landscape. For example, the 'natural' beauty of Cypress Gardens was created by digging canals and planting thousands of flowering plants (Branch 2002).

In 1971, one of the world's most visited attractions opened in Orlando – Walt Disney World. This changed Florida forever, including changing Orlando from a small town into a massive metropolitan area. During the 1960s, Walt Disney purchased over 40 square miles of land in Central Florida, just south of Orlando, to build his East Coast theme park. Disney World also drew many new tourists to Florida, which increased the state's exposure to a new wave of immigrants attracted to the climate and the economy. Other large attractions, such as Sea World and Universal Studios, were developed near Walt Disney World making Orlando the largest tourist destination in the U.S. Hotels, restaurants, shopping, and smaller attractions were also built nearby contributing to the area's sprawl and congestion with suburbs and populations expanding to support the tourist industry. In 2014, Orlando became the first U.S. city to have over 60 million total visitors in one year, a number which includes in-state visitors (Dineen 2016).

Agricultural Development

Agriculture is Florida's second largest industry, and it has helped shape land use patterns and influence natural land cover. Some of the major crops include tung oil, citrus, and sugarcane. Livestock and timber are also significant industries.

Timber for logging and naval stores became a major industry in Florida in the 1830s with Florida as the world's leading producer of naval store in the early 1900s. However, the industry's practice of abandoning deforested land without replanting depleted most of the forests' old growth by 1930. As a result, mills closed down, towns were deserted, and the deforested land was abandoned. Around the same time, the Florida Forest Service began to promote reforestation with faster growing trees that could be used for pulp, such as loblolly and slash pines. Most of Florida's timber land is in the northern half of the state, and many of those counties have at least 50%of their land covered in pine forests (Florida Forestry Association 2016).

After the longleaf pine forests had been cut down, locals began looking for new industries. They tried satsuma oranges (*Citrus unshiu*), but freezes and fungus decimated the groves. Tung oil seemed like a good option with trees brought to the United States from China. The oil is used in products such as paint, ink, and linoleum, and it is used for waterproofing. The tree was introduced in Florida in the 1920s, and by the 1930s, 90% of the tung oil produced in the U.S. came from Alachua County (Robb and Travis 2013). However, one problem with tung oil is that the tree is invasive, and its leaves and seeds are poisonous. Due to alternative products and a series of hard freezes in the late 1960s, the tung oil industry is now nearly gone in Florida.

The Spanish brought sugarcane to St. Augustine, however, early attempts to grow it at a large scale in St. Augustine and New Smyrna failed due to freezes and soil conditions. In the 1920s, growers planted sugarcane in South Florida, and the industry grew after the U.S. embargoed Cuban sugar. Sugarcane is grown commercially south of Lake Okeechobee in Palm Beach, Hendry, Martin, and Glades counties. Florida is now the largest producer of sugarcane in the U.S., and it produces over 50% of the nation's cane sugar (Baucum and Rice 2009). However, the crop has significant impacts on surrounding land cover and water regimes because it requires water management to control seasonal flooding of the fields. Also, run-off from fertilizers contributes to algae blooms and the growth of invasive aquatic species, which choke out other native plants and grasses.

Spanish settlers also brought oranges to Florida in the 16th century. These plants eventually became naturalized to Florida and could be found growing amidst other trees. The citrus industry boomed in the l870s with many groves along the St. Johns River. Yet, the freeze of 1895-96 destroyed groves and farmers moved further south. Additional freezes have occurred during the 20th century, and the industry continues to move further south (Davis 1937).

The Spanish settlers also brought cattle, with early cattle ranches located near Tallahassee, Gainesville, St. Augustine, and the St Johns River. The industry declined during the Civil War and did not recover until the 1920s due to problems with ticks and nutrition. After decades of research on nutrition, ranchers started relying more upon improved pastures versus pastures seeded with native grasses. Ranchers also began to depend more on maintenance of their own pastures after Florida passed a fence law in 1949 that ended open grazing.

Mining

The extraction of Florida's mineral resources contributed to the growth and decline of towns and impacted land cover and natural resources in the 20th century. Florida's main mineral resources include phosphate, limestone, and sand (Florida Department of Environmental Protection [FDEP] 2014). The state also contains deposits of heavy minerals that include zircon, leucoxene, ilmenite, and rutile (FDEP 2014).

Phosphate mining is a major industry in Central Florida, and the state produces about one-quarter of the world's phosphate (FDEP 2014). Phosphate was initially discovered in Alachua County in the late 1880s, but the first phosphate boom was in the Dunnellon area (Florida Industrial and Phosphate Research Institute [FIPR] 2016a). The industry later moved further south to the Polk County area, and Dunnellon's last mine closed in the 1960s. The City of Dunnellon continues to exist today, but other phosphate towns such as Romeo, LeRoy, Brewster, and Parkersburg do not. Early mining was done by hand, but this practice was later replaced by strip mining. Mining removes vegetation, alters drainage patterns and recharge, changes soil profiles, and destroys habitat. Processing phosphate is also water intensive, which has caused springs to dry up (Derr 1998). By 2000, more than 460 square miles of Florida had been mined for phosphate (FIPR 2016b).

The state's limestone, sand, and gravel are primarily used for road and building construction. Limestone has been quarried in Marion County since the early 1900s, and even though mines are located throughout the state, concentrations are still located in Marion and Miami-Dade County. Sand is mined throughout the state, but many mines are located in the Panhandle and Central Florida. Heavy minerals are mined in northeast Florida. Heavy minerals mining began in 1916 near the present day city of Ponte Vedra Beach. Two of these minerals, ilmenite and rutile, are used as pigments in manufacturing items such as paints, plastics, and paper (FDEP 2014).

Urbanization

Land booms have occurred multiple times in Florida resulting in rapid population growth and development. One of the first major land booms occurred after World War I. By this time, middle class people had the time, money, and means to travel to Florida. Automobiles and improving roadways made travel more accessible for middle class families, and Florida became a popular tourist destination. Cities developed to attract tourists, but also to meet the needs of visitors that were interested in buying homes. Developers built new communities to meet demand, and they altered the land to do so. For example, Carl Fisher cleared mangroves to build Miami Beach (George 1981). D.P. Davis dredged nearly 100 million cubic feet of sand to merge two small islands near Tampa into one, now known as Davis Islands, by covering the mudflats (History 2014). George Merrick designed and built the Mediterranean Revival community of Coral Gables, which included the construction of canals that offered gondola rides (Parks 2015). However, a few seasons of bad weather helped end the post-World War I boom by 1925.

Following World War II, development in Florida boomed again. New home financing options and improved construction techniques that lowered costs made homeownership possible for more people. Additionally, retirees were drawn to Florida for its climate and lower housing costs. Developers once again set out to build new communities in Florida. These developers utilized economies of scale to create large suburban communities that sometimes included shopping, schools, parks, and community centers (Nettles 2015). Once again, developers transformed the landscape by completely clearing large tracts of lands during construction. Developers also created new canals to maximize the amount of waterfront property. Some of these large housing developments were designed as new towns, such as Spring Hill or Beverly Hills, and other developments catered solely to retirees, such as Sun City. This boom slowed in the late 1960s due to an economic recession.

Since the 1970s, Florida has been a growth management state and has sought to regulate new development in an attempt to minimize infrastructure costs and environmental impacts. Florida's earliest land use regulation was the Zoning Enabling Act of 1928, which allowed local governments to control development by enacting and enforcing zoning codes (Arrant n.d.). No further regulation occurred until after Florida's mid-century boom, but in 1972 and 1973 Florida passed two planning statutes. The first created Regional Planning Councils (RPCs) to address regional land use issues and the impacts of large-scale developments. The other created Developments of Regional Impact (DRIs) and Areas of Critical State Concern (Arrant n.d.). DRIs are large development projects that impact more than one county, and are required to undergo an approval process that considers and mitigates the impacts. The DRI process has been scaled back since its inception, and the types of development it addresses was reduced in 2011. Areas of Critical State Concern are significant areas and natural resources that the state protects by overseeing local approvals for development. The state currently has five Areas of Critical State Concern: Big Cypress, Green Swamp, Florida Keys, Key West, and Apalachicola (Florida Department of Economic Opportunity 2016).

The next step in growth management was the Local Government Comprehensive Planning Act enacted in 1975, requiring local governments to have comprehensive land use plans. Nearly a decade later, in 1984, Florida adopted a State Comprehensive Plan with planning goals and action steps. The following year, Florida enacted the Growth Management Act. This revised the 1975 act by requiring local government plans and amendments to be adopted by ordinance and approved by the state. This act also required local governments to have Future Land Use Maps (FLUMs) and Land Development Regulations (LDRs) (Stroud 2012). Florida revised its comprehensive plan requirements again in 2011, this time significantly reducing the process for state review of local plans and generally relaxing local planning requirements (Shelley and Brodeen 2011). Although growth management policies have helped facilitate a coordinated land use planning process throughout the state, Florida is still highly impacted by rising populations and policies that incentivize development, making careful land use planning more important than ever.

Disruption of Natural Processes

Throughout Florida's history, people have disrupted natural processes to 'improve' the land. These efforts have included draining wetlands, converting forests to farm fields and citrus, introducing exotic species, and suppressing fires. Before people understood the causes of malaria or yellow fever, which were once prevalent in the state, they linked the diseases to swamp gases or miasma that came from standing water. Swamps were considered undesirable places with deleterious effects on health, and draining these areas was considered beneficial. Additionally, people believed that swamps and marshes, once drained, would make good agricultural land. In other cases, filling in marshes was a way to create more land for development. One of the largest of these projects was the draining of the Everglades. Early efforts began in the 1800s, but the initiative intensified in 1906 under Governor Napoleon Bonaparte Broward (Davis 2009). To drain the Everglades, a series of canals were dug to channelize and drain the water. The new canals often expanded or altered existing rivers, such as the Miami and Kissimmee rivers, but efforts to manage water and control flooding had limited success (Davis 2009). By the late 1970s and early 1980s, the state undertook plans to restore hydrology within the watershed where feasible. Efforts have also included dechannelizing and restoring the natural flow of the Kissimmee River, which serves as the headwaters of the Everglades and flows into Lake Okeechobee. Water treatment reservoirs have been built in several areas south of the Everglades Agricultural Area (EAA), and others are planned in areas throughout the Everglades watershed as part of the Comprehensive Everglades Restoration Plan (CERP) (U.S. Department of the Interior [DOI] 2016). Figure 2.1 provides a comparison of historic and current hydrology in the Everglades, as well as future hydrology as proposed to be restored under CERP, with primary flow patterns indicated by blue arrows.

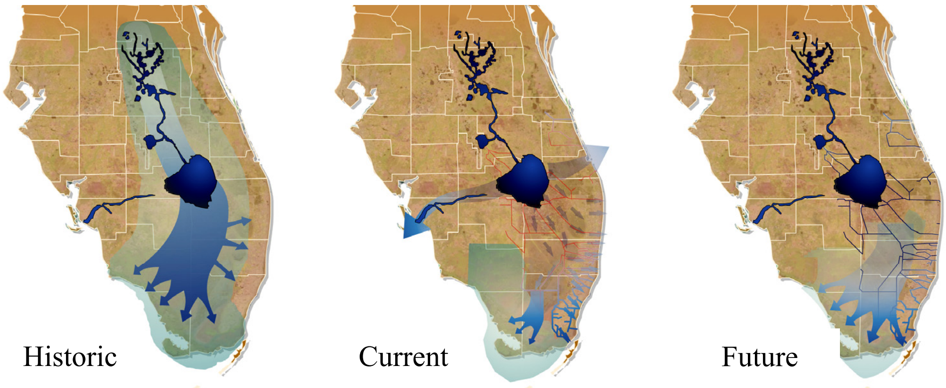

Figure 2.1. Historic, current, and future hydrologic patterns in the Everglades watershed. Future hydrologic patterns are those anticipated under the Comprehensive Everglades Restoration Plan (CERP). Primary flow patterns are shown by blue arrows, with canals indicated by blue and red lines. Image credit: Jacksonville District, U.S. Army Corps of Engineers.

Since the Spanish settlers arrived in the 1500s, people have been introducing new exotic species to Florida. As mentioned earlier, the Spanish brought citrus, sugarcane, and cattle as well as hogs. Some of the species that have been introduced are invasive and have led to changes in land cover. For example, melaleuca (*Melaleuca quinquenervia*) was introduced in the early 1900s and used as an ornamental, for erosion control, and in efforts to drain the Everglades (Serbesoff-King 2003; Silvers 2004). However, melaleuca often outcompetes native plants and does not provide habitat for most native species (Silvers 2004). Another example is the fast-growing Australian pine (*Casuarina spp*.), which mariners introduced to create windbreaks. Like melaleuca, these trees shaded out native vegetation and created areas that primarily contained one species (Pernas et al. 2013). The Brazilian pepper (*Schinus terebinthifolius*), introduced as an ornamental in the 19th century, has also invaded over 700,000 acres in Central and South Florida creating dense shrublands that shade out many other plants (Florida Fish and Wildlife Conservation Commission, 2016). The impacts of this exotic, invasive, and ecosystem-transforming species will be touched upon later in this chapter.

Many Florida ecosystems are dependent on fire including sandhills, flatwoods, and scrub. Frequent landscape-scale fires clear away undergrowth and help maintain open pine-dominated forests with high biodiversity. Fire suppression in Florida began in the 1930s to facilitate forest regeneration and protect areas of timber production. However, suppressing fires led to landscape-scale alterations in forest structure, and species dependent on fire-maintained forest, shrub, and grassland ecosystems declined precipitously. In recent years, natural and prescribed burns have been used to improve the health of fire-dependent ecosystems, but fire suppression is still a major issue across Florida (Florida Department of Agricultural and Consumer Services [FDACS] 2016).

Conservation

The formal conservation of lands and waters within Florida spans over a century, coinciding well with the land cover and land use changes detailed in this chapter. While the federal government created many of these protected areas, including the earliest, the sheer number, size, and natural resources conserved is impressive. Florida has been a magnet for conservation action by various governmental and private conservation entities because of its subtropical location, its peninsular geography, its many endemic and imperiled species, and its rapid development since the beginning of the 20th century.

President Theodore Roosevelt established Florida's first national wildlife refuge (NWR) and national forest. Roosevelt created the Pelican Island NWR in 1903 to protect wading bird populations from decimation by plume hunters. There are now 29 NWRs in Florida protecting hundreds of thousands of acres. Roosevelt also established the Ocala National Forest in 1908. Florida now supports three national forests covering over 1.2 million acres and oversees the 1,400-mile-long congressionally-authorized Florida National Scenic Trail. These national forests help protect at least 145 species of endangered, threatened and sensitive plant species and 51 such animal species. The National Park Service also manages large and diverse conservation areas including Everglades National Park and Big Cypress National Preserve in South Florida, plus national seashores and monuments across Florida.

The formation of Everglades National Park, recognized as a World Heritage Site and International Biosphere Reserve, began in 1915 when the Florida legislature gave 960 acres of land encompassing Royal Palm Hammock in Dade County to establish Royal Palm State Park. The legislature added 2,080 acres to the park in 1921. Congress authorized Everglades National Park in 1934, which included Key Largo and the Big Cypress Swamp. An additional 1.3 million acres was transferred to the federal government by Florida and donated or sold by several private landowners with Everglades National Park dedicated in December of 1947. The park now encompasses over 1.5 million acres and helps protect numerous federally imperiled species. However, water flows from Lake Okeechobee through the historic River of Grass to the park have been severely compromised with solutions still possibly decades away.

The Water Conservation Areas (WCAs) south and east of Lake Okeechobee were initially designated in the early 1900s by the Everglades Drainage District on state lands deeded to Florida by Roosevelt in 1904. The Central and South Florida Flood Control District expanded and formalized these areas during the development of the Central and South Florida Flood control project in the 1940s and 1950s. Additional lands were acquired by the state in the 1990s as a Save Our Rivers project. Covering nearly 850,000 acres, they are a critical component of South Florida's water management system. They are also extremely important for helping to recharge the Biscayne Aquifer, the major source of urban South Florida's drinking water supply.

Efforts at the state level to conserve Florida's biodiversity and water resources are likewise significant. Florida's first state park was initially acquired with private funds in 1929, and opened to the public two years later. Florida's State Park system now includes 161 state parks covering more than 800,000 acres. With over 100 miles of beach habitat and providing protection for thousands of Florida's plant and wildlife species, the park system attracts more than 25 million visitors annually.

Pine Log State Forest, located just north of Panama City, was established as Florida's first state forest in 1936. Now, 37 state forests, managed by the Florida Forest Service, protect nearly 1.1 million acres of productive habitats. Although it is difficult to pin down when the first state wildlife management area (WMA) was established, there are now over 150 Florida WMAs covering approximately 5.8 million acres. While natural resource and habitat management are important components of these areas, the hunting of game animals is one of the reasons for their popularity. Combined, the WMAs in Florida generate over 220,000 jobs and a $25 billion economic impact.

In more recent times, Florida has sought a more focused and science-based effort toward the conservation of its natural resources. In the 20 years between 1969 and 1989, the state protected approximately one million acres of land, with most acquired through fee simple (outright land purchases) during the latter half of that period. The major programs involved were the Environmentally Endangered Lands (EEL), Conservation and Recreation Lands (CARL), Save Our Coasts, and Save Our Rivers programs. In 1972, the Florida legislature enacted the Land Conservation Act, which created the EEL program, specifically designed to protect environmentally unique and irreplaceable lands (Knight et al. 2011). Governor Bob Graham (Democrat) is credited with creation of the CARL program, which was crafted by the Florida legislature in 1979 to acquire and manage public lands and to conserve and protect environmentally unique lands and areas of critical state concern.

In 1990, the CARL program was largely replaced by the Preservation 2000 (P2000) program, which was a 10-year, $3 billion land acquisition program funded annually through the sale of bonds (Farr and Brock 2006). At the time, it was the largest conservation land acquisition program in the country. The program's state governmental agency recipients, often with the help of private conservation organizations, purchased more than 1.7 million acres of new conservation lands under the program, including many of Florida's most important conservation holdings.

The state's second robust land protection program, Florida Forever (FF), succeeded P2000 with another 10-year, multi-billion-dollar commitment. The FF program was created under the leadership of Governor Jeb Bush (Republican) by the Florida legislature in 1999. It authorized the issuance of up to $3 billion in bonds for land acquisition, water resource development, preservation and restoration of open space, greenways and trails, and outdoor recreation (Farr and Brock 2006). The legislature also mandated public land protection agencies to focus on using alternatives to fee simple acquisition. Since 2000, FF has protected more than 1.3 million acres of water resources, environmentally sensitive lands, and parks (Department of Environmental Protection [DEP] 2016). Many of these areas have been protected through less-than-fee arrangements, involving purchase of conservation easements. Conservation easements allow lands to stay in private ownership but legally restrict what activities can occur on the land. At the same time, the land stays on the local tax rolls and under private management. Figure 2.2 shows conservation lands in Florida classified by date of protection based on the Florida Natural Areas Inventory Florida Conservation Lands dataset. This data includes both public and private lands that are either protected primarily for conservation or where conservation is an important activity (e.g., various military installations across Florida).

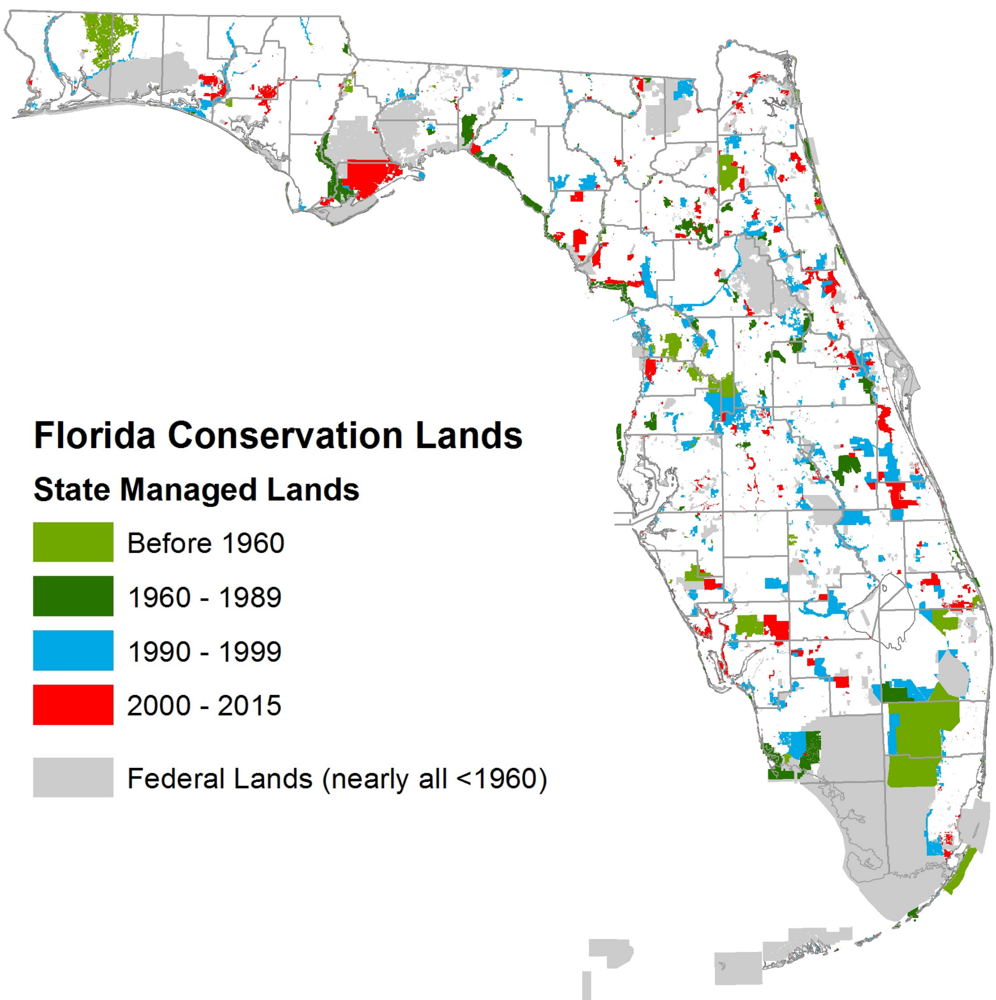

Figure 2.2. Florida conservation lands and date of protection. Data Source: Florida Natural Areas Inventory Florida Conservation Lands (Florida Natural Areas Inventory 2016)

Today Florida has a substantial acreage of its lands and waters in some kind of conservation designation. Combined local, state, and federal conservation holdings equate to 29.4% of the state, with 9,447,419 acres held in fee simple ownership and another 760,400 acres under conservation easements (this figure is slightly higher if private conservation lands and lands in private mitigation banks are included). These figures also include lands managed by the Department of Defense (e.g., Eglin Air Force Base) for conservation benefits (667,200 acres) and land under conservation easements held by the federal Natural Resources Conservation Service (121,122 acres). Figure 2.3 shows conservation and managed lands in Florida classified by managing entity.

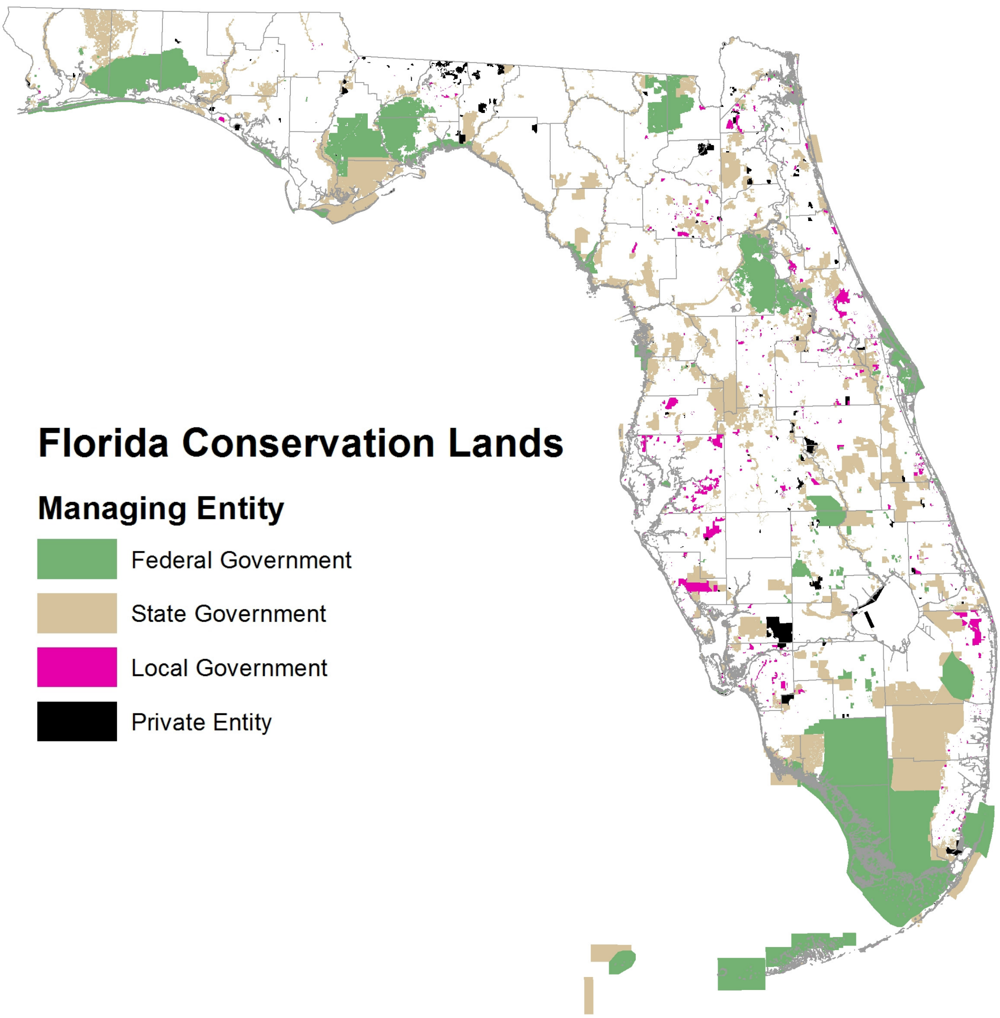

Figure 2.3. Florida conservation lands and managing entities. Data Source: Florida Natural Areas Inventory Florida Conservation Lands (Florida Natural Areas Inventory 2016).

While Florida's history of conservation achievement has been impressive, it has not been enough to prevent wholesale changes to and conversion of the Florida landscape – and its ecology – on a massive scale, and additional conservation land is needed to effectively conserve the still significantly, but quickly vanishing, natural resources that are still unprotected.

Climate Change Impacts on Land Use and Land Cover To-Date

It is important to understand how changes in climate are already impacting land cover within the state, as an indicator of what types of future changes may occur. Significant shifts in land cover are already being seen in both upland and coastal areas as a result of sea level rise, precipitation, and temperature change. Some of these are summarized here, though others are undoubtedly occurring or have been documented.

Coastal Land Cover Changes along the Big Bend Coast

Florida's Big Bend Coast, which stretches along the Gulf of Mexico from just north of Tampa to south of Tallahassee, remains the least developed coastal region in the lower 48 states of the U.S. The region's forests, salt marshes, and near coastal marine environments are legendary for their productivity due to a combination of factors including massive fresh water inputs from the Suwannee River and several first-magnitude springs. That said, it has certainly not been spared from human use, which is intensifying, while it is being rapidly inundated again by rising seas (Williams et al. 1999; de Santis et al. 2007; Raabe and Stumpf 2016).

An understanding of the area's geography is necessary to understand current changes. Like most of Florida, the area is low in elevation and topographically nearly flat; the highest points along the coast are the paleodune on Sea Horse Key and nearby Shell Mound, which started as a dune but was enhanced by Amerindian engineers more than 1000 years ago — neither of those peaks exceeds 20 meters in elevation. The flatness of the coastal region extends far out into the Gulf of Mexico.

Another distinctive characteristic of the Big Bend region relates to the abundant water, both fresh and somewhat salty. Tidal amplitudes in the Gulf of Mexico are small, less than half of those in the Atlantic. Massive influxes of fresh water keep the near-shore salinities in Gulf water at half of "normal" sea water. While all the rivers and spring runs moderate the Gulf's salinity, their waters do not deliver much sediment. Trapped sediments help build land, but the amount deposited on coastal areas of the Big Bend is a small fraction of that carried by rivers.

The natural ecosystems along the Big Bend reflect the impacts of sea salt, as determined by centimeters of elevational change and tempered by distance from the coast. As elevation rises from the open water of the Gulf one crosses sea grass flats, some of which are exposed at especially low tides, mud flats, and oyster bars. Salt marshes are next, often dominated by black needle rush (*Juncus roemerianus*) with saltmarsh cordgrass (*Spartina spp*.) on the depositional banks of meandering tidal streams. At slightly higher elevations, salt marsh shrubs flourish often under the dying crowns of the red cedars (*Juniperus virginiana*) and cabbage palms (*Sabal palmetto*) they replace as sea level rises. Healthy forested islands of cabbage palms and cedars surrounded by salt marsh are next at elevations of 50-60 cm where inundation is only by the highest of high tides as well as by storm surges, which can be several meters high. Inland and slightly uphill from the coastal hammocks of cedar and palms there can be slash pine flatwoods on sandy soils where fires are frequent or, more often, swamp forests referred to as hydric hammocks (Vince et al., 1989). These long hydroperiod wetlands can have as many as 25 species of canopy trees including several species of ash (*Fraxinus spp*.), oak (*Quercus spp*.), and elm (*Ulmus spp*.), with only scattered cabbage palms.

Big Bend ecosystems have been shaped by humans since they arrived some 14,000 years ago. For example, early as well as recent occupants harvested the bountiful shell and bony fish (McCarthy 2006). While modern clam farms benefit from new technologies, farming the sea has been underway for millennia, as indicated by archeological discoveries of massive fish weirs and managed oyster bars. Less than a century ago, pencil slat and brush factories near Cedar Key gobbled up thousands of red cedar and cabbage palm trees every month. Up until a few decades ago when the furniture mills closed, hardwoods were harvested from the hydric hammocks. To this day, stands of slash pine are clear-cut for pulp and saw timber, hunters seek deer, turkeys, bear, and other wildlife throughout the region while crabbers, oyster harvesters, and fisherman ply the coastal waters and up into the tidal creeks.

In addition to the direct effects of sea level rise, ecosystems in the Big Bend Region are being influenced by the decreasing frequency of the hard freezes that set the northern limits to the distributions of many plant species including mangrove trees (Williams et al. 2014). For reasons that are not yet clear, no tree species can withstand both high salinity and cold freezes. This means that where there are hard freezes, salt marshes predominate, whereas the coasts of warmer areas typically support mangrove forests. Black mangrove (*Avicennia germinans*), the most common species of mangrove tree in the region, can withstand super-high salinities but is killed by freezing temperatures. The northern limit of black mangrove is currently about halfway up the Big Bend Coast, but that limit continues to shift northwards as will be described in more detail in the next section. This massive switch from marsh to forest has numerous implications for the biota, biogeochemistry, and the effects of storm surges, which are blocked better by dense forests than by low-growing herbaceous vegetation.

The other big change underway along the Big Bend Coast is also related to global change, but is driven by Brazilian pepper, an invasive species described earlier in this chapter. Brazilian pepper is top-killed by hard freezes but, unlike mangrove trees, re-sprouts afterwards. The fact that it tolerates fairly high soil salinities allows it to proliferate where cabbage palms and cedar trees are succumbing to salt stress (Ewe and Sternberg 2005). Because it can grow taller than the live oak (*Quercus virginiana*) and other trees with which it competes, and can itself grow as a tree, a shrub, or a woody vine (Spector and Putz 2006), it crowds out native tree species in coastal hammocks up to about the same latitude as where mangroves stop.

Rising sea levels have driven the inland and uphill migration of Big Bend ecosystems since the end of the last glacial period some 14,000 years ago as they did during previous interglacials. The current rate of rise is by no means unprecedented; sea levels were rising more than twice as fast when paleoindians occupied the area. What is different now is that the uphill and inland migration is often impeded by the infrastructure of humans who are less willing to move than our coastal predecessors. Given the low human population density and sparsity of development along the Big Bend Coast, the financial consequences of sea level rise are modest in the aggregate while devastating for the people who do live in the region.

Changes in Mangrove Distribution within the Florida Peninsula

Mangrove forests consisting of black mangrove, red mangrove (*Rhizophora mangle*), and white mangrove (*Laguncularia racemose*) are a common coastal community on both the low energy Gulf and Atlantic shorelines in Florida. Along with tidal marshes and other coastal ecosystems, they provide a number of important services including carbon storage, shoreline protection and sediment accretion, water quality improvement, habitat for a number of important fish and wildlife species, as well as recreational opportunities (Osland et al. 2013).

The northern extent of each of the three mangrove species endemic to Florida varies due to differing resilience to freeze events. Precise range boundaries are difficult to determine, but over the past century, black and white mangroves have been found as far north as the Guana Tolomato Matanzas National Estuarine Research Reserve on the East Coast (Wunderlin and Hansen 2008; Zomlefer et al. 2006) and as far north as Cedar Key on the West Coast of Florida. Typically red mangroves are found further south than the other species due to a greater sensitivity to cold temperatures.

However, these ranges are not static, and as already noted change continues to occur. For example, in the Ten Thousand Islands, between 1927 and 2005 mangrove encroachment occurred upstream into salt and brackish marshes resulting in a roughly 35% increase in mangrove coverage (Krauss et al. 2011). Within the Tampa Bay region, Raabe et al. (2012) have documented conversion of marsh to mangrove habitat by comparing digitized nineteenth century topographic and public land surveys with 2005 digital land cover. Though specific conversion rates varied in different locations, the average ratio of non-mangrove to mangrove habitat over a 125-year period reversed from 86:14 to 25:75 across the four sites that they examined.

Depending on location, there are varying and interrelated reasons for these shifts that have been cited, including construction of waterways and interruption/reduction of freshwater flows (Krauss et al. 2011; Raabe et al. 2012), sea level rise (Krauss et al. 2011; Raabe et al. 2012), and changes in temperature resulting from climate change (Raabe et al. 2012; Williams et al. 2014) Storm disturbances have been a historic driver of change in forest structure (Doyle et al. 1995), and future changes may also be driven by precipitation (Ward et al. 2016),

South to north shifts in mangrove ranges seem particularly telling of the influence of climate change because, at least in Florida, the northern distribution of mangroves is limited by temperature. When mangroves begin to migrate further north, it is an indication that freeze events are no longer limiting colonization of mangroves in places where they have not recently existed. Northern migration of mangroves along the Atlantic Coast is now being documented and attributed to climate change. The frontline of this change is the Guana Tolomato Matanzas National Estuarine Research Reserve. In a 2013 study, Williams et al. (2014) surveyed the northernmost locations of black, red, and white mangroves, and compared those locations with historical data identifying the northern extent of these species. In the case of black mangroves, they found an occurrence 27 km north of the prior most northerly occurrence documented in 2007 (Wunderlin and Hansen 2008). They found a red mangrove 26 km north of the previous outlier documented in 2006 (Zomlefer et al. 2006) and a white mangrove occurrence approximately 67 km north of historic observations.

The overall future trend may be a gradual intrusion and northern expansion of mangroves into areas that have historically been dominated by saltmarshes or other types of coastal habitat. Whether this trend will continue, at what rate, and with what effect remains to be seen. At the very least, the changes that have occurred to date underscore the importance of minimizing human influences on these systems, including alteration of hydrology and freshwater flows. The ultimate impacts from climate change on coastal ecosystems is uncertain, but minimizing human impacts will help natural systems remain as resilient as possible to the changes that will occur.

Land Cover Changes in the Florida Keys

The Florida Keys are one of the most sensitive and at-risk regions in Florida with regard to climate change, and especially sea level rise, and changes to land cover to date are already being documented. One example is the loss of South Florida slash pine forest (*Pinus elliottii* var *densa*) as described by Alexander (1976) and Ross et al. (1993) in the Lower Keys. In a study on Key Largo, Alexander (1976) proposed that sea level rise was the cause of this loss, where flooded low-lying freshwater dependent pine communities had been replaced by more salt tolerant mangroves. A second and later study by Ross et al. (1993) reached the same conclusion through an examination of aerial photos and field evidence to compare historic and current distribution of pines on Sugarloaf Key. Ross et al. (1993) estimated the historical extent of pines on Sugarloaf Key to be approximately 217 acres prior to 1935. At the time of their study in 1991, it had been reduced to approximately 74 acres, with the earliest mortalities in areas with the lowest elevations. The areas of early pine mortality had been populated by new salt tolerant species. They also found that groundwater and soil water salinity were higher in areas of rapid pine forest reduction, and that pines in those areas exhibited higher physiological stress. At the time of their study, local sea levels had increased by 15 cm over the past 70 years, with the implication that further sea level rise would only increase the loss of upland pine communities. Ultimately, the entire Florida Keys as an upland ecosystem is endangered by projected sea level rise in the next century, which will necessitate consideration of various conservation strategies including potentially translocation of the many endangered species and subspecies found here (Noss et al. 2014).

The Impacts of Land Cover and Land Use Change on Florida's Climate

It is important to understand that the land cover and land use changes that have occurred in Florida have affected the climate — certainly in their contribution to the greater phenomenon of global climate change, but also most likely at a regional and local level. These changes in turn affect land cover and land use in the future. As described elsewhere in this chapter, the pre-1900 landscape of Florida has been significantly altered by agriculture and urbanization. One impact of dense urbanization can be the "heat island effect," where urban areas actually cause an increase in local temperatures due to the absorption and re-radiation of solar heat by buildings and paved surfaces. Within an urban or suburban environment, local temperatures can vary based on the amount of tree cover and density of buildings and paved surfaces. For example, a study conducted by Sonne et al. (2000) in Melbourne, Florida showed average summer temperatures to be as much as 1.3 degrees cooler in an undeveloped, forested site when compared to an adjacent residential site with 4.6 houses/hectare and significant tree canopy. Average temperatures were up to 2.9 degrees cooler when compared to a residential site without trees and 10.1 houses/hectare.

At the peninsular scale, Marshall et al. (2004) conducted a series of simulations that found urbanization and agricultural conversion during the 20th century has contributed to a regional increase in summer temperatures and an average decrease in precipitation of 10-12% compared to the pre-1900 total. An earlier study by Pielke et al. (1999) in South Florida found similar results. Changes modeled by Marshall et al. (2004) were particularly apparent in portions of the interior peninsula that had been drained and converted to agricultural land, and land cover changes were also found to have significantly impacted sea-breeze circulation and strength. An important note is that this study was based on 1993 land cover data. It would be useful to know how land cover change since 1993 has affected temperature and precipitation since then, particularly given the continued rate of urbanization. Modeling studies have also shown that drainage and conversion of wetlands to agricultural uses has likely increased the frequency, severity, and duration of freezes in South Florida (Marshall et al. 2003). These simulations were also conducted via a comparison of models that used pre-1900 land cover and 1993 land cover, which showed that wetlands exhibit a moderating effect on sub-freezing temperatures.

Current Land Use and Land Cover in Florida

A comparison of historic land cover data and current land cover/land use is useful to provide a quantitative understanding of changes and potential impacts to date from land use change. Kautz (1998) provides the most recent source of a detailed comparison of long-term land use change within the last 100 years in Florida. Kautz (1998) describes patterns of land cover and land use change between 1936 and 1995, driven in large part by population growth, urbanization, and agricultural conversion. He notes that between 1936 and 1995, Florida's population grew from 1.7 million to 14.1 million residents, resulting in significant declines in natural land cover. This included a 60% increase in agricultural lands and a 632% increase in urban lands. Forest area overall decreased by 22%, with herbaceous wetlands decreasing by 51%. By 1995, longleaf pine forests had decreased by 90% from 1936 levels, slash pines had become the dominant pine species in Florida, and non-commercial forests were only 3% of the remaining forest lands in Florida. Interestingly, between 1980 and 1995 some of the trends described above began to reverse, with herbaceous wetland area actually increasing, and agricultural land area decreasing — likely due to urban conversion.

A careful comparison between the data provided by Kautz (1998) and current land use/land cover needs to be conducted to identify more recent land use trends. Since 1995, the population of Florida has increased to over 19 million, resulting in the conversion of more than 18% of land in Florida to urban land uses as of 2010 (Carr and Zwick 2016). Without a doubt, continued population growth within Florida has only exacerbated the conversion of natural and semi-natural lands to urban land uses, and expanded the loss of biodiversity and ecosystem services. However, in some cases there are projects that could result in restoration of certain natural communities to the extent that statewide statistics could be affected. This includes the Kissimmee River restoration and various other wetland restoration projects in the upper Everglades watershed (as well as some in other watersheds). In addition, there is some momentum for restoration of longleaf pine flatwoods, sandhill, and upland pine forests in North Florida that could result in significant increases in acreage of several upland natural communities in the near future (Regional Working Group 2009).

As a means of visualizing these changes, Figures 2.4 and 2.5 compare the extent of major natural land cover types prior to European settlement based on Davis (1967), with a 2003 version of land use/land cover data. Current land use data is frequently updated and there have certainly been land use changes in the state since the data used for Figure 2.5 was created, including additional expansion of urban land uses, so this comparison should be updated in the future.

The basis for Figure 2.5 is an early version of the Cooperative Land Cover (CLC) dataset. This dataset has become the most comprehensive and up-to-date source of Florida land cover spatial information, and is a starting point for identifying more recent statistics on current land use and land cover. It is currently produced cooperatively by the Florida Fish and Wildlife Conservation Commission and the Florida Natural Areas Inventory, with the latest version completed in October 2015. In the following section, we have created several tables of current land cover and land use categories based on the October 2015 version of the CLC and other relevant data sources to characterize the current Florida landscape. The statistics make clear that although the majority of Florida is still rural, much of that rural land is agriculture or other disturbed categories (including due to land clearing and fire suppression) and natural uplands have become increasingly rare (Table 2.1). Other than freshwater herbaceous and forested wetlands, the top 10 land cover categories combined from the CLC source data are dominated by urban (which lumps all intensive to low intensive developed land uses in this table), agriculture, tree plantations, or land cover classes that are most often indicators of fallow agriculture or disturbed natural communities including shrubs and other rural and mixed hardwood-coniferous. Mixed hardwood-coniferous forests could be considered “natural” and in some limited locations are natural communities, but in the current Florida landscape they are primarily the product of either oldfield succession on former farmlands or fire suppression of various fire-adapted natural communities including flatwoods, sandhill, upland pine, and scrub (Myers and Ewel 1990). The only other exception, and by far the largest of the natural upland natural community classes, is flatwoods, which have been largely replaced by tree plantations but still occur on public and private lands across the state.

Table 2.2 provides more detail on current remaining natural communities in Florida also based on the Florida Cooperative Land Cover Data from 2015. With the clearing of uplands for agriculture and development, it is not surprising that 7 out of the top ten natural communities based on remaining acres are wetland types. Table 2.3 provides statistics regarding acres of protected natural and semi-natural land cover. Protected is defined here as occurring in any area included in the Florida Natural Areas Inventory Florida Conservation Lands database. Conservation lands are disproportionately wetlands, which is not surprising given their lower development potential and the dominance of large wetlands in South Florida conservation lands.

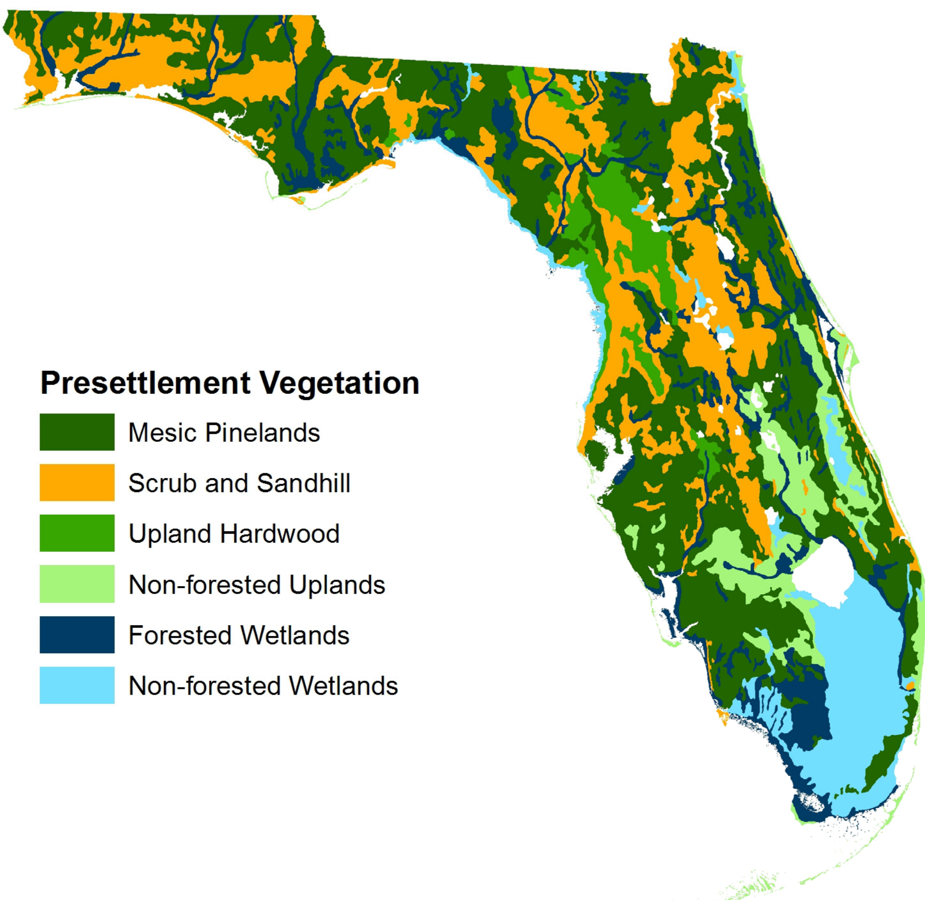

Figure 2.4. Pre-settlement vegetation map. Data Source: Davis (1967).

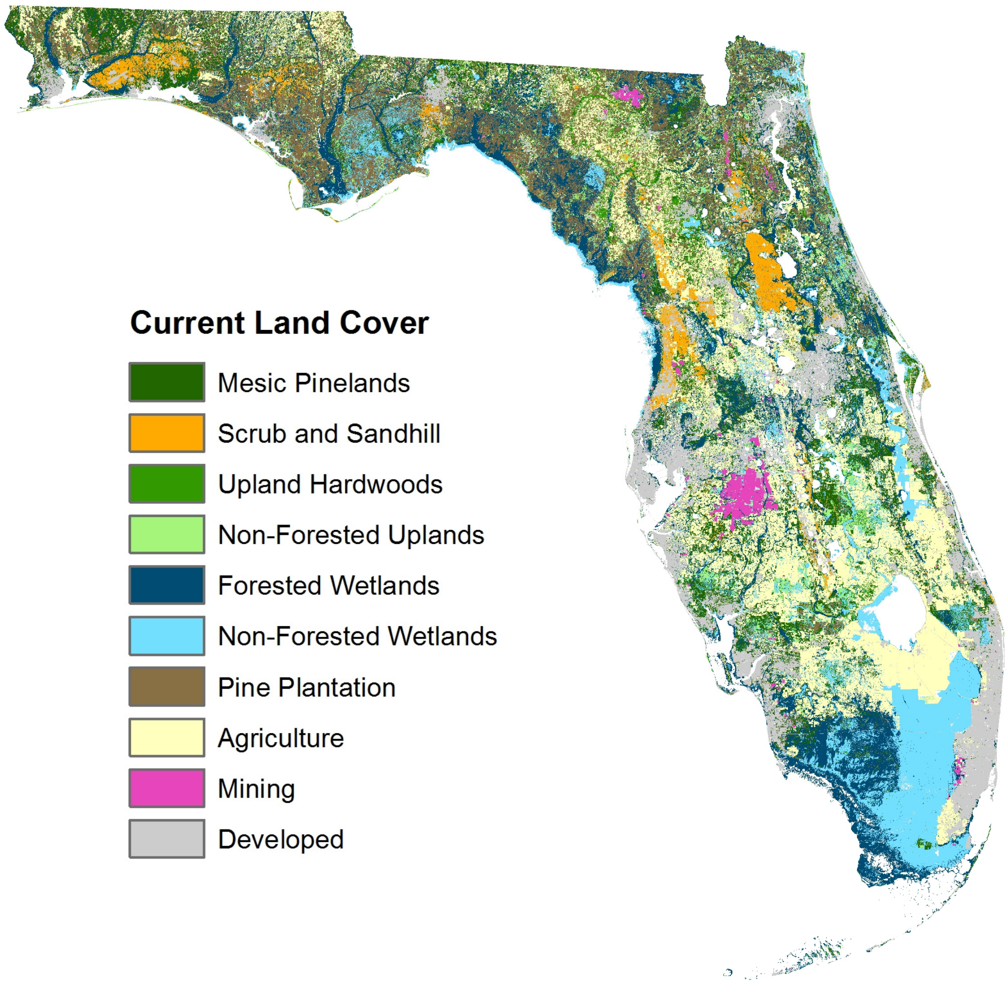

Figure 2.5. Current (2003) land cover. Data Source: FWC/FNAI Cooperative Land Cover, Version 1.0.

Table 2.1. Current major land cover classes based on Florida Cooperative Land Cover data (2015).

Land Cover Class	Acres	% of Statewide
Urban	5,664,034	15.76%
Freshwater Herbaceous Wetlands	4,637,696	12.91%
Freshwater Forested Wetlands	4,563,153	12.70%
Tree Plantations	4,516,626	12.57%
Pasturelands	4,094,759	11.40%
Crops, Groves, Nurseries	2,839,100	7.90%
Flatwoods	2,219,596	6.17%
Shrubs and Other Rural	1,923,632	5.35%
Mixed Hardwood-Coniferous	1,329,657	3.70%
Freshwater (Lakes, Ponds, Rivers, Streams)	1,310,344	3.64%
Sandhill and Upland Pine	943,053	2.62%
Scrub	784,757	2.18%
Mangroves	614,098	1.71%
Upland Hardwood Forest/Hammock	516,640	1.43%
Salt Marsh	378,678	1.05%
Extractive	256,978	0.71%
Dry Prairie	177,022	0.49%
Coastal Uplands	85,834	0.23%
Exotic Plants	66,089	0.18%
Rockland Forests	36,186	0.10%

Table 2.2. Current natural community types based on Florida Cooperative Land Cover data (2015).

Land Cover Class	Acres	% of Statewide	Land Cover Class	Acres	% of Statewide
Freshwater Forested Wetlands	2,676,694	17.21%	Cypress/Tupelo	92,145	0.59%
Marshes	2,435,732	15.66%	Isolated Freshwater Swamp	74,557	0.48%
Wet Prairies and Bogs	1,736,441	11.16%	Floodplain Marsh	49,974	0.32%
Mixed Hardwood-Coniferous	1,329,657	8.55%	Dome Swamp	48,862	0.31%
Mesic Flatwoods	1,325,011	8.52%	Strand Swamp	44,236	0.28%
Sandhill	775,755	4.99%	Tidal Flat	43,950	0.28%
Wet Flatwoods	761,947	4.90%	Scrub Mangrove	42,388	0.27%
Cypress	637,310	4.10%	Maritime Hammock	29,654	0.19%
Mangrove Swamp	571,710	3.68%	Other Coniferous Wetlands	26,800	0.17%
Floodplain Swamp	421,270	2.71%	Sand Beach (Dry)	24,386	0.16%
Salt Marsh	378,678	2.43%	Xeric Hammock	24,211	0.16%
High Pine and Scrub	290,829	1.87%	Other Hardwood Wetlands	23,022	0.15%
Isolated Freshwater Marsh	276,763	1.78%	Palmetto Prairie	21,131	0.14%
Hydric Hammock	240,562	1.55%	Coastal Scrub	19,554	0.13%
Upland Hardwood Forest	224,388	1.44%	Rockland Hammock	19,320	0.12%
Sand Pine Scrub	220,967	1.42%	Pine Rockland	16,866	0.11%
Basin Swamp	192,634	1.24%	Coastal Uplands	16,570	0.11%
Upland Pine	164,839	1.06%	Non-vegetated Wetland	13,828	0.09%
Scrub	159,788	1.03%	Keys Tidal Rock Barren	8,519	0.05%
Dry Prairie	155,891	1.00%	Coastal Strand	6,703	0.04%
Freshwater Non-Forested Wetland	138,786	0.89%	Slope Forest	5,875	0.04%
Mesic Hammock	126,285	0.81%	Dry Flatwoods	2,459	0.02%
Baygall	111,861	0.72%	Outcrop Communities	507	0.0033%
Pine Flatwoods/Dry Prairie	105,838	0.68%	Upland Glade	34	0.0002%
Scrubby Flatwoods	93,619	0.60%	**Total**	15,553,254	100.00%

Table 2.3. Acres of natural and semi-natural wetlands and uplands in conservation lands.

Description	Acres	Percent of Category
Natural Uplands in Conservation Lands	2,397,767	44.3%
Natural Uplands not in Conservation Lands	3,010,844	55.7%
Wetlands in Conservation Lands	6,155,458	56.2%
Wetlands not in Conservation Lands	4,798,293	43.8%
Semi-natural Uplands in Conservation Lands	1,167,281	14.9%
Semi-natural Uplands not in Conservation Lands	6,675,938	85.1%

Possible Future Changes in Land Use and Land Cover

Although the focus of this chapter is on historical land use and land cover changes to date, it would not be complete without a brief discussion of potential future changes from population growth and development. Climate change may also have significant impacts on land cover and land use throughout the state, but those topics are discussed in other chapters.

Though the rate of growth fluctuates, as of 2015 the population of Florida was increasing by approximately 1,000 people per day (O'Donnell 2015), requiring additional housing and infrastructure be built to accommodate them. A 2016 study of future population allocation and development scenarios for 2070 (Carr and Zwick 2016) showed the extensive impacts that continued development and land use change will have on existing agricultural and natural landscapes if current growth rates and development trends continue. In addition to creating a scenario that mapped future development at current trends and densities, Carr and Zwick (2016) created an alternative scenario that showed how future population growth in the state might be accommodated using higher densities and rates of infill. A baseline scenario that identifies 2010 land use patterns within the state was also created for comparison. Table 2.4, adapted from Carr and Zwick (2016), provides an acreage comparison of the 2010 baseline, a future "trend" scenario, and an alternative scenario for 2070, which shows the significant reduction in acreage of agricultural and other undeveloped lands that will occur if current population growth and development trends are maintained.

Coastal development will, at least in some places, be required to relocate inland in response to sea level rise, compounding the development pressure and impacts on existing undeveloped agricultural and natural landscapes. Where this occurs, the character and ability of inland landscapes to provide important agricultural and ecosystem services will be altered. Vargas et al. (2014), and Noss et al. (2014) have provided scenarios that show the potential impacts from "in-migration" of human population, combined with additional development to accommodate continued population growth. Figure 2.6 shows one such scenario for 2060, where future population growth was allocated throughout the state based on current trends and densities, and coastal populations impacted by a 1 m sea level rise were forced to relocate elsewhere within the state. Where coastal development remains in place, coastal protection and hardening structures may be used to stabilize the shoreline, which has been shown to cause significant damage to coastal ecosystems (Pilkey et al. 2009). Specific studies on the combined impacts of future development and sea level rise on biodiversity, natural communities, and landscape-level ecological priorities have been conducted by Noss et al. (2014) and the Florida Fish and Wildlife Conservation Commission (2008), with results showing that it is more critical than ever to carefully conduct future land use planning in a way that protects the resources critical to our state.

Table 2.4. An acreage comparison of Florida 2070 alternative population allocation scenarios not considering sea level rise (adapted from Carr and Zwick 2016).

	Baseline	**% of Land**	**Trend**	**% of Land**	**Alternative**	**% of Land**
Developed	6,412,000	18.56%	11,647,716	33.72%	9,777,000	28.30%
Protected (including protected agriculture)	10,870,000	31.47%	10,870,000	31.47%	18,647,664	53.98%
Agriculture (croplands, livestock, aquaculture)	7,518,267	21.76%	5,520,237	15.98%	4,827,759	13.98%
Other (mining, timber, unprotected natural areas)	9,742,733	28.20%	6,505,047	18.83%	1,290,577	3.74%
Totals (excluding open water)	34,543,000	100.00%	34,543,000	100.00%	34,543,000	100.00%

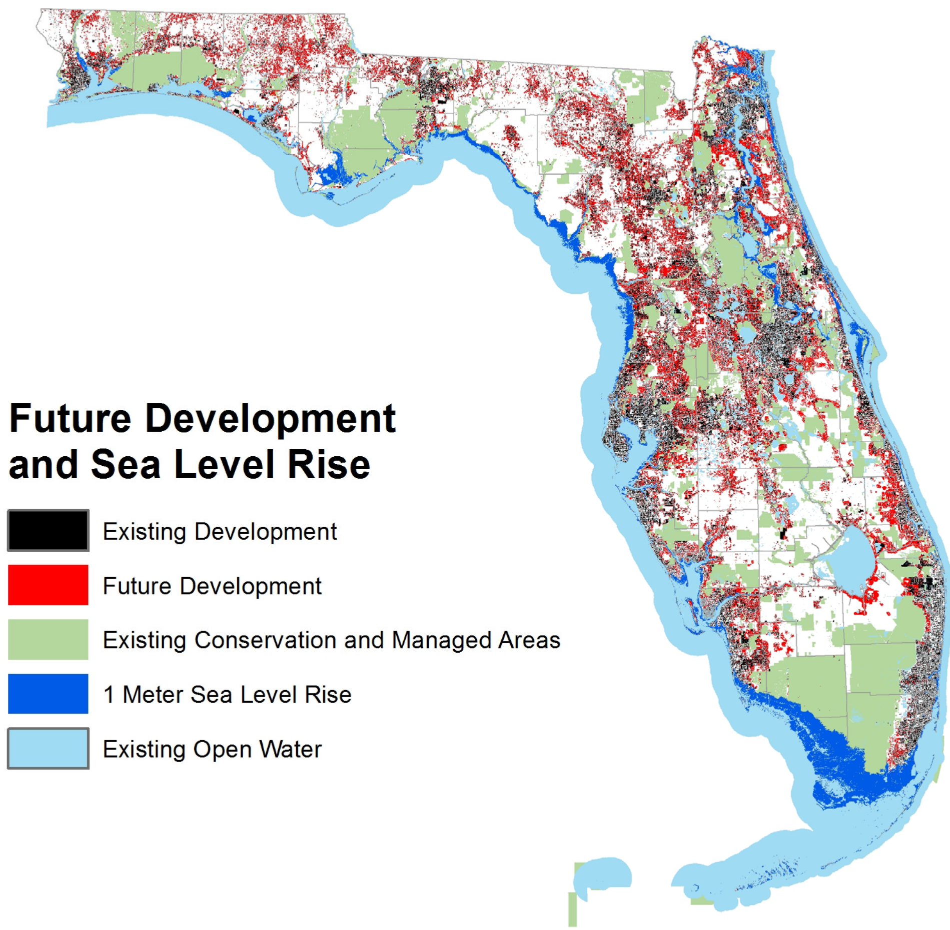

Figure 2.6. Future population allocation for Florida for 2060 with a one-meter sea level rise. Data Source: Noss et al. (2014), Florida Natural Areas Inventory Florida Conservation Lands (Florida Natural Areas Inventory, 2016)

Conclusion

It's clear from an assessment of historic land use and land cover patterns in Florida that significant changes have occurred since the beginning of the 20th century, primarily caused by human population growth, development, and activities such as agricultural production. Other natural phenomena have also caused shifts in the landscape, but the primary drivers have been humans. However, even today Florida still has highly significant cultural and natural landscapes and biodiversity that provide important services to the people that live in the state, in addition to possessing intrinsic values separate from their value to humans. As future changes continue to occur as a result of climate change and population growth, it will be more important than ever to conduct careful land use planning and management so that we can preserve these resources, and maintain the qualities that make Florida the special place that it is today.

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