

CONSERVING FLORIDA'S BIODIVERSITY

**A Report to Governor Lawton Chiles
by the Florida Biodiversity Task Force**

February, 1993



LAWTON CHILES
GOVERNOR

STATE OF FLORIDA

Office of the Governor

THE CAPITOL
TALLAHASSEE, FLORIDA 32399-0001

February 18, 1993

GREETINGS:

The attached report, *Conserving Florida's Biological Diversity*, prepared by the Florida Biodiversity Task Force, assesses the status of Florida's endangered and threatened wildlife and plant populations, and provides recommendations for better protecting these important natural resources.

In producing this report the task force, comprised of representatives of federal, State and regional government agencies, and non-profit organizations met on numerous occasions and held a symposium in December 1990.

I wish to thank each member of the Task Force for the outstanding effort and look forward to the implementation of several of these excellent recommendations for protecting and preserving Florida's unique natural resources.

With kind regards, I am

Sincerely,

A handwritten signature in cursive script that reads "Lawton Chiles".

LAWTON CHILES

LC/drs

National Parks

and Conservation Association

PAUL C. PRITCHARD

President

If there was ever a crisis facing the environment worldwide, it is the threat of losing the earth's diversity of plant and animal species. Changing patterns of land use have converted or destroyed the habitats of an enormous variety of species around the world, threatening them with extinction. The importance of preserving this diversity of life has been well documented; for example, the rosy periwinkle was near extinction when scientists discovered its value in treating leukemia. The need to save biotic diversity far outweighs any rationale for the mindless destruction of plant and animal species millions of years old.

Americans so far have relied on the federal government to identify threatened and endangered plants and animals and develop recovery plans for them. But, while the Endangered Species Act has resulted in many conservation victories, it cannot on its own keep up with the increasing rate of species decline.

"Conserving Florida's Biological Diversity," formerly "Nature 2000," is an effort to broaden responsibility for preserving biological diversity at the state and local levels. With the leadership of the State of Florida, the National Parks and Conservation Association developed this program, which recognizes that the recovery of threatened and endangered species requires the leadership of state governments and the help of local people.

Florida is ideally suited for this new approach to species preservation. It is one of the most biologically rich states in the country. It has a strong citizen-based commitment to the environment and a governor and other public officials who are truly committed to saving what is special about Florida.

This effort has been chaired by Ney Landrum of our Florida office, for which we thank him. It has had special leadership from Estus Whitfield and other citizen leaders of the State of Florida. Without the support of the governor and other public officials, it would not have moved forward.

We thank the people of Florida for their commitment to biological diversity, and we stand ready to help implement this report's recommendations.

Sincerely,



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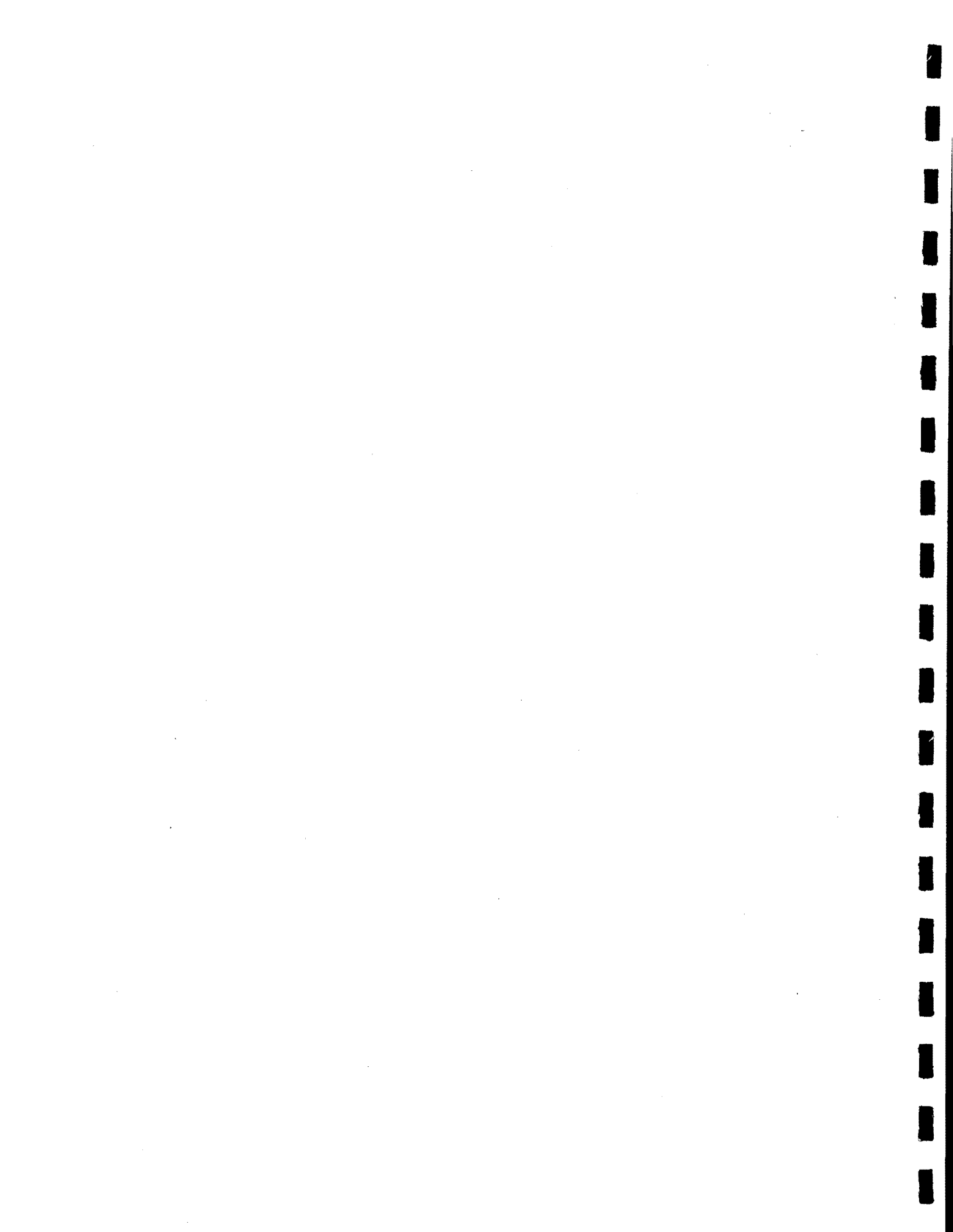
PREFACE

Florida harbors an unusually rich variety of plant and animal species and natural communities. This biological diversity--or biodiversity--is higher in Florida than in all but three other states in the continental United States. Many Florida species and natural communities are restricted to just one location or habitat and are not found anywhere else on Earth. The Apalachicola River Basin, the south-central highlands, the pine rocklands, tropical hammocks of south Florida, and the state's marine habitats contain especially high numbers of these endemic species.

But many of Florida's native plants and animals and natural communities are at risk. Nearly 17 percent (111 species) of all native fish, reptiles, amphibians, birds, mammals and invertebrates are thought to be in danger of extinction. Nearly half of all Florida's non-marine vertebrates are known or suspected to be declining. Native plants and natural communities are equally threatened. At every ecological level we examine--genetic, species, community, ecosystem and landscape--Florida appears to be on the brink of biological impoverishment.

The primary reason for these losses is that so much habitat has been converted and lost the conversion and loss of habitat through wetland dredging and filling, urbanization, agriculture, silviculture and mining. Vast acreages of natural communities have been severely degraded by drainage, sedimentation, alteration of natural fire regimes, fragmentation by roads and other urban development, and contamination. Wildlife and plant populations have also been reduced by overharvesting, commercial and non-commercial exploitation, incidental taking, road kills and boat mortality, and predation by domestic pets. Floridians overwhelmingly support wildlife conservation and environmental protection, but often don't clearly understand the link between habitat loss and degradation and species loss.

Many public and private agencies administer programs that affect the potential recovery of endangered and threatened species and natural communities. Land acquisition and management, regulation, survey and mapping, research and education are among the most important ongoing activities. However, none of these agency programs specifically claims preservation of biodiversity as a primary objective. Florida needs to fund strong regulatory, enforcement, habitat management, land acquisition, research and education programs aimed at all ages and interests if it is to stop current losses of biological diversity.



CONSERVING FLORIDA'S BIODIVERSITY

INTRODUCTION

Many of Florida's native plants and animals are in danger of extinction. The number of species at risk is increasing at an ever faster rate. This paper outlines the reasons why these species and the natural communities in which they live are so rapidly declining, and describes existing responsive programs and new strategies for the future.

Since life on Earth began, extinctions--even mass extinctions--have been a normal part of evolution. Geologic and climatic changes and, in the 19th century, excessive hunting and gathering, caused many populations and species to disappear.

Over the last 20 or 30 years, the diversity of life in Florida and across the globe has entered a marked decline through extinction.

The extraordinary losses in recent times differ, however, from earlier declines. First, the rate of diversity loss is far greater than ever before, and far greater than the rate at which new species evolve.⁶³ Second, habitat degradation, the destruction of the diverse natural settings of animals and plants, is proceeding at a scale orders of magnitude greater than at any time in evolutionary history. Third--this time, the human race is clearly responsible for, but capable of halting, these declines.

Biological diversity refers to the variety and richness among living organisms and the ecological systems and processes of which they are a part. Diversity occurs at many levels, including ecosystem, species and genetic.

Genetic diversity is the raw material of evolution and allows species and populations to adapt and survive changing environmental conditions. Species diversity, the number of kinds of plants and animals, is necessary to maintain stable food webs and other biological processes. A diversity of ecosystems--dynamic complexes of plant and animal communities and their physical environments--protects species and genetic resources as well as a host of ecological processes critical to human survival.

Due in large part to Florida's geographic location, an unusually high number of species and communities occur over the state's relatively small land mass, and a high proportion of these species are found nowhere else in the world. Thus, because Florida contributes substantially to global biological diversity, extinction of species and elimination of natural communities in Florida is of worldwide concern.

STATUS OF FLORIDA'S NATIVE PLANTS, ANIMALS AND NATURAL COMMUNITIES

Our Biological Diversity Baseline

Species and genetic diversity: In the continental United States, Florida is one of the three states with the highest numbers of species of plants and animals.²⁶ Furthermore, an unusually large number of subspecies, many of them listed as rare or endangered, also live in Florida and contribute to the state's high degree of genetic diversity. At least three factors contribute to this remarkable species and genetic diversity:

* Unlike any other state, the long peninsula of Florida extends through temperate and subtropical climatic zones, descending from the continent hundreds of miles into the warm seas. Biota from North America and the West Indies have settled along this latitudinal gradient, creating unique species assemblages and community structures. Moving southward down the Florida peninsula, the number of terrestrial animal species steadily decreases with decreasing variety in topography and habitat. Over the eons, organisms moving south from the North American mainland and north from the West Indies have colonized the panhandle and peninsula to the limits allowed by climate, habitat availability and their own mobility. Flying or floating, tropical West Indian colonists expanded their ranges in Florida as far north as their tolerance of winter cold would permit. The result of these colonizations is an unusual mingling of flora and fauna that varies from the north to the south of Florida.¹³

* Florida's landscape is tremendously productive due to the high humidity and rainfall generated by the Gulf of Mexico and the Atlantic Ocean. Most of the Earth's other land masses found at Florida's latitudes are deserts.¹³

* Florida's geologic past has created a diverse substrate that contributes to the state's great diversity. While some soil and rock formations are a youthful two or three thousand years old, the relict sand dunes on the state's central ridge are perhaps 25 million years old. A wide array of geological features underlie Florida's lakes, swamps, rivers, tropical hammocks, pine woods and scrubs, not only providing diverse habitats for many different species, but also acting as physical barriers or filters that isolate organisms depending on their mobility.¹³

Species endemism: Florida also boasts a high degree of "endemism," a biological term that describes species and natural communities that are restricted to one location or characteristic habitat and are not found anywhere else on Earth (Table 1).⁵⁰ Areas with many endemic species contribute more to global diversity than areas with similar numbers of species but less endemism.^{13,50}

Florida's terrestrial environment: Nine percent of Florida's 3,500 known native plants are endemic to the state. Many of these plants, and the animals that coexist with them, are congregated in just a few "hot spots"--the Apalachicola River Basin, the south-central highlands, and the pine rocklands and tropical hammocks of south Florida and the Florida Keys.^{7,26}

The critically endangered scrub and sandhill communities of the central Lake Wales ridge constitute some of the highest sources of endemism in the United States. About two dozen plant species grow nowhere else in the world except in Florida's scrub.⁷ Florida

Table 1

Number of native plants and animals inhabiting Florida's land and inland waters, including endemic species and subspecies (ssp.) (Source: Muller et al, 1989).

	<u>Total Species and Subspecies (ssp.)</u>	<u>Endemic</u>	<u>Nearly Endemic</u>
Vascular Plants	3500	235	40
Fishes	126	7	4
Amphibians	57	1+5 ssp.	3+1 ssp.
Reptiles	127	6+31 ssp.	2+4 ssp.
Birds	283	7 ssp.	2 ssp.
Mammals	75	2+56 ssp.	1+2 ssp.
Invertebrates		410	

scrub jays, sand skinks and scrub lizards are among the beautiful and peculiar animals endemic to Florida that live in the unique scrub.

The endemics of south Florida's pine rocklands and tropical hammocks include relict populations of North American plant and animal species whose ranges once extended beyond Florida.⁵⁹ Many of these species are now thought to be genetically distinct from their continental and West Indian relatives, and all live in distinctive habitats that are under severe pressure from development.

Florida's extensive coastline--very vulnerable to development--and the low flatwoods and ravines of the Apalachicola River also harbor pockets of high endemism.

Florida's marine environment: Florida's high level of biological diversity is especially evident in its marine environment (Table 1). Scientists cannot yet document the total number of marine organisms even to the nearest order of magnitude.⁶⁵ More than 1,000 species of fishes occur in nearshore marine, estuarine, or coastal freshwater habitats in Florida. For 30 percent or more of these species, Florida populations are the only, or at least the principal, populations in the continental United States. The most recent compilation of the fish fauna of Florida listed 1,120 species, which at that time (1958) represented approximately one-fourth of the species recorded for the entire northern portion of the Western Hemisphere. Eighty-five of the species are known only from Florida waters. Indications are that the fish fauna of this state is far richer than that of any comparable area in either North or Central America.⁵ The more significant coastal communities of fishes include those of the Indian River lagoon region, and the coral reef areas of the Florida Keys.^{28 29} Nearly 700 species of fish have been recorded in the Indian River region, and the fish fauna in the low-salinity portion of several of the tributaries to the lagoon is unique for North American waters. At least five species found in the latter communities may have no other North American breeding populations outside of these tributaries.^{72 73}

Marine invertebrates may be the most diverse faunal element in Florida, but we know very little about them because they are rarely studied. Florida's better-known invertebrate groups demonstrate the magnitude of Florida's biodiversity relative to the remaining Atlantic coastline. For example, 912 species of marine crustaceans (shrimps, lobsters, and crabs) are listed from the Atlantic coast of North America including Canada.² Other researchers listed 734 species of marine decapod crustaceans from Florida waters, and 279 of those species (38 percent) are known in the continental United States only from Florida; 35 species are thought to be endemic to Florida.¹

Several recent surveys demonstrate our lack of knowledge of Florida's marine invertebrates as well as a far greater diversity than that indicated by earlier literature. One survey of a portion of the central west coast of Florida led to the descriptions of 37 new taxa of marine invertebrates.²⁵

Natural community diversity: It isn't just the plants and animals, in and of themselves, that make Florida naturally unique. These species are an integral part of ecological communities that are closely interwoven by food webs, nutrient cycles, and other intricate relationships. Biologists classify distinct, recognizable combinations of plants, animals and physical conditions into natural communities. Depending on the classification scheme used, the number of natural communities in Florida varies from 13 to 81.¹³ At least 13 plant community subtypes described by the Florida Natural Areas Inventory are endemic to Florida.⁵⁰ Many provide prime habitat for rare and endangered organisms. Most are under siege from the same pressures that are threatening individual animal and plant species.

Losses of Natural Diversity:

Since the widespread settlement of Florida in the mid-1800s, at least 34 species of native plants and animals are believed to have become extinct (Table 2).

The increasing rate of species extinction is especially ominous. In the 400 years after Florida's sighting by Ponce de Leon, in 1513, four vertebrate taxa were slaughtered into extinction by European settlers. By the early 1900s, the plains bison, the Florida red wolf, the Carolina parakeet and the passenger pigeon had all been extirpated for food or sport. During the past half century alone, five more animals have disappeared from Florida and are presumed extinct, including the ivory-billed woodpecker, the dusky seaside sparrow, the Chadwick beach cotton mouse, the pallid beach mouse, and Goff's pocket gopher.⁴² These animals were not shot or trapped into extinction, but fell to the human destruction of natural habitat.

Federal and state government listings of Florida's endangered, threatened and special concern animals now include 16 fish, 28 reptiles and amphibians, 34 birds, 32 mammals and seven invertebrates.²¹ In other words, 117 species, or nearly 17 percent of Florida's total, are thought to be in danger of extinction or to warrant special protection because of increasing vulnerability. Currently, 32 recovery or management plans have been approved, and they provide for only 57 of these species. Some of these listed species are perilously close to extinction, and may not have any populations capable of surviving over the long term because of their small numbers. The total population of the endangered Florida panther is estimated at 30-50 individuals.²¹ The endangered Key deer numbers only 300-400 individuals,³⁷ and the American crocodile is down to 200-400 animals in the U.S. portion of its range.²⁰ Only 1,850 West Indian manatees still swim in Florida waters,²⁰ and threatened Florida black bears linger in just five populations consisting of a total of 500-1,000 individuals.⁶⁸ Biologists are concerned, too, that only 2,000-3,000 red-cockaded woodpeckers remain in Florida's pine woods.⁴⁵

Furthermore, nearly half (44 percent) of all non-marine Florida vertebrates are known or suspected to be declining in numbers or distribution according to a recent study by the Florida Game and Fresh Water Fish Commission.⁴⁷ Forty-nine declining species and subspecies that probably should be included among Florida's listed fauna, are not. Thirty of these animals are subjected to a regulated harvest or are completely unprotected (Table 3). Moreover, of the 294 declining species and subspecies listed as endangered, biologists have a good understanding of the population status and limiting factors of only 30. Fish and amphibians are presently in the best condition of all the vertebrate classes,⁴⁷ although a number of marine fish species - including snook, red drum, king mackerel and spotted seatrout - show striking declines.^{9,41}

Native plants are increasingly at risk, as well. Prior to 1984, only two Florida plant species were listed as endangered under the Endangered Species Act of 1973. After seven years of increased attention by the scientific community, 35 species appear on the lists. Florida currently is second only to Hawaii in the number of plant species it has on the U.S. government's endangered list. Many additional designations are expected; at least 167 plant taxa in Florida await review for federal listing as endangered or threatened.³⁵

Under Florida's rare plant law (The Preservation of the Native Flora of Florida), 182 plant species are considered endangered. Three entire genera of Florida plants are included in this endangered list. The threatened list consists of 70 species and nine broad botanical groups in which almost all Florida species are considered threatened. These groups consist

Table 2

Plants and animals believed extinct or extirpated from Florida (Source: Florida Natural Areas Inventory)

Common Name

Birds:

Dusky seaside sparrow
Ivory-billed woodpecker
Carolina parakeet
Passenger pigeon
Key West quail-dove
Whooping crane
Bachman's warbler
Zenaida dove

Mammals:

Bison
Gray wolf
Red wolf
Caribbean monk seal
Northern long-eared myotis
Indiana bat
Anastasia Island cotton mouse
Goff's pocket gopher
Pallid beach mouse

Invertebrates:
(incomplete list)

Florida arc mussel
Benedict's wharf crab

Plants:

Spider orchid
Beaked spikerush
Pondberry
Creeping-leaf stalkgrass
Rock Key devil's claws
Snake orchid
Mistletoe cactus
Blodgett's sage
Rugel's Key West horse-nettle
Hattie Bauer halberd fern
Ames halberd fern
Broad-leaved nodding-caps

Table 3

Animals native to Florida considered to be biologically vulnerable to extinction that are harvested or not currently protected under Florida Game and Fresh Water Fish Fish Commission rules. (Source: Millsap *et al*, 1990).

Taxa	Harvest Score*
Anastasia Island cotton mouse	3
Short-tailed hawk	2
Coastal dunes crowned snake	3
Mangrove terrapin	4
Peninsular crowned snake	3
Florida black bear	2
Cedar Key mole skink	4
Shoal bass	2
Wagner's mastiff-bat	3
Florida mink	2
Florida east coast terrapin	4
Central Florida crowned snake	3
Mississippi diamondback terrapin	4
Ornate diamondback terrapin	4
Carolina diamondback terrapin	4
Barbour's map turtle	2
American swallow-tailed kite	2
Suwannee cooter	2
Striped newt	4
Santa Rosa beach mouse	3
Florida scrub lizard	3
River otter	2
South Florida rainbow snake	3
Swainson's hawk	2
Seal salamander	3
Mangrove salt marsh snake	4
Sherman's fox squirrel	2
Florida pine snake	2
Eastern diamondback rattlesnake	4
Alabama shad	3

* Harvest scores are: 4 = harvested with no legal protection; 3 = no legal protection, but no substantial harvest other than accidental take or take of nuisance animals; and 2 = regulated harvest permitted by rules.

of four genera (Ilex, Rhododendron, Zephyranthes and Pinguicula), three families (cactus, orchid and bromeliad) and two natural groups (ferns and palms). A separate list of Commercially Exploited plants consists of 11 species and all members of one genus.³⁵

Moreover, most of the natural communities many of these species inhabit and, in fact, define, are considered at risk. Two dominant cover types in Florida for which reliable trend data exist are upland forests and marshlands. Upland forests include pine and hardwood forests, scrub, and tropical hardwood hammocks. Marshlands, which primarily support herbaceous vegetation, occur in both saltwater and freshwater systems.

Florida no longer has virgin forests. Only a few small examples of old-growth forest remain to represent the vast woodlands that once covered the state. Since 1936, Florida's forests, including wetland forests, declined from 20.9 million acres to 16.6 million acres (Figure 1). That is a loss of 4.3 million acres, or 21 percent, in 54 years. In 1936, longleaf pine forests accounted for 51 percent of all pinelands in Florida and 37 percent of all forests. However, in the past 50 years longleaf pine forests have declined from 7.6 million acres to only 0.95 million acres today. At this rate, longleaf pine forests on unprotected lands will disappear from Florida by 1995.⁴²

Most of the ancient scrub and sandhill ridges have also disappeared. Aside from five or six preserves, the scrub and sandhills that remain are for sale and disappearing quickly.⁷ Fifty percent of the tropical hardwood hammocks that existed in Dade County when it was first settled have been cleared for development.⁵⁹ Ecologists believe that the only secure upland communities are second-growth, broad-leaved forests and young, even-aged pines; together, they harbor only a fraction of Florida's native forest-dwelling wildlife.³³

In 1936, freshwater and saltwater marshlands covered more than seven million acres, or about 20 percent of the state. Dramatic losses between 1936 and 1987 leave only three million acres, or 40 percent of our original marshlands (Figure 1).⁴²

At least three natural communities in the marine environment are severely declining: seagrasses, mangroves and nearshore coral reefs. Seagrass areas in Florida are major nursery habitats for numerous species of fish and invertebrates, including pink shrimp, spotted sea trout, and lobsters.

Seagrasses also provide habitat for adults of numerous species, notably the declining population of West Indian manatees. Dramatic losses of seagrass beds in Tampa Bay and Florida Bay have been documented. The estimated 14,203 acres of seagrass meadows that remain in Tampa Bay represent an 81 percent reduction from the historical coverage of about 76,496 acres in the 1800s.⁴⁴ Biologists are documenting similar trends for mangroves and coral reefs. For example, between 1950 and 1980 the number of acres covered by mangroves decreased by seven percent at large study sites in Tampa Bay and Sarasota Bay.³³

It is not just individual plant and animal species and unique natural communities that Florida is losing. Some of the state's largest ecosystems are stressed by the same cumulative forces that drive their smaller components to extinction. For example, the relentless destruction of the Kissimmee-Okeechobee-Everglades ecosystem over the past century represents one of the most important biological losses in recent times. Sixty-five percent of the 3,900 square-mile Everglades ecosystem has been drained and converted to an engineered water control system.⁵⁸ We have lost an estimated 90 percent of the populations of wading birds in the Everglades, many of them listed species. From Florida panthers to the once productive fisheries of Florida Bay, many species are in some degree of trouble.

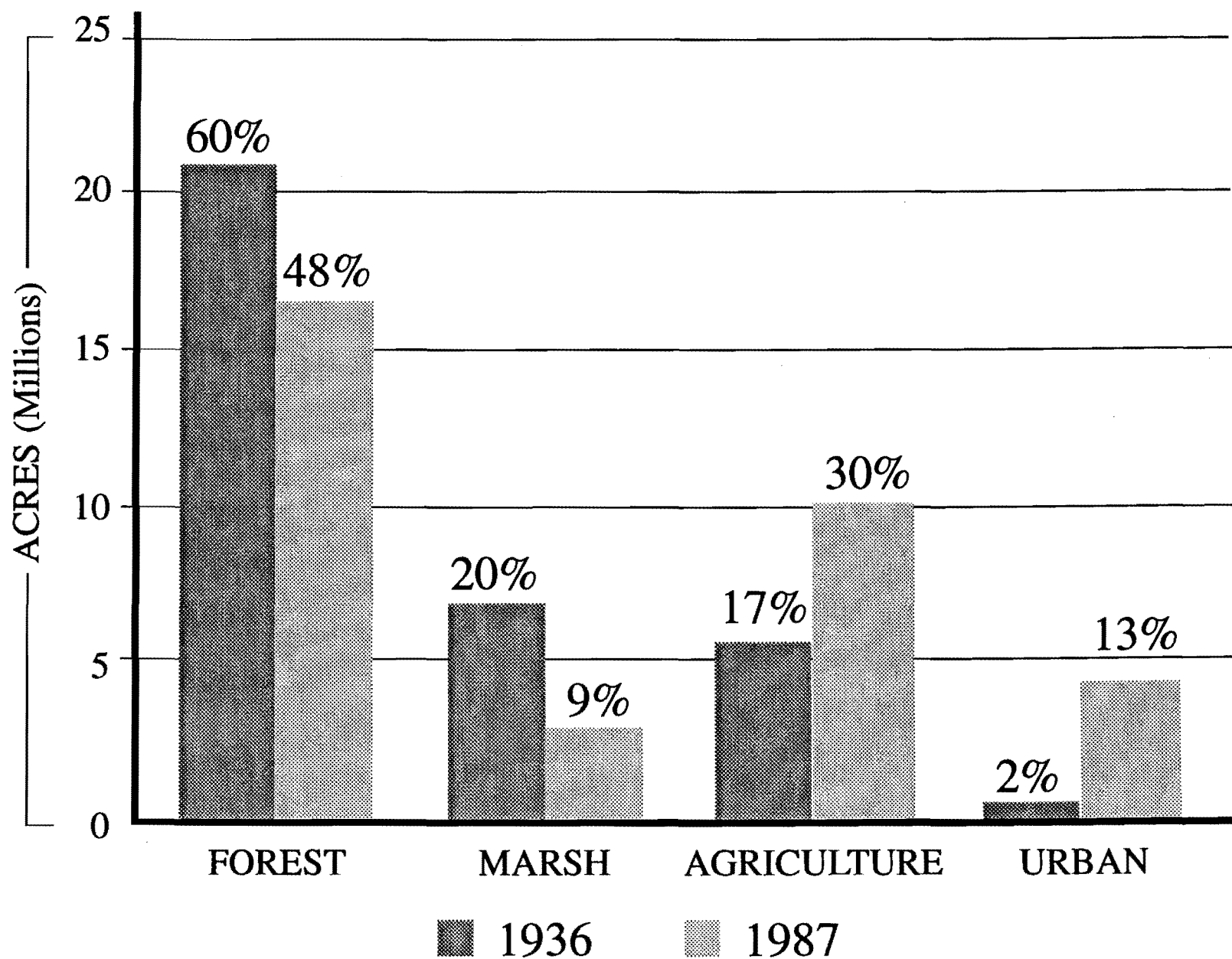


FIGURE 1: Percentage change in acreage of Florida forest, marsh, cropland and urban land, 1936-1987 (Source: R. Kautz, 1990).

The nutrient flows, wet-dry cycles and intricate food webs that once maintained this great water-dependent system have been severely disrupted. The State and federal efforts to restore this once great system are complicated and expensive.

AGENTS OF BIOLOGICAL DIVERSITY LOSS

At every ecological level--genetic, species, community, ecosystem and landscape--the state appears to be on the brink of biological impoverishment. This has happened despite the excellent intentions of federal and state legislation, a concerned public, and a respectable system of parks, forests, wildlife refuges and other public and private lands. The primary reason so many creatures are in trouble is conversion of habitat and loss to other uses. What remains is being fragmented and degraded.

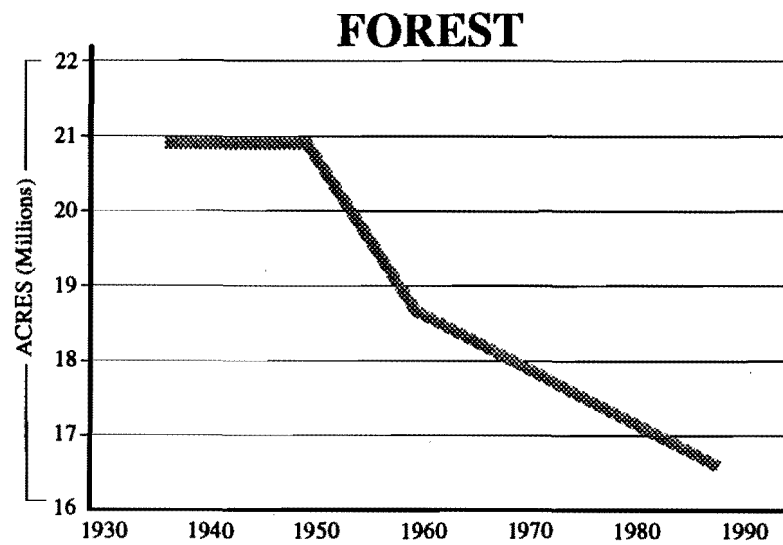
Habitat Conversion and Loss

In the decades following Florida's settlement, large areas of arable natural land were converted to agriculture. In the late 1800s, humans began draining and filling south Florida wetlands on a grand scale, and a new era of agricultural conversion began. Now, the greatest land changes are driven by runaway population growth. In the years to come, habitat conversion will transform millions of acres to cities, towns and transportation corridors. Wetland dredging and filling, urbanization, agriculture, silviculture, mining and coastal armoring are the principal agents of land-use conversion in Florida.

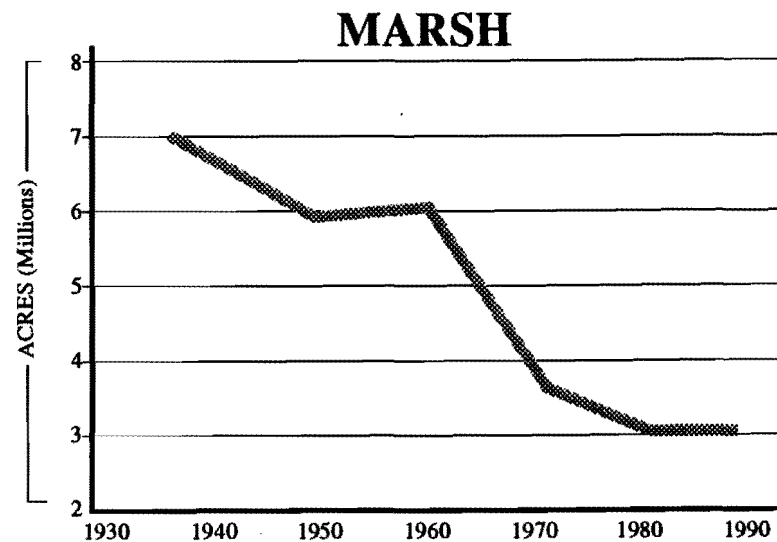
Wetland dredging and filling: Almost 60 percent of Florida's saltwater and freshwater marshlands have been dredged, drained or filled by developers, farmers, ranchers, phosphate, limerock and peat miners, and federal, state, regional and local government agencies. Between 1936 and 1987, the total area of marsh in Florida declined from nearly seven million acres (or 20 percent of the Florida landscape) to just over three million acres (nine percent of the land; Figures 1 and 2). Wetlands lost piecemeal are difficult to account for, but in some cases man has destroyed large portions of natural ecosystems. For example, the 700,000 acre Everglades Agricultural Area (EAA) was created by the dredging of huge canals through a vast, once pristine custard apple/sawgrass marsh south of Lake Okeechobee, and the construction in 1948 of the 85-mile-long, 38 foot high Hoover Dike, which helped prevent floods south of the lake and stored more water to accommodate irrigation and public water supply needs. In north-central Florida, two hundred thousand acres of marsh in the Upper St. Johns River basin were converted to citrus and cattle production. During the 1960s, the U.S. Army Corps of Engineers drained or covered with dredged spoil material some 45,000 acres of marshes, wet prairies and wetlands along the Kissimmee River and north of Lake Okeechobee, primarily for flood control.⁴²

The filling of submerged lands has been one of the major contributors to the loss of biodiversity in Florida's marine environment. It is estimated that dredging and construction of finger fills and roadbed causeways in Boca Ciega Bay destroyed 1,100 metric tons of seagrasses and 1,800 metric tons of aquatic animals living in bottom sediments, followed by annual losses of approximately 73 metric tons of fisheries species and 1,100 metric tons of bottom dwellers.⁶¹

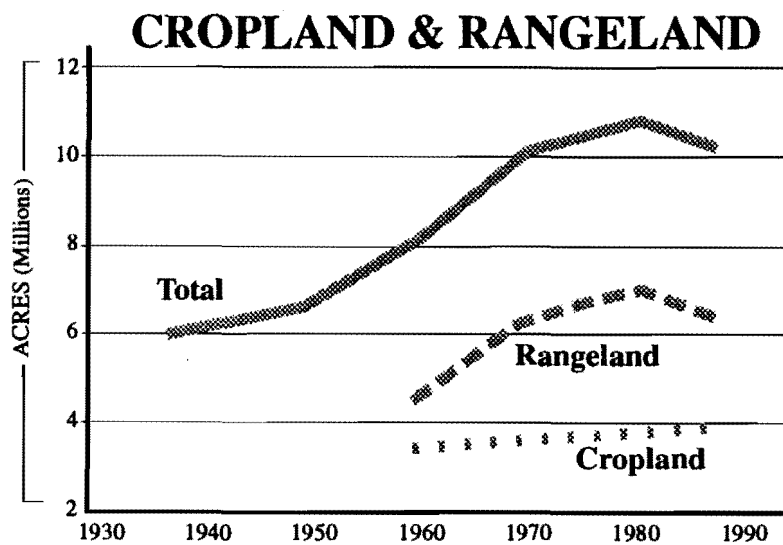
Urbanization: Florida's human population has grown 600 percent, from 1.7 million to 13 million, over the past 50 years (Figure 3). In addition, some 40 million tourists visit Florida each year. To meet the water, housing, utility and other needs of these millions of people, vast areas of land are cleared and converted from natural communities to human



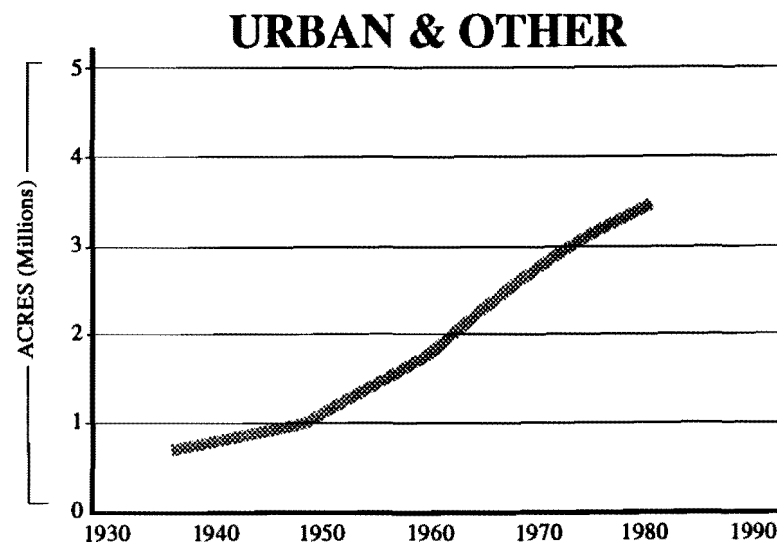
(a)



(b)



(c)



(d)

FIGURE 2: Loss or gain in acreage of forest, marsh, cropland, and urban lands in Florida, 1936-1987 (Source: R. Kautz, 1990).

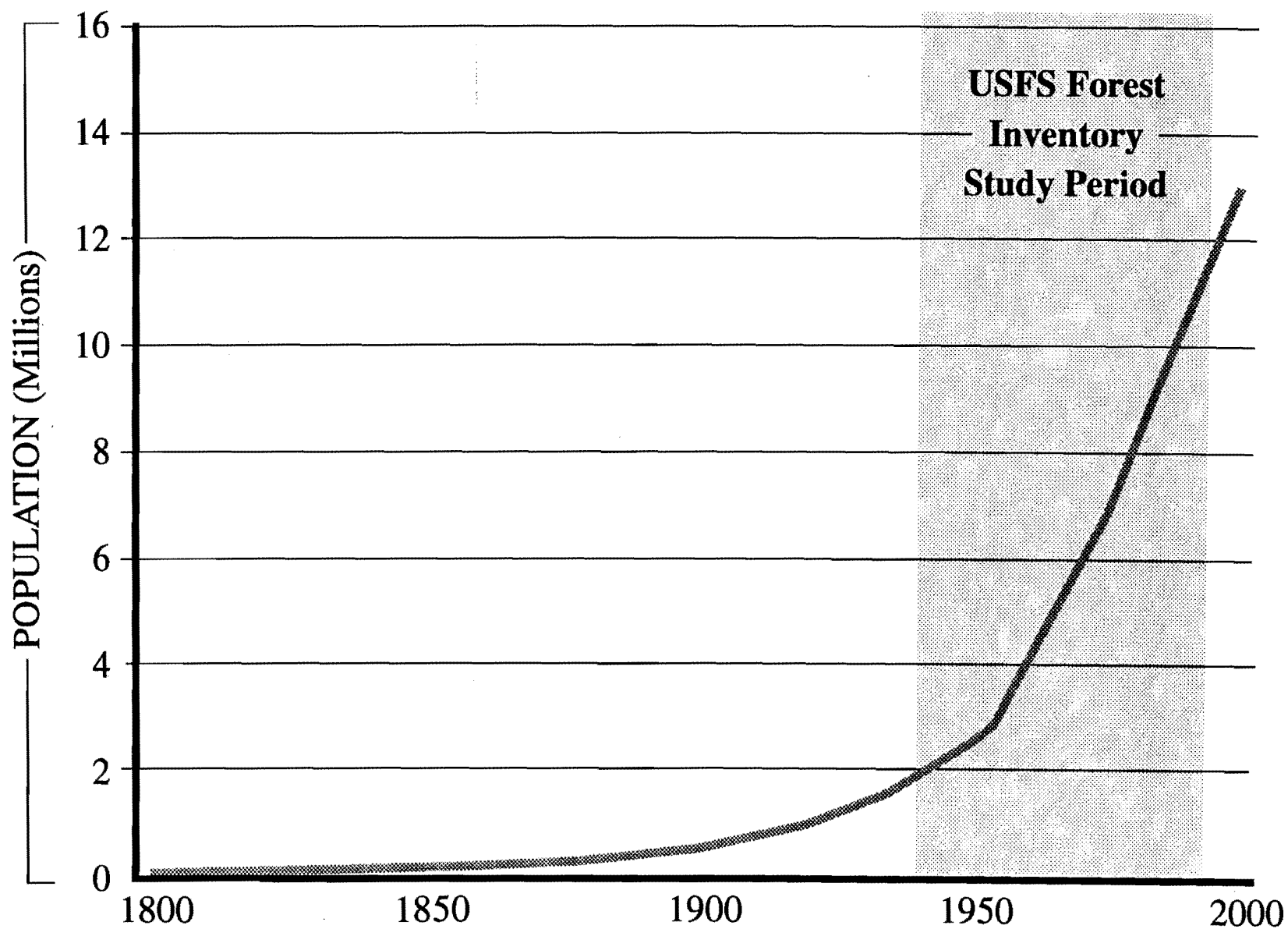


FIGURE 3: Florida population growth in millions, 1830-1987
(Source: R. Kautz, 1990).

use. Planners predict this growth will continue, and estimate that 20 million people will live here by the year 2020. Proportional to population growth, urban areas have increased from 0.7 million acres to 4.6 million acres during the last half century, an increase of over 650 percent (Figure 1).⁴²

Agriculture: Statewide land uses were first inventoried in 1936. Six million acres of native plant and wildlife habitat (17 percent of Florida's total acreage) had already been altered by then to produce crops and cattle (Figure 2). By 1980, agricultural and range lands had increased to 10.8 million acres. A slow decline in these land uses has begun in the last 10 years.⁴² This decline, however, does not indicate reduced impact on native plant and animal communities. Rather it reflects the conversion of agriculture to urban development. There has also been some degree of shifting within agriculture from relatively benign forms such as grazing cattle on native habitat, to more damaging uses such as citrus production. Climate and market conditions also may cause expansion of intensive forms of agriculture into natural habitats and into other agricultural areas. Agricultural areas that are abandoned, as in the case of the southward shift of citrus, do not readily restore themselves, and remain as marginal or poor habitat for years. Conversion of agricultural land to urban use is relatively easier than converting native habitat to urban use. Agriculture also serves effectively as a precursor to urban development, because it is relatively unregulated. Land clearers are able to readily eliminate native habitat for agriculture, thereby making more intensive subsequent land uses easier to permit.

Silviculture: During a study of land uses in Florida between 1936 and 1987, researchers found that commercial forest lands available for silvicultural use comprised 90 percent of all forest land in Florida. Ninety-eight percent of Florida's native longleaf pine forest has been converted to homogeneous, artificially regenerated pine plantations. Numerous studies have shown that the wildlife habitat values of natural pine stands are far superior to those of pine plantations.⁵⁷

Phosphate mining: Phosphate mining is a major industry in north-central and south-central Florida. In the south-central portion of the state, phosphate companies were permitted to mine just over 200,000 acres of upland habitat in 1978. In this six-county area, forest types are considered the most important upland habitats. None of this previously mined land can be completely restored to its native condition. Mining irreversibly alters the deep, sandy soils necessary for mixed forests, resulting in the loss of some of the last remnants of native sandhill and sand pine scrub. In hammocks, the distinctive combination of species that live there and their arrangement in that community are destroyed. Wildlife diversity plummets through loss of habitat and the resulting loss of the less mobile species. When mobile species move from mined land to adjacent habitat their presence stresses resources that resident populations are already using in those areas.

In 1978, phosphate companies were permitted to mine about 20,000 acres of wetlands in south-central Florida. These wetlands are especially important because they are the headwaters for small streams that affect the hydrologic regime and water quality of the Peace, Alafia and Myakka Rivers.

Mining is negatively affecting more than half of the approximately 75 species of native wildlife that are ecologically significant in the region.

In the north-central area of Florida, at least 150,000 acres are now being or will be mined. About 25 percent of this area is a system of large and small wetlands scattered in a mosaic among upland forests, which are important to the Suwannee River. Effects on

upland forests are somewhat less serious than the loss of wetlands in this region because the percentage of upland area affected is smaller. Because the diversity of plants and animals is greater in the northern area than in the south-central area, the potential for loss of overall diversity is greater.¹⁵

Reclamation of mined lands attempts to recreate some of the habitat types but does not replace the complex landscape that originally existed in an area.

Seawall construction: Approximately 128 miles of Florida's 710 miles of sandy shoreline have been seawalled, or otherwise armored or hardened to protect upland property.⁷⁴ The introduction of seawalls in the marine environment increases erosion of the sediments near seawalls due to wave action, and decreases the important surf-zone habitat on sandy beach areas. As the habitat loses its structural diversity and complexity after seawall construction, marine biological diversity severely declines and wave refraction increases causing further erosion.

Habitat Degradation

Hydrologic changes: The principal cause of ecological degradation in Florida wetlands has been drainage, diking, and channelizing, resulting in physical habitat alteration. When water levels are altered, ecosystem characteristics such as fire regimes, vegetation patterns, salination and exotic plant and animal invasions change dramatically and swiftly. Populations of animals and plants that live in these communities are adapted to specific water levels, salinities, and pronounced wet-dry cycles, and usually decline drastically in response to wetland drainage.¹⁴ In addition, such disturbances often result in greater opportunity for invasion by exotic species.

Cypress and mixed hardwood swamps are the preferred habitat of 12 of the 68 birds and 15 of reptiles and amphibians listed as threatened or endangered. All four of the listed terrestrial mammals in south Florida (Florida panther, Everglades mink, black bear and Big Cypress fox squirrel) use the besieged swamplands during parts of their life cycles, and have declined as the swamps were drained.¹⁴

The hydrology of many salt marsh communities has been altered and degraded through the creation of mosquito-control impoundments and ditches. Florida lost the dusky seaside sparrow to salt marsh destruction, and severe impacts on estuarine fish and shellfish follow salt marsh degradation. In addition, barren areas within salt marshes known as "salt barrens" have all but disappeared. These areas are important food production areas for juvenile marine fish species, which spend a large part of early life in the salt marshes.

Mangrove communities and their associated wildlife species have been destroyed by diking, impounding, flooding, and dredging and filling.⁵⁴ Mangroves are one of the most important species in the near shore marine environment because of their high organic material production, which in many areas of coastal Florida forms the beginning of the marine food chain.

Sedimentation caused by the development of upland areas, increased flow rates from drainage canals, and maintenance dredging of nearby channels has resulted in catastrophic changes in seagrass meadows and fragile coral reef habitats. High loads of sediments in the water column reduce the amount of sunlight reaching seagrasses and corals and may be the most important factor in their demise. Excess nutrients and toxins from agricultural and urban runoff also adversely effect marine biodiversity.⁴³ The diversion of freshwater flows

from the Everglades system is currently being cited as a likely cause of the of the hypersalinity in Florida Bay that is implicated in a seagrass die-off affecting up to 70,000 acres in the Bay.⁶⁹

Fire and succession: Fire is a normal and necessary agent of renewal in many of Florida's plant communities. In Florida's fire-adapted communities, the resident species assemblages not only tolerate fire, they often require it. Before Florida was settled, lightning periodically ignited portions of the damp Florida peninsula during the spring and summer. Low intensity flames burned with few impediments through the expansive woods and savannahs, reducing hardwood competition, recycling litter, humus and nutrients and stimulating rapid flowering, fruiting and seed germination among the native species.

Human settlement deeply affects natural fire regimes in Florida. The fragmentation of open wilderness physically restricts the sweep of flames across the landscape. Residents, especially new residents, often do not understand the important role fire plays in renewing natural areas and may try to prohibit fires in natural areas adjacent to their homes.

Habitat fragmentation: Wildlife no longer can range freely across the Florida landscape. Roads, ditches, dikes, housing developments, agricultural fields and other human uses are slicing the remaining natural habitats into smaller and smaller discontinuous pieces.

As ecosystems and natural communities lose their integrity and contiguity, habitat acreage is reduced, and the remaining lands simply don't have enough food, water and cover to support the original number of animals or plants that once lived there. Populations decline and the gene pool shrinks. Smaller populations are more susceptible to catastrophic declines in numbers of individuals and the effects of inbreeding, and thus are more vulnerable to extirpation.^{25,56,60} Few, if any, of our remaining land reserves are large enough to sustain, over the long term, species with very large home-range requirements, such as the Florida panther. Because areas that are not yet developed are isolated from one another, the dispersal and migration that keep some populations genetically healthy cannot occur.³⁶ Animals are cut off from essential habitat resources and are isolated from others of their kind.

Fragmentation of habitat results in other problems, many of which are not immediately obvious. For instance, disturbed areas surrounding undisturbed, isolated habitat fragments often build up unnaturally large populations of predators, such as raccoons, that are harmful to other native species.⁶⁷ Also resulting from fragmentation are the problems associated with the "edge effect." These problems occur as fragment size decreases and the proportion of edge to interior increases. The effect on the interior includes higher intensities of predation and nest parasitism, increased invasion by weedy and nonnative species of plants and animals, and increased vulnerability to poaching and dumping.⁷¹ Many species, notably reptiles and amphibians, require a certain landscape mosaic of plant communities or habitat elements to complete their life cycles, and this mosaic is disrupted through fragmentation.⁴⁸

Some natural communities in Florida now persist only as small fragments of habitat islands and require intensive management if they are to survive. Ancient Florida scrublands have been reduced by about two-thirds, and no one remaining scrub "island" contains all of the scrub-endemic plants that are restricted to central Florida. Efforts to preserve the unique scrub biota will require protecting a number of isolated scrub islands. Due to their fragmentation, these "islands" are no longer self-maintaining, and will have to be managed individually by controlled burning.^{7,52,53} We know even less about the management and

protection of other isolated habitat islands, such as tropical hardwood hammocks and coastal scrub.

Contamination: Tons of toxic compounds and their byproducts are introduced into the Florida environment each year. These often have unintended effects, both acute and chronic, on the native biota and natural communities. Pesticide-related poisonings are probably a significant problem as well, but are difficult to assess. Air and water pollution can cause diversity loss and extinction far from the original source. The cumulative effects of toxins and pesticides on ecosystems such as estuaries, lakes and coral reefs are especially difficult to fully assess and to reverse.

Pesticides: Pesticides are unique environmental contaminants since they are added to the environment for the deliberate purpose of killing living organisms. Most are highly nonselective and injure many nontarget organisms. In Florida, pesticides are used primarily on agricultural fields and on golf courses (to kill insects, mites, rodents, weeds and fungi), in aquatic weed control, and in mosquito control. The volume of restricted pesticide use in Florida is currently millions of pounds annually.⁴⁰ Generally, there is insufficient information to evaluate the effects of pesticides on native Florida plants and animals. Much of what we know is learned long after extensive damage has been done. For example, we know that as early as the 1940s, DDT and its metabolites caused eggshell thinning, reproductive failure, and severe population declines in eagles, pelicans and other birds. It was not until the 1960s that use of these compounds was restricted. Most populations of Florida's fauna and flora are not monitored as well as eagles and pelicans, and biologists suspect many species are experiencing overall downward trends.

Pesticide effects are well documented for at least one endangered Florida endemic, the large and attractive Schaus swallowtail butterfly. Scientists know that the range and distribution of this insect has shrunk steadily since the mid-1920s because of habitat destruction and mosquito pesticides. At present, Biscayne National Park protects the only remaining colonies of this endangered butterfly, although sporadic recolonizing on Key Largo occurs, depending on the annual intensity of mosquito spraying.¹²

The potential effects of pesticides on a number of federally listed Florida species have been evaluated by the U.S. Fish and Wildlife Service and the Environmental Protection Agency. Most federally listed animals and all federally listed plants are considered to be at risk from one or more pesticides.¹⁹

Other toxins: Many industrial byproducts have found their way into Florida ecosystems. For example, numerous toxic heavy metals such as lead, zinc, and mercury have been discovered at high levels in many aquatic systems throughout the state. The complete implications of the presence of these substances in Florida's waters remains to be discovered. However, in 1989, 1990, and 1991, upon confirmation of high levels of mercury, health warnings on eating bass caught in Everglades National Park and Big Cypress National Preserve were issued by the Florida Department of Health and Rehabilitative Services, and limited consumption was advised in many other aquatic systems (ranging from the Arthur R. Marshall Loxahatchee National Wildlife Refuge to the Suwannee River). Biologists believe that mercury was likely a major factor in the recent deaths of at least two Florida panthers. Other animals high in the food web also have been found to have significant levels of mercury contamination, including alligators, Florida softshell turtles, and several species of fish other than bass.⁶⁴

There appear to be many significant sources of mercury contamination. Atmospheric

deposition may be the largest route of mercury to the Florida environment. These atmospheric sources include incinerators, coal and gas burning electric power plants, agricultural burning such as sugar cane crops, and natural sources. The relative importance of these sources is uncertain for Florida, but it is clear that a major portion of the atmospheric mercury originates from man's activities. Relatively small amounts of mercury can spread over large distances, settle in the soil and water, move through the food web, and concentrate at high levels in carnivores. We know little about mercury's potential long-term effects on natural communities, and almost nothing is known about the distribution or effects of many other industrial byproducts.

Recently, attention has been focused on dioxin, which results from the combination of organic compounds with chlorine during some industrial processes, including the production of bleached pulp and paper products. Like mercury, it concentrates to a high degree in the food chain and in sediments. Although the potency to humans and other organisms is still under investigation, elevated levels in fish tissues from two Florida surface water bodies receiving pulp mill effluent have resulted in the issuance of fish consumption advisories for those streams.

Cumulative effects of toxins on ecosystems: A great deal of data exist that demonstrate the effects of multiple contaminants on fish, wildlife, and plants in estuaries. A 1971 inventory of Florida's Gulf-Coast estuaries estimated that 43 percent of the total estuarine area, excluding Florida Bay, was polluted. More than half of monitored Florida estuaries have elevated levels of toxic metals and 30 percent experience problems with algal blooms and sea grass losses which may be due in part to the presence of toxins and high nutrient levels.

For example, in Pensacola Bay, the combined effects of industrial wastes and sewage pollution all but halted fisheries production in this system.¹⁸ Despite some cleanup of discharges, many of the pollutants are bound in the bottom sediments and will continue to be reintroduced into the water column for years to come. In addition, bottom dwelling organisms tend to accumulate certain pollutants. When these are eaten by other organisms, the pollutants become concentrated and can cause adverse effects in larger organisms. Very little has been reported about the cumulative effects of toxins on other Florida ecosystems.

Thermal effects of power plants: The negative effects of electric power plants on marine biodiversity cannot be overemphasized. The use of marine waters for cooling has a great impact on the marine flora and fauna. The entrainment of organisms into the cooling system kills them by mechanical action once they reach the plant. The cooling water is heated in the plant, and the area where that water is discharged is radically changed by the increased heat. This thermal effluent negatively impacts submerged vegetation, benthic invertebrates, and fishes and reduces the biodiversity of the discharge site.^{31,32,46} For example, in one study the numbers and biomass of marine fishes in a tidal creek receiving thermal effluent were three to ten-fold less than in nearby creeks with normal temperature.⁶ If discharges are reduced or stopped, some recovery of the marine ecosystems may take place. Seagrasses in Biscayne Bay which had been decimated by thermal discharges showed some recolonization after cessation of the discharge.

Introduction of non-native species: Only Hawaii has a greater number of exotic species than Florida.⁵⁹ Exotic species are animals and plants introduced from another region that establish self-sustaining populations in their new home. Thirty-one birds, 25 reptiles and amphibians, and an untold number of plants and insects have joined and often replaced native Florida biota. Some have been introduced intentionally for their aesthetic or economic values, and others have hitchhiked into Florida along with imported plants,

foodstuffs, pets, or by other routes. When habitat is permanently commandeered by exotic organisms, many natives can no longer use it. The full potential of introduced species to alter natural environments is rarely recognized until they are well established. The impact of some of these species, however, is well documented.

Among the most notorious exotics are three plants--Australian pine, Brazilian pepper, and melaleuca--that have capitalized on south-Florida ecosystems. The worst of the big three botanical aliens is the melaleuca tree. By 1981, 40,000 dense stands of this vigorous intruder had infested over 500,000 acres in south Florida. This tree not only thrives in areas where hydrology has been altered, but also further lowers the water table through rapid water uptake and transpiration. One acre infested by melaleuca transpires three to six times the amount of water that an acre of sawgrass uses daily. Many pristine wetlands, mangrove communities, cypress strands, and the fringes of Lake Okeechobee have become biological deserts dominated by melaleuca. Solutions to the melaleuca problem are costly, time consuming, and not entirely successful.⁵⁵

The same can be said of the Australian pine and Brazilian pepper. Australian pine may exclude other species by growing in dense stands and shedding needles that may make the soil toxic to native plant species. Its thick root mat prevents such threatened species as sea turtles and American crocodiles from digging their nests. Brazilian pepper, with its toxic fruit, invades disturbed areas such as bulldozed sites, dirt roads, canal banks and fire lanes and undisturbed areas as well.⁵⁵

Eighteen lizard and 15 parrot and parakeet species head the list of exotic vertebrates established in south Florida. These animals are mostly confined to the urban Gold Coast, and their effects on native species are unknown. Biologists have tracked a tripling in the numbers of introduced amphibians and reptiles between 1958 and 1980 and find that rate of increase to be ominous.^{59,66}

There is also great concern that accidental release of cultured marine shrimp may introduce fatal shrimp viruses into the native population, possibly devastating marine fisheries. There have been two accidental releases of cultured, non-native marine shrimps from ponds in South Carolina during the last two years; commercial shrimpers in Florida have caught many specimens of one of those species in their nets.²⁴ At least three introduced species of fish in the genus *Tilapia* are very abundant in the Indian River Lagoon and Tampa Bay. These animals could cause overcrowding or interfere with breeding sites of native species.⁶²

Exotic plants have not devastated the terrestrial environment of north Florida to the extent that they have in south Florida. However, Japanese climbing fern, kudzu and Chinese tallow tree have caused serious local infestations and have begun to spread. Two aquatic non-natives, hydrilla and water hyacinth, have degraded wetlands and water bodies throughout the state. One exotic vertebrate, the wild hog, is thriving in flatwoods and dry prairies. It destroys soil structure and herbaceous vegetation, including threatened and endangered plants, but its long-term effects on ecosystem processes, such as nutrient cycling and seed germination, aren't fully understood.

Other Potential Agents of Biodiversity Loss

Humans directly reduce wildlife and plant populations and lower biodiversity in many ways other than habitat conversion and degradation. Hunting, fishing, shellfishing, commercial and amateur collection, road kills, and unmanaged domestic pets all contribute

to the decline of certain native populations in Florida.

Overharvesting: Excessive fishing and hunting historically have caused drastic reductions and extinctions in some wild animal populations. Hunting, fishing and shellfishing are regulated based on the concept of sustained yield, with harvest limits based on the capacity of the species to sustain the additional mortality without adversely affecting the population levels of that species. Harvesting reduces biodiversity when it reduces a species' population size to a level from which it cannot recover. The effects of overharvesting on populations today are greatly exacerbated today by significant degradation and reduction of natural areas and lack of adequate information.

Non-marine vertebrate species in Florida can be placed into one of four protection categories. Nearly half (42 percent) are considered protected and cannot be taken or harvested without a permit. Fourteen percent are harvested, but only at specific open seasons set by the Florida Game and Fresh Water Fish Commission. Thirty percent of the native vertebrates are unprotected, but essentially are not taken or harvested. Another 14 percent are unprotected and harvested. Biologists believe that most of the harvested species have secure populations in Florida. However, the 30 animals listed in Table 3 as either harvested or unprotected are thought to be at least as vulnerable to extinction as some species currently listed by the GFC as Species of Special Concern. Reasons for their vulnerability include current population size or a downward trend in their population size, range and distribution, their reproductive potential for recovery, and an ecological dependence on a threatened resource.⁴⁷

Marine biologists fear that the overhunting of terrestrial species that led to extinctions or catastrophic population declines in the last century is happening again in the seas. Increases in fishing have caused severe declines in abundance of many marine species. For example, in the early days of Florida, queen conch were so abundant and widely used that the natives of Key West became known as "conchs." However, the level of conch harvest was so intense that a moratorium was declared on commercial harvest in 1978, and a total ban was imposed in 1985. Restrictive management measures have also been instituted in response to crashes in king mackerel, snook, grouper and red drum populations. Declines in these fisheries are largely attributable to overfishing.¹⁸

Commercial and Noncommercial Exploitation: Florida's plant protection law--The Preservation of the Native Flora of Florida--lists 11 plants that are designated as Commercially Exploited.³⁵ Pressure exerted by commercial collectors is known in some cases, or suspected in others, to have caused declines in these species. This law regulates the commercial harvest of these plants from another person's land.

Many species of wildlife (e.g. alligators, tropical fish, snakes) are exploited for the pet trade, furs, leather food, or recreation. This exploitation is both non-commercial (Suwannee cooter, alligator snapping turtle, Barbour's map turtle) and commercial (frogs, marine tropical fish, freshwater turtles, raccoons, many snakes). The market for some of these items is unlimited and the commercial trade may be international in scope. There is little information on the extent of exploitation of most of these species.²² The Florida Game and Fresh Water Fish Commission has begun a no-cost permit system that will result in biological information from those who sell, or buy for resale, amphibians or reptiles or their parts.

Biologists suspect that commercial sponge species, important components in the marine environment, are being overfished in Florida Bay. The sponge population in that

area may be at risk because of the method used to take them, which allows very minimal regeneration.

Collection of "ornamental" coral reef species for the marine aquarium trade and by private individuals for aquaria continues, and biologists are concerned that the reefs are over-exploited. Most animals removed from reefs are the herbivorous and omnivorous fishes and invertebrates that maintain the reef in its natural state by grazing algae and other fouling organisms. Angelfish, parrotfish, and other species are also trapped and sold in large numbers as food fish. The framework of the reef itself is also at risk due to "live-rock" collection for the aquarium trade, which involves the taking of large quantities of fragmented rock upon which a vast multitude of attached or burrowing organisms live.³⁹

Incidental taking: The effects of incidental taking of listed plants and animals through activities, such as agriculture, silviculture and transportation development may be significant. Little data exists to document the full extent of these losses. Listed species whose nests and eggs are routinely taken in the course of development and other land clearing activities include gopher tortoises, scrub jays, red cockaded woodpeckers, and kestrels as well.

Incidental removal, or "bycatch", of endangered and threatened wildlife by shrimp trawlers and other vessels has been well documented. Loggerhead, green, hawksbill and leatherback sea turtles nest on Florida beaches and forage in Florida marine waters; all are listed as threatened or endangered. Many factors contribute to their decline, but the problem most easily correctable, at least in theory, is mortality associated with the towed nets and other gear of shrimp trawlers. Turtle excluder devices (TEDS) have been designed and mandated for use after a five-year period of voluntary use. Regulations requiring the use of TEDs are now in place, but widespread acceptance will not occur immediately and resistance to their use presents a law enforcement problem.⁵¹

The effect of shrimping bycatch on other species may be significant. For example, some marine biologists believe that shrimping was a contributing factor in the reduction of red snapper stocks off northwestern Florida. In one study of the bycatch in commercial shrimp nets, as many as 200 juvenile red snapper were caught in each one-hour tow of one net. Other species collected in great abundance were spot, croaker, sand seatrout, whiting, sheepshead, flounder, Spanish mackerel, and other species of snapper.²⁴

Road kills and boat mortality: Wild animal populations lose many individuals to cars, trucks and boats. A recent survey noted that in parks managed by the DNR, gopher tortoises, fox squirrels, scrub jays, terns, skimmers and indigo snakes were just a few of the listed or declining species killed by automobiles within park boundaries.¹⁷

We know that these deaths severely affect some listed species. Road mortality has accounted for 54 percent of all known panther deaths since 1979. Sixty-five of the remaining 300 endangered Key deer in Florida were hit and killed by cars in 1990, forty-three of which were killed on the highway.³⁷ In 1989, one of only five viable populations of black bear in Florida lost at least 20 of its 125 animals to road kills.⁶⁸ Furthermore, in 1991, nearly one-third of 174 documented manatee deaths resulted from collisions with boats or barges. This rate of manatee kill by boaters has continued steadily since 1979.²⁰ Road and boat deaths alone may drive some of these species to extinction.

Divers and boaters have seriously damaged coral reefs, which are unique to Florida in the continental United States. For example, a 1977 study found that 20 percent of a single staghorn coral reef at Dry Tortugas was destroyed by boat anchor chains in one

season.¹⁰ Portions of other near-shore coral reefs along the Florida Keys also have been destroyed by boat groundings.^{30,34,39}

Domestic pets: Cats and dogs kill wild animals, cause nest abandonments and transmit diseases. Many studies have documented the adverse effects (including extinction) of predation by domestic cats on populations of island-dwelling fauna, including pelicans, frigatebirds, petrels, reptiles and small mammals.^{3,16,38,49} In mainland and peninsular locations, cat predation to the point of extinction of certain populations isn't as well-documented. A major British study found that in certain suburban and urban areas, 30 percent of the songbirds were killed by cats.⁸ In Florida, cat predation is thought to substantially impact endangered and threatened beach mice.⁴ Cats also can transmit infectious diseases to native bobcats, panthers, otters, foxes, raccoons and mink.⁴⁵

Free-ranging dogs often disrupt ground-nesting birds, especially those that nest in colonies on open beaches (terns, oystercatchers, plovers and skimmers). Dogs commonly chase and kill Key deer and gopher tortoises.

Disease: Emerging concerns requiring further study are increased vulnerability to disease and a general demise in the health of wildlife populations. Stress factors such as: being pushed into marginal habitats, concentrated densities, and relocation, can weaken the health of the plants and animals subjected to them. For example, a highly contagious upper respiratory disease that devastated desert tortoise populations in the western United States, has recently been found in the gopher tortoise, a species that is frequently subjected to the above mentioned stresses.

Values and attitudes of Florida's human population: Studies nationwide and in Florida show that the public overwhelmingly supports wildlife conservation and environmental protection. Nevertheless, humans continue to have a negative effect on wildlife and natural communities in Florida. Perhaps the biggest hurdle for managers trying to garner public support and assistance are the commonly held attitudes and opinions people have about wildlife. Public officials and citizens often don't understand basic wildlife management principles, for example, that all wildlife need habitat, and that "important" (high-profile, endangered, charismatic) species need "less important" species to survive. Even the public's love of wildlife can sometimes be detrimental. For instance, people often feed raccoons, which leads to an unnaturally high population size. This, in turn, leads to intensive raccoon predation and possibly the elimination of the eggs and young of ground nesters, including many birds and turtles. Alligators that become habituated to humans through feeding, occasionally are destroyed because they are deemed "nuisance" animals when the food they've been taught to expect is withheld.

Sociologists have found that most people can be placed into one of three categories regarding wildlife. A large percentage of Floridians are humanely oriented, with a primary concern for individual animals, or a strong concern for the right and wrong treatment of animals. Another subset is more neutral; they either passively or actively avoid contact with wildlife, or actually dislike or fear it. And a third, smaller group, is primarily interested in the practical values of animals. None of these attitudes is immediately congruent with the concerns of managers of wildlife and natural communities, who are anxious to find solutions to the problem of declining wildlife populations, habitat loss and pollution. The first group of the public is most likely to work on behalf of wildlife, yet is very strongly oriented to individual animals and direct impacts on animals that they can easily see and understand.

It is largely because of these attitudes that natural resource managers have difficulty mobilizing the public to act on behalf of natural resource preservation and management. The management challenge lies in enlarging public concern beyond the right and wrong treatment of individual animals to the right and wrong treatment of native plant and animal populations and their habitats.¹¹

RESPONSES TO LOSS OF BIOLOGICAL DIVERSITY IN FLORIDA

Many public and private agencies administer programs that affect the potential recovery of endangered and threatened species and natural communities. To a greater or lesser extent, all of these programs address conservation of biodiversity, but few of them explicitly identify that objective in their charters. Land acquisition and management, regulation, planning, research and mapping, education and public or private initiatives are the most important ongoing activities.

Land Acquisition

Florida has two major statewide environmental land acquisition programs, the Conservation and Recreation Lands (CARL) and the Save Our Rivers (SOR) programs. In FY 89-90, the SOR and CARL programs each had approximately \$50 million available for land acquisition. Two other programs, the Land Acquisition Trust Fund (LATF) and the Save Our Coast (SOC) program, had much less money available for land acquisition. The LATF program had about \$1 million available each year, and the SOC program had approximately \$5 million remaining from bond sales. Both of these programs are administered by the DNR.

The SOR program, initiated in 1981, is administered by the Department of Environmental Regulation and implemented by the Water Management Districts (WMDs). Prior to passage of Preservation 2000 in 1990, the SOR program was restricted to "lands necessary for water management, water supply, and the conservation and protection of water resources." Endangered species protection was not addressed in the SOR statute, although some districts do consider endangered species protection when evaluating projects.

The CARL program, successor to the 1972 Environmentally Endangered Lands program, was initiated in 1979. It has a much broader directive, including: environmentally endangered lands, wetlands, lands for state parks, recreation areas, public beaches, state forests, wilderness and wildlife management areas, restoration of altered ecosystems, and, archeological/historical sites. Endangered and threatened species were not specifically mentioned in the CARL statute. However, the CARL statute was revised in 1992 to include a specific public purpose for the protection of threatened and endangered species.

In 1984, the Governor and Cabinet requested the Land Acquisition Advisory Council, which selects and ranks CARL projects, to develop a strategic, long-range plan for land conservation in Florida. The resulting Florida Statewide Land Acquisition Plan, as revised by the advisory Council in 1991, lists 29 specific objectives under nine major resource categories and nine general guidelines. Five of the 29 objectives are specifically targeted for endangered/threatened plants and animals. Two additional objectives address rare/endangered natural communities.

The passage of the Florida Preservation 2000 Act by the 1990 Legislature provided significant new funds to conservation land acquisition programs, and also brought additional attention to endangered/threatened species and natural communities. Under Preservation 2000, the CARL program will receive an additional \$150 million per year, SOR will receive an additional \$90 million per year; and \$60 million per year will be divided among various other programs.

Probably the most significant way that Preservation 2000 addresses endangered/threatened species and natural communities is in setting the criteria by which lands can be purchased by CARL and SOR through the bonds issued pursuant to Preservation 2000. Another significant change in existing statutes is that the Board of Trustees of the Internal Improvement Trust Fund may direct DNR to purchase, on an immediate basis, lands subject to auctions related to failed banks and savings and loan associations, lands which will be lost to development, or for which federal matching funds will be lost.

A very important effect of Preservation 2000 is the increased interest and commitment of local governments in providing funds for the acquisition of conservation lands. Fifteen counties and one city have active land acquisition programs, with more than \$600 million committed. Supporters of county land acquisition programs have been a key factor in continued funding of Preservation 2000, which in many cases provides matching funds to the county projects.

As a part of the P-2000 legislation, the Conservation and Recreation Lands (CARL) program's Land Acquisition Advisory Council (LAAC) was directed to conduct a needs assessment for determining which lands should be acquired with P-2000 funds over the ten year life of the program. At their October 19, 1990, meeting the LAAC approved a request by the Florida Audubon Society to convene a P-2000 map "charrette" to identify significant natural resources that could be targeted for acquisition using P-2000 funds. Along with Florida Audubon Society (FAS), The Nature Conservancy (TNC) and Department of Natural Resources (DNR) organized and hosted the "Preservation 2000 Map Charrette" workshop.

Methods

On November 26, 1990, a request for nominations for potential participants was sent to a list of biologists prepared by DNR. From subsequent nominations and the original list, a total of 75 individuals were selected that represented a diverse mix of biological expertise and geographical distribution. On January 3, 1991, invitations were issued to attend a workshop with the specific purpose to "formulate a conceptual land acquisition map of Florida ecosystems, rare and threatened habitats, endangered species habitats, endangered plant communities, essential wildlife corridors and other natural features of the state". Invitees were asked to come prepared to identify sites and produce maps based on three assumed levels of protection:

- * Idealized map showing total extent of Florida to acquire and manage for preservation/restoration given unlimited money and authority. Do not "color the whole state green."
- * Practical map with highest priority systems/sites to acquire and manage for preservation/restoration given P-2000 funding limits and existing authority. Consider a reduction of 50% of map one.

* Top priority map reflecting the highest priority projects-- "If you could assure the acquisition and protection of only three tracts of land in Florida, where would they be?"

Working maps at the charrette would be the USGS 1:250,000 topographic maps and a final summary map would be developed for display purposes on the USGS 1:500,000 Base Map.

On January 24 & 25, 1991, a group of 40 experts in ecology, botany, zoology, geology, hydrology, resource planning and land management convened at the Florida State Conference Center in Tallahassee, Florida. On the first day, participants identified sites on the 1:250,000 maps. That night, a small group of volunteers transferred the information onto 1:500,000 base maps that also identified existing publicly owned land. The second day was spent merging the maps into a summary display map through a consensus process - identified areas were proposed, discussed and revised until no one objected to their inclusion. Following completion of the workshop, the summary map was redrawn by hand, converted to different scales through xerox reduction and submitted to workshop participants in draft form. After minor revisions, the final was sent to the Florida Natural Areas Inventory for digitization in AUTOCAD.

Results

The maps resulting from the charrette process are included as Figures 4, 5, and 6. Figure 4 identifies existing public land and private conservation areas. Because of the large number of existing areas, not all are included. However, most large or regionally significant sites are included. Boundaries are approximate for these areas. Four different categories have been mapped: federal land, state land, regional/local government land and private reserves.

Figure 5 adds areas proposed for acquisition with P-2000 funds to the existing lands in Figure 4. Many of these areas are on the current acquisition lists of the various land acquisition programs throughout the state. The balance are additional areas considered by workshop participants to be important enough that protection of the resources present can only be accomplished through public acquisition and management.

Figure 6 is a complete map of Ecological Resource Conservation Areas. Areas of conservation interest have been added to Figure 5. They are sites where less-than-fee-simple techniques should be used to accomplish resource protection objectives. Landscapes are maintained where compatible land uses such as parks, forestry, rangeland, low intensity agriculture, and small urban zones are integrated properly to allow ecosystems to sustain an adequate level of functional stability and to provide connecting habitat corridors for the movement of species and maintenance of biological diversity.

Based on the digitized map, Table 4 provides a rough estimate of the acres included within each of the categories. These numbers were derived from hand drawn lines on the 1:500,000 scale base map and are subject to a wide margin of error created by broad sweeping lines that may not accurately follow existing political or resource boundaries. They are presented only to illustrate the relative size and relationship of the areas to each other and entire state.

FIGURE 4

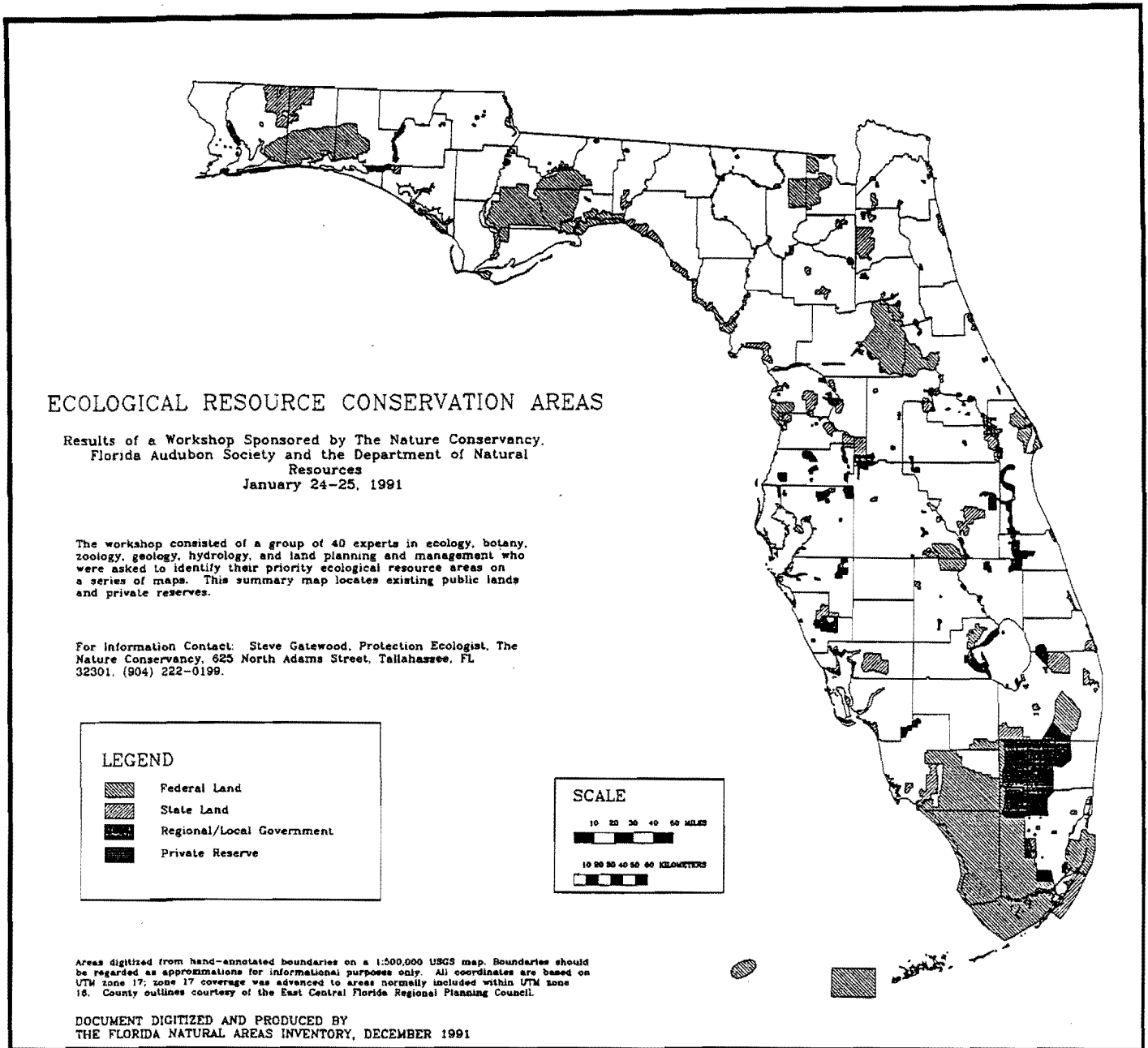


FIGURE 5

ECOLOGICAL RESOURCE CONSERVATION AREAS

Results of a Workshop Sponsored by The Nature Conservancy,
Florida Audubon Society and the Department of Natural
Resources
January 24-25, 1991

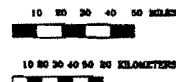
The workshop consisted of a group of 40 experts in ecology, botany, zoology, geology, hydrology, and land planning and management who were asked to identify their priority ecological resource areas on a series of maps. This summary map locates existing public lands, private reserves, and areas proposed for acquisition under Preservation 2000. Regional workshops are planned to refine the boundaries of the areas.

For information Contact: Steve Gatewood, Protection Ecologist, The Nature Conservancy, 625 North Adams Street, Tallahassee, FL 32301, (904) 222-0199.

LEGEND

-  Federal Land
-  State Land
-  Regional/Local Government
-  Private Reserve
-  P-2000 Acquisition Priority Areas

SCALE



Areas digitized from hand-annotated boundaries on a 1:500,000 USGS map. Boundaries should be regarded as approximations for informational purposes only. All coordinates are based on UTM zone 17; zone 17 coverage was advanced to areas normally included within UTM zone 16. County outlines courtesy of the East Central Florida Regional Planning Council.

DOCUMENT DIGITIZED AND PRODUCED BY
THE FLORIDA NATURAL AREAS INVENTORY, DECEMBER 1991

TABLE 6

ECOLOGICAL RESOURCE CONSERVATION AREAS

Results of a Workshop Sponsored by The Nature Conservancy,
Florida Audubon Society and the Department of Natural
Resources
January 24-25, 1991

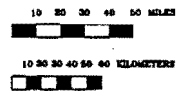
The workshop consisted of a group of 40 experts in ecology, botany, zoology, geology, hydrology, and land planning and management who were asked to identify their priority ecological resource areas on a series of maps. This summary map locates existing public lands, private reserves, areas proposed for acquisition under Preservation 2000 and broad regions identified as areas of conservation interest. The conservation interest areas are not proposed for acquisition, but represent landscapes of mixed land use where compatible activities such as forest land, range land, public land, low intensity agriculture and some urban areas should be integrated properly to allow ecosystems to sustain an adequate level of functional stability and to provide connecting habitat corridors for the movement of species and maintenance of biological diversity. Regional workshops are planned to refine the boundaries of the areas.

For information Contact: Steve Gatewood, Protection Ecologist, The Nature Conservancy, 625 North Adams Street, Tallahassee, FL 32301, (904) 222-0199.

LEGEND

-  Federal Land
-  State Land
-  Regional/Local Government
-  Private Reserve
-  P-2000 Acquisition Priority Areas
-  Areas of Conservation Interest

SCALE



Areas digitized from hand-annotated boundaries on a 1:500,000 USGS map. Boundaries should be regarded as approximations for informational purposes only. All coordinates are based on UTM zone 17; zone 17 coverage was advanced to areas normally included within UTM zone 16. County outlines courtesy of the East Central Florida Regional Planning Council.

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Table 4

Approximate acreages and percentages for the six categories of land from the Ecological Resource Conservation Areas map.

Land Category	<u>Acre¹</u>	<u>% of Florida²</u>
Federal	5,065,000	13.5%
State	1,433,000	3.8%
Regional/Local	1,522,000	4.1%
Private Reserve	75,000	0.2%
SUBTOTAL EXISTING	<u>8,095,000</u>	<u>21.6%</u>
P-2000 Acquisition Priority	3,167,000	8.4%
Conservation Interest Areas	6,283,000	16.8%
SUBTOTAL PROPOSED	<u>9,450,000</u>	<u>25.2%</u>
TOTAL	17,545,000	46.8%

¹ Rounded to nearest 1,000 acres.

² Area of Florida from Atlas of Florida, 1981 = 37,478,400 ac.

Discussion

The original purpose of the workshop, to identify areas for acquisition, was expanded to create this "vision" of integrated resource lands - Ecological Resource Conservation Areas. It is not intended as a blueprint for acquisition and preservation, but rather as a guide to identify those areas of the state where this group of experts believes land acquisition, conservation easements, tax incentives, regulation, zoning and other tools should be used together to maintain watershed function, wildlife habitat, ecosystem integrity and green space. The CARL and other land acquisition programs are using it as a planning tool to evaluate existing and proposed projects. Regional planners use it to cross political boundaries and infuse a regional perspective into local resource protection issues. It serves a similar purpose as any of the several statewide concepts for connected habitats, corridors, greenways and open space.

This is an ambitious proposal that would encompass almost half of the state (46.8%) in a network of resource conservation areas (Table 4). Currently, less than one-quarter (21.4%) of Florida is in public ownership and not all of this is dedicated to resource management. Ultimately about one-third (29.8%) would be publicly owned and most of it would need to be managed in a manner sensitive to ecological considerations. The balance (17%) consists of private lands where non-intrusive land uses continue and appropriate development is designed so that it does not compromise natural resource values or fragment resource connections.

Conceived as a one shot approach for a specific purpose by a limited number of people, the ERCA map does not claim to include all natural resource areas that are worthy of or in need of protection. It requires constant refinement by a much broader spectrum of individuals and organizations. Several meetings have been held with the five water management districts to refine acquisition proposals. Additional meetings are being considered along regional planning council lines to refine the map further.

The statewide network of green as advocated by the Florida Greenways Project of 1000 Friends of Florida and the Conservation Fund will not ultimately look like this. In fact, it should not since there are other considerations for inclusion in such a network, including recreation, transportation and utilities. However, this map illustrates the magnitude of the task ahead of us if we are to truly protect ecologically significant resources on a regional and statewide scale. Some areas are already degraded and will need restoration or rehabilitation. Others cannot be protected due to lack of funds or available authority. All will require management by public or private owners. The Ecological Resources Conservation Area map is one of the best concepts we have to date as along term target for conservation planning.

Land Management

Listed species and their habitats occur on public lands managed by several federal (National Park Service, U.S. Forest Service, U.S. Fish and Wildlife Service), state (Department of Natural Resources, Game and Fresh Water Fish Commission, Department of Agriculture), regional (Water Management Districts), and local agencies. Private lands, some of which are managed by organizations such as the Nature Conservancy and the National Audubon Society, are also important for the survival of listed species. Listed species protection and management is seldom a land management priority, and emphasis is often directed towards other uses which may not be compatible, such as recreation, hunting, timber production and livestock grazing.

The lack of active management, such as prescribed burning and exotic species control, often leads to habitat degradation and the loss of species. Virtually all agencies that manage land have prescribed burning programs. However, limited staffing and funding restrict the development and use of this critically important management tool. Most agencies have become sensitive to the need for listed species management and ecosystem management. The need seems particularly acute for plants and in the area of ecosystem management. Although there are nearly 140 occurrences of federally-listed plants on public and private lands managed for natural resources, there is insufficient information to determine whether any of them are stable, increasing or decreasing. The Nature Conservancy and other private organizations that manage natural lands are doing all that staff and funding will permit; however, other private lands either are not managed for natural resources or are managed for production with little or no attention to listed species.

Regulation

Federal Programs: Federally listed animal and plant species are regulated by the U.S. Fish and Wildlife Service (FWS), and the National Marine Fisheries Service.

In Florida, the U.S. Fish and Wildlife Service is the primary federal agency with responsibility for implementation of the Endangered Species Act of 1973. The Act provides broad authority to the Service to conduct numerous activities on behalf of threatened and endangered species. Section IV of the Act outlines the requirements for placing species on the endangered species list, designating critical habitat and preparing recovery plans. Section 5 of the Act provides authority for the purchase of lands to protect species and their habitats. Under this authority numerous refuges in Florida have been acquired including Crystal River National Wildlife Refuge for manatees, the Archie Carr National Wildlife Refuge for sea turtles and portions of the National Key Deer Refuge for Key deer. A major new refuge, the Lake Wales Ridge National Wildlife Refuge is being established for scrub endemics. Under Section 6 of the Act, the FWS has entered into cooperative agreements with the state of Florida; one with the Florida Game and Fresh Water Fish Commission for terrestrial and freshwater animals, one with the Department of Natural Resources for marine mammals and sea turtles and one with the Department of Agriculture, Division of Forestry for plants. Money is matched on a 3:1 federal to state share and since 1985, Florida has received almost 3 million dollars in federal funding. Section 7 of the Act requires all federal agencies to consult with the Service on all actions they "authorize, fund or carryout" that "may affect" listed species or their critical habitats. The result of a consultation is a biological opinion that specifies what the impact of the proposed action is likely to be on the species or its critical habitat. If there is a significant adverse impact (jeopardy biological opinion) the Service must provide reasonable and prudent alternatives that do not cause impacts to the species. The Service consults with dozens of federal agencies and produces several hundred biological opinions a year. Under Section 9, the Service can enforce the prohibitions enumerated in the Act. Violations involving direct take through shooting, nest destruction, etc. are more easily enforced. Recent developments indicate that the Service will be enforcing takings through habitat disturbance in the future.

The Corps of Engineers (Corps) regulates development activities in wetland and aquatic habitats. Section 10 of the Rivers and Harbors Act requires a permit for structures or work in or affecting navigable waters. Section 10 permits are granted by the Corps if "the structure or work is in the public interest". Section 404 of the Clean Water Act requires a permit for the discharge of dredged or fill material into the navigable waters of the United States. Section 404 permits are granted by the Corps unless "it would be contrary to the public interest." The Corps' assessment of public interest includes

balancing benefits with foreseeable detriments, and consideration of many factors, of which impacts on fish and wildlife are just one. (Navigable waters also include mud-flats, sandflats and wetlands, and, isolated wetlands which have sufficient connection with interstate commerce.)

State Programs: At the state level, the Florida Game and Fresh Water Fish (GFC) Commission has been established by the Florida Constitution to "exercise the regulatory and executive powers in the State with regard to wild animal life and fresh water aquatic life." The GFC has both direct regulatory controls and technical input into the regulatory programs of other agencies that have statutory responsibilities to consider fish and wildlife habitat. The GFC interprets its direct regulatory role as being restricted to the animals themselves and not their habitats. Therefore, GFC regulations are restricted to the taking of individuals and their nests or burrows. "Taking" covers a variety of activities from harassing to killing. Listed species - those classified by GFC rule as endangered, threatened or of special concern - receive primary attention.

The Department of Natural Resources (DNR) issues permits that authorize activities seaward of an established coastal construction control line. This authority primarily affects nesting sea turtles and hatchlings and their habitat.

The Department of Environmental Regulation (DER) issues permits for dredge and fill projects at the state level and is required to consider seven factors for permit issuance. Two of these considerations relate to the conservation of fish and wildlife, including endangered or threatened species and their habitats. The Department also considers whether an imbalance of flora and fauna would result from changes in water quality, and if the project will adversely affect the fishing, recreational values or marine productivity in the vicinity of the project. Even higher water quality standards are applied to Outstanding Florida Waters. The Department usually requests technical assistance from either DNR or GFC, depending on the nature of the affected area. Typically, if listed species are present on the site, or if the site is a suitable habitat for the listed species, the Department will try to see that the area is preserved.

The Department of Community Affairs (DCA) regulates large development projects in Florida (Developments of Regional Impact), and administers an Area of Critical State Concern program. If there are listed animals or plants on a development of regional impact, the developer may be required by DCA to set aside habitat, either onsite or offsite. Unlike permitting programs administered by the GFC, DRI approvals place the burden of documenting presence of listed species or prime habitat on the permit applicant.

Regional Programs: In addition to DCA requirements, individual regional planning councils (RPCs) may have specific species or habitat criteria and requirements set forth in comprehensive regional policy plans. Some plans consider specific types of plant communities worthy of protection regardless of the presence or absence of listed plants or animals. Local governments ultimately approve or deny the development order prepared by the regional planning council, and may require further wildlife or habitat preservation.

Florida's five water management districts (WMDs) have become much more involved in wetlands permitting in recent years. In many cases, the districts perform more stringent reviews than those performed by the DER or the Corps. As part of their management and storage of surface waters regulatory programs, the water management district's permitting authority includes consideration of the impact of regulated activities on both isolated and non-isolated wetlands.

Local Programs: Local governments derive much of their authority from their police powers, and from powers designated by the state. Many local governments have ordinances addressing the protection of rare and listed species. Many more are in the process of developing such ordinances in accordance with comprehensive plans. However, few local governments in the state have the staffing, resources, or inclination to address the cumulative impacts of land use on regional or statewide biological diversity.

Survey and Mapping

Florida has several major statewide survey and mapping projects that address rare/endangered species and biological diversity in general. The Florida Natural Areas Inventory (FNAI), funded primarily by the Conservation and Recreation Lands Trust Fund under a contract with the DNR, is one such project. The FNAI maintains a statewide computerized data base on the occurrence, general distribution, and management of rare/endangered species and rare or exemplary natural communities. More than 16,000 specific occurrences are described with accompanying maps. The FNAI taps a broad spectrum of sources to obtain the information, and frequently updates the data. Among other things, the data serve as a basis for recommending conservation land acquisitions and appropriate land management techniques.

The GFC conducts or funds numerous faunal surveys. Studies of the Florida panther, Florida black bear, Florida grasshopper sparrow, bald eagle and American crocodile are just a few of the many under way. The GFC's non-game wildlife program is especially important for its focus on unlisted as well as listed species. The Florida Audubon Society's statewide Breeding Bird Atlas, funded by the non-game wildlife program, is complete; additional non-game funding support has allowed increased coverage for the Breeding Bird Survey. The Non-game Habitat Protection Section of the Commission's Office of Environmental Services has used satellite imagery to complete a land cover map of the state that depicts 17 natural plant communities and four disturbed communities. The land cover map, together with models of the dynamics of wildlife populations, will be used to develop a statewide system for protecting and managing wildlife habitat.

The DNR, Florida Marine Research Institute, maintains a Marine Resources Geographic Information System with information on coastal natural communities. The information is used to manage species in marine and estuarine waters. The Department also conducts survey work on the manatee, several species of marine turtles, the right whale, and numerous non-listed species. Not a single complete survey of the marine biota of any estuarine or near-shore area of Florida has ever been accomplished, principally because there are not enough taxonomic experts in Florida to properly identify all the organisms involved. Biodiversity in many marine habitats is so high that surveyors often purposefully ignore elements of the biota because of the lack of funding and personnel to inventory all of them.

The Florida Division of Forestry is surveying red-cockaded woodpecker colonies on its lands and recently funded a survey of rare plant and natural communities of Lake Arbuckle State Forest.

The state's five water management districts conduct some survey and mapping work, particularly in connection with the Surface Water Improvement Management program.

The USFWS conducts and funds numerous status surveys that relate to the federal listing and management of endangered or threatened species. The U.S. Forest Service

conducts surveys of rare plants and red-cockaded woodpeckers on lands under its management. The Department of Defense is contracting for surveys of endangered/threatened species on many of its holdings.

In preparing local government comprehensive plans, many counties have mapped known locations of endangered and threatened species and natural communities within their boundaries. Some counties (e.g., Alachua, Collier, Leon and Palm Beach) have conducted their own surveys, particularly of natural communities.

Despite the amount of survey and mapping work already done, our knowledge of the distribution of many rare/endangered species remains inadequate for conservation purposes. Very little work has been done on invertebrates compared to vertebrate species. Plants, especially non-vascular plants, have received relatively little attention. The true status of many non-listed species of plants and animals is unknown. Considerable work is needed to document occurrences of natural communities. Additional survey and mapping information is vital if we are to make appropriate protection and management decisions.

Research

Federal agencies that perform research related to Florida's biodiversity include the USFWS, and its Cooperative Fisheries and Wildlife Research Unit at the University of Florida, its Sirenia Research Laboratory and its Fishery Research Laboratory in Gainesville, the U.S. Forest Service, the U.S. National Park Service, the U.S. Geological Survey, and the National Marine Fishery Service. Most federal focus has been on migratory birds and threatened and endangered species as mandated by the Migratory Bird Treaty Act and the Endangered Species Act of 1973.

The State University System funds perhaps the most diverse wildlife, plant and ecosystem research in Florida, much of it basic rather than applied. The Universities of Florida, Central Florida, and South Florida are responsible for most of the state's biodiversity-related research. A number of private universities and colleges also conduct research on Florida's natural resources, including the University of Miami, Florida Institute of Technology, Eckerd College, Stetson University and others.

The Florida Museum of Natural History at the University of Florida is charged by statute to serve as the state's base for natural resources research on the variety, evolution and conservation of wild species and the composition, distribution, importance and function of natural ecosystems.

State agencies with significant research programs include the GFC (especially the non-game wildlife program and the Bureau of Wildlife Research); the DNR (especially the Florida Marine Research Institute); the Department of Agriculture and Consumer Services (Florida Division of Forestry and Division of Plant Industry); and the water management districts. The DER has initiated a statewide research program called "Rapid Biological Assessment."

Four private research stations with widely varying funding sources and mandates do biodiversity-related research studies in Florida: Tall Timbers Research Station, Archbold Biological Station, Mote Marine Laboratory and Harbor Branch Marine Institute.

Several nonprofit groups, including The Nature Conservancy, National Audubon

Society and Florida Audubon Society have research arms that add to the study of natural resources in Florida.

Planning

The Department of Community Affairs (DCA), Florida's planning agency, helps protect endangered species, plant communities, and biodiversity through six programs, in addition to the Florida Communities Trust program. Programs that address the effects of proposed land uses on threatened and endangered species include the following:

- * Development of Regional Impact (DRI) program - oversees local government approval of large developments. DRIs comprise about five to ten percent of development in Florida;
- * Area of Critical State Concern (ACSC) program - oversees local approvals of development in environmentally sensitive areas such as the Florida Keys;
- * Florida Quality Developments program - gives state approval to innovative, well-planned large developments;
- * Electrical Power Plant and Transmission Line Siting program - reviews the 10-year site plans and the siting of new electric power plants and electric transmission lines;
- * High Speed Rail program - coordinates the review and siting of ancillary facilities after the high speed rail franchise is awarded;
- * Local Government Comprehensive Plan (LGCP) program - reviews the conservation elements of all local government comprehensive plans. Conservation elements address natural resources, including native vegetative communities, wildlife and wildlife habitat, and threatened and endangered wildlife.

Except for the LGCP program, the DCA programs oversee only a small portion of total development in Florida. In addition, the DCA currently has little oversight of the local land development regulations that will implement comprehensive plan restrictions. Recently, the Environmental Land Management Study Committee (ELMS III) has recommended the termination of the DRI review process in most local government jurisdictions by December, 1995.⁷⁰

Florida's 11 regional planning councils (RPCs) review and make recommendations on development that fit the criteria of the planning programs listed above. The RPCs also conduct intergovernmental reviews of applications for federal financial assistance, and assist the State Clearinghouse in conducting environmental impact statements for proposed federal agency development activities. The RPCs lack enforcement authority for many of the state planning programs in which they are involved.

Education

Florida's attractive natural environment and typically strong economy have brought phenomenal growth since the 1950s. Seventy percent of Florida's residents were born elsewhere. State population has increased by about 325,000 new residents each year to nearly 13 million in 1990. The population is projected to reach 20 million by the year

2020. In addition, Florida is visited each year by some 40 million tourists.

In 1989, the Florida Legislature passed the Environmental Education Act to promote environmental awareness among students, new residents, and visitors. This important legislation created the Save Our State Environmental Education Trust Fund and authorized the following;

- * The Florida Advisory Council on Environmental Education (FACEE), is an 11-member council which offers environmental education grants to qualified organizations and agencies. To date, the legislature has authorized the council to offer grants totaling \$1.8 million for environmental education projects.
- * The Interagency Coordinating Committee for Environmental Education (ICCEE) is composed of staff representing 16 agencies which conduct environmental education programs. The ICCEE communicates information and coordinates agency environmental education activities and accomplishments.
- * The Office of Environmental Education in the Department of Education coordinates environmental education in Florida's school system, and administers five Environmental Education Regional Service Projects. To date, \$1.06 million has been provided to develop environmental education curricula and to implement comprehensive environmental education activities at all levels of the public education system, including community colleges and universities.
- * The Governor's Environmental Education Grants Program is administered by the Governor's Office of Environmental Affairs. The Legislature initially authorized \$200,000 for environmental education grants to non-profit organizations and agencies to provide environmental education for Florida's visitors and residents.
- * The Environmental Education Foundation of Florida, Inc., has a 20-member Board of Directors appointed by the Governor. This non-profit corporation provides private funding and leadership to develop and implement environmental education projects and programs in Florida.

Public and Private Involvement

Public interest organizations volunteer assistance in each of the categories above. To increase land acquisition, citizens identify properties and lobby for their purchase, write and promote referenda to acquire environmentally sensitive lands; participate in land trusts and lobby the legislature to enact and fund land acquisition programs such as Preservation 2000 and the Conservation and Recreation Lands program.

Public interest groups often review and comment on public lands policies and lobby for land management funding. They assist with prescribed burning, trail maintenance, posting of signs, and with exotic plant removal. They also assist with stewardship on sanctuaries, preserves and other lands. These groups lobby the Governor and Cabinet and the state agencies to prevent incompatible uses of public lands.

Regulation of listed species and habitats is often addressed by public interest groups. They review and comment during rulemaking proceedings; watchdog permitting processes and appeal inappropriate permits; and report enforcement violations. Citizen participation in lobbying for better laws and funding are also important activities.

Public interest groups assist in planning for the management of listed species and endangered natural communities in a variety of ways, including participating in the development of management plans, local government comprehensive plans and land use regulations, and lobbying for and protecting the Growth Management Act.

Members of public interest groups participate in research and mapping studies by volunteering their expertise in data collection and in many other facets of information gathering.

Volunteers present environmental education programs to schools through speakers bureaus and at monthly meetings of conservation and other groups. They also assist in education through publication of magazines, newsletters, reports, brochures, videos and public service announcements.

A CALL TO ACTION: RECOMMENDATIONS

The following recommendations are proposed to vastly improve the conservation of Florida's biodiversity. Most of these strategies were drawn from a symposium convened in Tallahassee, December 6-7, 1990. Experts in many aspects of biodiversity in Florida identified impediments to biodiversity conservation in the areas of regulation, land acquisition, land management, planning and education. Strategies to overcome those problems were then developed and ranked.

I. Recommendations - Land Acquisition

Problem: Acquisition of lands containing important biological resources is the most effective way to preserve biodiversity. Although Florida has significant acquisition programs in place, funding is not secured. Land acquisition priorities have not been set for the purpose of protecting species diversity in the state. Project boundaries are not always designed to include habitat necessary to protect species diversity and targeted species.

Strategy 1: There should be a long-term, dedicated funding source for acquisition of lands to be purchased under the Florida Preservation 2000 Act.

- a. Recommend alternative funding sources to the Governor and the Legislature such as millage increases, bonds, tourist taxes and others.
- b. Reevaluate the level of funding to be provided under the Florida Preservation 2000 Act to assure it is adequate to acquire functioning ecological systems and areas vital to endangered and threatened species, and species of special concern.

Strategy 2: Public preserves and land acquisition project boundaries should be designed and acquired to avoid habitat fragmentation, to maintain viable populations, and to minimize other negative effects on species and habitats.

- a. Ensure that adequate funding is authorized and provided to conduct site surveys, design preserves and complete acquisition of targeted projects.
- b. Conservation and Recreation Land (CARL) project boundaries should continue to emphasize ecological systems and important biological diversity sites.
- c. The Florida Game and Fresh Water Fish Commission should continue to identify viable corridors as it plans and reviews new projects and additions.
- d. The state should acquire needed lands based on ecological criteria, including areas that can be restored to provide habitat.
- e. All acquisition agencies (DCA, DNR, GFC, DOF, Water Management Districts, local governments, non-profit organizations, adjacent states and the federal government) should coordinate their activities and expand cooperation on the specific projects each can acquire and protect.
- f. Provide assistance, incentives, or support to local governments considering projects.

- g. Consider surrounding land uses (existing and future) to determine effects on site viability.

Strategy 3: Land acquisition procedures should be further streamlined.

- a. It appears only state acquisition procedures need extensive streamlining - WMDs and local governments appear to move relatively quicker. Therefore, make more use of joint acquisition agreements and refine joint acquisition procedures with other agencies and non-profit groups.
- b. Establish criteria to allow local/regional/private entities to provide certain services on appropriate projects (appraisals, surveys, site evaluations, etc.).
- c. Revise existing DNR acquisition procedures to waive acquisition requirements as appropriate (Chapter 253, F.S. etc.).
- d. Provide additional staff and contract funds in the DNR Division of State Lands to process projects, especially acquisition agents, legal, and survey and mapping staff.
- e. Use eminent domain where needed to secure lands necessary for ecological and biodiversity protection objectives.

Strategy 4: The State should establish land acquisition priorities based on adequate ecological information.

- a. Continue to develop ecological system maps to be used for setting priority land acquisition projects.
- b. Improve and enhance coordination of the mapping efforts of the GFC (wildlife habitats), the Florida Natural Areas Inventory, the Florida Resources and Environmental Analysis Center and others.
- c. Complete the compilation of habitat maps for the state, including rare communities, and incorporate data into land acquisition programs at all levels.

II. Recommendations - Land Management:

Problem: Nearly two and a half million acres of uplands are in public ownership in Florida and additional lands are being acquired. Many of these lands contain threatened and endangered species and distinctive plant communities that are not being adequately managed. Agency priorities, lack of information, and inadequate funds and staff all contribute to the problem. Single purpose or multipurpose management of these lands often ignores natural processes which must function unimpeded for the health of the ecosystem. Infrastructure facilities such as airports, cemeteries, sewage treatment facilities, schools, recreation sites, and some private facilities such as transmission lines, are often sited on public lands because of lower land costs. These types of uses can seriously degrade the overall resource values of the "protected" lands. Insufficient funding is available to undertake necessary research and management.

Strategy 1: Increase human resources and funding for public land management

and monitoring. The Legislature must establish a management funding source for lands to be acquired under P-2000. P-2000 bond money is currently prohibited from being used for management purposes.

- a. The Legislature should establish an additional dedicated funding source for ongoing land management.
- b. The Legislature should provide for a state funded or supported stewardship incentive program for ecosystem management of private lands.

Strategy 2: Implement strategies for managing areas which contain small, remnant populations, threatened and endangered species habitat, and high quality, unique natural communities.

- a. The Legislature should set in law a requirement that land management agencies manage and enhance critical areas on public lands.
- b. The Legislature should set in law a requirement that land management agencies prepare critical area action plans within existing unit management plans and, where appropriate, include USFWS Recovery Plan recommendations.
- c. The Legislature should appropriate additional management funding, if necessary, for approved critical area action plans.

Strategy 3: Control non-native, invasive species.

- a. Agencies should give priority to non-native, invasive species control and eradication.
- b. Agencies should develop a non-native species control information sharing system (newsletter, source directory).

Strategy 4: Mandate, within agencies and among agencies, that ecosystem management be among the highest priorities for natural resource lands.

- a. The Legislature should set in law a requirement that ecosystem management be conducted as part of the land management process.
- b. The Department of Natural Resources and the Game and Fresh Water Fish Commission should analyze ecosystem management and describe its importance for maintaining and recovering listed species on public lands.
- c. An interagency committee named by the Legislature should conduct interagency land management workshops, field trips, and information exchange for ecosystem management progress and problems.
- d. The Legislature should set in law a program which identifies and provides a higher level of protection to higher quality lands (e.g. an "Outstanding Florida Lands" program).

Strategy 5: Prohibit incompatible uses of environmental and conservation lands.

- a. The Legislature should set in law a policy to prohibit uses of state owned protected areas that are incompatible with the state management objectives for that land.

III. Recommendations - Regulation and Planning:

Problem: Existing habitats of listed or rare plants and wildlife, along with high quality native plant communities, are being converted to other land uses at a rate that will further endanger these resources. The greatest threat is to upland resources not protected by laws as are wetlands, and which are below the thresholds of development regulated by the Developments of Regional Impact law (Chapter 380, Florida Statutes). For wildlife, significant protection is provided to individuals of most species under Chapter 39, Florida Administrative Code, but little protection is available to protect the animal's habitat through state or local government regulation.

Strategy 1: The state should develop a planning and permitting program based on ensuring ecological systems' health. Such a program would: integrate wetland and upland protection, prevent adverse secondary and cumulative impacts, and provide for the conservation of biological diversity as a part of permit approval.

- a. Establish a regional resource plan for each Water Management District or Regional Planning Council and implement appropriate revisions to existing regulatory programs.

Strategy 2: The Legislature should develop a statewide permitting program to regulate the conversion of the habitat of listed plants and animals and high quality native plant communities. This program would have the following features or characteristics:

- a. Establish a listing process for plant communities to identify those in greatest need of protection.
- b. Result in protected areas of suitable size and biological characteristics to achieve conservation goals. Avoid regulations which randomly protect small parcels that do not contribute to the attainment of conservation goals.
- c. Use mitigation banking as one method of achieving conservation goals to help protect suitably-sized parcels without being a major disincentive to development.
- d. The state should work with the Legislature to develop provisions to allow some "incidental take" of listed species under state law. Currently only the Federal Endangered Species Act formally provides this procedure.
- e. Either establish a comprehensive regulatory program which is able to adequately consider listed species habitat needs or direct the Game and Freshwater Fish Commission to develop its own rules for protecting habitat for key species of wildlife, i.e., certain kinds of land alterations must obtain a Game and Freshwater Fish Commission "permit".

Strategy 3: Provide encouragement, subsidies, and performance requirements to local governments to better implement comprehensive plan provisions for habitat protection.

- a. Legislate state oversight by the Florida Department of Community Affairs of local land development regulations which implement Chapter 163, F.S.
- b. Fund appropriate state agencies to provide information to counties on species habitats and occurrences, and native plant communities, maps of these resources, development of model habitat protection ordinances, and development of species-specific "Best Management Practices."
- c. Modify Chapters 163 and 187, F.S., to provide clearer mandates for listed species habitat protection.
- d. Local governments should use the comprehensive planning process as amended, to provide compatible uses adjacent to protected natural areas.

Strategy 4: Develop a package of incentives that would allow or encourage landowners to protect valuable biological resources on their property. This would work best in concert with some kind of regulatory program and could be tailored to meet specific species or native plant community goals.

- a. Provide regulatory incentives in DER and WMD permitting programs to mitigate for destroying wetlands of relatively low ecological value by preservation or enhancement of regionally significant wetland systems and associated uplands.
- b. Modify federal inheritance or estate laws to provide for meaningful conservation, for example, by granting major conservation easements in lieu of forcing the development of large holdings to pay estate taxes.
- c. Encourage local governments to waive recreational park impact fees where a landowner permanently protects important habitat not required to be protected elsewhere.
- d. Develop direct subsidies to the landowner to protect certain resources, or acquire certain development rights from a landowner that will not interfere with intended uses.
- e. Ease permitting requirements for redevelopment of already developed land.
- f. Develop a statewide transfer of development rights (TDR) system to encourage development out of sensitive areas.

Strategy 5: Encourage private stewardship of the habitat of listed species of plants and animals and of native plant communities.

- a. Assist agricultural and silvicultural interests in developing techniques that might reduce their impact on natural systems, plants, and wildlife.

- b. Promote plant and wildlife management techniques on private lands to increase resource value and to increase landowner sensitivity to those resources.

IV. Recommendations - Research:

Problem: Some species which are not listed as threatened or endangered are declining significantly and should be considered for listing. Efforts to address conservation problems through habitat management, land acquisition, education, and regulation depend on information obtained through research. There is general agreement among natural resource professionals that many conservation problems should be perceived and addressed collectively, in the framework of threatened biodiversity. This requires that the research community continue its commitment to understanding relationships and processes at the population, community, and landscape levels. This must be balanced by a continuing commitment to research at the specific and sub-specific levels.

The participants of the research workshop focused on identifying research areas that should receive priority attention. Successful implementation of these recommendations requires increased coordination among research entities (government agencies, universities, private institutions) and among disciplines (researchers, managers and educators).

Strategy 1: The research community should develop a comprehensive inventory of Florida biota by expanding current survey and monitoring efforts and initiating new ones. Populations, species, and communities are all necessary units of investigation. The data obtained from these efforts should be widely accessible and subject to continuous updating. Results should be disseminated regularly in technical and educational publications.

Strategy 2: The research community should establish as a priority the study of small populations and communities, including what factors limit them and how can they be maintained over long periods of time. In order to accomplish this, agencies and universities that fund conservation research must elevate the priority of natural history projects and must provide sustained funding for such projects. The Governor should mandate this priority as it pertains to expenditure of state funds for conservation-related research.

Strategy 3: Resource agencies should provide training for field personnel interested in participating in collection of voucher specimens. Enlist the assistance of local native plant society chapters to establish sample plots and collect data on listed plant species in state-owned natural areas. Standard monitoring/sampling protocols should be established, whereby collected information could be used to assist the managing agency. Managing agencies would be responsible for updating the FNAI database. Researchers should determine how best to communicate to government and private-sector personnel the importance of responsible voucher collection. Researchers should explore possible means of increasing funding for developing and maintaining the database. Increase funding for collecting and storing voucher specimens.

V. Recommendations - Education:

Problem: Many Floridians don't understand the intrinsic value of biodiversity, nor its importance to business, community and themselves. People can identify with and understand threats to individual animals and plants, but not populations and ecosystems. The public doesn't recognize Florida ecosystems or understand the impact of altering the landscape and natural resources. Many people think that economic growth is

incompatible with preserving Florida's threatened, endangered, and declining native plants, animals, and natural communities, and believe that conservation costs too much. Finally, conservation of biodiversity in Florida depends on individual and collective lifestyle changes. Consumers don't understand where products really come from and where they go when they are discarded or used up.

In addition, Florida is largely populated by "newcomers" who refer to other regions of North America as home. Most of these new residents do not have memories or bonds to the natural Florida that is rapidly vanishing. Furthermore, environmental education is not reaching all of the diverse ethnic groups, cultures and socioeconomic groups of native Florida.

Strategy 1: Develop "the Florida story" depicting the importance of Florida's biodiversity and natural resources that conveys a sense of home, heritage, and pride in the state, and the threats to them that can be easily understood by the public and decision makers and communicate it to those groups.

Strategy 2: Educate public officials and citizens about the need to acquire natural lands for the protection of endangered species and about the benefits to humans in doing so.

Strategy 3: Develop a mass media campaign that gives real examples of alternatives and successes to illustrate the compatibility of economic growth and conservation. Target primarily consultants, developers, local governments, architects and landscapers, farmers and foresters, environmental organizations, teachers, students and new residents through workshops, articles, brochures, videos and curriculum materials.

Strategy 4: Ensure participation and the sharing of information among the many, diverse ethnic and cultural groups represented in Florida and the full range of socioeconomic levels.

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GLOSSARY

Acute - Of great importance or consequence.

Amphibians - A class of vertebrates; frogs, toads, salamanders.

Armoring/armored - The placement of manmade structures or devices in or near the beach and dune system for the purpose of preventing erosion of the upland property or to protect upland structures from the effects of coastal wave and current activity.

Benthic - Pertains to the bottom of a body of water.

Biodiversity - Word coined to describe biological diversity. Biological diversity - Pertaining to the variety of life; exists at three fundamental levels: species diversity, genetic diversity and community or ecosystem diversity.

Biomass - Weight of all the biological matter within a specified area.

Biota - The animal and plant life of a region.

Broad-leaved - Having relatively broad leaves. Said of evergreens such as the rhododendron and holly to distinguish them from needle-bearing evergreens such as the pines and cedars.

Chronic - 1. Of long duration; continuing; constant. 2. Prolonged; lingering; as certain diseases. 3. Subject to a disease or habit for a long time; inveterate.

Crustaceans - Arthropods of the class Crustacea which include, but are not limited to, lobsters, crayfishes, shrimps, crabs and barnacles.

Ecological - Involves the relationship between organisms and their environment.

Ecosystem - An ecological community, together with its physical environment.

Edge Effect - Concept of increased variety and density at the junction of two plant communities.

Endangered - Any species whose prospect of survival are in jeopardy.

Endemic - 1. Peculiar to a particular region or locality. 2. Native or indigenous; in contrast to that which is foreign or introduced.

Estuarine - Pertaining to or found in an estuary.

Even-Aged - Refers to a stand of trees which naturally seeded or were artificially planted at the same time.

Evolution - Cumulative change in the characteristics of populations of organisms, occurring in the course of successive generations.

Exotic Plants - Plants which are of foreign origin; not native.

Extinction - No longer existing in living form.

Extirpation - Disappearance of a species from a given area.

Fauna - The animal life of a locality or region or that existing during a specific geological period of time.

Flora - The plant life of a given locality or a geological period.

Food Web - A complex pattern of several interlocking food chains in a complex community or between several communities. **Food chain** - A group of organisms involved in the transfer of energy from its primary source, plants, as algae, insects, small fishes, larger fishes, fish-eating birds or mammals.

Gene Pool - All the genetic information contained in the reproducing population of a species.

Genetic Diversity - Total diversity of inheritable characteristics within an individual population or species.

Genera - Plural of genus. **Genus**- taxonomy. A subdivision of a family which includes one or more closely related species, as canis which includes dogs and Trifolium which includes the clovers.

Habitat - The natural area in which an organism or population normally occur.

Hammock - In Florida, refers to a forest comprised almost exclusively of hardwoods, and made up of trees which form a densely canopied overstory, shrubs and small trees in the understory and usually little, if any, ground cover.

Hardened - Refers to a process whereby sand from an area is mixed with a bonding agent and applied to the foredune, creating an impervious crust to resist erosion. This act disrupts the natural movement of sand.

Hydrologic Regime - Natural reoccurring water cycles.

Hydrology - Encompasses the properties and distribution of water and its effect on the earth's surface, in the soil and underlying rocks, and on the atmosphere.

Invertebrates - Animals which lack a backbone or spinal column.

Landscape Mosaic - The patterning of landscapes in space and time which can be a very important driving force in the ecological processes of these environments.

Latudinal gradient - The differences in a species that occur with respect to changes in latitude.

Listed species - Species of vertebrates, invertebrates and plants of which perpetuation into the future has been deemed of international, federal, state, or regional concern. See Rules 39-27.001, 39-2.003, 39-27.004 and 39-27.005, F.A.C. for those considered Endangered, Threatened or Species of Special Concern by the Florida Game and Fresh Water Fish Commission. Organizations who create and maintain lists of said species include

Convention on International Trade in Endangered Species of Wild Fauna and Flora, United States Fish and Wildlife Service, Florida Game and Fresh Water Fish Commission, Florida Department of Agriculture and Consumer Services. In Florida, the Official Lists of Endangered and Potentially Endangered Fauna and Flora in Florida is compiled by the Florida Game and Fresh Water Fish Commission.

Marine - Of, pertaining to, living in, or related to the seas or oceans.

Mosquito Impoundments - A dike constructed to hold water on coastal marshes during the mosquito breeding season and designed to break the life cycle of the insect. This act causes the loss of non-target species, both animals and plants.

Natural Communities - A distinct and reoccurring assemblage of populations of plants, animals, fungi and microorganisms naturally associated with each other and their physical environment.

Nutrient Flow - Passage through and exchange of nutrients within an ecosystem.

Old-Growth Forests - A forest that has never been cut; virgin forest.

Orders of Magnitude - The figure that results when a value of a quantity is raised to ten times that value.

Organism - A single plant or animal.

Predation - The act of capturing and killing other animals for food.

Prescribed Burning - Fire ignited and controlled under a planned prescription required to manage natural lands.

Relict - Features or populations left over from past geological periods generally in scattered locations.

Salination/Salinity - Salt content of the water.

Sandhill - A natural community that is typically comprised of widely spaced longleaf pine, an understory of deciduous oaks in various densities and heights, and a ground cover of herbs and grasses, particularly wiregrass, which occurs on rolling hills of deep sand.

Scrub - A fire maintained natural community occurring on xeric uplands in many forms; often characterized as a closed to open canopy forest of sand pines with dense clumps or vast thickets of scrub oaks and other shrubs dominating the understory. The ground cover is generally very sparse, being dominated by ground lichens or rarely, herbs. Open patches of barren sand are common. Where the overstory of sand pines is widely scattered or absent altogether, the understory and barren sands are exposed to more intense sunlight.

Second-Growth - A forest that replaces a harvested old growth forest.

Sediment - Material that settles to the bottom of water or is suspended in water.

Silviculture - The care and cultivation of forest trees; forestry.

Species - A group of organisms of interbreeding natural populations that are reproductively isolated from other groups.

Species of Special Concern - Defined by 39-27.005 F.A.C.; a species categorized by the following criteria: (1) has a significant vulnerability to habitat modification, environmental alteration, human disturbance, or human exploitation which, in the foreseeable future, may result in its becoming a threatened species unless appropriate protective or management techniques are initiated or maintained. (2) may already meet certain criteria for designation as a threatened species but for which conclusive data are limited or lacking. (3) may occupy such an unusually vital or essential ecological niche that should it decline significantly in numbers or distribution other species would be adversely affected to a significant degree. (4) has not sufficiently recovered from past population depletion. (5) occurs as a population either intentionally introduced or being experimentally managed to attain specific objectives.

Submerged Lands - Those lands laying below mean or ordinary high water.

Subspecies - Subdivision of a species forming a group whose members resemble each other in certain characteristics, and differ from other members of the species.

Substrate - The medium upon which an organism lives or on which it attaches.

Taxa - A group of organisms.

Taxonomic - Of or pertaining to taxonomy. **Taxonomy** - The science of classification; the arrangement of animals and plants into groups based on their natural relationships; also called systematics.

Terrestrial - 1. Adapted to and living on land; not aquatic. 2. botany. Growing on the ground.

Threatened - Indicative of impending danger or harm. "Threatened species: as defined by Chapter 372.072 F.S.; means any species of fish and wildlife naturally occurring in Florida which may not be in immediate danger of extinction, but which exists in such small populations as to become endangered if it is subjected to increased stress as a result of further modification of its environment.

Topography - The physical features of the land; hills, ravines, slopes.

Toxins - In general, any poisonous substance.

Upland - High ground above the lowlands along rivers or the oceans.

Vertebrates - Animals which possess a vertebral column.

Virgin Forests - In North America, the woodlands that existed at the arrival of European man, and their condition prior to his alteration of them.

Water Column - A cylindrical shaft of water.

Wave Refraction - Defined by Shore Protection Manual, U.S. Army Corps of Engineers Research Center, 1984; (1) The process by which the direction of a wave moving in shallow water at an angle to the contours is changed. The part of the wave advancing in shallower

water moves more slowly than that part still advancing in deeper water, causing the wave crest to bend toward alignment with the underwater contours. (2) The bending of wave crests by currents.

Wetland - A native plant community that is subjected to daily, seasonal or permanent flooding.

