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Wildlife Habitat Conservation Needs in Florida

Updated Recommendations for Strategic Habitat Conservation Areas

Mark Endries, Beth Stys, Gary Mohr, Georgia Kratimenos,
Susan Langley, Karen Root, Randy Kautz

Florida Fish and Wildlife
Conservation Commission

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Updated Recommendations for Strategic Habitat Conservation Areas

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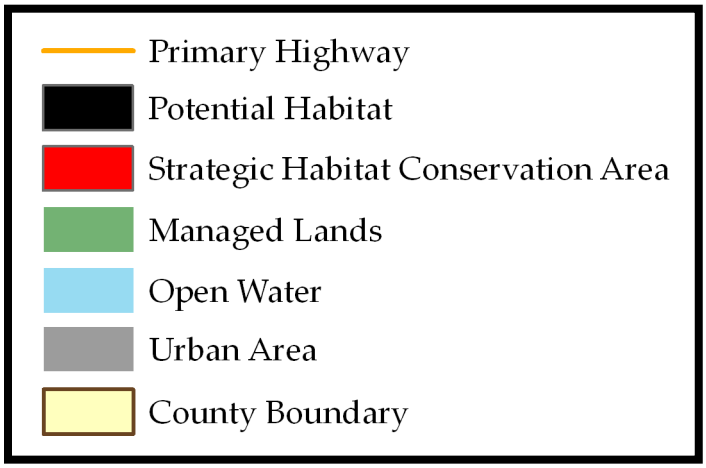

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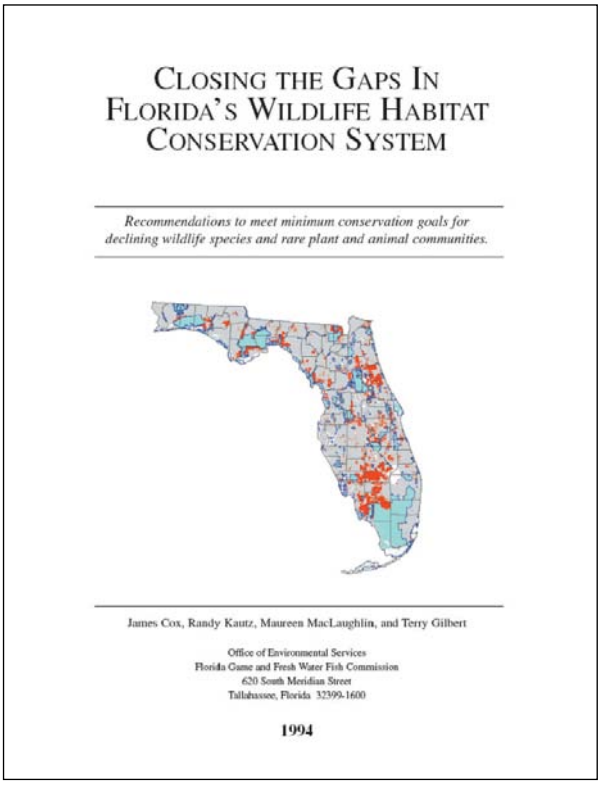
Wildlife Habitat Conservation Needs in Florida

Updated Recommendations for Strategic Habitat Conservation Areas

Abstract

In 1994, researchers from the Florida Fish and Wildlife Conservation Commission (FWC) completed a report, entitled *Closing the Gaps in Florida's Wildlife Habitat Conservation System* (Cox *et al.,* 1994), assessing the security of rare and imperiled species on existing conservation lands in Florida. The biologists that authored this report used species-occurrence data, habitat data, and the analytical capabilities of Geographic Information Systems (GIS) to assess the protection afforded to 62 focal species on lands managed for conservation and to identify important habitat areas in Florida that have no conservation protection. These areas, known as Strategic Habitat Conservation Areas (SHCA), depict areas needed for protection and serve as a foundation for conservation planning in Florida. Since 1994, landscape-level habitat changes, transfer of land from private to public ownership, and changes in land use have reduced the appropriateness of using Cox *et al.*'s (1994) findings to accurately assess Florida's current biodiversity and wildlife conservation status. Advances in technological capabilities, revised habitat data, and more extensive species-occurrence data allowed us to reassess Florida's biodiversity protection status. Additionally, advances in population-viability modeling techniques allowed us to examine the security of species given their current distribution, habitat needs, and the amount and distribution of habitats currently protected. We identified SHCA for a new selection of focal species, including many species that were in the original report. This project will help determine how habitat-protection needs have changed since 1994 and where protection efforts should be focused to ensure the long-term conservation of Florida's wildlife.



CLOSING THE GAPS IN FLORIDA'S WILDLIFE HABITAT CONSERVATION SYSTEM

Recommendations to meet minimum conservation goals for declining wildlife species and rare plant and animal communities.

James Cox, Randy Kautz, Maureen MacLaughlin, and Terry Gilbert

Office of Environmental Services
Florida Game and Fresh Water Fish Commission
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1994

Chapter 1
Scope of Florida's Biological Diversity

Florida is well known for its biodiversity and the the degree of endangerment of its ecosystems (Noss and Peters, 1995; Stein et al., *2000). Biodiversity and the conservation needs of a region are often measured in terms of species richness, relative rarity of species, number of species at risk of extinction, and variety of natural communities or ecosystems. Florida ranks high according to many of these measures and is considered a hot spot of biodiversity in the United States (Stein* et al., *2000). For example, the high biological values of the Lake Wales Ridge, the tropical ecosystems of south Florida, and the ravine systems of the Florida Panhandle are recognized on national maps of biodiversity hot spots (Chaplin* et al., *2000). Moreover, south Florida's everglades and rockland habitats, longleaf pine (*Pinus palustris*) forests, and scrub habitats are considered to be among the nation's 21 most endangered ecosystems (Noss and Peters, 1995).*

Overview

Number of Species

Florida ranks fourth in the nation for the number of endemic species and is in the top 5 states for diversity of birds and reptiles (Stein, 2002). Millsap *et al.* (1990) reported that 668 terrestrial and freshwater vertebrate taxa occur regularly in Florida, including 126 fishes, 127 reptiles, 57 amphibians, 283 birds (excluding some migratory birds), and 75 mammals. Muller *et al.* (1989) reported that 115 of these vertebrates (17%) were endemic to Florida and 100 (15%) were listed by state or federal agencies as imperiled (Sullivan, 2004). More than 4,100 species of native and naturalized vascular plants occur in Florida (Wunderlin and Hansen, 2003). Muller *et al.* (1989) identified 235 plant species (7%) as endemic or mostly restricted to Florida, and 534 (13%) are listed by state or federal agencies as threatened or endangered (Coile and Garland, 2003). Although the total number of invertebrate taxa in Florida remains unknown, they far outnumber known taxa of vertebrates and plants (Franz, 1994). At least 410 invertebrate species are considered to be endemic (Muller *et al.,* 1989); but only 16 are listed as imperiled by state and federal agencies (Sullivan, 2004). When considering the number of species occurring in Florida's estuarine and marine ecosystems, the biological diversity of the state increases dramatically. More than 1,000 species of fish inhabit Florida's near shore and offshore waters (Comp and Seaman, 1985). This represents 25% of the fish species recorded in the northern portion of the Western Hemisphere; 78 of these species have been reported only from Florida waters.

Jay Exum

Florida Scrub-Jay

Natural Communities

Species typically organize into recognizable natural communities based on factors such as climate, soils, hydrology, and landforms, and we can measure biological diversity at the community level. Commonly used classification systems for natural communities in Florida include those produced by Davis (1967), Soil Conservation Service (undated), Hartman (1978, 1992), Ashton and Ashton (1988), Florida Natural Areas Inventory (FNAI) and the Florida Department of Natural Resources (FDNR) (1990), Myers and Ewel (1990), Kautz *et al.* (1993), Kautz *et al.* (1998), and the Florida Department of Transportation (FDOT) (1999). These accounts divide the natural communities of Florida into as few as 14 (Hartman, 1978) to as many as 66 (FNAI and FDNR, 1990) types. The most thoroughly defined classification is provided by FNAI and FDNR (1990), who described 23 terrestrial, 19 palustrine (*i.e.,* freshwater wetlands), 7 lacustrine (*i.e.,* lakes and ponds), 4 riverine, 1 subterranean (*i.e.,* caves), and 12 marine and estuarine community types in Florida. Perhaps the most widely used system in the state today is the Florida Land Use, Cover and Forms Classification System (FLUCCS) (FDOT, 1999). The FLUCCS system is designed for a wide variety of mapping applications, and the classification system accommodates both developed and agricultural land uses as well as natural communities.

Ecoregions

Multiple natural-community types organized at a landscape-scale are referred to as an ecological region, or ecoregion (Bryer *et al.,* 2000). Ecoregions are relatively large units of land or water containing distinct assemblages of species, natural communities, and environmental conditions. Florida's natural communities are contained within 2–4 ecoregions (Bailey, 1994; Griffith *et al.,* 1994; Bailey, 1998; The Nature Conservancy, 1999). In general, the ecoregions covering Florida consist of these three areas: the southern extent of the temperate zone extending roughly from Cedar Key on the west coast to St. Augustine on the east coast; the temperate to tropics transitional zone covering most of peninsular Florida; and tropical south Florida, which includes the area of the state south of Lake Okeechobee.

Factors Giving Rise to Florida's Biological Diversity

Factors that give rise to Florida's unique biota include climate, geographic position, and geology. These factors have interacted over time to produce the suite of organisms and ecosystems that uniquely set natural Florida apart from other areas of the nation and world.

Climate

Florida has a humid, temperate to subtropical climate with abundant rainfall, mild winters, and hot summers (Chen and Gerber, 1990). Rainfall amounts are generally lower in late fall, winter, and early spring, during which time most of the rain falls in advance of occasional continental fronts moving through the state. The rainy season occurs during the summer, when afternoon thunderstorms are common. Lightning associated with frequent storms occurs more in Florida than any other area of the nation (Chen and Gerber, 1990). Heavy rains and damaging winds from tropical depressions and hurricanes may strike anywhere in the state between June and November. These conditions have given rise to species and natural communities adapted to wet conditions and frequent wildfires.

Geography

The Florida peninsula (1.7 million total hectares, 1.4 million land hectares; U.S. Census Bureau, 2005) extends from the southern end of the temperate zone to the northern end of the tropics. Consequently, species and communities of plants and animals typical of the temperate zone commonly occur in northern Florida, and tropical species characteristic of the Caribbean Basin are present in south Florida. The biota of the peninsula from Gainesville to Lake Okeechobee consists of a combination of species that are typical of temperate and tropical climates and some that are unique to the area.

Jay Exum

Roseate Spoonbill

The warm marine waters of the Atlantic Ocean and Gulf of Mexico, both influenced by Caribbean Sea waters, embrace the Florida peninsula. The productive estuaries where fresh and salt waters mix nurture communities, such as salt marshes, mangrove swamps, seagrass beds, oyster reefs, coral reefs, tidal flats, and high-energy beaches. Each of these communities provides habitat for species tolerant of high-energy coastal and marine environments or that take advantage of the land-water interface. Coastal specialists such as manatees (*Manatus trichechus*), marine turtles, Brown Pelicans (*Pelecanus occidentalis*), Cuban Snowy Plovers (*Charadrius alexandrinus*), Roseate Spoonbills (*Platalea ajaja*), and diamondback terrapins (*Malaclemys terrapin*) occur in Florida because of the presence of these communities.

Geology

Florida's biota, natural communities, and ecosystems are also the product of the state's geology and resulting landforms. The land area of Florida is part of the Florida Platform that extends above sea level (Schmidt, 1997). The Florida Platform formed over millions of years as calcareous sediments deposited in shallow seas and then gradually compressed into a limestone basement rock, the entire state is underlain by limestone. Over the millennia, sea levels rose and fell in response to global climate changes that either flooded or exposed various regions of the Florida Platform. Acidic waters leaching from the land into the limestone bedrock gradually eroded the limestone to produce a labyrinthine system of caverns beneath the state. Subterranean caves and their unique biota, such as Geor-

Randy Kautz

Everglades marsh

gia blind salamanders (*Haideotriton wallacei*) and blind cave crayfish (*Procambarus* spp.), occur in areas where the limestone outcrops lie near the surface. Clear, nonacidic spring waters flow out of underground aquifers, giving rise to spring runs. In other areas, caverns in the underlying limestone have collapsed, producing sinkholes and lakes.

Most of the state was once a flat, sandy sea bottom. These regions now support the pine flatwoods and cypress swamp ecosystems so common in the state. Aeolian sands deposited as dunes at the edges of ancient seas now support scrub habitats along the coast and linear ridge systems of inland areas. The ancient dunes of Lake Wales Ridge, once a series of isolated islands, have been evolving for 25 million years and now support many endemic species of plants and animals.

The higher elevations of the Northern Highlands and Brooksville Ridges in north-central Florida formed as an upward warping of the underlying limestone. Where the limestone occurs near the surface, fertile soils support the predominant vegetation of upland hardwood forest. However, in ridge areas where the soils consist of deeper sands, the predominant vegetation is longleaf pine–xeric oak (*Quercus* spp.) sandhills. By contrast, the Everglades of southeastern Florida formed within the past 5,000 years on a shallow layer of peat over a limestone base.

Factors Affecting the Loss of Biological Diversity

Population Growth and Habitat Loss

Habitat loss is often cited as the leading reason that plant and animal populations are declining (Wilcove *et al.,* 2000). Most habitat loss can be attributed to growth of human populations, which requires conversion of the natural landscape to meet human needs (Figure 1). The human population of Florida was 15.98 million residents in 2000. By 2005, the human population increased to 17.79 million residents (U.S. Census Bureau, 2006).

Although population growth remains the ultimate cause of habitat loss, tourism is a significant additional stressor. Florida hosted 85.8 million tourists in 2005 (Visit Florida, 2006). With an average length of stay of 5.4 days (Bureau of Economic and Business Research, 2001), an estimated 1.27 million tourists were present in Florida every day. The number of tourists visiting Florida each year has grown 20% since 2000, and this trend seems unlikely to change.

Every new resident or visitor places new demands on infrastructure (*e.g.,* homes, commercial and business facilities, lodging, restaurants, transportation needs, water supply, wastewater treatment, recreational opportunities). As a result, more lands will have to be developed, which will place additional strains on the state's biological diversity. Recent predictions indicate that our state's human populations may double to 36 million in the next 50 years, resulting in the conversion of 1.1 million ha of agriculture and 1.1million ha of native habitat to human use (Zwick and Carr, 2006).

Recent figures indicate the loss of 0.5 million ha of natural and semi-natural habitats and 360,000 ha of crop and pasture land between the late 1980s and 2003, with about 106,000 ha converted to human uses each year during this time period (Kautz *et al.,* 2007). As a result, most remaining tracts of rare natural communities, such as pine rocklands and tropical hardwood hammocks, now occur only on public lands (Cox *et al.,* 1994). Kautz (1998) estimated that continued development would relegate all scrub and sandhill habitats to public lands by the years 2010 and 2020, respectively.

Human population growth and subsequent habitat loss have taken their toll on individual species as well. By the early 1900s, at least four vertebrates, the

USFWS

Figure 1 *Habitat fragmentation due to urbanization.*

USFWS

Dusky Seaside Sparrow

plains bison (*Bison bison bison*), Florida red wolf (*Canis lupus floridanus*), Carolina Parakeet (*Conuropsis carolinensis*), and Passenger Pigeon (*Ectopistes migratorius*), were either extirpated from Florida or driven to extinction. Since the 1930s, the rate of species extinctions has increased dramatically, mostly from loss of natural habitats to support an expanding human population. Species now extinct because of habitat loss include the Dusky Seaside Sparrow (*Ammodramus maritimus nigrescens*), Chadwick Beach cotton mouse (*Peromyscus gossypinus restrictus*), pallid beach mouse (*Peromyscus polionotus decoloratus*), and Goff's pocket gopher (*Geomys pinetus goffi*).

Habitat Fragmentation

Fragmentation severs natural linkages (*i.e.,* wildlife corridors) between previously connected patches of habitat. At the local scale, this loss may deny individuals access to suitable habitat patches within their home ranges. Remaining patches may become too small to meet species' habitat requirements, or they may become too far apart for dispersal. Edge effects often degrade habitat quality within smaller patches, including increased exposure to light and temperature extremes and higher likelihood of human activity. At the landscape scale, dispersal corridors needed to maintain viable metapopulations may be lost, resulting in local extinctions. In many areas, land development results in the loss or alteration of isolated wetlands or adjacent upland habitats. Many amphibians, including flatwoods salamander (*Ambystoma cingulatum*), eastern tiger salamander (*Ambystoma tigrinum*), striped newt (*Notophthalmus perstriatus*), oak toad (*Bufo quercicus*), pinewoods treefrog (*Hyla femoralis*), ornate chorus frog (*Pseudacris ornata*), and gopher frog (*Rana capito*) depend upon increasingly isolated wetlands for breeding habitats needed to maintain regional populations (Hart and Newman, 1995). These species typically spend most of the year in uplands habitats but return to the same temporary wetlands to breed each year; loss of these wetlands can eliminate populations from an area. Similarly, many species of aquatic turtles, including Florida cooter (*Pseudemys floridana*), Florida mud turtle (*Kinonsternon subrubrum*), Florida softshell (*Apalone ferox*), common snapping turtle (*Chelydra serpentina*), and diamondback terrapins (*Malaclemys terrapin*), spend most of their lives in aquatic systems but return to uplands each year to nest. Development of uplands can eliminate nesting habitats.

Kevin Enge

Florida cooter

Nonnative Species, Pollution, Overexploitation, and Disease

Other recognized threats to biodiversity include infestations of nonnative species, pollution, overexploitation, and disease (Wilcove *et al.,* 2000). Florida is now home to many nonnative species of plants and animals, usually introduced by humans purposefully or inadvertently. Well-known nonnative plants infesting

NOAA

Brazilian pepper

large areas of Florida include melaleuca (*Melaleuca* spp.), Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casuarina* spp.), cogongrass (I*mperata cylindrica*), hydrilla (*Hydrilla verticillata*), and water hyacinth (*Eichhornia crassipes*).

An estimated 279 species of nonnative animals have been reported in the state, and at least 68 have had established breeding populations for more than 10 years. Established species include Cuban treefrog (*Osteopilus septentrionalis*), giant toad (*Bufo marinus*), spectacled caiman (*Caiman crocodilus*), Mediterranean gecko (*Hemidactylus turcicus*), Muscovy Duck (*Cairina moschata*), Eurasian Collared Dove (*Streptopelia decaocto*), Budgerigar (*Melopsittacus undulatus*), European Starling (*Sturnus vulgaris*), rhesus monkey (*Macaca mulatta*), feral pig (*Sus scrofa*), black rat (*Rattus rattus*), and black-tailed jackrabbit (*Lepus californicus*). These species often compete with and crowd out native species and present difficult management problems.

The effects of pollution can be acute (*e.g.,* a fish kill resulting from a toxic waste spill) or chronic (*e.g.,* low species diversity and depressed populations downstream from a wastewater outfall) and may sometimes occur years later (*e.g.,* White Pelican die-off due to release of toxic agricultural chemicals from soils following restoration and reflooding of marshes along the northern shore of Lake Apopka). Overexploitation can have detrimental consequences, such overfishing affecting fish stocks or the inadvertent reduction of the populations of marine species killed in the by-catch of commercial-fishing operations. Diseases can affect the well-being of species of wildlife and plants, especially species with small populations. Florida panther researchers routinely vaccinate captured animals to prevent the occurrence and spread of disease, particularly feline leukemia virus, throughout the population of this endangered animal (Land *et al.,* 2005).

FWC

Muscovy Duck

Climate Change

Observations show increases in average air and ocean temperatures, widespread melting of snow and ice, and rising average sea levels worldwide. These changes will affect the ecosystems of Florida, bringing a new set of challenges to Florida's plants and animals.

Global surface temperatures have been recorded since 1850. The 10-year span from 1998–2007 was the warmest on record, and temperature increase is a global phenomenon. Rising sea levels are consistent with the observed warming trend. The global average sea level has risen since 1961 at an average rate of 1.8 mm/yr. Since 1993, the rate has increased to 3.1 mm/year. This increase is attributed to thermal expansion of ocean waters and to melting glaciers, ice caps, and polar ice sheets.

The threats that climate change and sea level rise pose to wildlife are widespread. A study conducted by the International Union for Conservation of Nature (IUCN) found that 35% of the world's birds, 52% of amphibians, and 71% of warm water reef-building corals are particularly susceptible to the effects of climate change; 70%–80% of these species are already identified as threatened (Foden *et al.,* 2008). Estimates not yet available for other species groups are likely to exhibit similar trends in susceptibility to climate change.

Florida's geography, low elevation, and predominantly coastal human population make it particularly susceptible to the predicted effects of global climate change. Observational evidence reveals that many natural systems in Florida are already being affected by regional climate changes, particularly temperature increases (Intergovernmental Panel on Climate Change, 2007). Warming triggers the earlier timing of spring events and poleward shifts in plant and animal ranges. In Florida, a northward shift is evident in the current ecoregion extents. One significant shift involves the northward expansion of the sub-tropical zone and with it the species limited to the sub-tropics. This has

resulted in the range expansion of temperature-sensitive exotics such as melaleuca and Brazilian pepper in the state. Climate change can influence the timing of plant flowering, alter species composition and functioning of current habitats and ecosystems, and impact the availability of food resources. Cumulatively, these impacts could affect the timing and success of migratory events. Florida encompasses a major migration corridor for many species of birds and invertebrates. On a local level, as the species composition and dynamics of plant communities are altered in response to climate change, species dependent upon these communities will have to adapt to these changes or they will face population declines or extinction.

A 1-m rise in sea level would result in losing roughly 9% of the current land area in the state. Florida's coastal areas in particular will be significantly affected by rising sea levels, including areas of high human population and major economic centers, such as Jacksonville, Miami, and Tampa–St. Petersburg. Rising sea levels may result in a wide variety of catastrophic problems for Florida's natural systems. Sea level rise is predicted to inundate low coastal areas, erode beaches, and cause saltwater intrusion into estuaries and groundwater aquifers, affecting the availability of drinking water. The current systems of coastal marshes are very susceptible to changes in sea level. A National Wildlife Federation study estimated a loss of 50% of Florida's salt marshes given a 15-inch (38.1-cm) rise in sea levels (National Wildlife Federation, 2006). A 1-m sea level rise would inundate the lower Everglades, a unique and fragile ecosystem critical for wildlife.

Challenges from climate change and sea level rise are expected to be numerous and widespread. Decisive action on both a global and local scale is needed to combat these challenges. As an agency, the FWC hosted a first-of-its-kind, climate change summit to discuss the future of Florida's fish and wildlife and how best to conserve and manage the resources. The FWC is also developing a comprehensive climate change strategy to serve as a guideline for future management.

Gains in Biodiversity Conservation

Land Acquisition

Probably the most significant gains in biodiversity conservation in Florida have come from aggressive public land acquisition programs. The State of Florida first established a bond program to purchase outdoor recreational lands in 1964. Since then, the state has created a series of land-acquisition programs, including Environmentally Endangered Lands (1972), Conservation and Recreation Lands (1979), Save Our Coast and Save Our Rivers (1981), Preservation 2000 (1990), and Florida Forever (2000). These programs have protected more than 1.1 million ha through either fee-simple acquisition or the purchase of conservation easements that preclude future development. As of May 2009, 4.5 million ha of land were set aside for some type of conservation use.

Strategic Habitat Conservation Areas

Closing the Gaps identified 1.9 million ha of privately owned lands as SHCA. SHCA are lands in need of protection to maintain natural communities and viable populations of many species that are indicators of the state's biological diversity. Since the publication of Cox *et al.* (1994), 0.59 million ha (30%) of lands mapped as SHCA for biodiversity conservation have come under public protection. However, application of the results of a land-use change analysis (Kautz *et al.,* 2007) reveals that 157,800 ha of SHCA had been converted to urban and agricultural uses as of early 2003.

Mitigation Banks

During the past 20 years, a number of privately owned mitigation banks have been established to protect various components of Florida's biodiversity, including wetlands, gopher tortoises (*Gopherus polyphemus*), and sand skinks (*Neoseps reynoldsi*). Typically, a private enterprise purchases a tract of land, conveys a conservation easement on the property to a public agency, initiates restoration and management activities, and sells mitigation credits to developers who need to mitigate for effects of development projects within the service area of the mitigation bank. About 28,400 ha have been protected through this mechanism, including 4,000 ha of lands identified as SHCA (Cox *et al.,* 1994).

Wildlife Underpasses

Collisions with motor vehicles are a source of wildlife mortality that can be addressed through construction of highway underpasses designed to allow wildlife to safely traverse heavily traveled roads (Forman *et al.,* 2003; Figure 2). Wildlife underpasses, culverts, and amphibian tunnels designed to ensure safe passage of wildlife beneath roads are increasingly used to maintain landscape linkages for many species of wildlife (Foster and Humphrey, 1995; Land and Lotz, 1996; Roof and Wooding, 1996; Evink, 2002; Forman *et al.,* 2003; Smith, 2003). In the early 1990s, numerous underpasses were installed in Alligator Alley in southern Florida as part of the project to upgrade the highway to interstate standards, with the principal purpose being to reduce

John Wooding

Figure 2 *Wildlife underpass.*

Florida panther roadkills (Foster and Humphrey, 1995; Land and Lotz, 1996; Evink, 2002). Additional underpasses were installed under SR 29 north and south of I-75 to further reduce panther roadkill mortality by linking adjacent habitats (Land and Lotz, 1996). Highway underpasses for Florida black bears have also been installed under SR 46 over the Wekiva River (Roof and Wooding, 1996) and were incorporated into the design of the Suncoast Expressway in west-central Florida. Current plans to broaden I-4 to six lanes between Daytona Beach and Deland also include construction of three underpasses to accommodate an expanding black bear population in central Volusia County. In other areas of the state, such as along US 441 across Paynes Prairie in Alachua County, fences and culverts have been installed to link wetland habitats on either side of the road and reduce the number of reptiles and amphibians killed on the highway. Smith (2003) has proposed design standards for wildlife underpasses in Florida based on the needs of target species. Hoctor *et al.* (2000) proposed a broad-scale set of landscape linkages intended to ensure long-term connections between natural areas throughout the state.

Species Recovery

Jay Exum

SOUTHERN BALD EAGLE

Southern Bald Eagle (*Haliaeetus leucocephalus*) populations have risen dramatically since the early 1970s. The first FWC survey documented the presence of 88 Southern Bald Eagle nests in Florida in 1973. By 1987, the number of active nests had increased to 391. The number of active Southern Bald Eagle nests surveyed annually now exceeds 1,133 (Nesbitt *et al.,* 2005). This population increase is due in part to the banning of pesticide DDT and to the implementation of nest-protection guidelines (U.S. Fish and Wildlife Service [USFWS], 1987). These nest protections restrict construction activities within specified distances of eagle nests. In response to the improved status of Southern Bald Eagle populations nationwide, the USFWS removed the Bald Eagle from the Federal List of Endangered and Threatened Wildlife and Plants (USFWS, 2007).

USFWS

RED-COCKADED WOODPECKER

Although few Red-cockaded Woodpecker (*Picoides borealis*) groups occur on private lands, the Red-cockaded Woodpecker population in Florida is sufficiently secure on public lands. The FWC downlisted the species from threatened to a species of special concern. Downlisting was justified in part by the number of groups on public lands and by the willingness of public land managers to focus part of their efforts on maintaining old-growth pines needed as cavity trees. In addition, research efforts have developed new technologies for installing inserts into the cavities of younger trees, and new translocation technologies have helped establish additional family groups in existing or new areas to supplement local populations on public lands.

FWC

AMERICAN ALLIGATOR

The American alligator (*Alligator mississippiensis*) has responded dramatically to population management. Intense past harvesting efforts and depleted populations of American alligators in many areas of Florida prompted FWC to list it as threatened and close hunting seasons. However, the alligator population proved to be resilient, and alligators were later downlisted to a species of special concern. The population rebounded to the point that alligators are now managed through controlled hunts and the removal of nuisance animals by licensed alligator trappers.

Jay Exum

FLORIDA BLACK BEAR

The Florida black bear (*Ursus americanus floridanus*) is a wide-ranging species whose population and range within Florida has been increasing in recent years (Eason, 2003; Simek *et al.,* 2005). Historically, bears were distributed throughout Florida, but the range was severely reduced and fragmented by large-scale land clearing in the early 1900s and by unregulated harvest (Eason,

FWC

2003). Black bear populations reached their low point between the 1950s and 1970s with state-wide estimates of only several hundred to a thousand individuals (Maehr, 1992a; Eason, 2003). In response to declining populations, FWC closed bear-hunting seasons statewide except in Baker and Columbia counties and Apalachicola National Forest in 1971 and listed the Florida black bear as a threatened species in 1974 (Maehr, 1992a). The FWC eventually closed bear hunting in all areas of the state in 1994. Since then, bears are making a slow, steady recovery. The statewide population estimate increased to 1,282 individuals in 1998 (Eason, 2003) and more recently to between 2,042 and 3,213 individuals (Simek *et al.,* 2005). Populations centered in the Ocala and Apalachicola national forests show the most growth (Simek *et al.,* 2005). Black bears require large areas, occur at low densities, and reproduce at slow rates. The increased number of bears reported in recent years appears to be the result of population growth that has occurred gradually over several decades in response to the closure of hunting seasons statewide. In addition, highway underpasses designed to reduce roadkills have been installed in several locations with plans to install more (Roof and Wooding, 1996; Evink, 2002).

PERDIDO KEY BEACH MOUSE

The Perdido Key beach mouse (*Peromyscus polionotus trysillepsis*) is an example of an endangered species that has been saved from extinction, at least for the time being. Historically, Perdido Key beach mice inhabited the dune systems of Perdido Key from the west end of the Florida Panhandle into Alabama (Holler, 1992). Humphrey and Barbour (1981) estimated that only 78 mice remained in Gulf State Park in Alabama and Gulf Islands National Seashore in Florida. Presumably, Hurricane Frederick extirpated beach mice from Gulf Islands National Seashore in 1979, leaving only the population at Gulf State Park. A population of beach mice was reestablished at Gulf Islands National Seashore in 1987 by translocating mice from Gulf State Park. However, Hurricane Opal and subsequent predation led to the extirpation of beach mice from Gulf State Park by 1998. A second translocation program in 2001–2002 resulted in the reestablishment of beach mice at Perdido Key State Park in Florida. Unfortunately, in 2004 Hurricane Ivan led to the extirpation of beach mice in Perdido Key State Park. As of 2008, the only reproducing population of beach mice occurs at Gulf Islands National Seashore (J. Gore, personal communication). Translocation programs have successfully maintained viable populations of Perdido Key beach mice on public land. If not for the management efforts of public agencies, the species would almost certainly be extinct today.

USFWS

FLORIDA KEY DEER

The Key deer (*Odocoileus virginianus clavium*), an endangered subspecies of the white-tailed deer, is found on only a few islands in the Lower Florida Keys, principally on Big Pine and No Name keys. By the 1940s, the population fell to about 100 deer because of illegal hunting (Frank *et al.,* 2003). The National Key Deer Refuge was established in 1957 to protect habitat for the remaining herd, and in 1967 the USFWS listed the Key deer as endangered. Since then, active land acquisition and population-management programs have allowed the population to increase to 700–800 deer (Frank *et al.,* 2003). One piece of the management program involved the construction of a highway underpass under US 1 and the development of deer-proof grates to reduce roadkill mortality (Lopez *et al.,* 2003).

Conclusion: The Need for an Update to Habitat Conservation Priorities

Florida has a rich and unique diversity of life forms that have been shaped by many factors, including climate, geographic position, geology, and human impacts. However, years of persecution, overexploitation, and habitat loss have resulted in extinction or extirpation of some species from the state, relegated remaining examples of some natural communities to public lands, and degraded most of the state's once pristine ecosystems. If human demands continue as predicted, increased stress on Florida's biodiversity and ecosystems is expected.

Closing the Gaps, produced to assess the implications of continued habitat loss, was an effort to identify the minimum amount of land needed to ensure the long-term persistence of Florida's biodiversity. The

approach focused on a set of species and natural communities that were probable indicators of and surrogates for the habitat-conservation needs of most components of the state's biodiversity. A variety of conservation-planning methodologies aided in identifying appropriate lands. Coarse-scale filters helped identify specific natural communities (*e.g.,* sandhill, scrub) necessary to ensure the protection of associated biota, and they identified the habitats needed by wide-ranging species (*e.g.,* Florida panther) to ensure protection of habitats of other species with smaller area requirements. Fine-scale filters functioned to identify local occurrences of single species (*e.g.,* bat caves) or communities (*e.g.,* pine rocklands, tropical hardwood hammocks) not identified by the coarse-scale filter. Landscape linkages were identified so that dispersal corridors and habitat connections could be maintained, particularly for wide-ranging species like the Florida black bear. Habitat specialists like the Florida Scrub-Jay (*Apheolocoma coerulescens*) were selected as focal species to ensure that their unique habitat requirements would be met. Population-viability modeling pioneered by Shaffer (1981, 1987) was applied to ensure that lands identified for protection were large enough to support viable populations of target species. Methodologies developed by Scott *et al.* (1993) were employed to identify gaps in landscape conservation. Knowingly, this process of conservation planning cannot protect all areas of the landscape supporting biodiversity. In addition, identified lands had to be strategically located if they were to support viable populations of target species or protect sustainable natural communities. The goal of the project was to provide a data-driven, science-based, defensible product for use in habitat conservation protection statewide.

Closing the Gaps has met with success on many levels. A few examples of how the concepts and information presented by Cox *et al.* (1994) have been used include the following:

- The number of acres of SHCA purchased was specified in statute as a measurable goal for Florida Forever (Florida Statutes 259.105).
- Lands identified in *Closing the Gaps* were used to evaluate and rank proposals submitted to Preservation 2000 and Florida Forever land-acquisition programs.
- The Florida Communities Trust land-acquisition program used the presence of SHCA on a prospective parcel of land as a ranking criterion for eligibility to receive funding.
- SHCA were one of the data layers used to identify and rank lands for acquisition as part of the Florida Forever Conservation Needs Assessment (FNAI, 2000).
- SHCA were one of the layers used by the University of Florida GeoPlan Center to identify ecological greenways (Hoctor *et al.,* 2000).
- Several of Florida's 11 regional planning councils incorporated SHCA into maps of natural resources of regional significance as part of the process for developing Strategic Regional Policy Plans prescribed by Florida law in 1995 (Florida Statutes 186).
- SHCA and biodiversity hot spots identified in *Closing the Gaps* were considered "best available data" used by local governments as part of Evaluation and Appraisal Reports required to update comprehensive land-use plans on a five-year cycle.
- SHCA were used as an input to rank the Florida landscape with respect to their importance to wildlife as part of the FWC Integrated Wildlife Habitat Ranking System (2001) data set (Endries *et al.,* 2003), which was produced at the request of the FDOT as a tool for rapidly evaluating the likelihood that new road projects would adversely affect important wildlife areas.
- Chapter 373 (Part IV) (Florida Statutes) and Chapter 40 (Florida Administrative Code), which prescribe procedures to be followed to obtain an Environmental Resource Permit, specify that impacts to fish and wildlife must be considered, and data in *Closing the Gaps* have been used for this purpose.
- Rule 9J-5 (Florida Administrative Code) requires that assessments of effects on wildlife habitats resulting from Developments of Regional Impact must be made using "best available data," which includes SHCA and biodiversity hot spots from *Closing the Gaps.*
- *Closing the Gaps* has been translated into Japanese by the Ecosystem Conservation Society of Japan and used as a model approach for conservation planning in Japan.
- *Closing the Gaps* was used as the example of how to conduct regional conservation planning by a team of scientists that developed a set of measurable objectives for application to conservation planning efforts (Tear *et al.,* 2005).

Although the results presented by Cox *et al.* (1994) have had many applications, *Closing the Gaps* has gradually become dated. When *Closing the Gaps* was published in 1994, the public conservation system of Florida consisted of about 2.81 million ha, but since then, an additional 1.04 million ha have been protected, including more than 0.59 million ha of SHCA. These large-scale changes in the Florida landscape point to the need to reassess the habitat protection needs of Florida's biodiversity in light of the land-use conversions that have occurred over the past 10–15 years.

Newer land-cover and natural-heritage data and advances in scientific methodologies are now available

to facilitate an update to the biodiversity-conservation needs of Florida. The original land-cover data that formed the basis for the habitat models in *Closing the Gaps* came from late-1980s satellite data, and occurrence records used to develop species models and identify strategic habitats remained current through about 1992. However, land-cover data from 2003 are now available and natural-heritage occurrence records needed for population modeling continue to be collected by FNAI, FWC, and others. Improvements in population viability modeling techniques now allow for spatially explicit identification of strategic habitats needed to support populations. In addition, since 1994, tremendous advances have been developed in computer-processing power, GIS software, and data-storage capabilities, which are the basic tools needed to update a conservation plan for a region as large as the state of Florida.

The goal of this next generation of conservation planning is to determine what components of Florida's biological diversity have been secured since 1994, what opportunities for land protection have been lost, and where land-protection priorities need to be refocused to ensure that Florida's biological diversity is secured for future generations before remaining opportunities are lost. Given the inevitable pressure of human population growth on Florida's environment, the time is ripe (as it was in 1994) to produce an updated vision of the strategically located Florida lands needed to protect the state's rich and unique natural heritage.

Chapter 2
Goal and Objectives

Goal of Project

The goal of this project is to identify the minimum amount of land needed in Florida to ensure the long-term survival of key components to Florida's biological diversity. This project is a reanalysis of *Closing the Gaps* using a new suite of species, updated and more recent data sets, and improved analytical techniques, including spatially explicit population-viability analyses. Significant changes to Florida's ecosystems have occurred subsequent to the original analysis. For effective land management and planning to continue, we must reassess the level of protection that Florida's managed lands provide our biological resources.

Results from this analysis cannot be directly compared with the results from *Closing the Gaps* for a number of fundamental reasons:

- Each analysis used different suites of species. The species analyzed in this report include all species for which SHCA were identified in *Closing the Gaps,* species whose habitats were not adequately protected in the Habitat Conservation Needs of Rare and Imperiled Wildlife Report (Cox and Kautz, 2000), species subject to changes in their federal listing status (recently completed and proposed), and additional species whose habitats are thought to be threatened because of recent population trends. Furthermore, in this report we did not directly assess rare plants and natural-community types as they did in *Closing the Gaps.* We limited our assessments to terrestrial vertebrate species.
- Construction of a potential-habitat map for the current analysis did not necessarily follow the same steps used to map habitat in *Closing the Gaps.* By not confining ourselves to the original mapping methods, we could incorporate new information learned about a species, collaborate with other agencies and researchers who had existing habitat maps of wildlife species, employ data sets that did not exist during the original analysis, and incorporate new or different mapping and analytical techniques.
- Of the data sets that were updated since the original analysis, some cannot be directly compared, for example the FWC 1985–1989 land-cover image (Kautz *et al.,* 1993) and the FWC 2003 land-cover image (Stys *et al.,* 2004). The FWC 2003 land-cover image divides the state into 43 land-cover categories, whereas the FWC 1985–1989 land-cover image has 26 land-cover categories. The only way to use the new land cover in replicating the analysis in the original report would be to reclassify the FWC 2003 land-cover image into 26 classes and lose the more recent classification of the 2003 image.
- The capabilities and techniques of population-viability analysis have changed dramatically. This is discussed in detail in Chapter 5 of this document.

This report is intended to replace the recommendations given in *Closing the Gaps.* Like the original analysis, some fundamental assumptions exist in the framework of the reanalysis:

- Lands under some form of governmental protection promote long-term stability of wildlife habitats. This level of protection includes public ownership of lands as well as private landowner agreements such as conservation easements. Private landowners can be excellent land stewards and are essential in the make-up of land ownership in the state of Florida. However, without some form of governmental protection, it is impossible to identify those landowners that consider wildlife and habitats in their land management decisions. As a result, lands managed for conservation and protected by law for the long-term protection of wildlife and natural resources are the only lands we could use to assume long-term habitat stability.
- Our analysis focuses on maintaining the viability of a species at a statewide scale. Therefore, when considering the needs or perhaps even the very existence of some individual population centers for species in the state, we will consider the population viability of the species statewide before addressing those needs.
- Conservation efforts should focus on those components of the state's biodiversity that are least protected by the current system of lands managed for conservation, and land-acquisition and private-landowner agreements should target those areas least protected.
- Lands chosen for protection should be sufficient in size or situated in such a way to provide a functional mosaic of habitat patches that are geographically distributed throughout the entire state and are essential for the long-term survival of both individual species and wildlife communities.

Objectives to Accomplish Goal

We set a number of objectives to reach our goal.

- Select the species that compose the focal group for analysis.
- Produce a map of potential habitat for each species.
- Determine if the amount of potential habitat that exists on lands managed for conservation is adequate for the long-term persistence of the species in Florida.
- If warranted, identify suitable privately owned lands in the state that would benefit the long-term persistence of the species in Florida.
- Make any additional recommendations regarding research, management, and habitat protection relevant to ensuring the species' long-term viability.

Sources of Error and Appropriate Uses of This Report and Associated Data

It is incumbent on the users of this report to understand the limitations of these data and to appropriately use the results of the analysis. The species-habitat maps represented in this report are of a generalized nature, and some are based on a limited number of occurrence records and expert knowledge. We used the best-available data to construct each map. None of the maps presented in this report have undergone independent and quantitative validations or accuracy assessments. On-site surveys, sampling, and reviews by species experts were conducted for some species and are detailed in the individual species write-ups in Chapter 6. We believe the species maps in this report accurately represent the distribution and habitats of each species and are reasonable and defendable if used appropriately.

There are various sources of error and bias inherent in the data and ultimately in the analysis results. However, we attempted to minimize these errors by using data from known sources and by using species-habitat maps verified and reviewed by species experts. Nevertheless, we recognize the following sources of error and bias that may affect our results:

- Base vegetation map—All of the potential-habitat maps used the FWC 2003 land-cover image as the base map representing the habitat classes that exist statewide. Misclassifications in the FWC 2003 land-cover image are possible because the land-cover image was not assessed for accuracy. During map construction, local managers visually inspected and reviewed the map, and map creators conducted cursory site inspections of many areas, but the accuracy of the land-cover image statewide was not formally assessed. Thus, the effects of misclassification errors on species-habitat delineations are unknown.
- Positional accuracy—Species-location data were obtained from a variety of sources, some of which had no estimation of positional accuracy. In constructing our potential-habitat maps we used the best-available data for each species. Generally, we used species-location data to determine the geographic range of the species of interest; however, species-location data used for generating some species-habitat maps were opportunistically gathered and locations taken from systematic surveys were limited for most species (*i.e.,* most location data did not include locations indicating the absence of a species). Detailed use of location data for specific species is described in the individual species accounts of Chapter 6 under "Analyses of Individual Focal Species and Development of SHCA."
- Temporal accuracy—Species models are not intended to predict species occurrences at any given time. The majority of the habitat maps were constructed using the FWC 2003 land-cover image. Changes in land use and the resulting changes in land cover have occurred since 2003. These changes could result in the alteration of areas identified as potential habitat so they they no longer have the habitat characteristics needed by wildlife. In contrast, these changes could result in the modification or restoration of previously inappropriate areas to appropriate habitat for a species, yet these areas would not be documented in the potential-habitat map. The timeliness of species-location data was also quite variable, although we attempted to obtain the most current species-specific location data available. Historical records of species locations were scrutinized and used only if more recent records were not available.
- Species-specific bias— Species maps in these analyses do not reflect habitat quality or population density (although species population-viability analyses assume that population density is static). Generally, data on rare or more secretive species usually associated with habitats within restricted geographic ranges were more limited than were data on more common and wider-ranging species. Differences in the availability of data on different species are likely to have influenced the degree of uncertainty associated with each species map and affected subsequent analyses (see error propagation and cascading below); however, we did not attempt to weigh the influence of each species in composite maps (*e.g.,* hotspots) based on "rarity" or listing status. It is also important to recognize that species select and use

habitats at different spatial scales, which may not be adequately captured by the base vegetative land-cover data or other ancillary data because of specific habitat requirements that were not recognized in the classification schema.

- Error propagation and cascading—Errors could have occurred when multiple data sets were combined, which occurred extensively in these analyses; however, these errors are difficult to quantify, especially if errors in input data layers are unknown. Nevertheless, it is important to recognize a degree of uncertainty associated with most data layers, which may lead to errors in resultant data layers. For example, errors in species-location data may lead to errors in the species-habitat map that are subsequently carried over into the Population Viability Analysis (PVA) and ultimately the determination of SHCA for a given species.

The end users of these data are ultimately responsible for their appropriate use and are cautioned to apply the results of these analyses carefully. Scale is likely to be the most important consideration for the appropriate use of all spatial data, including data presented in this report. Most species'-habitat maps are based on classified Landsat Enhanced Thematic Mapper Plus (Landsat ETM+) imagery, which has a resolution of 30-m pixels. Landsat ETM+ is considered medium- (*i.e.,* meso-) scale imagery that is appropriate for mapping at regional scales ranging from 1:100,000 to 1:1,000,000 (Aber *et al.,* 1993). This project is principally based on classified Landsat ETM+ satellite imagery and followed similar protocols to those of the U.S. Geological Survey (USGS) National Gap Analysis Program (Scott *et al.,* 1993; USGS, 2006a). Thus, we adopted and subscribed to a similar set of appropriate and inappropriate uses (from Scott and Jennings, 1994).

Appropriate Uses

- Statewide biodiversity planning;
- Regional (Councils of Government) planning;
- Regional habitat conservation planning;
- County comprehensive planning;
- Large-area resource management planning;
- Coarse-filter evaluation of potential impacts or benefits of major projects or plan initiatives on biodiversity, such as utility or transportation corridors, wilderness proposals, regional open space and recreation proposals, etc.;
- Facilitate cooperative management and planning by determining the relative degrees of responsibility that land stewards have for specific biological resources;
- Basic research on regional distributions of plants and animals and helping target both specific species and geographic areas for needed research;
- Assessing environmental effects of large projects or military activities;
- Estimating potential economic effects from loss of biological resource-based activities;
- Educating all levels of students and citizens.

Inappropriate Uses

- Using the data to map small areas (less than thousands of hectares), which typically require a 1:24,000 scale or finer mapping resolution, finer scale data (*e.g.,* aerial photographs), and ground surveys.
- Combining data from this analysis with other data finer than 1:100,000 scale to produce new hybrid maps or answer queries;
- Generating specific area measurements from data finer than the nearest thousand hectares (minimum-mapping-unit size and accuracy affect this precision);
- Establishing exact boundaries for regulation or acquisition;
- Establishing definitively whether or not a feature occurs in an exact geographic area;
- Determining abundance, health, or condition of any feature;
- Establishing a measure of accuracy of any other data by comparing them with data from this analysis;
- Altering the data in any way and redistributing them as a Wildlife Habitat Conservation Needs in Florida data product;
- Using the data without acquiring and reviewing the metadata and this report.

Chapter 3
Development of the Geographic Information System

Geographic information systems are an ideal tool for modeling the potential distribution of species and habitats and have become integral to the statewide assessment of landscapes. Given appropriate digital habitat and wildlife data, these tools can be used to identify environmentally sensitive lands, view projects in a landscape perspective, and allow habitat quality and wildlife needs to be simulated as a function of proposed management (Connor and Leopold, 1998). Since Closing the Gaps *was published in 1994, numerous data sets have been updated with new information, and today many more data sets exist. Some of the principal data sets used in the current report are summarized in the following subsections.*

Wildlife Distribution Information

Location Information

Information about wildlife distribution allows biologists to document the geographic locations of species at given points in time and can be collected both visually by direct observation or remotely (*e.g.,* radio-telemetry, global positioning systems).

Wildlife distribution information was obtained from a variety of sources. The FNAI maintains a Florida Element Occurrence (FLEO) database of more than 27,500 geographically referenced points documenting wildlife and rare-plant occurrences. The database documents the occurrences of endangered, threatened, or rare plants and animals; high quality natural communities; and other occurrences of natural-resource interest. An "element" is any exemplary or rare component of the natural environment, such as a species, plant community, bird rookery, spring, sinkhole, cave, or other ecological features. An "Element Occurrence" represents the spatial location of an element. The FNAI maintains precise point locations for all FLEOs. Many of these come from museum records, scientific studies, and data compiled from many agencies including the FWC.

The Division of Habitat and Species Conservation of the FWC maintains a database (WildObs) documenting the occurrences of wildlife, including wading-bird rookeries, southern bald eagle nests, Florida black bear locations, shorebird surveys, and individual sightings of wildlife. The WildObs database has more than 44,000 records of wildlife.

Wildlife distribution records were also gleaned from scientific literature and acquired from land managers or project biologists who had newer or recent data. Much of these data required entry into the GIS. A full description of the point-location information used to construct any potential-habitat map is given in Chapter 6 under "Analyses of Individual Focal Species and Development of SHCA."

Breeding Bird Atlas Blocks

The Breeding Bird Atlas (BBA) project (Kale *et al.,* 1992; FWC, 2003) vector polygon data was used to help delineate known breeding ranges for selected bird species. The BBA was a collaborative effort between private groups and government agencies to confirm the locations of breeding birds throughout the state in one-sixth of a 7.5-minute quadrangle map (an area of about 3,080 ha blocks).

Florida Land Use and Land Cover

Florida Land Use, Cover and Forms Classification System (FLUCCS)

The FLUCCS (FDOT, 1999) is a land-use, land-cover database that contains categorized land-use and land-cover features. The features were photo-interpreted from 1:12,000 USGS color infrared Digital Orthophoto Quarter-Quadrangle (DOQQ).

FWC 2003 Land-Cover Image

In 2004, the FWC completed a digital land-cover data set for Florida derived from 2003 Landsat ETM+ satellite imagery (Stys *et al.,* 2004). All classification was conducted in ArcView® (ESRI Version 3.3, 2002) using the Image Analysis extension (Leica Geosystems Version 1.1a, 2002). The digital data set is a 30-m raster

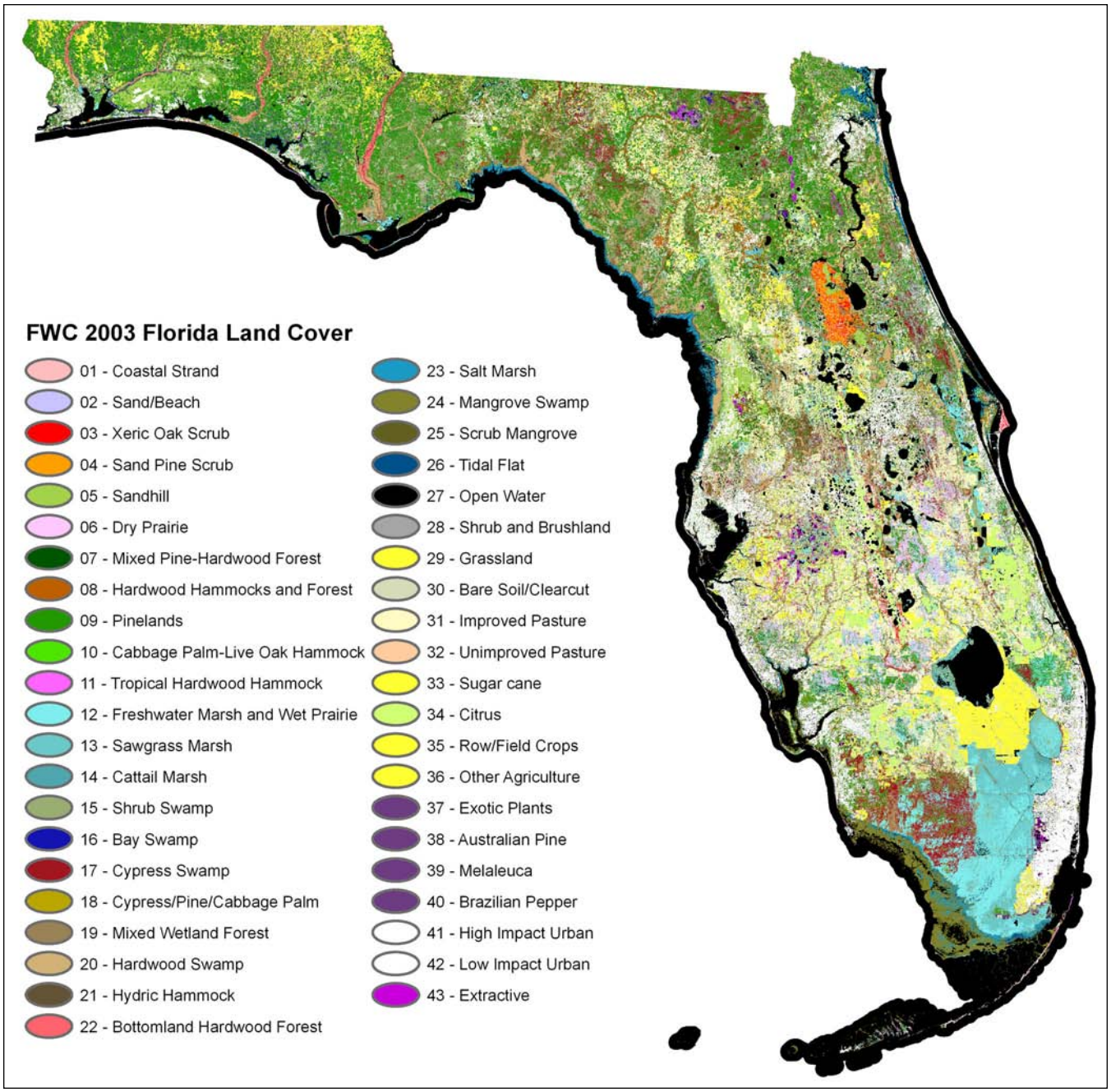

Figure 3 *Land-cover map of Florida developed from 2003 Landsat Enhanced Thematic Mapper data.*

Table 1 *Land-cover classes derived from Landsat ETM+ satellite imagery for the state of Florida.*

Plant Communities	Hectares
Upland	
Coastal Uplands	
Coastal strand	6,076
Sand/beach	13,211
Xeric Uplands	
Xeric oak scrub	59,448
Sand pine scrub	78,604
Sandhill	308,269
Mesic Uplands	
Dry prairie	497,086
Mixed hardwood–pine forest	359,954
Hardwood hammock and forest	397,043
Pineland	2,643,186
Cabbage palm–live oak hammock	3,982
Tropical hardwood hammock	6,231
Wetland	
Palustrine	
Freshwater marsh and wet prairie	894,131
Sawgrass marsh	282,745
Cattail marsh	26,332
Shrub swamp	437,635
Bay swamp	82,541
Cypress swamp	630,448
Cypress/pine/cabbage palm	18,780
Mixed wetland forest	590,557
Hardwood swamp	739,297
Hydric hammock	14,457
Bottomland hardwood forest	34,421
Marine/Estuarine	
Salt marsh	181,054
Mangrove swamp	238,085
Scrub mangrove	2,638
Tidal flats	6,181
Aquatic	
Open water*	3,088,949
Disturbed	
Transitional	
Shrub and brushland	668,661
Grassland	32,527
Bare soil/clearcut	445,266
Agriculture	
Improved pasture	1,199,463
Unimproved pasture	57,458
Sugarcane	211,571
Citrus	385,312
Row/field crops	567,642
Other agriculture	90,706
Exotic Plants	
Exotic plants	21,734
Australian pine	53
Melaleuca	27
Brazilian pepper	286
Urban	
High-impact urban	1,257,835
Low-impact urban	399,349
Mining	
Extractive	51,466

*Open water includes areas of inland freshwater lakes, ponds, rivers and creeks, and the brackish and saline waters of estuaries, bays, tidal creeks, and coastal waters extending approximately 3.5 miles from land.

image of the entire land and inland water area of Florida. The 2003 land-cover image (Figure 3) contains 43 land-cover types, including 26 natural and semi-natural vegetation types, 16 types of disturbed lands (*e.g.*, agriculture, urban, mining), and 1 water class (Table 1). Specific plant communities were mapped based on (1) base category similarities in the 1992 land-cover map; (2) the ability to classify communities accurately using satellite data, image classification techniques, and available software; (3) the need to meet the project timeline; and (4) the importance of various communities to wildlife species. For a complete description of all land-cover classes, please see Appendix A in this document. An accuracy assessment for the land-cover map was not conducted.

Florida Managed-Areas Database

The FNAI Florida Managed Areas (FLMA) database includes public and private lands that the FNAI has identified as having natural-resource value and that are being managed at least partially for conservation purposes (FNAI, 2005; Figure 4). The Inventory database includes boundaries and statistics for more than 1,600 federally, state, locally, and privately managed areas, all provided directly by the managing agencies. National parks, state forests, wildlife-management areas, and local and private preserves are examples of the managed areas included. We used the FLMA database dated March 31, 2005. Since this database contains both public lands and some privately owned lands managed for conservation, we will simply refer to lands included in this database as "managed" throughout the remainder of this document.

Figure 4 *Distribution of current Florida Managed Areas identified by Florida Natural Areas Inventory.*

Other Geographic Data Sets

Soils

Digital versions of vector polygon Soil Survey Geographic (SSURGO) database (Soil Survey Staff, 2005a) and State Soil Geographic (STATSGO) database (Soil Survey Staff, 2005b) maps for Florida were used to further define potential habitat when soils were an important consideration. Soils were often used to help refine selected land-cover categories by limiting the potential-habitat mapped to those areas with appropriate land cover and appropriate soils. The digital SSURGO map series duplicates the original soil-survey maps and is the most detailed soil map available. The mapping scales generally ranged from 1:12,000 to 1:63,360. At the time of analysis, the digital copy of the SSURGO map was incomplete for some counties in Florida, and where missing, the STATSGO map was used in its place. The STATSGO database consists of a broad-based inventory of soils and non-soil areas that occur in a repeatable pattern on the landscape and that can be cartographically shown at the scale mapped. The approximate minimum area delineated is 625 ha. The soil maps for the STATSGO database are compiled by generalizing the more detailed soil-survey maps.

The National Hydrography Dataset

The 1:24,000 scale vector line National Hydrography Dataset (NHD) (USGS, 2005) was used as the main river layer. The NHD is a comprehensive digital spatial data set that contains information on surface-water features such as lakes, ponds, streams, rivers, springs, and wells. The data are based upon the hydrography data of USGS 1:100,000-scale digital line graphs.

County Boundaries and Roads

The county boundaries and roads used in all analyses were originally created from the U.S. Census Bureau's 2000 TIGER/Line files. The TIGER/Line files are a digital database of geographic features, such as roads, railroads, rivers, lakes, legal boundaries, census statistical boundaries, etc. covering the United States (U.S. Census Bureau, 2003). From these data we used the legal-boundary and roads data to compile detailed county-boundary and roads layers for Florida.

Digital Orthophoto Quarter-Quadrangle (DOQQ)

The DOQQs were available from the Florida Department of Environmental Protection's (FDEP) Land Boundary Information System Web site (Land Boundary Information System, 2005). Orthoimagery combines the image characteristics of a photograph with the geometric qualities of a map. We used a complete set of 2004 JPEG 1-m-resolution true-color orthographic imagery.

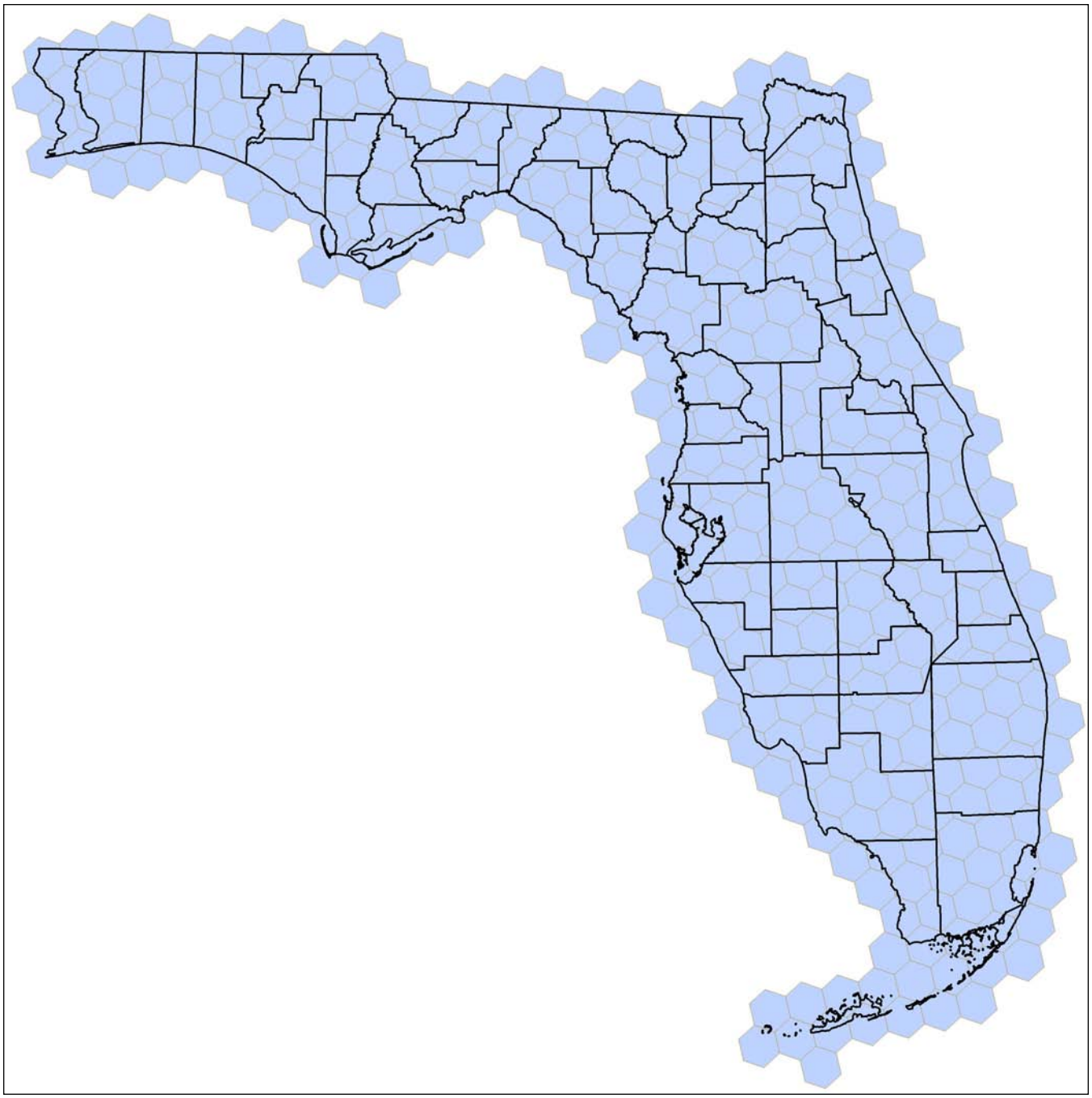

Figure 5 *Florida Ecological Mapping and Assessment Program (EMAP) hexagons.*

Florida Ecological Mapping and Assessment Program Hexagons

The U.S. Environmental Protection Agency's Ecological Mapping and Assessment Program (EMAP) hexagonal units encompassing Florida (Figure 5) are part of a global hexagonal grid system used in biodiversity analysis (White *et al.,* 1992; U.S. Environmental Protection Agency, 1993). The advantages of using the hexagonal grid include its equal-area sampling structure, its independence from political and administrative boundaries, and its hierarchical structure, which can facilitate increasing or decreasing grid densities in future analyses (White *et al.,* 1992). The EMAP hexagon units were used with a variety of species to limit the range of potential habitat identified.

Chapter 4
Selection of Species and Habitats for Analysis

Selection of Species for Analysis

We selected 62 wildlife species for analysis (Table 2). We analyzed 54 of the species individually and 8 species of wading birds as a group. This project was limited to terrestrial vertebrate wildlife, so we directly addressed only their needs. However, identifying and protecting SHCA lands should protect other wildlife and plant species.

As in the original analysis, the 62 species represent "focal" species. The focal species approach incorporates a variety of concepts and considerations. Given unlimited resources, time, and ability, we would map and assess the habitat needs of all terrestrial wildlife species in the state. Because this is not feasible or realistic, the focal-species approach identifies the needs of wildlife collectively by strategically selecting a subset of species. This selection process uses several ecological concepts that describe the species–ecosystem relationship (*e.g.,* community indicators, keystone species, umbrella species).

Table 2 *List of species evaluated, common and scientific names. Federal and state listing status provided (E: Endangered; T: Threatened; SSC: Species of Special Concern; N: Not currently listed). Strategic Habitat Conservation Areas were developed for the species in* ***bold****.*

Species Common Name	Species Scientific Name	Federal Status	State Status
AMPHIBIANS AND REPTILES			
American crocodile	***Crocodylus acutus***	**E**	**E**
Bog frog	*Rana okaloosae*	N	SSC
Flatwoods salamander	*Ambystoma cingulatum*	T	SSC
Gopher tortoise	*Gopherus polyphemus*	N	T
Mole skinks			
Cedar Key mole skink	*Eumeces egregius insularis*	N	N
Florida Keys mole skink	*Eumeces egregius egregius*	N	SSC
Pine barrens tree frog	***Hyla andersonii***	**N**	**SSC**
Rim rock crowned snake	*Tantilla oolitica*	N	T
Salt marsh snakes			
Atlantic salt marsh snake	***Nerodia clarkii taeniata***	**T**	**T**
Gulf salt marsh snake	***Nerodia clarkii clarkii***	**N**	**N**
Sand skink	***Neoseps reynoldsi***	**T**	**T**
Seal salamander	***Desmognathus monticola***	**N**	**N**
Striped mud turtle (Lower Keys population)	*Kinosternon baurii*	N	E
Striped newt	***Notophthalmus perstriatus***	**N**	**N**
BIRDS			
Black Skimmer	*Rynchops niger*	N	SSC
Black-whiskered Vireo	*Vireo altiloquus*	N	N
Cooper's Hawk	***Accipiter cooperii***	**N**	**N**
Crested Caracara	*Caracara cheriway*	T	T
Cuban Snowy Plover	***Charadrius alexandrinus***	**N**	**T**
Florida Burrowing Owl	***Athene cunicularia floridana***	**N**	**SSC**
Florida Grasshopper Sparrow	***Ammodramus savannarum floridanus***	**E**	**E**
Florida Sandhill Crane	*Grus canadensis pratensis*	N	T
Florida Scrub-Jay	***Aphelocoma coerulescens***	**T**	**T**

(continued next page)

Table 2 *List of species evaluated, common and scientific names. Federal and state listing status provided (E: Endangered; T: Threatened; SSC: Species of Special Concern; N: Not currently listed). Strategic Habitat Conservation Areas were developed for the species in* ***bold****. (continued)*

Species Common Name	Species Scientific Name	Federal Status	State Status
Florida Snail Kite	***Rosthramus sociabilis plumbeus***	**E**	**E**
Limpkin	*Aramus guarauna*	N	SSC
Louisiana Waterthrush	*Seiurus motacilla*	N	N
Mangrove Cuckoo	***Coccyzus minor***	**N**	**N**
Mottled Duck	*Anas fulvigula fulvigula*	N	N
Painted Bunting	*Passerina ciris*	N	N
Red-cockaded Woodpecker	*Picoides borealis*	E	SSC
Seaside sparrows			
Louisana Seaside Sparrow	***Ammodramus maritimus fisheri***	**N**	**N**
Scott's Seaside Sparrow	***Ammodramus maritimus peninsulae***	**N**	**SSC**
MacGillivray's Seaside Sparrow	***Ammodramus maritimus macgillivraii***	**N**	**N**
Short-tailed Hawk	***Buteo brachyurus***	**N**	**N**
Southeastern American Kestrel	*Falco sparverius paulus*	N	T
Southern Bald Eagle	*Haliaeetus leucocephalus*	T	T
Swallow-tailed Kite	***Elanoides forficatus forficatus***	**N**	**N**
Wading birds			
Great Egret	*Ardea alba*	N	N
Reddish Egret	*Egretta rufescens*	N	SSC
Snowy Egret	*Egretta thula*	N	SSC
Little Blue Heron	*Egretta caerulea*	N	SSC
Tricolored Heron	*Egretta tricolor*	N	SSC
White Ibis	*Eudocimus albus*	N	SSC
Roseate Spoonbill	*Platalea ajaja*	N	SSC
Wood Stork	*Mycteria americana*	E	E
White-crowned Pigeon	***Patagioenas leucocephala***	**N**	**T**
MAMMALS			
Bats			
Gray bat	***Myotis grisescens***	**E**	**E**
Southeastern bat	*Myotis austroriparius*	N	N
Beach mice			
Anastasia Island beach mouse	***Peromyscus polionotus phasma***	**E**	**E**
Choctawhatchee beach mouse	***Peromyscus polionotus allophrys***	**E**	**E**
Southeastern beach mouse	***Peromyscus polionotus niveiventris***	**T**	**T**
St. Andrews beach mouse	***Peromyscus polionotus peninsularis***	**E**	**E**
Florida black bear	***Ursus americanus floridanus***	**N**	**T***
Florida Key deer	***Odocoileus virginianus clavium***	**E**	**E**
Florida mouse	***Podomys floridanus***	**N**	**SSC**
Florida panther	***Puma concolor coryi***	**E**	**E**
Florida salt marsh vole	***Microtus pennsylvanicus dukecampbelli***	**E**	**E**
Fox squirrels			
Big Cypress fox squirrel	***Sciurus niger avicennia***	**N**	**T**
Sherman's fox squirrel	*Sciurus niger shermani*	N	SSC
Lower Keys marsh rabbit	***Sylvilagus palustris hefneri***	**E**	**E**
Rice rats			
Sanibel Island rice rat	***Oryzomys palustris sanibeli***	**N**	**SSC**
Silver rice rat	***Oryzomys palustris natator***	**E**	**E**

*Other than those found in Baker and Columbia counties or in Apalachicola National Forest.

Several of the species selected for analysis (*e.g.,* Florida scrub-jay, crested caracara) serve as community indicators. These are species that are linked to a very specific type of habitat. Community indicators are often the first to leave if the habitat is not optimal. The presence or absence of community indicators in an ecosystem provides a measure of assessing the health of that ecosystem.

Keystone species are those that have a disproportionate effect or value on their environment relative to their numbers or biomass (Stiling, 1999). For example, the gopher tortoise (*Gopherus polyphemus*) is considered a keystone species because of its burrow. More than 300 other species (*e.g.,* indigo snake, gopher frog) use the burrows (Diemer, 1992). If lands were managed for the benefit of gopher tortoises, then the other species that use the microhabitats that gopher tortoises create would also benefit.

An umbrella species is a species whose conservation affords protection to numerous co-occurring species (Noss, 1990; Ryti, 1992; Williams and Gaston, 1994; Lambeck, 1997; Fleishman *et al.,* 2000). By meeting the habitat requirements for an umbrella species, a land manager will also meet the habitat requirements for a variety of other species. This maximizes conservation efforts by protecting species diversity with minimal financial and land commitments. Typically, umbrella species are wide-ranging habitat generalists. Examples in Florida include the Florida black bear, Cooper's hawk, and Florida panther.

Identifying community indicators, keystone species, or umbrella species independent of one another is inadequate for assessing the habitat needs of all species within an entire ecosystem. No single concept adequately encompasses the habitat requirements of all species in an ecosystem. For example, a limitation of the umbrella species concept is that habitat specialists, often geographically restricted species, may have more specific habitat needs than a habitat generalist (Thomas and Mallorie, 1985; Quinn *et al.,* 1997).

The focal-species approach that we used in our species selection process incorporates consideration for all species. Focal species' requirements for survival define the attributes that must be present in a landscape to meet the requirements of the species that occur there (Lambeck, 1997). Furthermore, focal species are the most sensitive to such threats as the loss, fragmentation, or exotic invasion of habitats. By combining several concepts, we constructed a list of focal species that collectively represents the landscape needs of other Florida wildlife. By using this approach, it is possible to manage a whole community, ecosystem or state by focusing on the needs of a select group of species.

Selection of the focal species for this analysis proceeded as follows:

- We included species for which SHCA were identified in *Closing the Gaps.* This reassessment will identify any potential-habitat changes, incorporate any new habitat protected by public acquisition or conservation easement, and incorporate any new information on population status. A species that may have needed SHCA in 1994 may now be adequately protected through land acquisition, and protection priorities may have shifted to new areas because of habitat gain or loss. Additionally, different methodologies and information sources might identify further changes in SHCA.
- We included the 17 species whose habitats were determined to be inadequately protected in "Habitat Conservation Needs of Rare and Imperiled Wildlife" (Cox and Kautz, 2000). We determined that these species should be evaluated for the need to identify species-specific SHCA.
- We included additional focal species identified by FWC biologists as having declining populations and threatened habitats, or which new information would alter their habitat and SHCA analysis. Additionally, we included species proposed for change in listing as endangered, threatened, or species of special concern.

Development of Species-Habitat Maps

We created potential-habitat maps using available relevant data. The diversity, availability, and quality of the data varied considerably between species. Furthermore, the distribution and life history requirements of many species are not well known. Therefore, we could not standardize the methods used in developing the potential-habitat maps of the focal species. The development process of each species' potential-habitat map can be found in the individual species sections. All GIS analyses were performed using ArcGIS® (ESRI Version 9.0, 2003). Generally, the process for composing the habitat maps proceeded as follows:

- We compiled available data concerning the species range and/or occurrence information. These data came from existing GIS data sets, museum records, peer-reviewed literature, hardcopy and digital spreadsheets, and points plotted on paper maps. We entered all non-GIS location data into a GIS.
- The authors conducted a thorough literature review of the ecology of each species, particularly literature pertaining to habitat requirements and use.

- The modeler then used the data and literature collected to outline the steps using ArcGIS® Model Builder (ESRI Version 9.0, 2003) and generated draft potential-habitat maps. Typically, many different potential-habitat maps were generated to assess how different techniques, inclusion or exclusion of data sets, and changes in mapping steps affected the mapping results. In the absence of location information, review of the scientific literature helped to identify important habitat associations that could be modeled. It was up to the modeler's discretion to select the model that best captured the potential habitat available to a species.
- Each model was then subjected to expert peer and technical review within and outside the FWC. Based upon this critique, revisions were carried out if necessary. A full description of the methods used to create a potential-habitat map for a species is provided in Chapter 6, "Analyses of Individual Focal Species and Development of SHCA."
- If feasible, map verification was conducted by visiting sites identified as potential habitat (field verification) or by computer. Field verification included sampling for the presence of the species (specimens or sound or visual evidence) or visual assessment of the appropriateness of habitats identified as potential habitat. Computer verification involved overlaying newer data sets or newly acquired occurrence records onto the potential-habitat map itself.

The resulting maps identified the potential habitat available to a species statewide, taking into consideration its known range. Potential habitat includes areas where the species could be found based on land cover, soils, proximity to known locations, distance from certain features (*e.g.,* roads, urban areas), and any other feature that could be incorporated into the GIS and mapping processes. Potential habitat includes areas that have been occupied by the species based on occurrence records, and areas where occupancy is unknown, but possible, based on the available data. No qualitative measures for habitat were used in the development of the potential-habitat maps. For many species, potential habitat exists statewide, but the known distribution of the species is limited in the state. For example, after extensive sampling, the seal salamander is known to inhabit only five small spring-seepage ravines in Florida, even though many of these types of ravines occur in the state. Knowing the distribution of the seal salamander, we limited our potential-habitat map to the spring-seepage ravine system where they are found. We could not restrict the habitat mapping in this way for species lacking known distributions.

Chapter 5
Population Viability Analysis

Overview

The PVA evaluates potential threats faced by a population and estimates the risk of extinction or decline based on species-specific data (Gilpin and Soulé, 1986; Soulé, 1987). The PVA by itself can also provide a powerful tool for assessing the requisites for the long-term viability of a species. Population models, which serve as the basis for assessing viability, may range from very simple population models (*e.g.,* Boyce, 1992; Burgman *et al.,* 1993) that assume contiguous, homogeneous habitat for a single population to spatially explicit metapopulation models that address noncontiguous or patchy environments for several populations (*e.g.,* Pulliam *et al.,* 1992; Root, 1998). Single-species population models are advantageous because they are quantitative, rigorous, testable, and predictive (Akçakaya, 2000).

Effective population modeling requires detailed information about the demographics, density dependence, dispersal characteristics, habitat requirements, exposure to catastrophes, population sizes, and distribution of required habitat of the species. The major parameters of interest include survival rates, fecundity values, life-history stages, carrying capacity, home range or territory size, population sizes, mating structure (*e.g.,* monogamous), sex ratio, age of sexual maturity, annual probability of reproduction, lifetime contribution, dispersal characteristics, habitat preferences, and density-dependence type. Table 3 lists the major parameters that we researched for each species. When data for the focal species was unavailable, we used studies of closely related species.

Table 3 *Parameters of interest for developing a risk assessment for each focal species.*

Parameter
Sex ratio
Breeding system
Lifespan
Age at first breeding
Age at last breeding
Annual survival for each age or stage (*e.g.,* adults and juveniles)
Proportion of reproductively mature individuals breeding each year
Average number of young per year per individual
Abundances (current and historical trends)
Population growth rate (*i.e.,* annual rate of increase)
Maximum growth rate (*i.e.,* population growth rate at lowest abundance)
Dispersal characteristics:
Who disperses?
At what ages/stages does dispersal occur?
How far annually?
Annual average dispersal distance
Maximum annual dispersal distance
What landscape features act as a barrier? (*e.g.,* rivers, mountains)
Home range size or territory size
Average population density or population (location)-specific densities
Carrying capacity of optimal habitat
Number of populations, including their size and location
What limits populations? (*e.g.,* territories, prey, habitat structure)
What are the current and historical ranges of the species?
What is the annual correlation in survival and fecundity among populations/locations?
Are there unique life history traits? (*e.g.,* cooperative breeding, long-distance migration)

PVA Methodology

We thoroughly examined relevant scientific literature and contacted species experts to collect population and demographic parameter estimates for all focal species. Based on this information, we developed best, worst, and average estimates for use in the risk assessment, noting any data weaknesses for each species. We conducted risk assessments for each species across its distribution in Florida and created a metapopulation model for each species by using the most recent available data. We used the model to address the following questions:

- Do current trends or demography suggest a decline?
- What is the risk of a large decline or extinction?
- Is there a threshold size for maintaining viable populations?
- What effect does the current distribution have on the long-term prognosis for this species?
- What are the most critical parameters determining the risk of a decline in this species?

Where sufficient data existed, we constructed structured models based on age, stage, or size. We also explored a range of values for parameters that are less well known, thus creating a set of outcomes based on best, worst, or average parameter estimations. The risk of extinction for each species was simulated from the contribution of each potential-habitat patch to the survival of a population and the collective contribution of all populations.

For the final part of the risk assessment, we performed sensitivity analyses of the model and its parameters. This identified the most critical parameters for each species' model and estimated the effect that increases or decreases in model parameters had on the overall risk for the species viability.

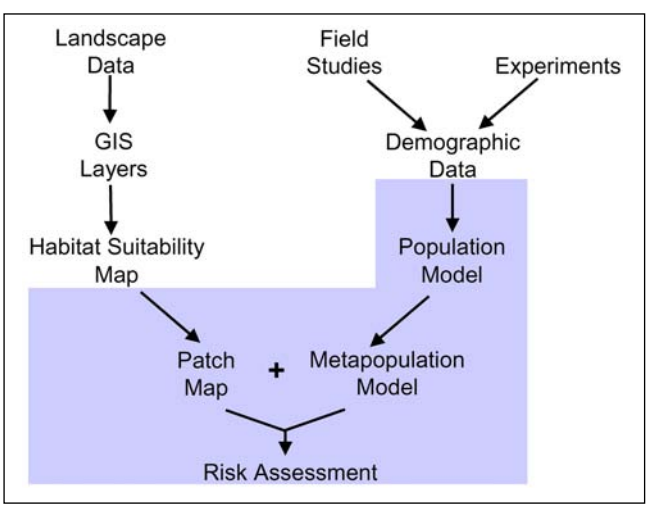

Figure 6 *Schematic diagram of Population Viability Analysis (PVA) flow.*

We combined the spatial aspects of the potential-habitat maps into the demographic model for a stage-based, stochastic, spatially explicit model (see Figure 6 for a diagram of the process). Details of the model for each species are found in Chapter 6, "Analyses of Individual Focal Species and Development of SHCA," and details of the PVA can be found in Root and Barnes (2006).

Modeling Populations Spatially

The potential-habitat map for each species delineated the spatial structure of the species' metapopulation. Each habitat map was a 30-m raster with potential habitat designated as "1" and nonhabitat designated as "0." However, in some cases the potential-habitat map's 30-m grid was resampled to a larger pixel size because the software package had limitations on the maximum number of pixels (rows × columns) that it could process.

We intersected this layer with a grid that contained the areas in Florida currently under management. This created a managed-habitat layer that designated protected habitat as "2" and unprotected as "1." To delineate distinct populations based on these two layers (all and managed), we combined these maps with any available data on the maximum dispersal distance for the species (to estimate neighborhood size) in the Spatial Data component of RAMAS Multispecies (Applied Biomathematics, Version 1, 2002). Dispersal, in this context, represented one-way movement from one population to another to establish permanent residency.

Cells were separated into different populations if they were beyond the maximum dispersal distance for that species. We made no allowances for the permeability of the habitat. We simply considered the linear distance regardless of potential obstacles such as roads or urban areas. This was because we lack the data for most focal species to assess how they move through the landscape.

These discrete, independent populations were assigned a carrying capacity based on the area (*i.e.,* the number of cells of suitable habitat) and our best estimate of maximum density or abundance. The initial abundance of each population was usually based on the area and the average density or abundance reported for the species. RAMAS Multispecies is limited to 500 populations that can be tracked at a time. Therefore, for a few species (*i.e.,* sand skink, striped newt, gopher tortoise), the neighborhood distance was increased to reduce the number of populations to 500 or less. Decreasing the number of populations (or patches) does not change the results of the demographic model, only the number of distinct populations.

Once the spatial structure was delineated, we combined the demographic data with the metapopulation data in the Metapop component of RAMAS Multispecies. All models were stage- (or age-) structured to allow individuals with distinct survival and/or fecundity rates to be tracked separately. The models were generally female only, but a 1:1 sex ratio was assumed unless otherwise specified. All populations were initialized with a stable age distribution to minimize initial variation in the first few years of the model. We assumed carrying-capacity density dependence based on the estimates from the spatial analysis (as described above). In some cases, we imposed the density ceiling only on some stages (*e.g.,* breeders in a territorial species). No habitat changes were allowed (except where specifically mentioned), and habitat was assumed to be homogeneous in quality and readily available. We ran 10,000 replications of each model (*i.e.,* given set of parameters) and each replication covered the next 100 years.

Assumptions

It is important to note that all of the PVA models incorporate the following assumptions:

- All potential habitat was equal in quality and availability and did not change over the course of the simulation.
- There was no dispersal among populations unless specified otherwise, and distinct populations were independent.
- The models usually included only females but assumed a 1:1 sex ratio.
- The models all incorporated stochasticity in the parameters, commonly as much as a 10% coefficient of variation around the means, to mimic demographic stochasticity and some level of environmental stochasticity.
- A stable age distribution was established at the start of the model simulation and was based on the demographic matrix.
- There were no catastrophes included in the models, except where specifically mentioned.

Our approach was to opt for a more conservative model when the data was uncertain, and in the absence of any clear trends in abundance, we usually assumed the population was nearly stable (*i.e.,* finite population growth rate near 1). Therefore, the models represent a cautious view of the risks faced by these species based on the smallest number of assumptions and the best available data.

Finally, we completed two sets of sensitivity analyses. Sensitivities and elasticities based on the demographic matrix were estimated to identify the critical demographic elements affecting the deterministic population-growth rate. We also ran a series of different versions of the baseline model to examine effects such as changing the carrying capacity, fecundity, or survival. We estimated the risk of extinction, risk of decline, average population abundance, and mean time of occupancy. After all of the models were completed and the analyses run, we gave recommendations about the habitat needs of each of the focal species. In particular, the models suggested guidelines for (1) determining the minimum area required for viable populations, (2) indicated the most critical or influential parameters, (3) identified the specific importance of individual locations, and (4) highlighted species most vulnerable to decline or extinction.

Chapter 6
Species-Habitat Mapping and SHCA Identification

The primary measure we used to determine a species' level of long-term security was the probability of decline in abundance provided by the results of the PVA. Based on input provided by Karen V. Root (personal communication), we selected a threshold value of a 40% probability of a 50% decline in abundance. We considered species that meet our habitat-planning goal to be stable and have an adequate amount of conservation land in the state. If the PVA returned a result suggesting a significant chance of decline in abundance (a greater than 40% probability of a 50% decline) based on potential habitat identified on managed lands only, we then identified the minimum amount of privately owned lands needed to achieve population stability for a species. Additional information provided by the PVA, such as number of stable populations and predicted longevity of populations, also factored into our decision regarding a species' level of security. The minimum amount of privately owned habitat areas identified for each species are called Strategic Habitat Conservation Areas because of their importance in providing the species with the base of habitat needed for long-term persistence (Cox et al., *1994)*

Analyses of Individual Focal Species and Development of SHCA

Potential-habitat maps for individual species identify all potential habitats available to a species statewide with consideration (if possible) of its known range. To truly assess a species at a statewide level, the potential-habitat maps need to encompass and identify all habitat potentially available to a species throughout its entire range in the state. The majority of potential-habitat maps include appropriate habitat areas even if the species is not known to occupy it. When good distribution information exists for a species, we used this information to improve the precision of the potential-habitat map by reducing identified potential habitat to those areas within the range of the species. For many species, we have extremely minimal distribution information and do not know all areas of occupancy in the state. Hence, we were unable to refine the potential-habitat maps in this way.

This methodology differs slightly from that of *Closing the Gaps.* In the original report, the potential-habitat areas mapped for a greater number of species were restricted by documented occurrences. Typically potential-habitat areas were selected if they fell within artificial boundaries such as BBA or buffers around points. Consequently, many of the *Closing the Gaps* potential-habitat maps have potential habitat limited to these artificial boundaries. For the current report, we have reduced the number of artificial boundaries in our maps and identified potential habitat based on the appropriateness of habitat statewide.

Our chosen methodology for creating potential-habitat maps has its advantages and disadvantages. The main advantage is that identification of all available habitat for a species in the state, even if little distribution information exists for that species, provides a picture of the entire amount of potential habitat available for a species in the state. Therefore, the potential-habitat maps could be used to search for previously undocumented presence locations and to identify potential areas that could support species relocation. Furthermore, the potential-habitat maps could help identify areas in need of restoration to optimize the habitat for a species. For example, Florida scrub-jays require scrub habitat with oaks and other shrubs 1–4 m tall. The FWC 2003 land-cover image classifies scrub habitat regardless of stand age, height, or quality. The potential-habitat map for Florida scrub-jays would identify all scrub areas that could be functional or transformed to optimal habitat with restoration effort.

A significant disadvantage is that our potential-habitat maps may overestimate the amount of habitat for a species, affecting the results of the PVA and our assessment of the security of the species in the state. This overestimation is due to our not having limited our habitat identification to areas of known occupancy. Therefore, it is possible that our maps identify areas with no species presence as potential habitat. Furthermore, our potential-habitat maps lack any qualitative measure of habitat, and all areas identified in a potential-habitat map are considered to have the same level of suitability. In reality, habitat occurs at various levels of suitability. As a result, our assessments could over- or underestimate occupancy. Given the limitations, we believe the potential gains outweigh the drawbacks of our chosen methodology.

Some of the areas identified as potential habitat may already have been converted to other uses that

would render it unsuitable for the species (*e.g.,* agriculture, urban, extractive). Additionally, some lands may have been brought into public ownership. Because of the temporal nature of this study, the following information should only act as a guide, and verification of the status of all lands should occur prior to making any decisions based upon the information contained in this document.

Amphibians and Reptiles

AMERICAN CROCODILE

Phil Frank

The American crocodile (*Crocodylus acutus*) is a coastal crocodilian that occurs in parts of Mexico, Central and South America, the Caribbean, and South Florida (Thorbjarnarson, 1989). Development supporting a rapidly growing human population in Florida along coastal areas of Palm Beach, Broward, Dade, and Monroe counties has been the primary factor endangering the United States' population (Mazzotti, 1983). American crocodiles now occur in most areas of appropriate habitat in southern Florida. Most of its remaining Florida habitat is currently protected in public ownership or in Florida Power and Light's Turkey Point Power Plant property. In these areas, destruction of habitat has not been an issue. However, questions need to be addressed about how to support a viable crocodile population when confronted with upstream development and the resulting alteration of freshwater flow.

The American crocodile occurs in a variety of habitats throughout its range, including freshwater rivers and inland freshwater reservoirs. Historical records from Florida have always associated American crocodiles with protected tropical coastal shorelines of the extreme southern portion of the state (Kushlan and Mazzotti, 1989). These shorelines had mangrove vegetation on areas of low elevation (most of the shoreline) and tropical hardwood forests on areas of high elevation (in isolated patches). Today much of the shoreline between southern Biscayne Bay and Rookery Bay is still undeveloped. Most of the American crocodiles remaining in Florida occur in this area.

We used a natural-history–based model of potential habitat created by Mazzotti *et al.* (unpublished data) as an initial identification of potential habitat for American crocodiles. To make the Mazzotti *et al.* model more compatible with this project, we intersected the Mazzotti *et al.* model with a reclassification of the FWC 2003 land-cover image, which kept only those habitat classes appropriate for American crocodiles. The final map shows only those areas that were identified in both (Figure 7). The selected habitats in the FWC 2003 land-cover image included coastal strand, salt marsh, mangrove swamp, scrub mangrove, and tidal flat.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Two-thirds of the potential habitat is categorized as managed. The baseline growth rate for both of these models was 1.01, which made them sensitive to small changes in survival and fecundity. Sensitivity analyses on these baseline models indicated that adult survival was the most influential parameter in the model. Assuming no changes, the probability of extinction in the next 100 years under baseline demographic parameters was 8.9% for the model containing all potential habitat and 34.8% for the managed-lands model. A risk of decline in abundance (*i.e.,* a 27.3% probability of an 80% decline in abundance) was evident when all potential habitat was considered. There was a 64.9% probability of an 80% decline in abundance occurring in managed land only.

Because of the limited range of American crocodiles in Florida and the risk of decline in abundance identified in the PVA, SHCA were identified for this species (Figure 8). Strategic Habitat Conservation Areas

Figure 7 *Potential-habitat map for American crocodile.*

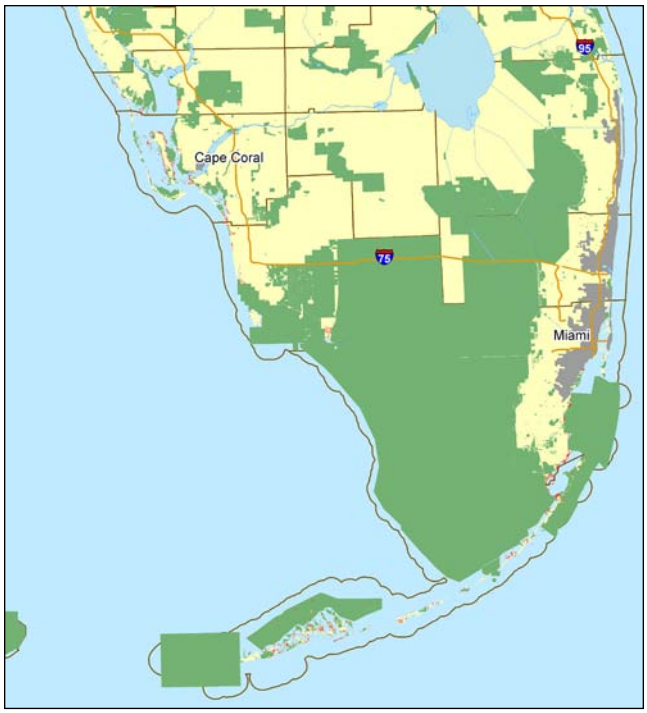

Figure 8 *Proposed Strategic Habitat Conservation Areas for American crocodile.*

for American crocodiles includes all potential-habitat patches greater than 1 ha on privately owned lands. Data incompatibility and digitizing errors in the FLMA database required us to manually clean up the SHCA.

BOG FROG

FWC

Discovered in 1982, the rare bog frog (*Rana okaloosae*) is found only in or near shallow, flowing, acidic seeps and bogs associated with the small stream tributaries of the Yellow and East Bay river systems (Moler, 1992). Because of the limited distribution and habitat specificity of this species, protection and active management of habitats is imperative. Threats to bog frog habitat include stream impoundment and habitat succession.

We obtained bog frog location records from paper topographic maps maintained by Paul Moler (n = 64). We also used 10 additional location records from the FLEO database not identified in Paul Moler's maps.

To generate the the habitat map (Figure 9), we identified all shrub swamp, bay swamp, and mixed wetland forest from the FWC 2003 land-cover image

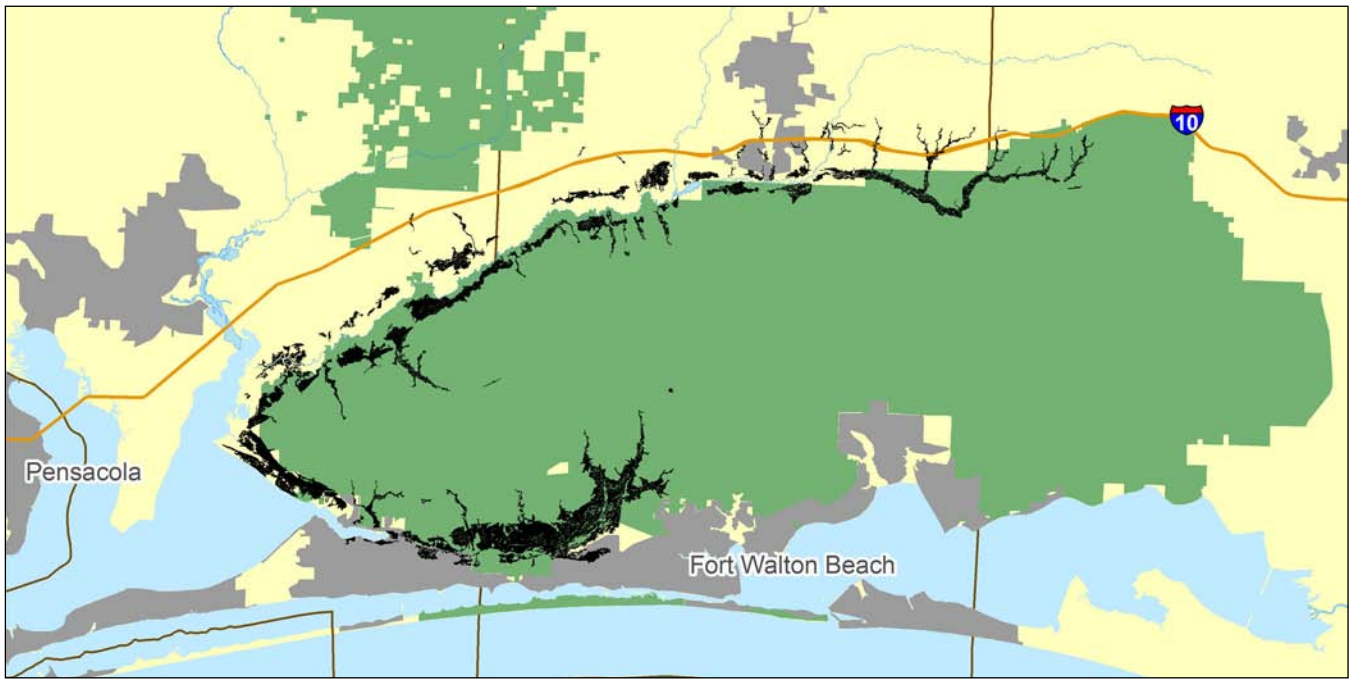

Figure 9 *Potential-habitat map for bog frog.*

and limited potential habitat to those habitat patches that intersected the East Bay and Yellow to Shoal to Titi river systems from the NHD. Additionally, all FWC 2003 land-cover mesic upland and palustrine wetland habitats within 90 m of a location record were identified as potential habitat. Bishop (2005) identified 75 m as the minimum linear stream distance for protection of habitat for *R. okaloosae.* The 90-m distance we used was the nearest possible distance interval over 75 m possible using the FWC 2003 land-cover image.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The baseline growth rate for the metapopulations in both of these models was 1.0378, which made them relatively insensitive to small changes in most demographic parameters. Assuming no changes, the probability of extinction or decline in the next 100 years for both models with baseline demographic parameters was 0%. About 79% of the potential habitat is on managed lands. The abundance was smaller in the managed-lands model than it was in the model for all lands.

We did not identify SHCA for this species because an already large percentage of potential habitat is managed for conservation, and the PVA does not reveal any threat of extinction or decline in abundance. However, the limited geographic distribution of this species makes conservation of bog frog habitat critical (Moler, 1992). If habitat areas for bog frogs are available for purchase, efforts should be made to secure these areas for conservation protection. One such site recently purchased is the Florida Forever Yellow River Ravines project, which was identified as a high-priority acquisition project. This purchase serves a dual role: protecting bog frog habitat and connecting Blackwater State Forest with Eglin Air Force Base.

FLATWOODS SALAMANDER

Pierson Hill

In Florida, the flatwoods salamander (*Ambystoma cingulatum*) occurs from the Florida–Alabama state line eastward to Jefferson County, and in the peninsula from Marion County north. Ideal upland habitats include open-canopy, mesic, longleaf pine (*Pinus palustris*)–wiregrass (*Aristida* spp.) savannas and flatwoods, and ideal breeding sites contain ephemeral wetlands with an open overstory and at least partially encircled with a graminaceous ecotone (Figure 10; Means *et al.,* 1996; Palis, 1997). Adult and subadult flatwoods salamanders are fossorial, whereas larvae are aquatic. In late fall, adult salamanders migrate to wetland breeding sites in response to rainy weather associated with cold fronts (Palis, 1997). The silvicultural practice of converting longleaf pine savannas and flatwoods to bedded slash pine plantations is considered a major threat to the security of *A. cingulatum* in Florida (Means *et al.,* 1996).

FWC

Figure 10 *Flatwoods salamander breeding habitat.*

Recent research has changed the taxonomy for this species. Pauly *et al.* (2007) described two species of flatwoods salamander based on analyses of mitochondrial DNA, allozymes, and morphology. The frosted flatwoods salamander (*A. cingulatum*) occurs east of the Apalachicola–Flint Rivers, whereas the reticulated flatwoods salamander (*A. bishopi*) occurs to the west. The Apalachicola River has caused major disjunctions in distributions of other species because of repeated marine embayments during the Pliocene and Pleistocene interglacials, and the river apparently represented an east–west barrier to gene flow in this salamander species (Pauly *et al.,* 2007). Besides being genetically distinct, the two species differ significantly in the number of costal grooves, body and tail shape, size, and pattern (Pauly *et al.,* 2007). The scientific community has accepted this taxonomic change (Crother, 2008).

In May 1999, the USFWS listed the flatwoods salamander as a threatened species because of population declines associated with the degradation and loss of more than 80% of its habitat (USFWS, 1999a). In 2008, the USFWS proposed listing *A. bishopi* as an endangered species (USFWS, 2008). The FWC lists the flatwoods salamander as a species of special concern.

The FLEO database has 68 location records for flatwoods salamanders. In response to the listing and re-

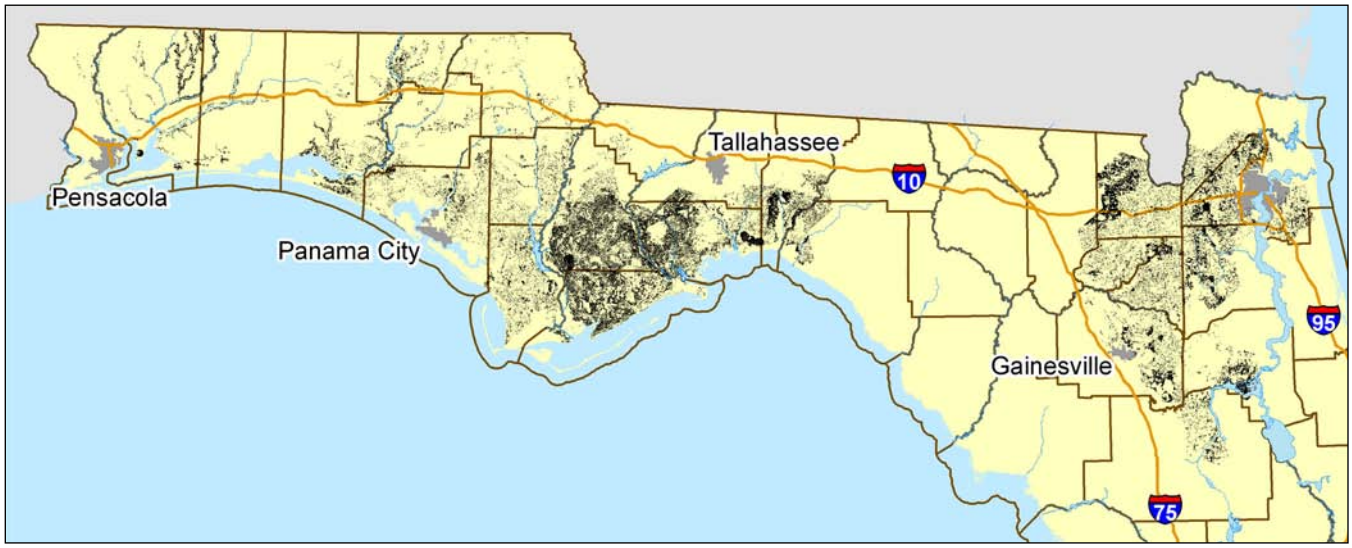

Figure 11 *Potential-habitat map for flatwoods salamander.*

covery efforts, recent surveys conducted by FWC and USFWS resulted in the identification of 155 sites associated with 47 populations (USFWS, 2008). The FWC conducted a four-year survey (2001–2005) of ponds throughout the range of *A. cingulatum.* Each pond surveyed for salamanders was ranked for its suitability of supporting flatwoods salamanders.

At the time we conducted our species assessment, the FWC did not officially recognize the *A. bishopi* species designation. As a result, our flatwoods salamander analysis was conducted assuming only a single species present in the state. We constructed the potential-habitat map using the FWC 2003 land-cover image, FLUCCS database, STATSGO database, EMAP Hexagons, FLEO data, and recent survey data (Figure 11). All analysis was limited to areas that fell within EMAP hexagons that either contained a FLEO record or were bordered by at least two hexagons containing a FLEO record. We began constructing the map by identifying the appropriate breeding and upland habitats from the FWC 2003 land-cover image. We selected cypress swamp, cypress–pine–cabbage palm, and mixed wetland forest communities for breeding sites, and we selected pinelands habitat to represent upland habitat. We limited breeding sites to patches no bigger than 12.7 ha, the maximum pond size Palis (1997) found in his survey of *A. cingulatum* breeding sites. We refined the uplands habitat type by removing all areas classified as commercial/industrial pineland in the FLUCCS database.

We further refined both breeding and upland habitats by retaining all areas with mesic and hydric soils based upon the STATSGO database (ANFLOOD = freq; DRAINAGE = P, SP, V; HYDRIC = Y; and HYDGRP = D or C). We identified breeding sites as potential habitat only if they were contiguous with upland habitat. We selected upland habitats that were contiguous with a breeding site and within 290 m from breeding habitat as potential habitat. To capture the efforts of the 2001–2005 *A. cingulatum* pond survey, we included all mixed hardwood–pine forest; pinelands; all freshwater marsh categories except sawgrass marsh, hardwood swamp, hydric hammock, and bottomland hardwood forest; and all transitional FWC 2003 land-cover image categories as potential habitat that were within 1,700 m of a pond that was given a rank of "potential" or "highly likely." The maximum dispersal distance recorded for flatwoods salamanders is 1,700 m (Ashton, 1992).

We ran two PVA models, one combining all potential habitat and one limited to potential habitat occurring on managed lands. The baseline growth rate for the metapopulations in these models was 1.0089, which made them quite sensitive to small changes in survival and fecundity. Assuming no changes, the metapopulation containing all potential habitat had a 0% probability of extinction and a 4% probability of a 20% decline in abundance in the next 100 years under baseline demographic parameters. For the metapopulation on managed-lands habitat only, the abundance was smaller than for the metapopulation with all potential habitat, although the risks on managed lands were quite similar to those of the whole population (no chance of extinction and a 9% probability of a 20% decline in abundance).

We did not identify SHCA for this species. Although recent surveys identified significant population declines, our mapping efforts identified a large amount of potential habitat. There are several possible reasons why the map depicted a lot of potential habitat.

First, the pineland habitat class in the land-cover map does not differentiate pine species, canopy structure, or ground cover, and it contains all pine-dominated land-cover areas as a single class. Flatwoods salamanders principally require open-canopied, mesic, longleaf pine–wiregrass savannas and flatwoods and open-canopy wetlands supporting herbaceous vegetation. The salamander may require more specific habitat than this general classification allows. Second, long-term droughts occur that limit reproductive success, despite suitable-looking habitat. Third, fall–winter precipitation that is insufficient to fill breeding ponds has undoubtedly contributed to the observed decline of the species (K. Enge, personal communication). Flatwoods salamanders have not been detected anywhere in the Florida peninsula since 1998.

In Florida, plantation forestry appears to be the greatest threat to *Ambystoma cingulatum* habitat (Palis, 1997). Alteration and degradation of wetland breeding sites is also of major concern. Therefore, we recommend that conservation efforts be focused on restoring and properly managing existing habitat areas to optimize habitat structure and quality for this species.

GOPHER TORTOISE

Jay Exum

The gopher tortoise (*Gopherus polyphemus*) is one of four North American species of tortoises. It is the only tortoise occurring east of the Mississippi River, with a range that includes much of the Southeastern Coastal Plain, from eastern Louisiana to southeastern South Carolina and throughout Florida (Auffenberg and Franz, 1982). Suitable adult tortoise habitat is characterized by the presence of relatively well-drained, sandy soils; an abundance of herbaceous ground cover; an open overstory to allow sunlight to reach the ground; and sparse shrub cover (Cox *et al.,* 1987). The availability of suitably drained soils is one of the main limiting factors of gopher tortoise distribution. Land-cover types considered important to gopher tortoises include coastal strand, sand pine scrub, longleaf pine–turkey oak sandhill, mixed hardwoods and pines, upland hardwood hammocks, and oak hammocks (Auffenberg and Franz, 1982; Diemer, 1986).

The major threat to the gopher tortoise in Florida is direct loss of habitat due to commercial and residential development and the conversion of native plant communities to agriculture and silviculture. Because of the amount of habitat reduction in Florida and the inferred population decline (an estimated 50%–60% over the past 60–93 years; Enge *et al.,* 2006), the FWC reclassified the gopher tortoise from species of special concern to threatened in November 2007.

We created the potential-habitat map using the FWC 2003 land-cover image, the SSURGO and STATSGO databases, FLUCCS database, and a general map of natural vegetation (Davis map; Davis, 1967). We identified land-cover types representing coastal strand, sand pine scrub, sandhill, xeric oak scrub, dry prairie, pineland, mixed hardwood pine forests, shrub and brushland, and unimproved pasture from the FWC 2003 land-cover image. Then we refined these selected land-cover types by retaining only areas identified as a natural community type, unimproved pasture, or herbaceous rangeland in the FLUCCS database. We removed pinelands identified as commercial/industrial pinelands found on private lands in the FLUCCS database. Additionally, we selected and retained all pinelands identified as pine flatwoods in the FLUCCS database. Finally, we further refined all other pine classes, mixed hardwood pine forests, and shrub and brushland. We created a map of xeric soils by identifying areas that have high to moderate infiltration rates, are deep to moderately deep, are excessively to moderately well drained, and have a 0%–5% chance of flooding annually. We grouped these areas along with areas identified as forests of longleaf pine and xerophytic oaks, north Florida coastal strand, south Florida coastal strand, upland hardwood forests, and sand pine scrub in the Davis map. We retained only those areas of pinelands, commercial pinelands on managed lands, mixed hardwood pine forest, and shrub and brushland identified within the xeric soils/Davis map as potential gopher tortoise habitat. Finally, we combined all areas that were retained through the various refinement steps to create the final gopher tortoise potential-habitat map (Figure 12).

Potential habitat for this species includes more than 1.3 million ha, of which more than 540,000 ha (40%) are on managed lands. Based upon the model simulations and forecast of the PVA, there are more than 200 populations on conservation lands that remain occupied for most of 100 years. Assuming no changes in habitat or catastrophic population loss from environmental factors or disease, we measured the probability of extinction in the next 100 years under baseline

Figure 12 *Potential-habitat map for gopher tortoise.*

demographic parameters at 0%, and the probability of a decline was low (*i.e.,* 5% probability of a 20% decline). However, considering projections of human population growth, further loss of upland habitat is inevitable, and we should address these imminent declines with directed management actions.

Although current conservation areas may provide the minimum habitat requirements sought for populations of gopher tortoises in Florida, one of the objectives of the recently approved Species Management Plan (FWC 2007) is to increase the amount of protected habitat from 0.54 million ha to 0.79 million ha by 2022, through land acquisition and conservation easements. Strategic Habitat Conservation Areas identified for other species include more than 240,000 ha of potential gopher tortoise habitat. Based on the results of the PVA analyses, management of and research on the gopher tortoise should target adult survival because it was the most influential parameter in the model.

MOLE SKINKS

CEDAR KEY MOLE SKINK

FWC

The Cedar Key mole skink (*Eumeces egregius insularis*), which is not listed by the FWC, is one of five subspecies of mole skink found in Florida. Subspecies are identified by coloration and morphological characteristics such as scale counts, tail pigmentation, and the position and width of dorsal stripes (Mount, 1965). The body of *E. e. insularis* is various shades of gray and brown with dorsolateral stripes that fail to reach the tail. The tail varies from a dull, dark orange to maroon to pink (Mount, 1965). *Eumeces e. insularis* is confined to the islands in the vicinity of Cedar Key, Florida, and requires a mostly dry, loose, sandy substrate to burrow in with its characteristic "sand-swimming" manner (Christman, 1992a). This lizard commonly occurs at land's edge in and under tidal wrack at or above the high-water mark but can also be found inland in open sandy areas.

Historical records (n = 4) came from the FLEO database. All records were made in the 1960s. We could not determine the potential-habitat areas for the Cedar Key mole skink solely using the FWC 2003 land-cover image. The habitat requirements of the lizard are too fine-scale for a 30- × 30-m-pixel habitat map. We used the SSURGO database for Levy County as the base data layer for the potential-habitat map. We then identified areas of upland with sandy soils known to have populations of skinks. Next, we used the longest minimum distance from one habitat patch to any other as the maximum dispersal distance. We buffered each known population area by this distance and all upland, sandy soil types that fell within this buffer and were not classified as open water in the FWC 2003 land- cover image were included as potential habitat (Figure 13).

Biologists conducted a field survey to identify errors of commission and omission. Presence of the skink confirmed suitable habitat. A total of fourteen locations contained the Cedar Key mole skink. Omitted areas were incorporated into the model using SSURGO data.

There are approximately 305.4 ha of potentially suitable habitat for the Cedar Key mole skink. Less than 21% (62.6 ha) of the potential habitat is on managed lands. We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Under the baseline parameters, both models had a 0% risk of extinction or decline in abundance over the next 100 years, assuming no catastrophe or loss of habitat. The baseline growth rate was 1.0586, which made the models relatively insensitive to small changes in survival and fecundity.

Figure 13 *Potential-habitat map for Cedar Key mole skink.*

We did not select habitat areas as SHCA for this species. However, we believe that the rarity and small total area identified as potential habitat warrants conservation of known habitat areas outside of current conservation areas available for this species.

FLORIDA KEYS MOLE SKINK

Kevin Enge

The Florida Keys mole skink (*Eumeces egregius egregius*), another subspecies of mole skink found in Florida, is currently listed as a species of special concern by the FWC. Subspecies are identified by coloration and morphologic characteristics such as scale counts, tail pigmentation, and the position and width of dorsal stripes (Mount, 1965). The body of *E. e. egregius* varies from shades of grey-brown to darker brown with a salmon,

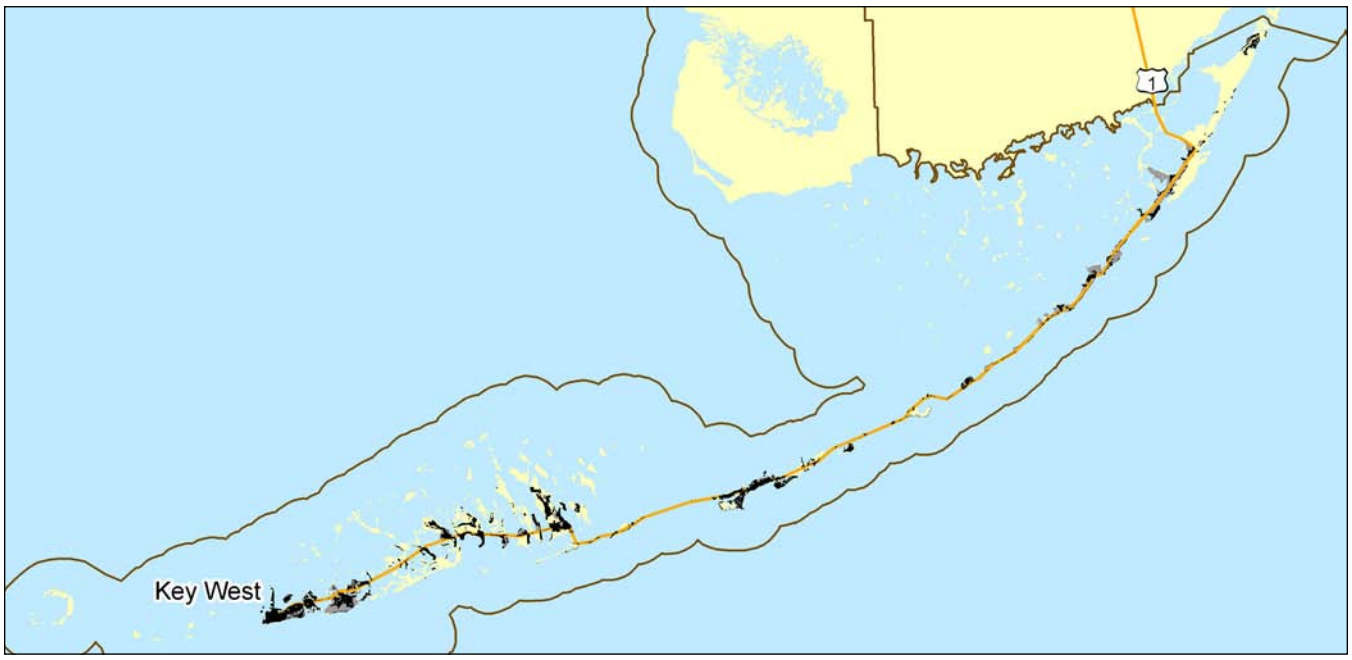

Figure 14 *Potential-habitat map for Florida Keys mole skink.*

pink, or orange tail (Mount, 1965). This skink is a member of the distinctive, isolated fauna found in the Dry Tortugas and the lower Florida Keys. Those skinks found in the upper Keys share characteristics with that of the mainland skink subspecies, *E. egregius onocrepis* (Christman, 1992b). The Florida Keys mole skink probably requires a mostly dry, loose, sandy substrate to be able to burrow in its characteristic "sand-swimming" manner; however, little is actually known about its habitat requirements. It commonly occurs at land's edge amongst the tidal wrack but can also be found inland (Christman, 1992b).

The potential-habitat map is very general in design because of the lack of knowledge about the habitat requirements of this species, as well as the lack of current information on its distribution in the Florida Keys (Figure 14). The potential-habitat areas for the Florida Keys mole skink were identified using the FWC 2003 land-cover image and the SSURGO database. Using the SSURGO database, we identified all upland soils for the Florida Keys not classified as open water in the 2003 land cover. Next, we merged all areas in the Florida Keys classified as Sand/Beach from the FWC 2003 land-cover image with the identified soils to complete the model. No field verification was performed on this subspecies.

Approximately 8,592 ha of potentially suitable habitat exist for the Florida Keys mole skink. Less than 23% (1,941 ha) of the potential habitat was on managed lands.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Under the baseline parameters, either with all potential habitat or only managed-lands habitat, there was 0% risk of extinction or decline over the next 100 years, assuming no catastrophe or loss of habitat. The baseline growth rate, 1.0586, made both models relatively insensitive to small changes in survival and fecundity.

Results from the PVA analysis suggest that given the amount of potential habitat available to *E. egregius,* even if one included only what is currently protected, no SHCA are warranted. Strategic Habitat Conservation Areas identified for Florida Key deer and Lower Keys marsh rabbit will also help add habitat protection for the Florida Keys mole skink.

PINE BARRENS TREE FROG

FWC

Listed by the FWC as a species of special concern, the pine barrens tree frog (*Hyla andersonii*) was not discovered in Florida until 1970 (Christman, 1970). It now occurs over 177 locations in Santa Rosa, Okaloosa, Walton, and Holmes counties, as well as 38 locations in Alabama. *Hyla andersonii* is highly specialized in its

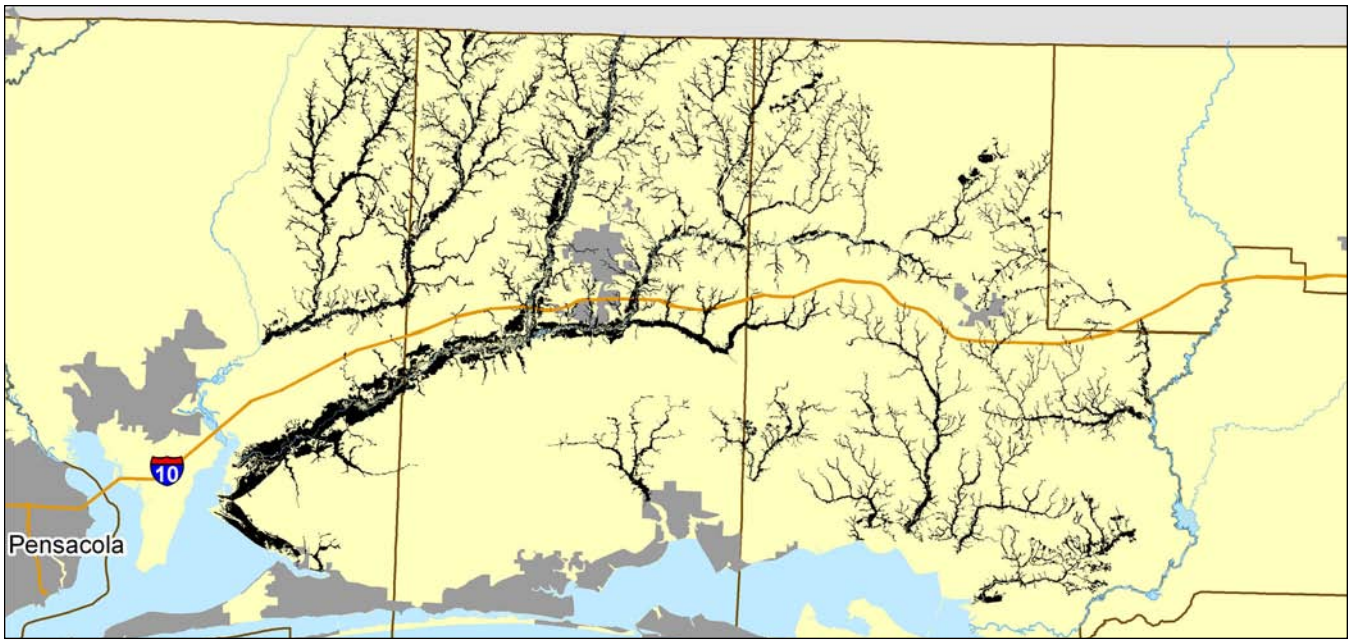

Figure 15 *Potential-habitat map for pine barrens tree frog.*

habitat preferences (Means, 1992). It occupies acid seepage bogs, which occur in areas with a clay substrate overlain with well- to excessively drained sandy soils. As rain falls and passes through the surface sands, it reaches the impenetrable clay substrate and moves laterally until it seeps out along hillsides or stream cuts. A unique community of wetland plants and animals, including the pine barrens tree frog, occupies these seepage bogs.

All location information was collected and digitized from maps maintained by Paul Moler of the FWC. We also used an additional nine FLEO database records (1994–1998) not identified by the maps.

We selected bay swamp, cypress/pine/cabbage palm, and mixed wetland forest from the FWC 2003 land-cover image to represent habitats used by the pine barrens tree frog. We limited potential habitat to those subwatershed hydrologic units (Florida Natural Resources Conservation Service, unpublished data) containing a pine barrens tree frog location (Figure 15).

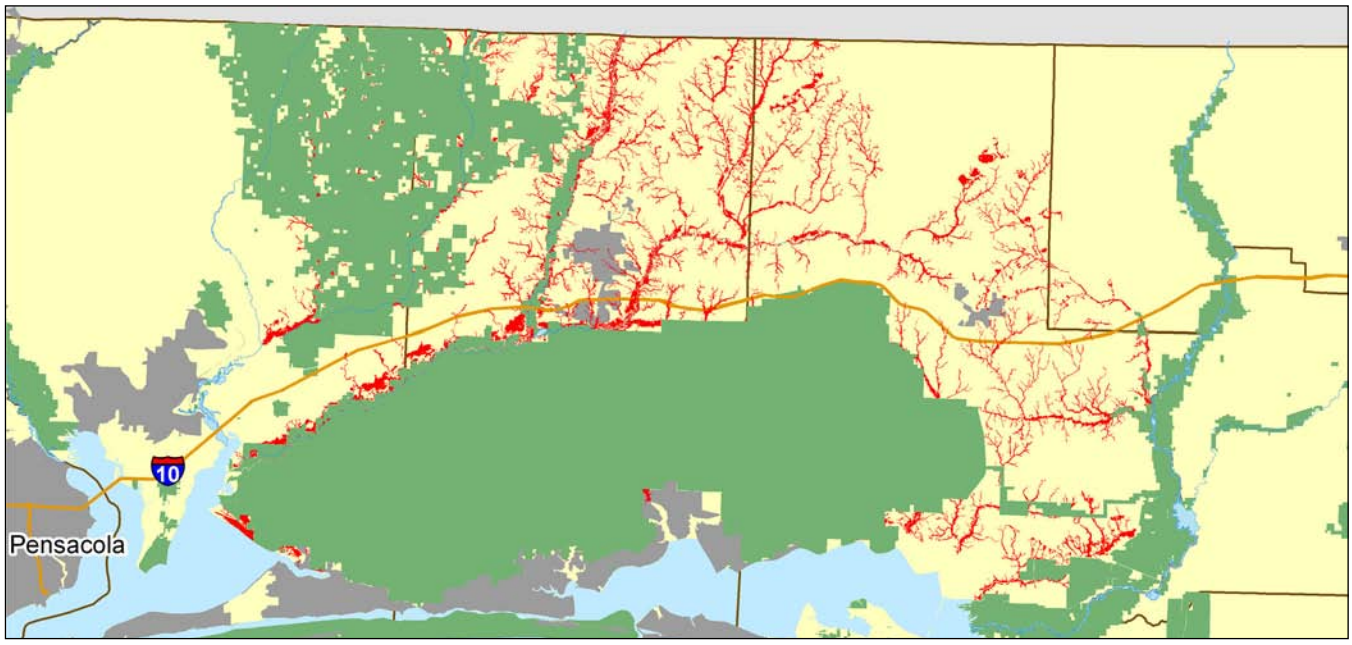

Figure 16 *Proposed Strategic Habitat Conservation Areas for pine barrens tree frog.*

Additionally, all forested habitats within 90 m of a location record were identified as potential habitat.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The baseline growth rate for the metapopulations in these models was 0.9979, which made both models quite sensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years under these baseline demographic parameters was 0%, but the model run on all potential habitat showed a high probability of a decline (*i.e.,* 54% probability of a 60% decline). Approximately 48% of the potential habitat was on managed lands, which resulted in a much smaller abundance than the model using all potential habitat. Given the reduced abundance on managed lands, an increased risk of a decline was evident (*i.e.,* 94% probability of a 60% decline), but the risk of extinction remained 0%.

Because of the large risk of decline in abundance for this species, SHCA identified for this species include all privately owned habitat areas identified in the potential-habitat map (Figure 16). Although further land acquisition is needed, even if all potential habitat is managed for conservation, PVA results show a high probability of population decline. This suggests the usefulness of further conservation efforts (*e.g.,* habitat restoration).

RIM ROCK CROWNED SNAKE

Kenneth Krysko

Little is known about the rim rock crowned snake (*Tantilla oolitica*). It occurs in Dade and Monroe counties, but its existence in theLower Keys is unconfirmed (P. Moler, personal communication; Campbell and Moler, 1992). *Tantilla oolitica* is a burrower, commonly found beneath slash, rocks, or litter in a variety of habitats with sandy or rocky soils, including pine flatwoods, tropical hardwood hammocks, and shrub and brushland (Campbell and Moler, 1992). It is listed by the FWC as threatened because of the rapid depletion of habitat throughout its described range.

We constructed the potential-habitat map using the FWC 2003 land-cover image and a data layer of ecoregions of Florida (Bailey, 1998; Figure 17). Eleven occurrence records exist for the rim rock crowned snake in the FLEO database, the most recent record documented in 1991. Based on the location of these occurrences, we limited all analyses to the Miami Ridge–Coastal Islands ecoregion within Monroe and Dade counties. First, we selected mixed hardwood pine forest, hardwood hammocks and forest, pineland, and tropical hardwood hammock land-cover categories from the FWC 2003 land cover to represent the primary habitat areas for this species. Additionally, we selected all dry prairie, shrub and brushland, unimproved/woodland pasture, exotic plants, and Australian pine habitats within 120 m of any primary habitat and merged with the primary habitat layer. This identified secondary habitats in proximity to primary habitat areas. In the final step, we selected those habitat blocks in and within 120 m of the Miami Ridge–Coastal Islands ecoregion. We did not perform map verification for this species.

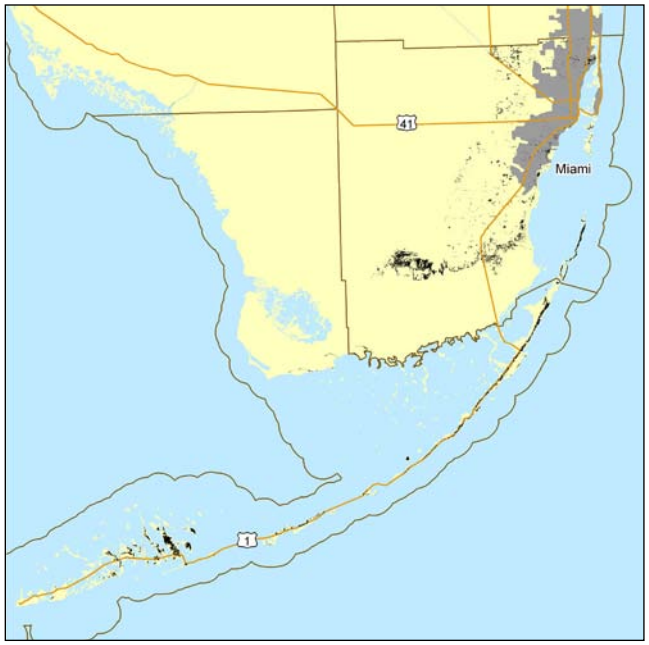

Figure 17 *Potential-habitat map for rim rock crowned snake.*

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The baseline growth rate for both these models was 1.0254. Sensitivity analyses of these baseline models indicated that adult survival was the most influential parameter. Assuming no changes, the probability that *T. oolitica* would become extinct during the next 100 years was 0% in both models. A noticeable reduction in the overall abundance manifested in the model run on only managed lands. Only 56.9% of the potential habitat was categorized as managed. Given little risk of decline in abundance on managed-lands habitat, we did

not identify SHCA for this species. By proxy, SHCA identified for the Florida Keys–restricted species as well as portions of SHCA for the short-tailed hawk and Florida panther would aid the rim rock crowned snake.

SALT MARSH SNAKES

ATLANTIC SALT MARSH SNAKE

USFWS

Salt marsh snakes (*Nerodia clarkii*) are among the few North American reptiles adapted to estuarine environments (Kochman, 1992a). The Atlantic salt marsh snake (*N. c. taeniata*) is one of three salt marsh snakes occurring in Florida. Subspecies are identified by the dorsal pattern of 4 rows of stripes or dark blotches running head to tail (USFWS, 1993). The Atlantic salt marsh snake is gray to pale olive with black partial stripes that break up posteriorly into rows of spots.

Nerodia c. taeniata occurs only on the east coast of Florida and is likely to be restricted to the salt marshes of Volusia County (Kochman, 1992a; USFWS, 1993). South of Volusia County this species intergrades with the more common mangrove salt marsh snake (*N. c. compressicauda*) in the marshes of Brevard and Indian River counties. Development pressure resulting in habitat loss and salt-marsh alteration caused by draining, diking, and impoundments, precipitates hybridization with freshwater snakes. These are the primary reasons the Atlantic salt marsh snake is listed as threatened (Kochman, 1992a; USFWS, 1993).

We developed the potential-habitat map for the Atlantic salt marsh snake based upon the FWC 2003 land-cover image (Figure 18). Salt marsh, mangrove swamp, and tidal-flat land-cover categories that fell south of Halifax creek, east of the Kennedy Boundary Parkway, and west and north of Launch Pad 39B in John F. Kennedy Space Center were identified as potential habitat. We conducted an aerial survey of predicted potential-habitat areas to confirm that these areas appeared to be appropriate habitat for *N. c. taeniata.*

We ran two PVA models, one on all potential habitat and one on only potential habitat located on managed lands. The baseline growth rate for both of these models was 1.0326, which made them quite sensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years identified for both models was 0%, but a high probability of decline in abundance was evident (*i.e.,* 39% probability of a 50% decline) in both models.

Figure 18 *Potential-habitat map for Atlantic salt marsh snake.*

Because of the large probability of a decline in abundance, we identified SHCA. Strategic Habitat Conservation Areas identified for the Atlantic salt marsh snake includes all privately owned patches of potential habitat >1 ha (Figure 19). The size criterion

Figure 19 *Proposed Strategic Habitat Conservation Areas for Atlantic salt marsh snake.*

of 1 ha or greater was used to focus protection (in the form of SHCA identification) on the larger patches of potential habitat. Some manual cleanup of the SHCA map was necessary because of data incompatibility and digitizing errors in the FLMA database.

GULF SALT MARSH SNAKE

The Gulf salt marsh snake (*N. c. clarkii*) is tan with dark brown to black stripes that run completely down its body. In Florida, it occurs in saline habitats along the gulf coast from the Alabama border to the vicinity of Cedar Key (Kochman, 1992b) where it intergrades with the more common mangrove salt marsh snake

FWC

(Kochman, 1992b). The Gulf salt marsh snake is unlisted in Florida but is considered to be rare.

Thirty-two location records are available for this species. Thirty records exist in the FLEO database (dates from 1957 to 1996) and two exist in the WildObs database (1993 and 2005).

The potential-habitat map identified all appropriate habitats for the Gulf salt marsh snake based upon the FWC 2003 land-cover image. We selected all salt marsh, mangrove swamp, and tidal flat habitats along the gulf coast east of the Alabama border and north of the Withlacoochee River entrance from the FWC 2003 land-cover image as potential habitat (Figure 20).

Fifteen of the 32 occurrence records were located in areas identified as potential habitat. The maximum distance between a record and potential habitat was 1,761 m (mean = 129 m).

We ran two PVA models, one on all potential habitat and one on only potential habitat located on managed lands. The baseline growth rate for both of these models was 1.0326, which made them quite sensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years identified for both models was 0%, but a high probability of decline in abundance was evident (*i.e.*, 39% probability of a 50% decline). Approximately 74% of the potential habitat was on managed lands, making the population smaller than for the metapopulation with all potential habitat.

Given the large risk of decline in abundance reported by the PVA, we identified SHCA. Strategic Habitat Conservation Areas identified for the Gulf salt marsh snake included all privately owned habitat patches >1 ha (Figure 21). We used the size criterion of 1 ha or greater to focus protection (in the form of SHCA identification) on the larger patches of potential habitat. Some manual cleanup of the SHCA map was necessary because of data incompatibility and digitizing errors in the FLMA database.

Figure 20 *Potential-habitat map for Gulf salt marsh snake..*

Figure 21 *Proposed Strategic Habitat Conservation Areas for Gulf salt marsh snake*

SAND SKINK

FWC

The sand skink (*Neoseps reynoldsi*) is a fossorial lizard that prefers open, well-drained, exposed sandy soils free of ground-covering grasses. The sand skink is restricted to the Lake Wales, Mount Dora, and Winter Haven ridges in central Florida. This species is ubiquitous on the Lake Wales and Winter Haven ridges where natural habitats remain, but many of these areas are unprotected and threatened by future development (Christman, 1992c). *Neoseps reynoldsi* is well adapted for life in loose subsurface sands—its vestigial front legs are tiny, with only one toe, and the rear legs

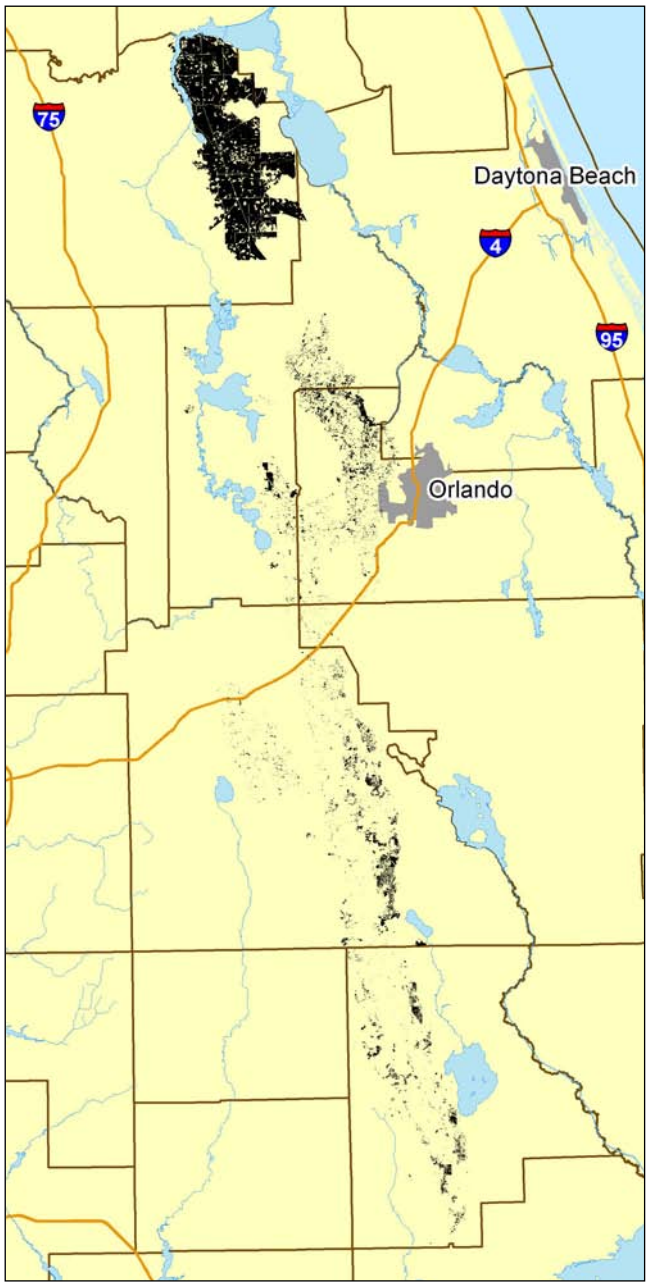

Figure 22 *Potential-habitat map for sand skink.*

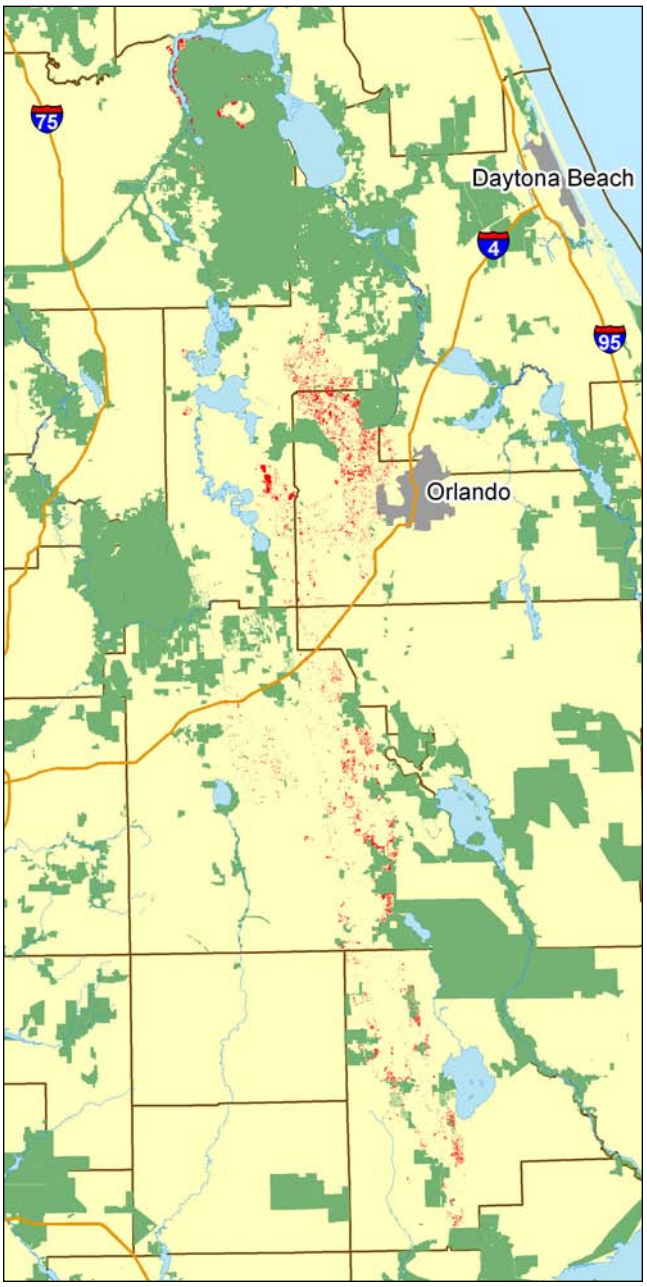

Figure 23 *Proposed Strategic Habitat Conservation Areas for sand skink.*

are only slightly larger, with two toes (Christman, 1992c). The specialized body of the skink consists of a wedge-shaped head and small grooves into which the forelegs can be retracted to optimize its "sand-swimming" locomotion. The FWC and USFWS list the sand skink as threatened.

One hundred and fifty-nine records exist for *N. reynoldsi:* 131 FLEO database records (1952–1998) and 28 locations obtained from FWC staff (Paul Moler). The potential-habitat map was created by using the FWC 2003 land-cover image, a physiographic map of Florida (Puri and Vernon, 1964), and the SSURGO database (Figure 22). We used the SSURGO database to identify appropriate soils in or within 1 km of any recorded location or within Lake Wales, Mount Dora, and Winter Haven ridges. Ridge delineation was derived from the physiographic map of Florida. We used the 1-km buffer to identify appropriate areas in proximity to a recorded location or ridge. Using the FWC 2003 land-cover image, we removed all identified areas classified as dry prairie, wetland plant community, marine and estuarine, aquatic, or disturbed community.

The potential-habitat map for this species includes more than 83,000 ha, of which almost 65,000 ha are on managed lands (77%). Appropriate PVA analysis of this species was not possible because of limitations of the PVA software, which analyzed only up to 500 populations. Because of the patchiness of the sand skink habitat map, the 500-population limit is exceeded. As a result, we relied on survey data and expert opinion in our decision to identify SHCA for this species. Because the sand skink is a threatened species, and high levels of development have resulted in habitat loss throughout its range, we identified SHCA for this species (Figure 23). Strategic Habitat Conservation Areas identified for this species include all privately owned habitat areas identified in the potential-habitat map.

SEAL SALAMANDER

Kevin Enge

The seal salamander (*Desmognathus monticola*), lacking lungs, exchanges gases across its skin. For respiration to be effective, their skin must be moist and permeable, which makes them susceptible to dehydration. As a result, *D. monticola* requires continuously moist microhabitats. Extensive past and current sampling efforts in Florida have resulted in only one location of *D. monticola:* five small and continuously wet spring-seepage ravines associated with Canoe Creek in Escambia County (B. Means, personal communication). Outside Florida the main population centers for this species are in the southern Appalachian Mountains. The closest known population to Florida's population occurs 30 miles to the north in Georgia. The seal salamander is unlisted but is considered to be rare in Florida.

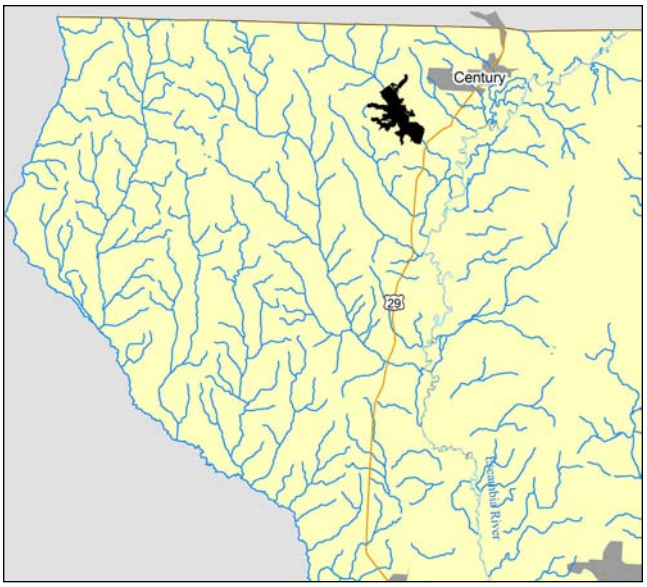

Figure 24 *Potential-habitat map for seal salamander.*

To generate the potential-habitat map, we selected all forested habitats in the FWC 2003 land-cover image that are either <200 m in elevation or <150 m from Canoe Creek south of Bratt Road (the northern border) and the powerline just north of Highway 29 (the southern border; Figure 24). This area encompasses all five spring seepages and includes the nearby upland forested areas.

No part of the potential habitat fell on managed lands. Because of this, only one PVA model was run on the entire potential-habitat map. The baseline growth rate for the population in the model was 1.0170, which made it moderately sensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years under baseline demographic parameters was 0%, and the probability of a decline was low (*i.e.,* 5% probability of a 20% decline). However, because no potential habitat is under any level of conservation protection, SHCA were identified for this species. Strategic Habitat Conservation Areas include all mapped potential habitat (Figure 25).

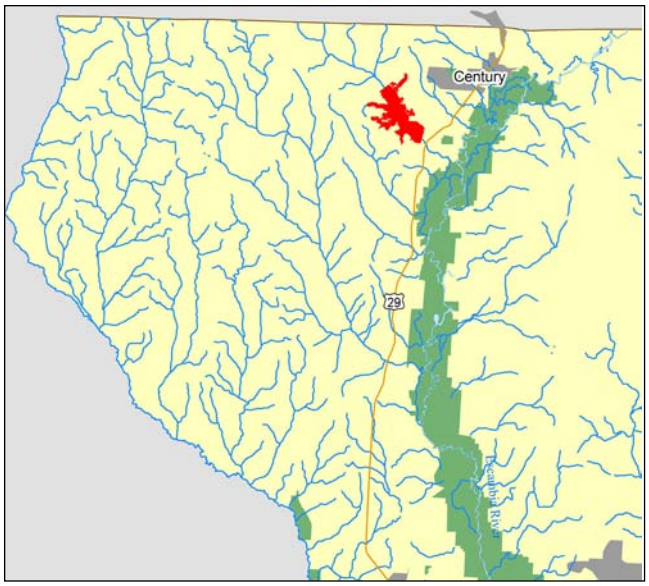

Figure 25 *Proposed Strategic Habitat Conservation Areas for seal salamander.*

STRIPED MUD TURTLE (LOWER KEYS POPULATION)

USFWS

The striped mud turtle, *Kinosternon baurii,* is a small, aquatic turtle found from eastern Virginia south to the Florida Keys along the Atlantic Coastal Plain (Iverson, 1992). Historically, taxonomists considered the lower Florida Keys population to be a separate subspecies (*K. baurii baurii;* Stejneger, 1925), but recent DNA analyses found no significant genetic differences between upper Florida Keys or mainland Florida populations and the lower Florida Keys population (Karl and Wilson, 2001). Nonetheless, the Lower Keys population of striped mud turtle is isolated from the rest of Florida by a more than 10 km expanse of open seawater. The turtle is another member of the unique community of species occupying the lower Florida Keys that warrants protection. The FWC currently lists the Lower Keys population of *Kinosternon baurii* as endangered because of its isolation and habitat loss (Lazell, 1989).

The Lower Keys population of *Kinosternon baurii* is highly specialized for life in temporary ponds (Dunson, 1992) with salinities less than 15 ppt. If pond salinity is greater than 15 ppt, striped mud turtles will leave to find other ponds or will find suitable terrestrial retreats such as rock ledges or tree roots. The turtles display site fidelity to ponds, returning repeatedly to the same pond throughout their life.

Historical records of this species came from the FLEO database (n = 21) dated 1951–1991. The habitat features described for the striped mud turtle cannot be adequately assessed using currently available GIS data sets. Therefore, the potential-habitat map created is very general in design. We identified potential habitat for the striped mud turtle using the FWC 2003 land-cover image (Figure 26). We selected all areas classified as pineland, tropical hardwood hammock, and freshwater marsh and wet prairie west of the Seven-mile

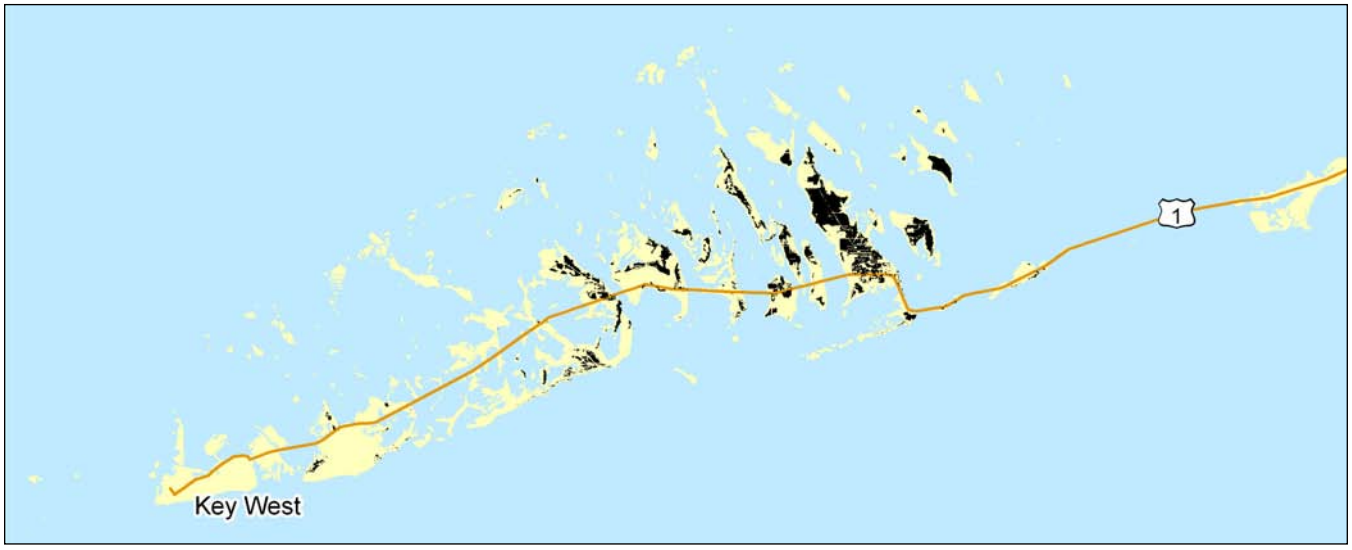

Figure 26 *Potential-habitat map for striped mud turtle (Lower Keys population).*

Bridge as potential habitat. We did not verify the generated map.

The habitat map identified approximately 2,539 ha of potential habitat, about 64% of which are on currently managed lands. For PVA, we ran baseline, optimistic, and pessimistic models for all potential habitat and for only potential habitat located on managed lands.

The baseline growth rate for the models was 1.0043. Assuming no changes, a 0% probability of extinction was evident in the next 100 years for both the models with all potential habitat and just those on managed lands. The risk of decline in abundance was very small, with only a 6%–7% probability of a 20% decline in abundance reported for both models. However, a noticeable reduction in overall abundance occurred when we considered only potential habitat on managed lands, which reflects a reduction in carrying capacity.

Based on these PVA results, management and research on the striped mud turtle should focus on survival rates, because these parameters had the greatest influence on long-term trends. We did not identify SHCA for this species. Strategic Habitat Conservation Areas identified for other Florida Keys species encompass areas used by the striped mud turtle.

STRIPED NEWT

FWC

Striped newt

FWC

Striped newt paedomorph

A rare and enigmatic component in southern pine forests, the striped newt (*Notophthalmus perstriatus*) is endemic to Florida and southern Georgia (Christman and Means, 1992). They are restricted to xeric upland habitats (sandhill and scrub communities) and breed in sinkhole, cypress, or bay ponds lacking predaceous fish (Christman and Means, 1992; Franz and Smith, 1999; Johnson and Owen, 2005). Since the species was first described, striped newt populations have been in decline (Dodd and LaClaire, 1995; Franz and Smith, 1999). Recent surveys assessed striped newt localities in Florida (Franz and Smith, 1999; Johnson and Owen, 2005). Of the 51 historic newt sites visited by Johnson and Owen (2005), only 29 obtained a habitat rank of excellent or good, and relative abundance of *N. perstriatus* is low at most sites where the species persists. Currently unlisted, the biological status of the striped newt is under review by the USFWS.

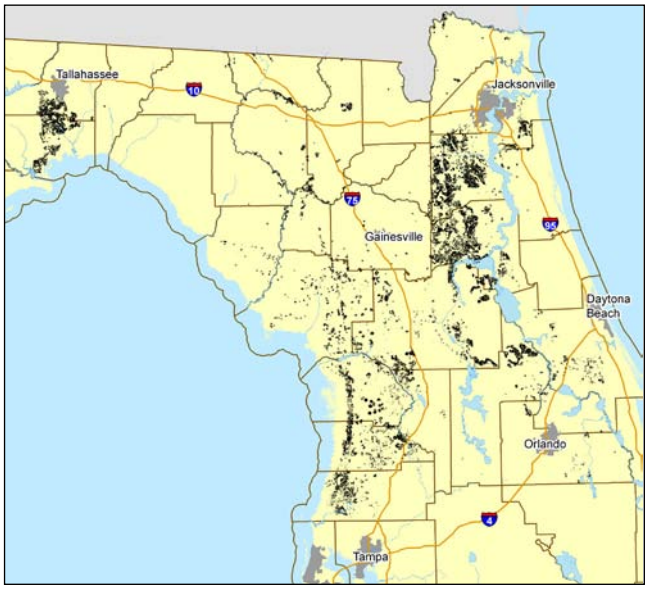

Figure 27 *Potential-habitat map for striped newt.*

Location data used in the model for these newts came from a variety of sources: 59 FLEO database records, 45 records obtained from Johnson and Owen (2005), 16 records obtained from Means and Means (1998), and 14 WildObs records. We constructed the potential-habitat map by using the FWC 2003 land-cover image (Figure 27). Analysis was limited to Florida, including areas east of the Ochlockonee River and north of Hillsborough, Polk, Osceola, and Brevard counties. Potential habitat in the FWC 2003 land-cover data was mapped based on rules established for each of three habitat categories: bay swamp, cypress swamp, and open water (used for breeding); primary upland (sandhill); and secondary upland (xeric oak scrub, sand pine scrub, hardwood hammocks and forests, pinelands, and shrub and brushland). Breeding habitat was limited to habitat patches that were smaller than 9 ha and contiguous to upland habitats. Nine ha is the esti-

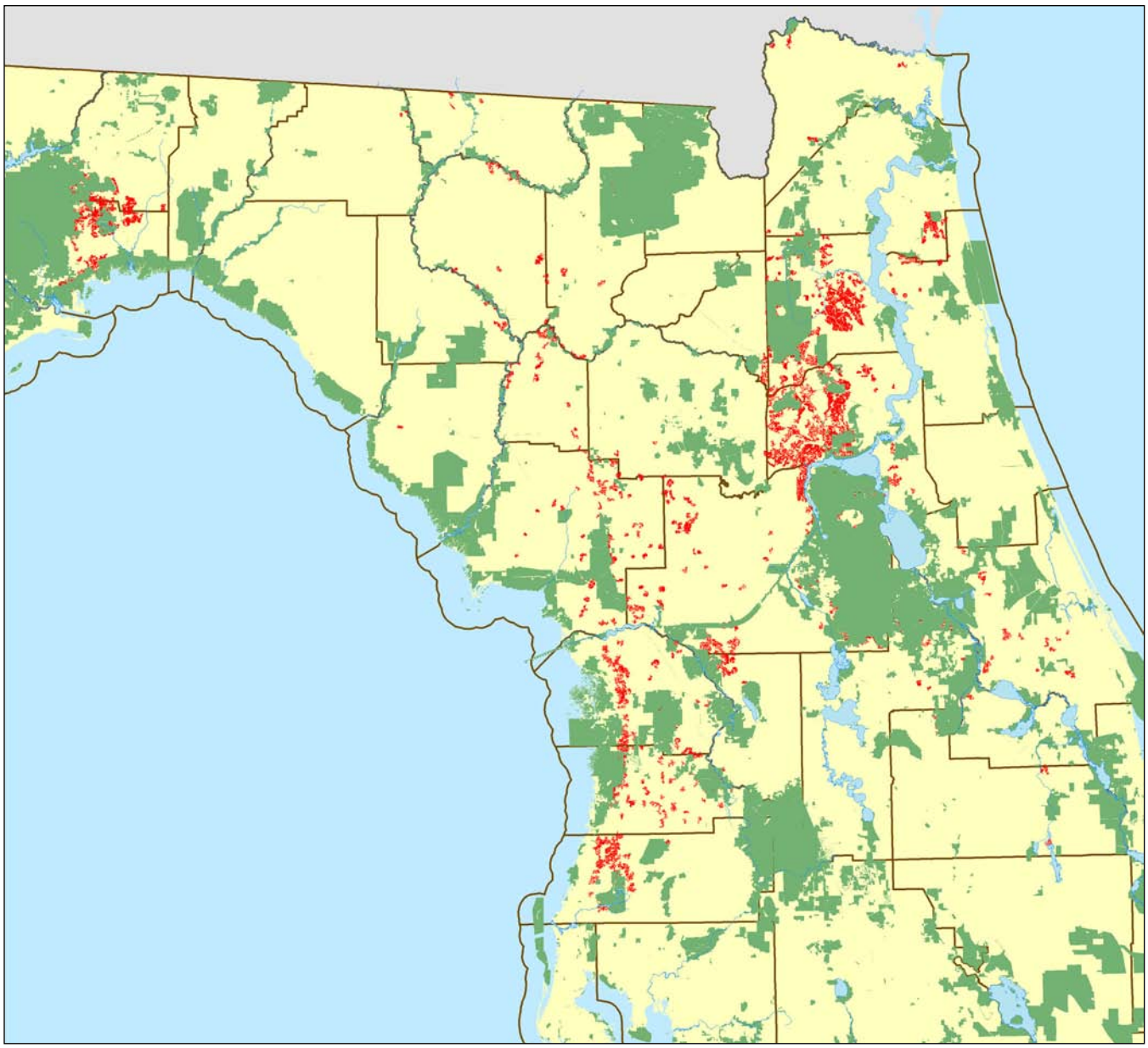

Figure 28 *Proposed Strategic Habitat Conservation Areas for striped newt.*

mated area of the largest pond (Smith Lake pond) known to have striped newts. Newts will use mesic flatwoods as long as they are within 500 m of xeric uplands (K. Enge, personal communication), and Johnson (2003) recommended 1,000 m as a "core habitat" distance of uplands from breeding ponds. Therefore, primary upland habitats in the potential-habitat map included those areas contiguous to (via all upland habitats) and within 1,000 m of bay and cypress swamp breeding habitat. Secondary upland habitats in the potential-habitat map included those areas that were contiguous to and within 500 m of primary upland habitat and within 1,000 m of bay and cypress swamp breeding habitat. We merged the selected areas of the three habitat categories to create the potential-habitat map for striped newts.

Appropriate PVA analysis of this species was not possible because of limitations of the PVA software. As a result, we relied on recent survey data and expert opinion in the decision to identify SHCA for this species. The results of Johnson (2003) demonstrated a significant reduction in the quality and availability of striped newt habitat. Of the 244,576 ha of potential habitat identified for striped newt, only 38% (94,800 ha) is located on managed lands. Johnson and Owen (2005) state that relative abundance is low where the newt per-

sists. Striped newts are vulnerable to a wide variety of threats including ditching, draining, and destruction of their breeding ponds; the degradation of the surrounding uplands that is due to fire suppression; and habitat loss that is due to urban and agricultural development. Given the documented decline of the striped newt abundance statewide, recent reduction of quality and availability of newt habitats, and the small percentage of potential habitat that is currently protected, we concluded to identify SHCA (Figure 28).

The potential-habitat map for the striped newt includes all areas that meet the criteria outlined above, regardless of individual habitat-patch size. For SHCA, we identified potential-habitat patches that were >79 ha on privately owned lands. We derived the threshold of 79 ha using a distance estimate identified by Johnson (2003), who observed that a majority (80%) of all newts do not move >500 m from a breeding pond. A circle with a 500-m radius would be roughly 79 ha.

Birds

BLACK SKIMMER

USFWS

Of the world's three skimmer species, only the Black Skimmer (*Rynchops niger*) occurs in the Americas. The Black Skimmer ranges along the Atlantic and gulf coasts from Massachusetts to Texas and through Central and South America. They may occasionally wander inland or be blown there by the winds of summer storms, but most remain along coastal beaches and bays (Tveten, 1993).

Skimmers are tactile feeders and are the only birds whose lower mandibles are longer than the upper. When the lower mandible touches a fish, the upper bill instantly snaps shut. Tactile feeding enables skimmers to forage at night or in low-light conditions. Skimmers are also active during the day, especially when feeding their young (Gochfeld and Burger, 1994). Skimmers forage in still, shallow water along beaches and in sheltered salt marshes and estuaries (Loftin, 1996).

Black Skimmers nest on open sandy beaches with sparse or no vegetation and often nest in clusters within

FWC

larger tern colonies (FWC, 2005b). Nesting with other species may reduce egg predation. The loss of habitats along coastal areas that is due to urban development has resulted in skimmers selecting alternate nest sites such as on rooftops (Loftin, 1996; Coburn *et al.,* 2001), in parking lots (Tveten, 1993), or farther inland (Langridge and Hunter, 1986, as cited by Loftin, 1996).

From 1998–2000, FWC biologists annually surveyed all breeding sites of 13 species of seabirds, including Black Skimmers, in coastal Florida (Gore *et al.,* 2007). The surveys identified a mean of 1,689 nesting pairs of Black Skimmers. They were found at 38 different ground-colony locations during the 3-year study (mean of 22). This represents a potential decline of 24.9% from the Florida population size estimated by Clapp *et al.* (1983). The surveys also found a mean of 147 breeding pairs at 14 rooftop sites, which was once considered to be a rare phenomenon. This large number of rooftop nesting sites represents over half of all colonies of Black Skimmers in Florida. However, the roof sites typically supported only small colonies of skimmers consisting of 9% of all breeding pairs of Black Skimmers in Florida. The existing data suggest a large decline in the population of skimmers in Florida in the last 20 years (Gore *et al.,* 2007).

To identify potential habitat for the Black Skimmer, we first reclassified the FWC 2003 land-cover image to retain only coastal strand and sand/beach, the primary nesting/breeding habitats for this species. Next, we refined the map by only identifying those areas within proximity to the 38 Black Skimmer ground colony sites observed in the 1998–2000 seabird surveys (Figure 29). To do this, we manually selected these areas using DOQQs as a guide to identify areas not extensively modified by human development. Species experts verified that the maps properly identified the habitats as being appropriate for Black Skimmers.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Results of the PVA on all potential habitat indicated no probability of extinction of the species in the next 100 years under baseline demographic parameters and only a small chance of a small decline in abun-

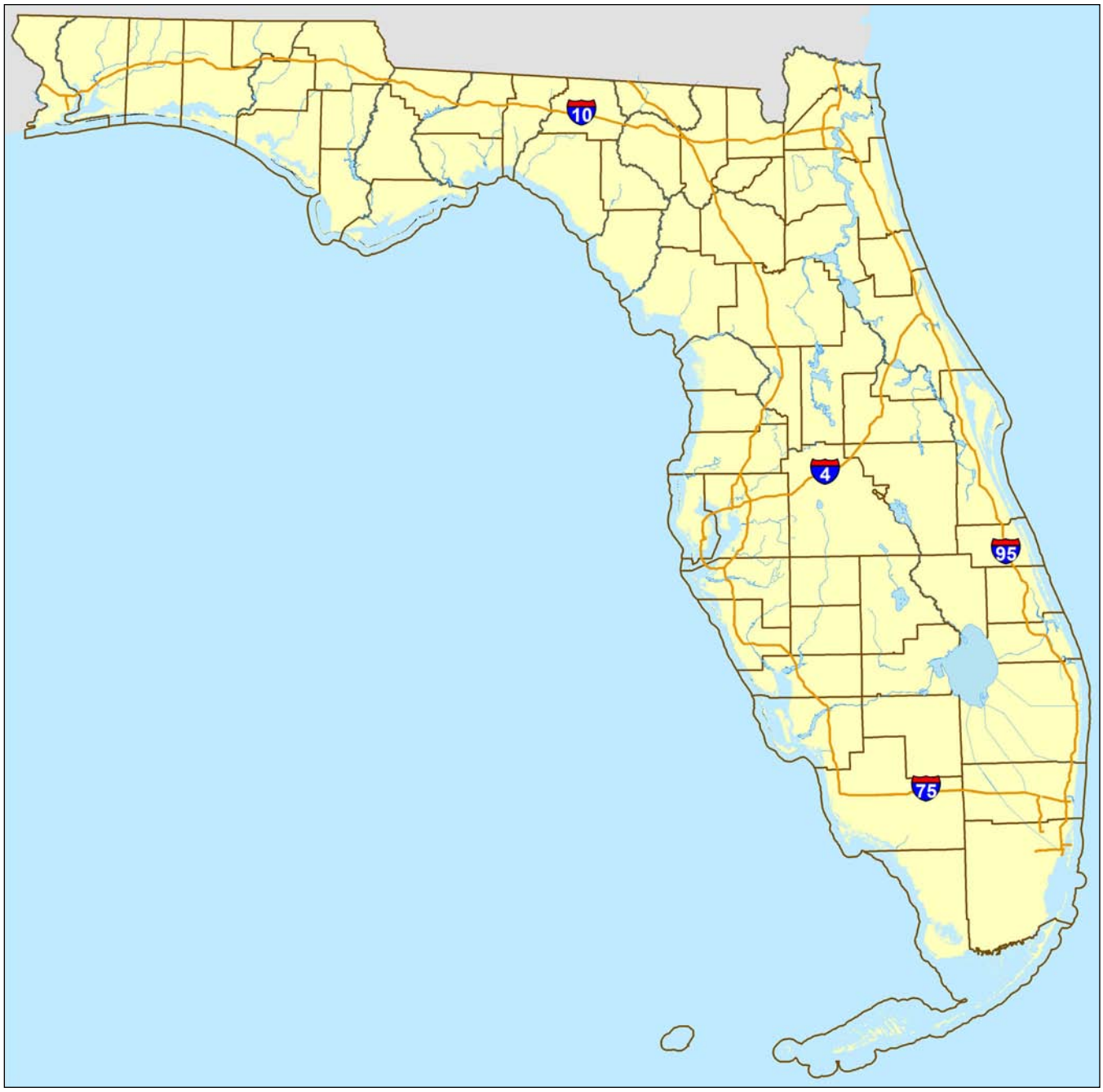

Figure 29 *Potential-habitat map for Black Skimmer.*

dance (*i.e.,* the probability of a 25% decline was approximately 11%). The results of the PVA on managed habitat (approximately 66% of the potential habitat) indicated 0% probability of extinction of the species in the next 100 years and a 28% probability of a 25% decline in abundance. Based on the low probabilities of extinction and decline, we did not identify SHCA for this species.

The PVA indicated that the predictions changed sharply with only small changes in adult survival or fecundity. Although the PVA does not account for changes in human population growth and its consequences, human population in Florida is expected to increase. Given the temporal/spatial concentration of skimmers and their low tolerance for human disturbance (especially at the nesting site), it seems reasonable that adult survival and fecundity would decline during the next 100 years, resulting in a greater extinction risk than we identified (J. Gore, personal communication).

BLACK–WHISKERED VIREO

Brian Millsap

Figure 30 *Potential-habitat map for Black-whiskered Vireo.*

The Black-whiskered Vireo (*Vireo altiloquus*) breeds extensively throughout the Caribbean Basin, and southern Florida is within the northernmost extent of its breeding range. This species is generally considered to be a mangrove specialist in Florida (Chace *et al.*, 2002), but it also inhabits hammocks and other hardwood areas that border mangroves (Merritt, 1996). However, within its core range, *V. altiloquus* prefers subtropical dry limestone and mesic lowland forests to mangroves. Although recent information is lacking regarding the population size and trend of *V. altiloquus* in Florida, Cox (1987) reported no significant population changes between 1969 and 1983. However, major threats to the species include nest parasitism by cowbirds (*Molothrus ater* and *M. bonariensis*) and loss of mangrove habitats along the Florida coastline. Black-whiskered Vireos are not currently listed as endangered, threatened, or a species of special concern by the FWC or USFWS.

Potential-habitat analysis was limited to EMAP hexagons where BBA blocks contained confirmed or probable breeders (n = 92) or where FLEO database records (n = 50) indicated breeding behavior or nest sites. Within these hexagons we identified potential habitat by isolating mangrove swamps and hardwood hammocks and forests within 100 m of mangrove swamps using FWC 2003 land-cover image (Figure 30).

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The baseline growth rate for these models was 1.0097, which made them sensitive to small changes in survival and fecundity. The probability of extinction in the next 100 years under baseline demographic parameters was 0% for both models, and little risk of a large decline in abundance was evident (*i.e.*, an 8% probability of a 50% decline in abundance under either scenario). Because of the low probabilities of extinction and low probabilities of large declines in abundance, we did not create SHCA for this species.

COOPER'S HAWK

Cooper's Hawks (*Accipiter cooperii*) breed in Florida as far south as Glades and Lee counties, and northern migrants occur throughout Florida in fall, winter, and spring (Layne, 1986; Toland, 1996). They occur in almost any habitat containing trees and shrubs and adequate prey. Preferred nesting habitat consists of deciduous, mixed, and evergreen forests and deciduous stands of riparian habitat interspersed with openings (Rosenfield and Bielefeldt, 1993; Toland, 1996). Because systematic surveys have not been conducted, recent population size and trends are unknown. Cooper's Hawks are tolerant of human disturbance and habitat fragmentation and can breed successfully in suburban and urban settings (Rosenfield and Bielefeldt, 1993); however,

Jay Exum

Toland (1996) reported that nesting individuals rarely tolerate human disturbance and prefer to nest in dense, closed-canopy forested areas. Historically, threats to the species were believed to be the use of pesticides and persecution by humans. Although these threats continue, loss of suitable nesting habitat is likely to be the most immediate threat in the 21st century. The FWC does not currently list the Cooper's Hawk as endangered, threatened, or a species of special concern.

We limited the potential-habitat analysis to the entire land area of Florida north of the southern distribution boundary reported in Toland (1996). Within this range, we used the technique described by Cox and Kautz (2000) to analyze potential habitat. From the FWC 2003 land-cover image, we identified large (>20 ha) patches of nest-site habitat (mixed hardwood–pine, hardwood hammocks and forests, tropical hardwood hammock, cabbage palm–live oak hammock, bay swamp, and hardwood swamp) that fell within areas containing three or more preferred habitat cover types (xeric oak scrub, dry prairie, shrub and brushland, grassland, improved and unimproved pastures, and agriculture, sand pine scrub, sandhill, pinelands, mixed hardwood–pine, hardwood hammocks and forests, tropical hardwood hammock, cabbage palm–live oak hammock, bay swamp, cypress swamp, cypress/pine/cabbage palm, mixed wetland forest, hardwood swamp, bottomland hardwood forest) located within 300 m of each other. The final potential-habitat map consisted of patches of nest-site habitat within a diverse mosaic of preferred habitats within 300 m of these nesting habitat patches (Figure 31). The potential-habitat map contained more than 3.5 million ha, of which almost 780,000 ha are on managed lands (approximately 22% of the total).

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The baseline growth rate in both of these models was 0.985, which means that slight changes have noticeable impacts on the final abundance and on the risk of a decline. PVA results indicated that the probability of extinction in the next 100 years under baseline demographic parameters was 0% in both analyses.

Figure 31 *Potential-habitat map for Cooper's Hawk.*

Figure 32 *Proposed Strategic Habitat Conservation Areas for Cooper's Hawk.*

The risk of a large decline, though, was very large: the risk of a 90% decline in abundance was 21%–22% in the next 100 years, and the probability of a 50% decline was 96%–97%. A noticeable reduction in the abundance occurred when only managed habitat was considered because the carrying capacity was effectively reduced by 75%. Because of the high risk of decline in abundance, we identified SHCA for this species. Strategic Habitat Conservation Areas included the large nest site habitat patches described above (Figure 32).

CRESTED CARACARA

Jay Exum

Florida's population of Crested Caracaras (*Caracara cheriway*) is limited to the south-central region of the peninsula, where nesting and foraging habitats include grassy prairies and pastures that are interspersed with small wetlands or streams and small clumps of live oak (*Quercus virginiana*), cabbage palm (*Sabal palmetto*), and cypress (*Taxodium*). Caracaras are frequently found in improved pastures and grasslands managed principally for cattle grazing (Morrison, 1996). Based on historic records, Layne (1996) reported that caracaras were "considerably more abundant" prior to the 1940s and that the major reason for the subsequent decline in abundance was the conversion of natural prairie habitat to agricultural and urban development. The FWC and USFWS currently list Crested Caracaras as threatened.

We identified potential habitat for Crested Caracaras within their known range in south-central Florida (Figure 33). We determined this range by identifying EMAP hexagons where Florida BBA blocks contained records that indicated confirmed or probable breeding activity (n = 139) or where FLEO database records (n = 216) or WildObs database records (n = 605) indicated breeding behavior or nest sites. We also used additional nest-site locations provided by J. Morrison (n = 84, unpublished data) to define the species' distribution. Within this range, primary nesting and foraging habitats (dry prairie and improved pasture) were identified from the FWC 2003 land-cover image. The potential-habitat map contained more than 980,000 ha, of which less than 150,000 ha (15%) is on managed lands.

The potential-habitat map for this species probably overestimates the amount of appropriate habitat because of this species' tendency to prefer open areas with a mosaic of small wetlands and nesting and perching habitats that are frequently single trees. Neither of these habitat characteristics can be distinguished from available habitat maps.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Results indicated that the probability of extinction in the next 100 years under baseline demographic parameters was 0% and the chance of a decline was also 0%. A noticeable reduction in abundance occurred when only managed-lands habitat was considered because the carrying capacity was effectively reduced by 85%, although the risks did not increase noticeably based on the PVA.

No SHCA are proposed for this species. However, given the large reduction in overall abundance identified when only managed lands are considered, protecting additional habitat for this species is encouraged. Humphrey and Morrison (2000) concluded that occupancy and nesting on public lands is not "consistent or predictable" when compared with private ranch lands within the species' range. Thus, private landowner incentives may go a long way in protecting habitat for this species.

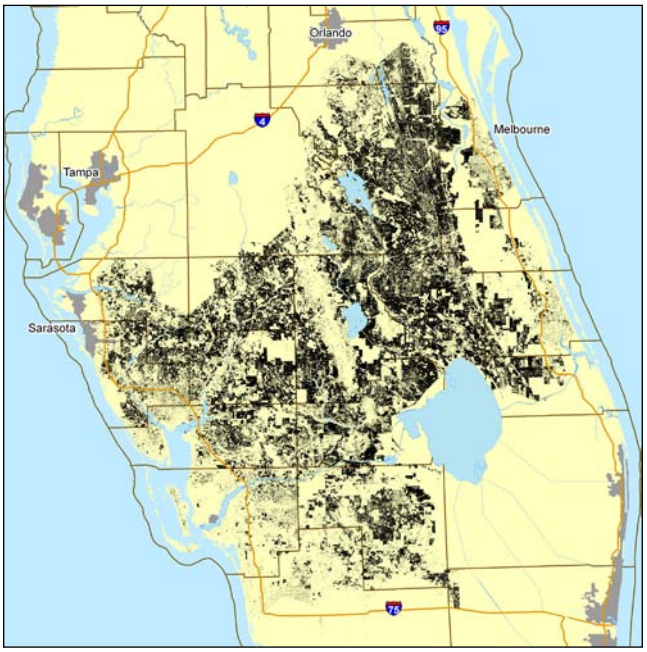

Figure 33 *Potential-habitat map for Crested Caracara.*

CUBAN SNOWY PLOVER

Alex Kropp

Snowy Plovers (*Charadrius alexandrinus*) are small shorebirds found throughout the United States along coastal beaches, inland mudflats, salt flats, and alkali-lake habitats. Two North American subspecies of Snowy Plovers have been described: the Western Snowy Plover (*C. a. nivosus*), which occurs west of the Rocky Mountains and in coastal areas of the western Gulf of Mexico; and the Cuban Snowy Plover (*C. a. tenuirostris*), which occurs in coastal areas of the Gulf of Mexico east of Louisiana and in northern Yucatán and the West Indies (Page *et al.,* 1995). Blake (1977) questioned the validity of *C. a. tenuirostris;* however, more recent work has identified genetic differences between the western and eastern plover populations (Gorman, 2000), and there is now little doubt that *C. a. tenuirostris* represents a distinct population (LaMonte *et al.,* 2005). Some Florida breeders migrate from the state, and others move from their breeding areas to other coastal locations in Florida for winter (Page *et al.,* 1995). Along the sandy beaches of the gulf coast in Florida, the population is shrinking because of habitat degradation and increases in the recreational use of beaches (Page *et al.,* 1995). The FWC lists Cuban Snowy Plovers as threatened.

Figure 34 *Potential-habitat map for Cuban Snowy Plover.*

In 2002, the FWC reassessed the status and distribution of the Cuban Snowy Plover in Florida. From this study, more than 3,700 location records were collected, documenting 213 breeding pairs of Cuban Snowy Plovers. In 2006, the FWC reassessed the status and dis-

Figure 35 *Proposed Strategic Habitat Conservation Areas for Cuban Snowy Plover in the Florida Panhandle.*

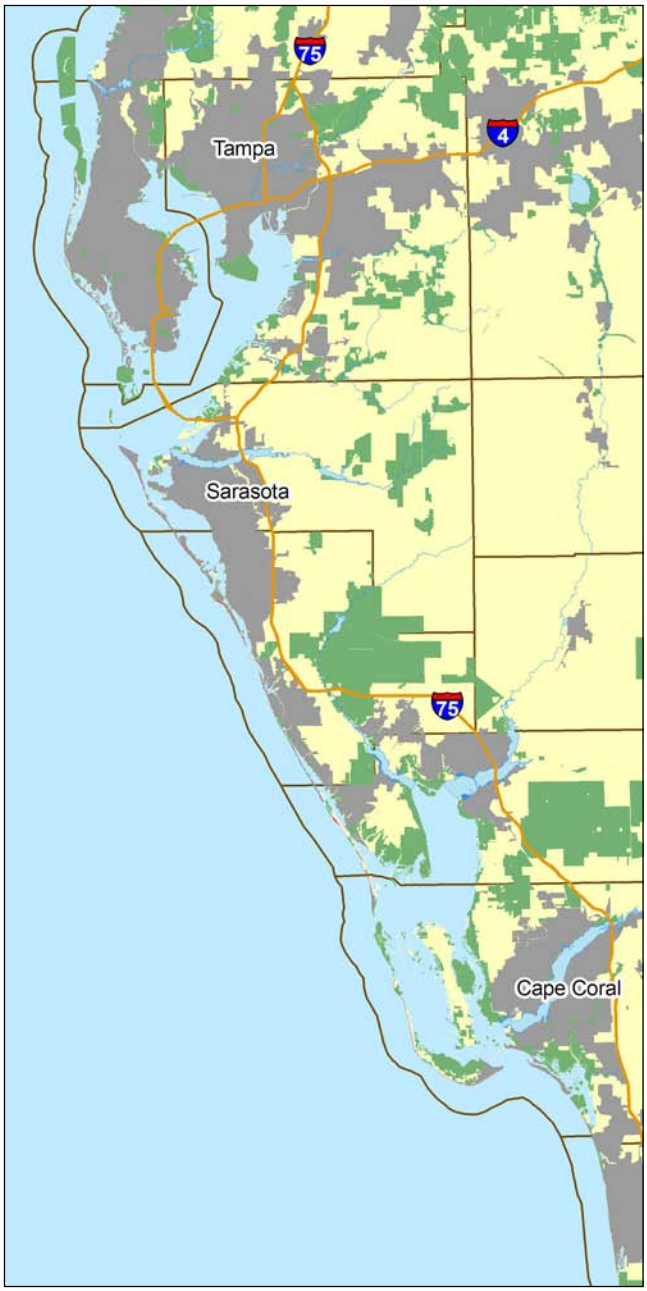

Figure 36 *Proposed Strategic Habitat Conservation Areas for Cuban Snowy Plover from Tampa Bay area south to Charlotte Harbor.*

tribution of the Cuban Snowy Plover following the protocol defined in 2002. The 2006 survey documented at least 222 breeding pairs, a 4.2% increase. However, separating the change by region reveals that there was a 22.1% increase in breeding pairs in the Northwest and a 25% decrease in the Southwest compared with 2002 (Himes *et al.,* 2006).

We limited potential-habitat analysis to the gulf coast of Florida, from the Alabama border south to the Collier County line. The potential-habitat map included beach and coastal-strand habitats from the FWC 2003 land-cover image within this range (Figure 34). Additionally, we included any tidal-flat habitat within 60 m of selected beach or coastal strand within this range as sandy-substrate–tidal-flat areas used by plovers. We further identified occupied habitat for this species using the 2002 and 2006 FWC survey work and DOQQs. We manually excluded those areas where plovers were not observed and added in areas not captured in the FWC 2003 land-cover map because of the dynamic nature of coastal habitats in Florida. Species experts verified that the maps properly identified the plover habitat. Additionally, we field-verified sites on Tyndall Air Force base, Anclote Key, Honeymoon Island, and Caladesi Island.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. There were 3 distinct populations observed in the models when we used a conservative dispersal distance of 50–200 km (Stenzel *et al.,* 1994). Density estimates vary, but available data in Florida suggest a nesting density of 0.8 pairs per km of coastline (Gore and Chase, 1989). We set initial abundance at 300 females, with a carrying capacity of 750 for all three populations. This conservative estimate results in approximately 0.03 females/ha for initial abundance and 0.07 females/ha for the carrying capacity. Habitat on managed lands accounts for 66% of all potential habitat, so initial abundance and carrying capacity were adjusted accordingly for the managed-habitat-only models. The potential-habitat model indicated 10,136 ha are suitable for the Cuban Snowy Plover.

The baseline growth rate in these models was 0.9983, which means that slight changes have noticeable impacts on the final abundance and the risk of a decline. Sensitivity analyses on the baseline models indicated that the percentage of animals surviving to adulthood was very important. Assuming no changes, there was 0% probability of extinction in the next 100 years in the model containing all potential habitat and 1% in the managed-habitat-only model. A noticeable reduction occurred in abundance when only managed habitat was considered. Only 66% of the potential habitat was categorized as managed, which reduced the carrying capacity by one-third. This reduction increased the risk of a 50% decline in abundance from 36% for all potential habitat to 41% for managed-lands habitat only.

Results of the PVA should be interpreted with caution. Inappropriate management on both public and private beaches, alterations of habitats that are due to development and beach renourishment, pet disturbance, and human disturbance, including vehicles, all threaten Cuban Snowy Plover populations in

Florida. None of these factors could be directly assessed with the PVA. Therefore, the PVA could be considered a best-case scenario with minimal disturbance to pristine habitat.

Strategic Habitat Conservation Areas were identified for the Cuban Snowy Plover because the PVA reveals a significant potential for reduction in abundance when considering only managed-lands habitat. The SHCA include all privately owned potential-habitat patches >1 ha in size and adjacent to the gulf (Figures 35, 36). Some manual cleanup of the SHCA map was necessary because of data incompatibility and digitizing errors in the FLMA database.

FLORIDA BURROWING OWL

FWC

The Florida Burrowing Owl (*Athene cunicularia*) is a small, ground-nesting bird found in open, well-drained habitats in Florida. Florida Burrowing Owls excavate burrows in sparsely vegetated sandy ground and may be found on dry prairies, residential areas, golf courses, pastures, and airports. It is listed as a species of special concern by the FWC because of its vulnerability to habitat destruction, particularly in urban environments. In Florida, high densities of Florida Burrowing Owls occur in urban areas of Lee County, although dense local populations also occur in other parts of the state (Millsap, 1996a).

Our habitat mapping did not include these urban habitats because of the difficulties in applying the fine-scale modeling techniques necessary to accurately depict conditions in a highly dynamic region. Researchers have suggested a 10-m protection buffer around owl burrows in urban environments (Millsap and Bear, 2000). This protection buffer is not currently implemented, and adequate habitat protection in urban environments is uncertain. Our modeling focused on "natural" habitat types in order to promote areas that could provide protected habitat that is not exposed to the immediate possibility of human development. However, we recognize the importance of urban habitat and emphasize the need for further research into urban Florida Burrowing Owl habitat protection.

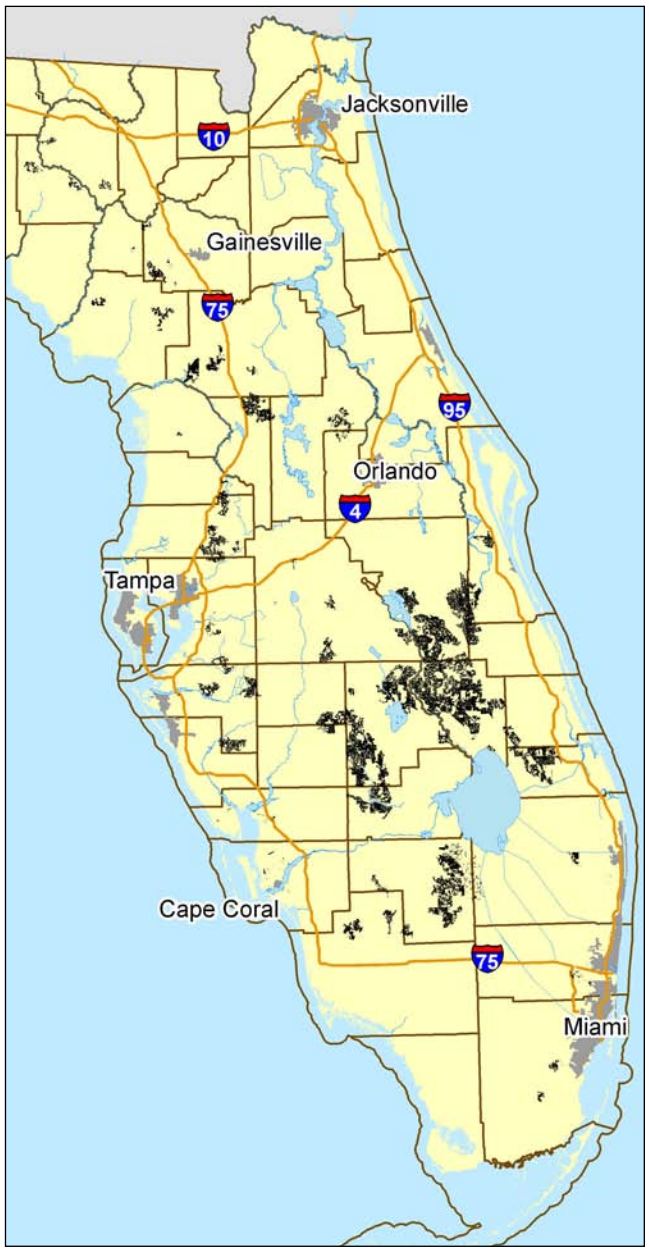

Figure 37 *Potential-habitat map for Florida Burrowing Owl.*

We created the map of potential Florida Burrowing Owl habitat using a Florida Burrowing Owl occurrence database and the FWC 2003 land-cover image (Figure 37). We identified five land-cover types as habitat: dry prairie, grassland, bare soil/clearcut, improved pasture, and unimproved pasture. Our database of occurrences included owl or burrow occurrences from the FLEO database (n = 102), the WildObs database (n = 1044), and occurrences collected by biologists and volunteers (n = 1092). In Florida, young females disperse approximately 1,100 m from the nest on average (Haug

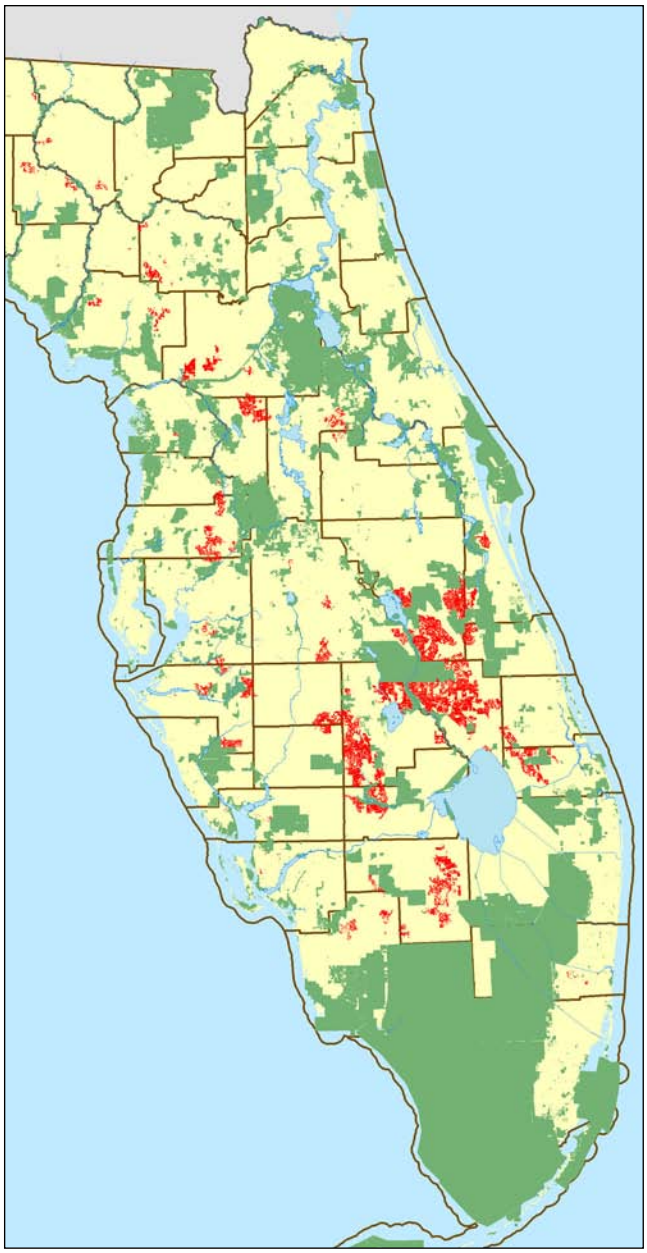

Figure 38 *Proposed Strategic Habitat Conservation Areas for Florida Burrowing Owl.*

et al., 1993). Therefore, all contiguous blocks of habitat within 1,100 m of Florida Burrowing Owl occurrences were retained as potential habitat.

The potential-habitat map for this species includes more than 350,000 ha spread across peninsular Florida, of which less than 45,000 ha are on managed lands (12%). For the PVA, we ran baseline models for all potential habitat and for only potential habitat on managed lands. The baseline growth rate for the populations in these models was 0.9853, which made them quite sensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years under these baseline demographic parameters was 0%, but the probability of a large decline was very high (*i.e.,* a 23% probability of a 90% decline). Comparison of the two model scenarios suggest that although the abundance was smaller for the managed-lands model, the risks were quite similar (a 6% chance of extinction in the next 100 years and a high risk of a large decline [*i.e.,* 41% probability of a 90% decline]). Based on the probability of a significant decline in population on both managed and unmanaged lands, we created SHCA for this species (Figure 38). Strategic Habitat Conservation Areas for this species include all potential habitat not occurring on managed lands.

FLORIDA GRASSHOPPER SPARROW

Dameron Black

The Florida Grasshopper Sparrow (*Ammodramus savannarum floridanus*) is a small grassland bird, so named because of its grasshopper-like song. The Florida Grasshopper Sparrow is generally found in dry, sparse prairie habitats with little shrub cover. It prefers early-successional-stage prairies. A family will occupy and defend a territory that is on average about 2 ha (Delany *et al.,* 1995; Delany, 1996; Vickery, 1996). Suitable habitat also includes patchy bare areas that the sparrows use for foraging on insects and that are interspersed among larger tracts of prairie. In Florida, the Florida Grasshopper Sparrow's range has shrunk, and the birds are now restricted to the northern and western edges of Lake Okeechobee to central Osceola County (Delany *et al.,* 1985). This species is most likely to occur in large, unbroken tracts of prairie habitat. Thus, habitat loss and fragmentation principally contribute to decline in Florida Grasshopper Sparrow populations, which has caused the FWC and USFWS to list it as an endangered species.

The potential-habitat map was created using the FWC 2003 land-cover image (Figure 39). Mapped

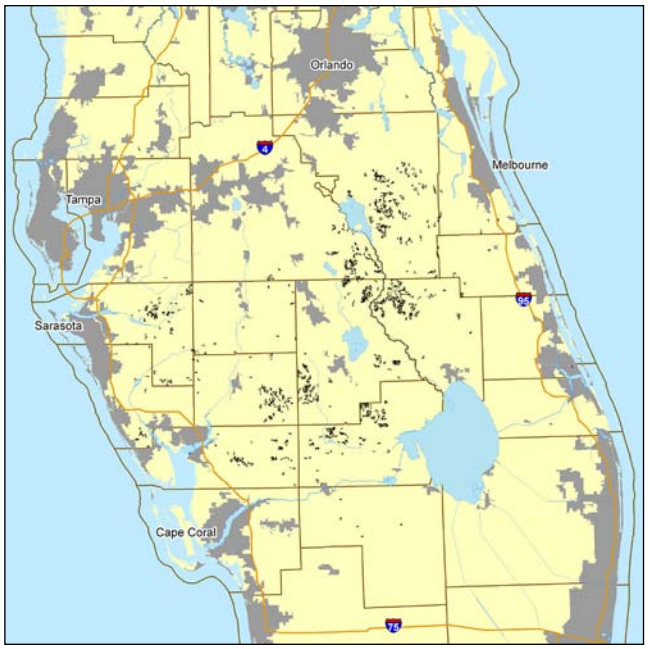

Figure 39 *Potential-habitat map for Florida Grasshopper Sparrow.*

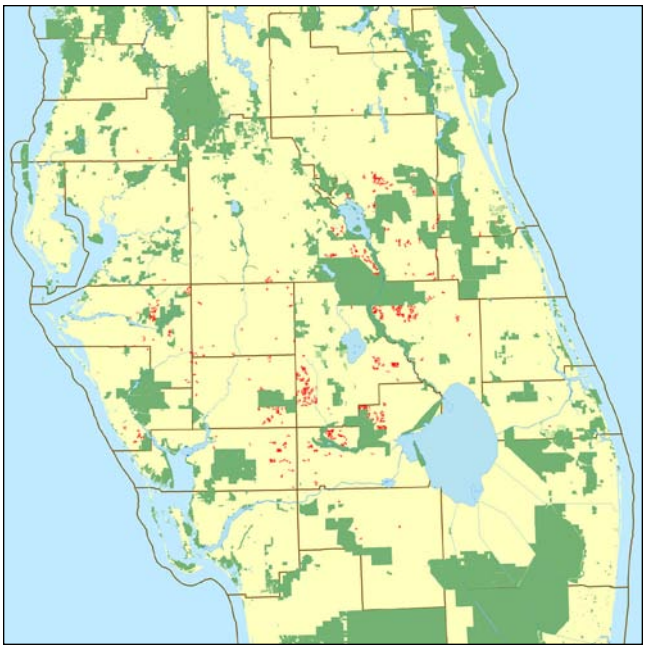

Figure 40 *Proposed Strategic Habitat Conservation Areas for Florida Grasshopper Sparrow.*

potential habitat includes those patches of dry-prairie that are >90 m from any forested habitat, based upon recommendations by M. Delany (Cox *et al.*, 1994), and that are >44 ha in size. The estimated patch size needed to support a population of 25 breeding pairs of Florida Grasshopper Sparrows is 44 ha (T. Delany, personal communication).

Results of our PVA indicated that the survival of breeding adults is the most important factor influencing the growth rate for populations of this species. This parameter accounted for about 37% of the variation seen in the population trends. The chance of extinction was 0% over the next 100 years, assuming a population of 50 breeding pairs and no catastrophes or habitat alteration. Populations with less than 50 breeding pairs might not persist for the next 100 years, even under assumptions of no catastrophes or loss of habitat, unless migration occurred from a nearby population. If only managed habitat was included in the model, the risk of extinction over 100 years dramatically increased to 85%.

A more optimistic model, which incorporated a higher estimated rate of survival for breeders, produced much more positive results. In this version of the model, the juvenile survival was the most important factor in population growth, explaining about 26% of the variation seen in the population trend, but survival of breeding adults was nearly as important. Under this model design, the chance of extinction was 0% for both habitat scenarios.

Survival of this species in habitats existing solely on managed lands is uncertain because of variations in the estimated annual survival of adult breeders, potential impacts of catastrophic events, and habitat alteration. Therefore, we created SHCA for this species (Figure 40). All potential habitat outside of managed lands was retained as SHCA for this species.

FLORIDA SANDHILL CRANE

FWC

The Florida Sandhill Crane (*Grus canadensis pratensis*) is a tall, heavy-bodied, long-necked bird commonly found in wet, marshy upland habitats. The FWC lists it as threatened, and it has been severely negatively impacted by habitat loss from human development. Management of the Florida subspecies is further hampered

by the seasonal occurrence of migratory sandhill cranes interspersed with nonmigratory populations of native birds, which distorts the appearance of Florida population sizes, densities, and habitat use. Florida Sandhill Cranes principally use prairies, pastures, low-lying uplands, and herbaceous wetlands. They also feed in grain fields and on feed lots (Nesbitt and Williams, 1990). No recent information is available concerning the status and trend of crane populations statewide, although the central and southern populations appear to be self-sustaining (Nesbitt, 1996).

We used a model created by Nesbitt and Hatchitt (2006) to assess the status of Florida Sandhill Cranes. Nesbitt and Hatchitt (2006) created this model using the 2003 FWC landcover image and data from the Florida BBA. They isolated 6 land-cover types commonly used by Florida Sandhill Cranes for nesting, roosting, or foraging. Dry prairie, freshwater marsh and wet prairie, shrub swamp, grassland, improved pasture, and unimproved pasture were classified as habitat and all others as nonhabitat. In Florida, crane home ranges average approximately 1,366 ha (Nesbitt and Williams, 1990). Nesbitt and Hatchitt (2006) retained all upland areas that were within 3 km of marsh and marsh areas that were within 0.5 km of grassland. Finally, these researchers retained only the remaining land cover within the range of the species as delineated by the Florida BBA (Figure 41).

The results of the PVA suggest that the Florida Sandhill Crane was relatively stable with a 0% probability of extinction or declines over the next 100 years. This was not surprising because the demographic values yielded a growth rate of 1.05 (5% increase possible annually). However, when the model with all habitat populations was compared to the model that included only those areas currently under management, abundance decreased to 20%. No SHCA were created for this species because of the low probability of decline over the next 100 years, despite lower abundance when assessed on managed lands only.

Nesbitt and Hatchitt (2006) used more conservative methods to estimate the impacts of Florida Sandhill Crane habitat loss in Florida. They found a 16.6% average decline in the amount of suitable Florida Sandhill Crane habitat in Florida every 10 years from 1974–2003 and that as little as 12% of occupied Florida Sandhill Crane habitat occurs on public lands. Further, they estimated a 35.7% decline over that same 30-year period in the total population of Florida Sandhill Cranes, indicating a much more foreboding future for this species in the face of continued decline in habitat. Although we did not create SHCA for this species, we recommend a vigorous and concerted effort to increase the amount and quality of potential Florida Sandhill Crane habitat under conservation protection to ensure the long-term survival of this species in Florida.

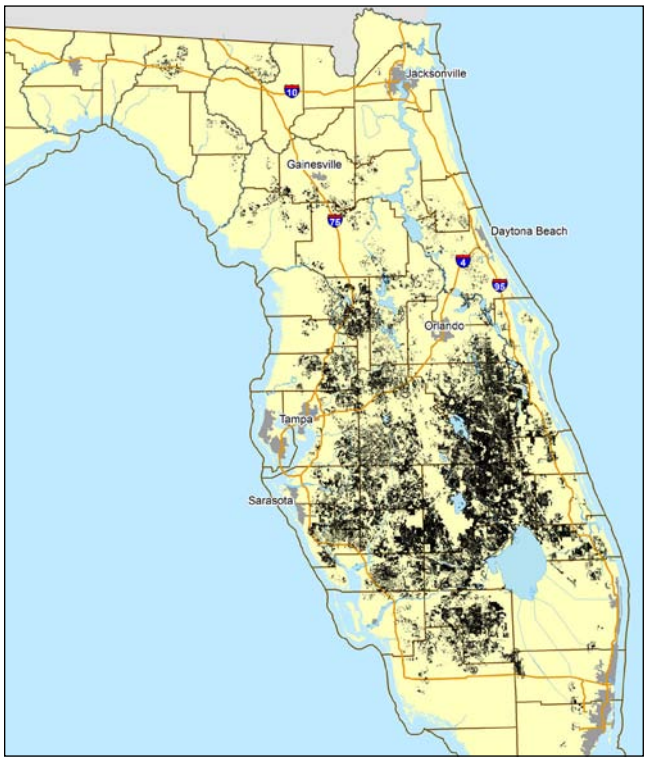

Figure 41 *Potential-habitat map for Florida Sandhill Crane.*

FLORIDA SCRUB–JAY

Jay Exum

Figure 42 *Potential-habitat map for Florida Scrub-Jay.*

The Florida Scrub-Jay (*Aphelocoma coerulescens*) is endemic to Florida, occurring only in remaining scrub and scrubby flatwoods of the Florida peninsula (Woolfenden and Fitzpatrick, 1984, 1996a,b). Major threats to the Florida Scrub-Jay include habitat loss and predation. Because of their territorial nature, Florida Scrub-Jays are very vulnerable to habitat fragmentation and loss. Much of the scrub habitat in the species' historic range has been converted to citrus trees, improved pastures, and housing developments, causing Florida Scrub-Jay populations to decline. In addition, disrupted fire regimes, which reduce habitat quality, may fragment suitable habitat and magnify habitat loss (Woolfenden and Fitzpatrick, 1996b; Breininger *et al.,* 2006). Thus, the total population's size and geographic extent is greatly reduced (Woolfenden and Fitzpatrick, 1996a) from its historical range and size. The FWC and USFWS list the Florida Scrub-Jay as threatened.

We used a 1992–1993 Florida Scrub-Jay statewide map (Scrub-Jay map; Fitzpatrick *et al.,* 1994) and the FWC 2003 land-cover image to identify potential habitat for Florida Scrub-Jay (Figure 42). The Scrub-Jay map plotted the location of all Florida Scrub-Jay–occupied tracts of habitat as of 1992–1993. Using the FWC 2003 land-cover map, we identified all habitat patches consisting of either xeric oak or sand pine scrub habitat that intersected these Florida Scrub-Jay–occupied tracts. Next, we identified all sandhill, dry prairie, pineland, and hardwood-hammock and hardwood-forest land-cover habitats from the FWC 2003 land cover that intersected the Florida Scrub-Jay–occupied tracts in the Scrub-Jay map.

Neither the Scrub-Jay map nor the FWC 2003 land-cover image data set is thoroughly adequate to identify potential habitat for the Florida Scrub-Jay. Scrubby flatwoods, a primary habitat type for Florida Scrub-Jays, is not explicitly represented in either data set. In the FWC 2003 land-cover image scrubby flatwoods can be classified as sandhill, dry prairie, or pineland. A review of a draft potential-habitat map using only scrub land-cover categories suggests that the map significantly underestimates the amount of Florida Scrub-Jay habitat (K. Miller and B. Stith, personal communication), prompting us to merge the additional land-cover categories that intersected the Scrub-Jay map. The Scrub-Jay map missed some habitat locales because the project relied on soil maps to identify Florida Scrub-Jay habitat, and scrubby flatwoods are not predictably shown by soil maps.

It is likely that our map underestimates the potential habitat for this species. First, our map identifies only habitat that intersects or is contained within the areas identified in the Florida Scrub-Jay map. Second, Florida Scrub-Jays occupy areas of disturbed scrub along the suburban interface. Many of these areas were classified as urban in the land-cover map and therefore were not identified as potential habitat. We could not feasibly identify those urban areas that might support Florida Scrub-Jays. Regardless, we believe that the map gives a reasonable estimation of potential habitat available for Scrub-Jays when used with caution.

The demographic model for the Florida Scrub-Jay included 6 stages, which reflected its unique cooperative-breeding life-history strategy. The model was run with two separate classes: for breeding pairs that have helpers and for breeding pairs that do not have helpers. We assumed that populations were distinct and independent if they were separated by at least 5 km, a density of 1 female/9 ha, and an initial abundance of 75% of the carrying capacity. The PVA identified 80 populations with all potential habitat and 79 populations when using only managed-land habitat. More connectivity between populations is likely (and therefore fewer isolated individual populations), especially in habitats off the Lake Wales Ridge (K. Miller, personal communication).

During the next 100 years, the PVA predicted a 1% probability that the Florida Scrub-Jay would become extinct for both habitat schemes. Given that the Florida Scrub-Jay is a territorial species, we were not surprised that the model predicted that these jays would be highly sensitive to habitat loss and fragmentation.

We identified SHCA for this species because of highly restrictive habitat requirements and territorial behavior. The Multi-Species Recovery Plan (USFWS,

1999b) suggested that populations should have >100 breeding pairs. Based upon the PVA, only 6 existing populations contained >100 breeding pairs as of 1999. Stith *et al.* (1996) reported that the species may have declined by as much as 20% to 50% in the previous decade. Previous PVA indicated that a population of Florida Scrub-Jays with <10 breeding pairs had a 50% probability of extinction over 100 years and populations with >100 pairs had a 2%–3% chance of extinction (Stith, 1999). Furthermore, results from Stith (1999) indicated that 3 of 21 metapopulations identified had sufficient numbers of breeding pairs to support a low extinction risk and an estimated 99% probability of survival over 100 years (Stith, 1999). Our PVA model was probably optimistic (a "best case" scenario) because it was based principally on demographic data from the high-quality scrub habitat found at the Archbold Biological Station. On the other hand, our model used "worst case" dispersal parameters that may have underestimated connectivity of populations outside of the Lake Wales Ridge.

Strategic Habitat Conservation Areas include all potential habitat that does not occur on managed lands (Figure 43). It will be important to protect all of the largest populations and many of the smaller ones in between to serve as stepping stones for long-term persistence of this specialized species. Large, unprotected Florida Scrub-Jay habitats exist in Levy, Western Marion, Northern Lake, and Volusia Counties and along the Lake Wales Ridge.

Figure 43 *Proposed Strategic Habitat Conservation Areas for Florida Scrub-Jay.*

FLORIDA SNAIL KITE

Jay Exum

The federally and state-listed endangered Florida Snail Kite (*Rosthramus sociabilis plumbeus*) has a small range in Florida but may also be found in mainland Cuba and on Cuba's Isle of Pines. Two other snail kite subspecies occur in the neotropics (*R. s. major* and *R. s. sociabilis*) in Central America. Originally, the range for the Florida snail kite was larger, but loss and degradation of wetland habitat has reduced the range in Florida to wetlands in the southern and central portions of the state south of the 29th parallel (Davis and Ogden, 1994; Kitchens *et al.,* 2002). The Florida Snail Kite may be found in freshwater marsh, wet prairie, and open swamp habitats where their primary food source, the freshwater apple snail (*Pomacea paludosa*), is abundant (Bessinger, 1988). They nest on a variety of substrates (almost always over water to deter predators), solitarily or in loose colonies, and roost communally (Rodgers, 1996). Florida Snail Kites disperse to small, widely scattered, flooded wetlands throughout the peninsula during drought conditions and to flooded dry prairie and grassland vegetation types during very wet years.

We obtained occurrence records (n = 1,622) from WildObs (n = 23, 1987–1991) and FLEO (n = 23, 1981–2001). We also obtained telemetry data from a University of Florida project (n = 1,565, 2003–2005), supplied by Andrea Bowling. The potential-habitat map is very general in design. First, we created the range for Florida Snail Kites

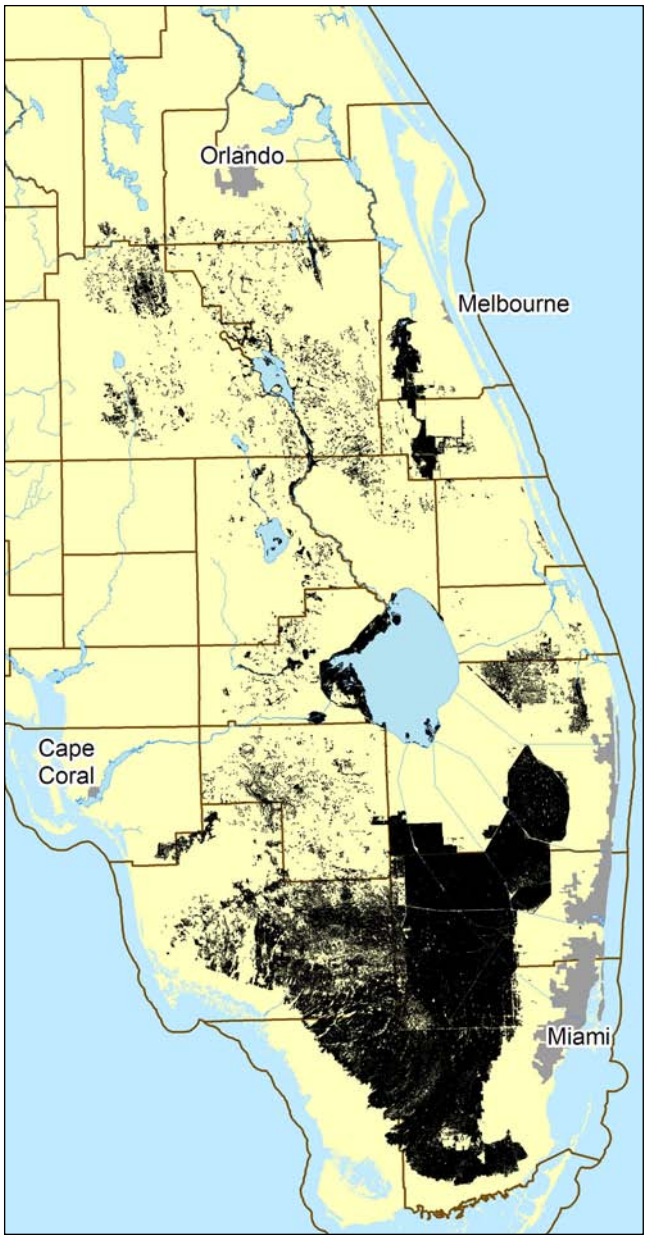

Figure 44 *Potential-habitat map for Florida Snail Kite.*

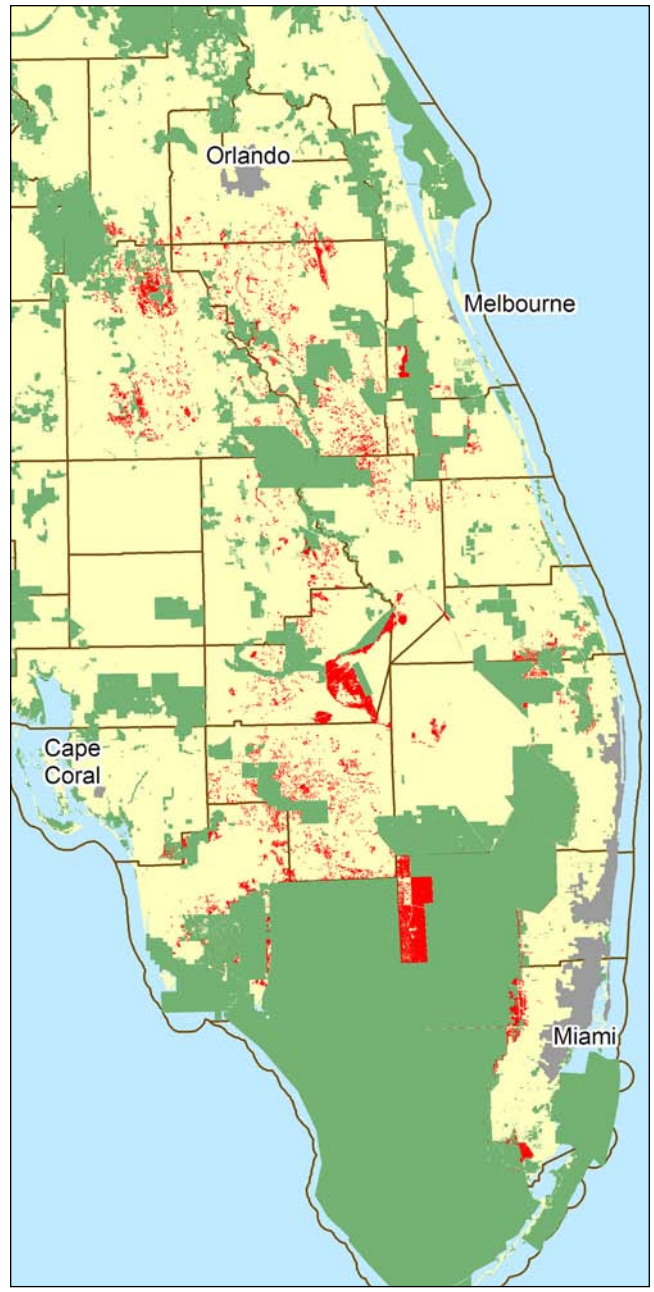

Figure 45 *Proposed Strategic Habitat Conservation Areas for Florida Snail Kite.*

by identifying all EMAP hexagons that contain multiple occurrences or were connected to a hexagon containing multiple occurrences. This rule identified the core range and remove isolated hexagons that had only a single observation. Next, we selected the primary nesting and foraging habitat that intersected the EMAP range. Primary nesting and foraging habitat was collectively represented by the freshwater marsh and wet prairie, sawgrass marsh, cattail marsh, shrub swamp, and cypress swamp land-cover categories of the FWC 2003 land-cover image. The final step excluded all selected habitat patches less than 10 ha. The 10-ha patch criterion was an attempt to identify habitat areas minimally affected by wetland dry-downs, a hydrologic event where the water table drops below ground level. Increases in the frequency and duration of wetland dry-downs are generally believed to adversely affect apple snails and therefore Florida Snail Kites (USGS, 2006b). Snodgrass *et al.* (2000) found a positive relationship between hydroperiod and wetland size, and their figures suggested that wetlands greater than 10 ha were less affected by dry-down events than smaller areas were.

Seventy-eight percent of the University of Florida telemetry locations not situated over open water areas in the FWC 2003 land-cover image (n = 1,208) are on

areas identified as potential habitat. This gave us limited but reasonable assurance in the accuracy of the potential-habitat map (Figure 44).

We ran baseline PVA models on all potential habitat and on potential habitat located on managed lands only. We ran a second set of models that assumed intermittent flooding for the first 50 years of the simulation. Assuming no changes, the probability of species extinction or decline in the next 100 years under these baseline demographic parameters was 0%. Approximately 83% of the potential habitat was on managed lands, making this metapopulation abundance smaller than the metapopulation abundance on all potential habitat, although the risks were similar (0% chance of extinction or decline in the next 100 years). However, including periodic flooding caused a dramatic increase in the risks. Overall, this model had an annual growth rate of 1.08. Despite this high growth rate, in the model run that assumed intermittent flooding the probability of species extinction was 60% when including all potential habitat. If just the managed habitat was used, then the probability of extinction for this species increased to 65%. These results directly reflect the cumulative impacts of periodic reductions in survival; without these periodic fluctuations, the risk of extinction is negligible.

Based on the extremely high probability of extinction that is due to the effects of seasonal habitat flooding, we identified SHCA for this species. The SHCA for the Florida Snail Kite include all potential habitat that does not occur on managed lands (Figure 45).

LIMPKIN

Tim O'Meara

Figure 46 *Potential-habitat map for Limpkin.*

The Limpkin (*Aramus guarauna*) is currently listed as a species of special concern by the FWC. Limpkins have a large range in the New World. In the U.S., they occur in Florida and Georgia, most often in spring-fed rivers and streams, canals, and at lake edges, wherever their primary food source, the freshwater apple snail (*Pomacea paludosa*), is abundant.

The occurrence records (n = 592, possibly multiple birds per record) were from WildObs (n = 19, 1988–2003), FLEO (n = 29, 1980–2001), and BBA (n = 440, 1986–1991) databases. We obtained additional survey locations (n = 104, 1988–2003) from Katy NeSmith of FNAI.

The freshwater marsh and wet prairie, sawgrass marsh, cattail marsh, shrub swamp, cypress swamp, hardwood swamp, and mixed wetland forest classes from the FWC 2003 land-cover image were selected as primary habitat within the Limpkin's peninsular range. We identified areas of open water from the NHD data set (hydrography areas for streams and rivers, canals and ditches, inundation areas, and rapids) and an FDEP lake-areas data set. Potential habitat was identified as all contiguous blocks of primary habitat within 100 m of open water (Figure 46).

We used a subset of the occurrence records (n = 50, 2002–2004) collected around the date of the satellite image (2003) for verification purposes. Because of the uncertainty of exact point locations and because many of the points fell in open water, the distance from each point to potential habitat was measured. All FLEO

database records used for verification were within 200 m or less of potential habitat.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Results of the PVA indicated the probability of extinction in the next 100 years under baseline demographic parameters was 0% for both the model scenarios. A noticeable reduction occurred in abundance when considering only managed habitat. Approximately 69% of the potential habitat was categorized as managed, which reduced the carrying capacity by 30%. Insignificant probability of extinction or large declines occurred with the assumed densities used in either model. In fact, even a 30% reduction in carrying capacity (*i.e.,* the managed-habitat-only scenario) did not significantly increase the risk of a decline. Therefore, no SHCA were created for this species.

LOUISIANA WATERTHRUSH

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The Louisiana Waterthrush (*Seiurus motacilla*) occurs throughout the eastern U.S. but is restricted to the northern portions of the Florida Panhandle. Little is known about abundance and population trends because empirical data is lacking. However, Stevenson and Anderson (1994) suggested that the species' range may be expanding in Florida. Waterthrushes prefer deciduous forest along flowing streams (Cox, 1996a). This species has been identified as a forest-interior species intolerant of deforestation (Morton, 1980; Whitcomb *et al.,* 1981); however, more research is needed to identify the degree of deforestation that the species will tolerate.

We identified potential habitat for Louisiana waterthrushes within their known range in the Florida Panhandle from EMAP hexagons that contained BBA blocks with records indicating confirmed or probable breeding activity (n = 9). Because FLEO database records (n = 3) and WildObs database records (n = 3) were limited, hexagons that fell within the species' range reported by Robinson (1995) were also included to identify the breeding range in Florida. Within this range, perennial streams from the NHD were identified, and deciduous-forest habitat types (mixed hardwood–pine forest, hardwood hammocks and forest, mixed wetland forest, hardwood swamp, and bottomland hardwood forest) within 30 m of the streams were selected from the FWC 2003 land-cover image (Figure 47).

We ran two PVA models, one on all potential habitat and one on potential habitat occurring only on managed lands. The results of the PVA run on all potential habitat indicated that the probability of Louisiana Waterthrush extinction in the next 100 years

Figure 47 *Potential-habitat map for Louisiana Waterthrush.*

was 0% and the probability that they would experience a large decline in abundance was small (*i.e.,* 7% probability of a 50% decline). Less than 20% of the potential habitat occurred on managed lands, which resulted in lower metapopulation abundance and higher risks of extinction. An 8% chance of extinction was evident in the next 100 years and an increased risk of a large decline (*i.e.,* 28% probability of a 50% decline) when considering only potential habitat on managed lands. Because of the low probabilities of extinction, we determined that SHCA were not warranted for this species.

MANGROVE CUCKOO

http://hanks-place.com

Very little is known of the biology or population status and trends of Mangrove Cuckoos (*Coccyzus minor*) because of the species' secretive nature and preference for remote coastal habitats (Hughes, 1997). Mangrove Cuckoos are rare to uncommon residents of southern coastal Florida (Stevenson and Anderson, 1994) and are principally associated with large mangrove swamps. However, cuckoos can also be found in adjacent scrub and brushland. They nest in tropical hardwood habitats, especially in the Florida Keys, where the highest population densities are likely to occur (Smith, 1996). Mangrove Cuckoos are not currently listed by the FWC. Smith (1996) indicated that the species appears to be secure because much of the remaining suitable habitat is currently in public ownership and is unlikely to be fragmented by development.

Potential-habitat analysis was limited to the Mangrove Cuckoo's range in Florida. We identified this range by isolating EMAP hexagons that contained Florida BBA blocks (n = 43) with >1 record that indicated confirmed or probable Mangrove Cuckoo breeding activity or FLEO database records (n = 17) that indicated breeding behavior or nesting activity. Within the species' range, we identified potential habitat by isolating mangrove swamps and identifying tropical-hardwood hammocks and forests and shrub and brush within 100 m of mangrove swamps

Figure 48 *Potential-habitat map for Mangrove Cuckoo.*

from the FWC 2003 land-cover image (Figure 48). The resultant model probably overestimates potential habitat because cuckoos prefer extensive tracts of undisturbed mangrove or tropical-hardwood habitat (Smith, 1996). Bancroft *et al.* (1995) found that cuckoos were absent from seasonally deciduous forest fragments smaller than 12.8 ha during the breeding season; however, no empirical data exist indicating the amount of fragmentation (*i.e.,* minimum habitat patch size) cuckoos will tolerate during the nonbreeding period. Thus, we did not incorporate the patch size parameter in the model.

Figure 49 *Proposed Strategic Habitat Conservation Areas for Mangrove Cuckoo.*

The potential-habitat layer includes almost 200,000 ha, of which about 180,000 ha (*i.e.,* 90%) are on managed lands. We assumed high vagility for this species because it is migratory throughout much of its range, although its status is unclear in Florida.

We ran baseline models for both types of metapopulations, all potential habitat and managed-lands-only habitat. The baseline growth rate for the populations in these models was 0.9617, which made them sensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years under these baseline demographic parameters was 0%. However, a very large probability of a decline was evident (*i.e.,* 99% probability of an 80% decline). Most (90%) of the potential habitat occurred on managed lands, but the risks under both model schemes were identical. Because of the high probabilities of large declines in abundance, we determined that SHCA were warranted for this species (Figure 49). SHCA include all habitat not currently managed.

MOTTLED DUCK

Marc Epstein

Florida's Mottled Duck (*Anas fulvigula fulvigula*) is one of a worldwide group of 25 closely related, mallard-type species and one of four waterfowl species that breeds in Florida (Bielefeld, 2003). Endemic to Florida, the Mottled Duck is nonmigratory and ranges from Gainesville south to Florida Bay, inhabiting both brackish and freshwater marshes, and a large proportion of its population exists within urban/suburban areas (R. Bielefeld, personal communication). Wetland habitat associations include prairie wetlands, flood-plain marshes, and coastal impoundments. Mottled Duck nests occur in upland grasslands near wetland habitats. Biologists perceive the greatest threat to *A. f. fulvigula* to be hybridization with introduced mallards (Bowers, 2002). Native Mallards migrate north to breed in the spring and are therefore geographically isolated from Mottled Ducks during breeding season. Introduced Mallards do not migrate and therefore can interbreed with Mottled Ducks, resulting in fertile, hybrid offspring.

The FWC has conducted an annual breeding survey since 1985 to obtain a population-density estimate in the core of the Mottled Duck's range. In 2003, the FWC redesigned the methodology of the survey to provide a more reliable estimate of the statewide Mottled Duck population. Overall, the population in this core area has been relatively stable since 1985.

We created the potential-habitat map by identifying Mottled Duck wetland and nesting habitats. From the FWC 2003 land-cover image, we selected freshwater marsh and wet prairie, sawgrass marsh, cattail marsh,

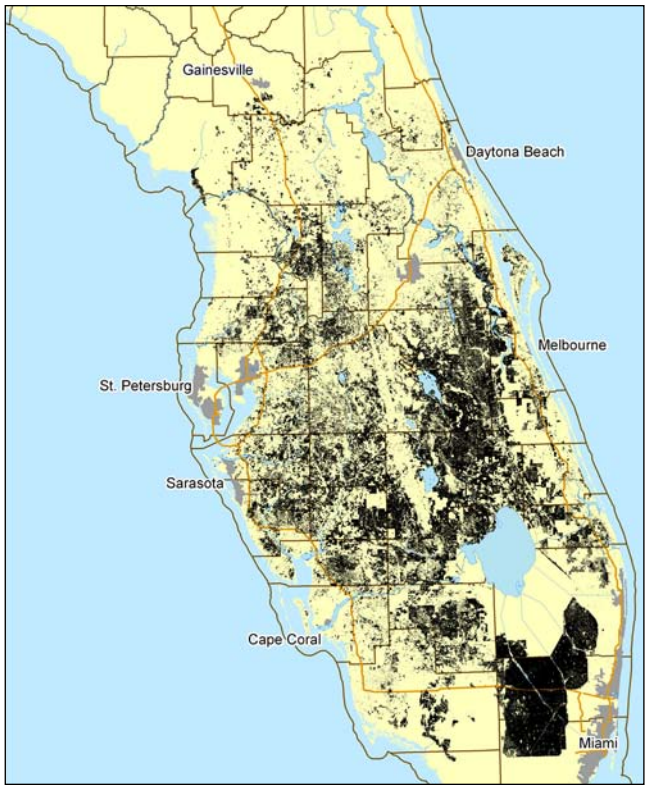

Figure 50 *Potential-habitat map for Mottled Duck.*

salt marsh, tidal flats, and all open-water areas within 100 m of water's edge. For nesting habitat, we identified coastal strand, dry prairie, shrub and brushland, grassland, improved pasture, unimproved pasture, sugar cane, citrus, row/field crops, and other agriculture communities from the FWC 2003 land-cover image. Patches of either wetland or nesting habitat had to be contiguous to be identified as potential habitat. Potential nesting habitat was further reduced by including only those contiguous habitats less than 620 m from wetland habitat. This is the maximum distance identified in FWC studies within which the species nests. The final potential-habitat map merged the two groupings to a single category (Figure 50). Of the 389,180 ha of potential habitat identified, less than half (34%) was on managed lands.

We ran "optimistic" and "pessimistic" PVA models for two different modeling schemes: (1) all potential habitat and (2) potential habitat occurring only on managed lands. The optimistic model incorporated a greater nesting success than the pessimistic model, reflecting the variability in reported nesting success across the Mottled Duck's range. The baseline growth rate for these models was slightly above 3% annually. Sensitivity analyses on these baseline models indicated that the percentage of ducks surviving during transition from juvenile to adult is critical, as is survival of adults.

With the above parameters, our optimistic model for scheme 1 predicted an extinction probability of 0% over the next 100 years but a 5% risk of a 20% decline in abundance. The risk of extinction or declines in scheme 2 was similar. In the short term, extinction risk at 25 years was close to 0% for both model schemes. Decreasing the adult survival or the fecundity by 5% had no effect on the risk of extinction, but the risk of a decline increased noticeably (*i.e.,* 69%–73% risk of a 20% decline).

The pessimistic model produced dire results. Extinction probability was predicted as 100% for both schemes. The average time to extinction in the pessimistic models was less than 30 years. Carrying capacity was increased by 10% and again by 20%, with virtually no positive effect on the population. When juvenile survival was increased by as little as 5% in the model, the resulting extinction risk for this population was cut in half. When adult survival was increased by 5%, the extinction risk fell below 1%. Under the optimistic parameters, occupancy in both scenarios was secure for the next 100 years. Under the pessimistic parameters, however, the occupancy estimated in the model of all potential habitat was only 48 years.

Given the results of the optimistic PVA, no SHCA were identified for this species. However SHCA identified for the Short-tailed Hawk, Big Cypress fox squirrel, Florida Scrub-Jay, Florida Burrowing Owl, Cooper's Hawk, and Florida Grasshopper Sparrow all include potential habitat identified for the Mottled Duck.

PAINTED BUNTING

FWC

The breeding range of the eastern population of Painted Buntings (*Passerina ciris*) extends from Brevard County, Florida, to North Carolina (Cox, 1996b). Migrants are often found throughout the northern Florida peninsula and eastern Panhandle. Scrub communities and edges of maritime hammocks are key natural habitats for the species, but Painted Buntings can also inhabit hedges and yards, roadside thickets, fallow fields, and

Figure 51 *Potential-habitat map for Painted Bunting.*

shrubby areas (Cox, 1996b; Lowther *et al.,* 1999). Sauer and Droege (1992) reported declining population trends throughout its range; however the cause(s) for this decline is unknown (Cox, 1996b). Nevertheless, the population of Painted Buntings has exhibited an annual average decline of 4.6% since 1966 (Sauer *et al.,* 2001), and there is currently an ongoing multistate study to monitor this species throughout its range (Delany, 2008). The FWC does not currently list the Painted Bunting as endangered, threatened, or a species of special concern.

We limited our analysis of the Painted Bunting's potential habitat to areas within EMAP hexagons where researchers documented breeding activity. We identified breeding-range hexagons in two ways: by using BBA blocks containing records with confirmed or probable breeding activity (n = 76) and by using WildObs database records (n = 11) indicating breeding behavior or nest sites. To identify potential habitat within the breeding range, we used the FWC 2003 land cover and selected all xeric oak scrub, shrub and brushland, hardwood hammocks and forest, and cabbage palm–live oak hammocks that were located on "extremely well"- and"well"-drained soils (STATSGO database) within 60 m of the xeric oak and brushland classes (Figure 51).

Of the 88,000 ha of potential habitat, <15,000 ha (*i.e.,* <17%) occurred on managed lands. Because of the high vagility of this species, we assumed that the various subpopulations acted as a single population or metapopulation.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Results from the PVA indicated that the probability of extinction in the next 100 years under the baseline demographic parameters was 0% for both models. However, a dramatic reduction in the overall abundance occurred when considering only managed-lands habitat because only 17% of the potential habitat is currently under management. Risks of a 50% decline in abundance over the next 100 years was slight, only 6%–7%. Because of the low probabilities of extinction and low probabilities of large declines in abundance, we determined not to designate SHCA for this species; however, results from ongoing research may warrant future changes in habitat protection.

RED–COCKADED WOODPECKER

USFWS

The Red-cockaded Woodpecker (*Picoides borealis*) is a federally endangered, cavity-nesting species. Once common throughout the southeastern United States,

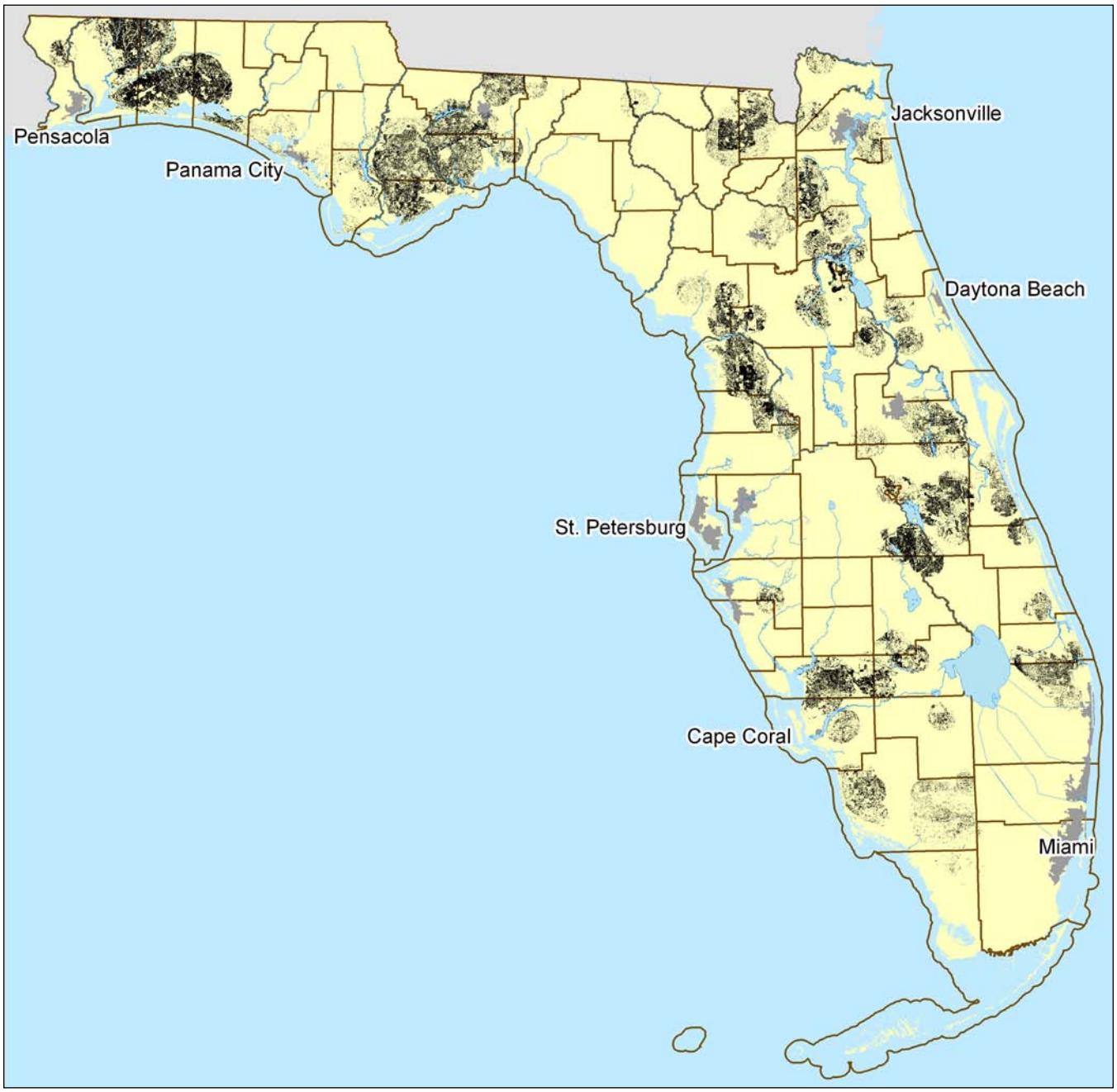

Figure 52 *Potential-habitat map for Red-cockaded Woodpecker.*

populations have declined because of habitat loss, although the species still has a broad distribution. Some of the largest populations occur on public land in Florida, although populations occur on private land as well (Jackson, 1994).

This species generally requires patches of mature, open pine forest for their clusters. Patches of mature pine (greater than 80 years) maintained by frequent occurrences of fire provide optimal foraging habitat (Jackson *et al.,* 1979). Common pine species found in Red-cockaded Woodpecker habitat include longleaf (*Pinus palustris*), slash (*P. elliottii*), and shortleaf (*P. echinata*). Red-cockaded Woodpeckers excavate nest cavities in live pine trees and may use the same nest repeatedly for years. Family groups of Red-cockaded Woodpeckers create aggregations of cavities, called clusters, and cooperatively breed.

We created the habitat map from a variety of data sources and records (n = 3,976; Figure 52). We solicited nest-tree and cluster location data (n = 3,611) from a

variety of biologists and woodpecker managers across the state that were combined with FLEO database records (n = 229) and records from the WildObs database (n = 136). We classified land-cover types representing sandhill, dry prairie, mixed hardwood–pine forests, and pinelands from the FWC 2003 land-cover image as potential habitat. All areas classified as commercial pines in FLUCCS and occurring on private land (by excluding lands identified in the FLMA database) were removed from consideration as habitat. Distance of dispersal from natal sites varies by sex, age, location, and habitat quality. However, past research indicates that female Red-cockaded Woodpeckers may disperse between 3 and 24 km from the natal area (Walters *et al.,* 1988; also see DeLotelle *et al.,* 2004, for longer distance dispersal). Therefore, we retained all suitable habitat within 10 km of each tree and cluster location as potential habitat in this map.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Assuming no changes, the probability of extinction or a decline in abundance over the next 100 years for both models under baseline demographic parameters was 0%. This was not surprising because the demographic values yielded a growth rate of 1.03 (3% increase possible annually). However, the abundance dropped over 100 years even using this growth rate. This probably reflected the cooperative breeding lifestyle, which reduces the number of active breeders each year. The model was very sensitive to the breeder survival rate and the fecundity of the breeder class. Much of the variation (62%) in the population growth rate was attributable to changes in breeder survival rates. If the survival rates have been overestimated or conditions change to reduce them, the risk of extinction increases rapidly. About 79% of the potential habitat occurred on managed lands, resulting in a reduced abundance but still showing little risk of a decline or extinction. Therefore, we did not create SHCA for this species. This model did not exclude, however, small patches of habitat. As much as 400 ha of contiguous habitat are likely to be needed to support 10 clusters of birds in order to sustain populations. Our model did not distinguish this aspect of population viability; we examined the sum of Red-cockaded Woodpecker habitat in Florida.

SEASIDE SPARROWS

The Louisiana (*Ammodramus maritimus fisheri*), Scott's (*A. m. peninsulae*), and MacGillivray's (*A. m. macgillivraii*) are among five subspecies of seaside sparrows that reside in Florida. *Ammodramus m. macgillivraii* is found along the Atlantic coast in Duval County and now includes the Smyrna Seaside Sparrow (*A. m. pelonota*),

Eric Soehren

once considered to be a separate subspecies (Post and Greenlaw, 1994; Hale, 1996). *Ammodramus maritimus fisheri* occurs from western Texas to northwestern Santa Rosa County, Florida. *Ammodramus m. peninsulae* occurs eastward along the Gulf Coast to Pasco County in discontinuous local distributions and now includes the Wakulla Seaside Sparrow (*A. m. juncicola*), once considered to be a separate subspecies. Two additional subspecies, Dusky Seaside Sparrow (*A. m. nigrescens*) and Cape Sable Seaside Sparrow (*A. m. mirabilis*) were not considered in our analyses. *Ammodramus m. nigrescens* was formerly found only in Brevard County and is now extinct, and *A. m. mirabilis* is limited to the Everglades National Park. Populations of seaside sparrows in Florida are small and disjunct, and the *A. m. peninsulae* (including *A. m. juncicola*) remains the largest Florida population (Kale, 1983) which is estimated to have 5,000–10,000 individuals (McDonald, 1988, as cited by Post and Greenlaw, 1994). All subspecies of seaside sparrows inhabit coastal salt and brackish tidal marshes where cover is somewhat continuous. Because they occupy relatively narrow, easily fragmented coastal marsh communities, loss of habitat from anthropogenic (*e.g.,* dredging and filling) and natural causes (*e.g.,* hurricanes) are major threats to seaside sparrows. Scott's Seaside Sparrow is listed by the FWC as a species of special concern, while MacGillivray's and Louisiana seaside sparrows are not currently listed.

We limited our analysis of seaside sparrows potential habitat to areas within EMAP hexagons where researchers documented breeding activity. Range hexagons were identified from BBA blocks (Louisiana, n = 9; MacGillivray's, n = 9; and Scott's, n = 59), FLEO database records (Louisiana, n = 3; Scott's, n = 10), or WildObs database records (Scott's, n = 3) that indicated breeding behavior or nesting activity. Within the range of each subspecies, we isolated salt marsh and all freshwater marsh within 100 m of salt marsh by using the FWC 2003 land-cover image to identify potential habitat (Figures 53, 55, 57).

Figure 53 *Potential-habitat map for Scott's Seaside Sparrow.*

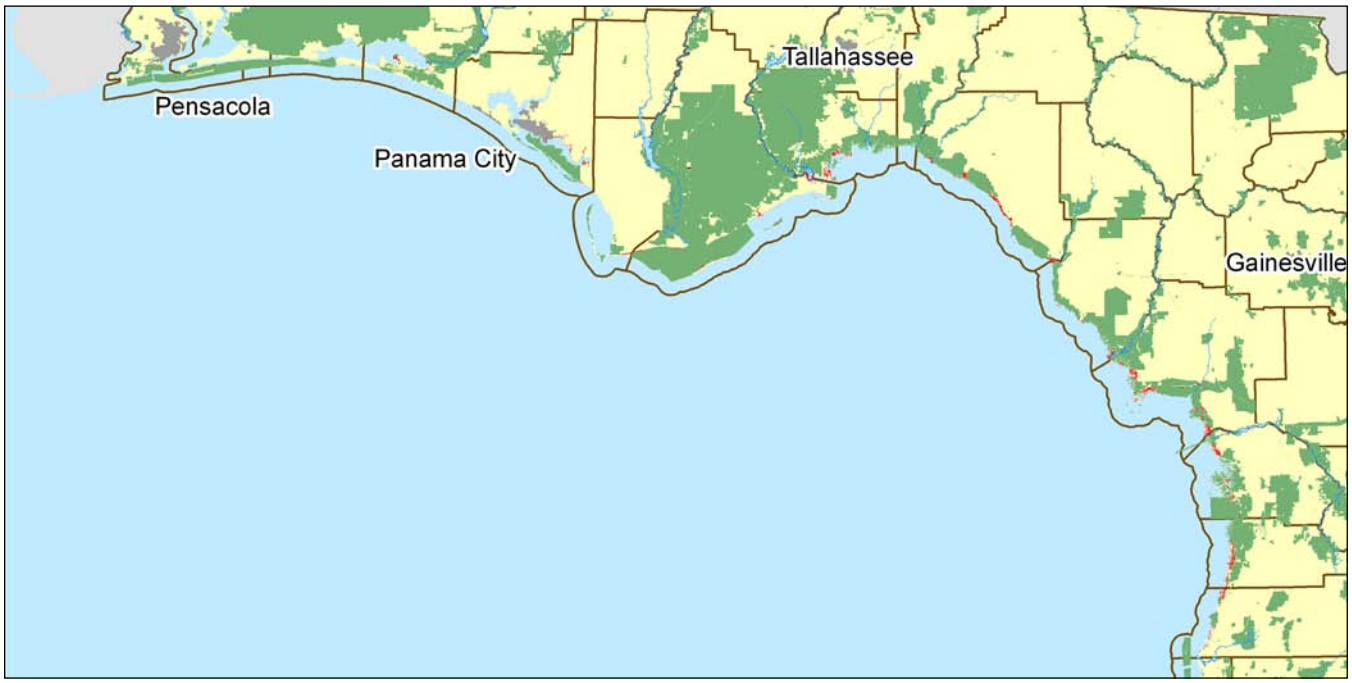

Figure 54 *Proposed Strategic Habitat Conservation Areas for Scott's Seaside Sparrow.*

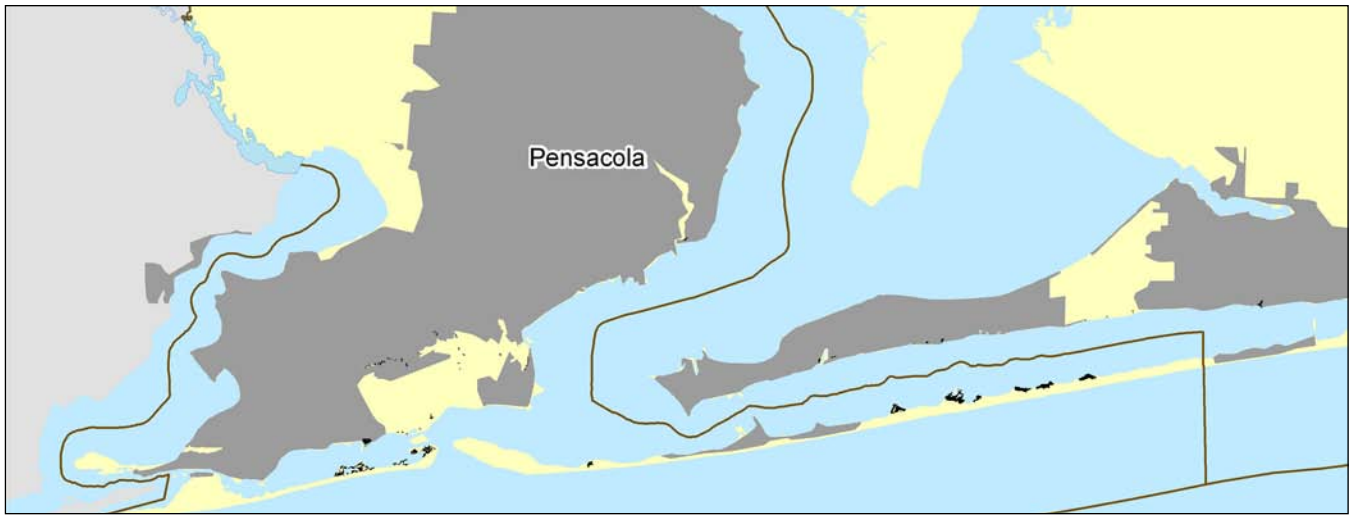

Figure 55 *Potential-habitat map for Louisiana Seaside Sparrow.*

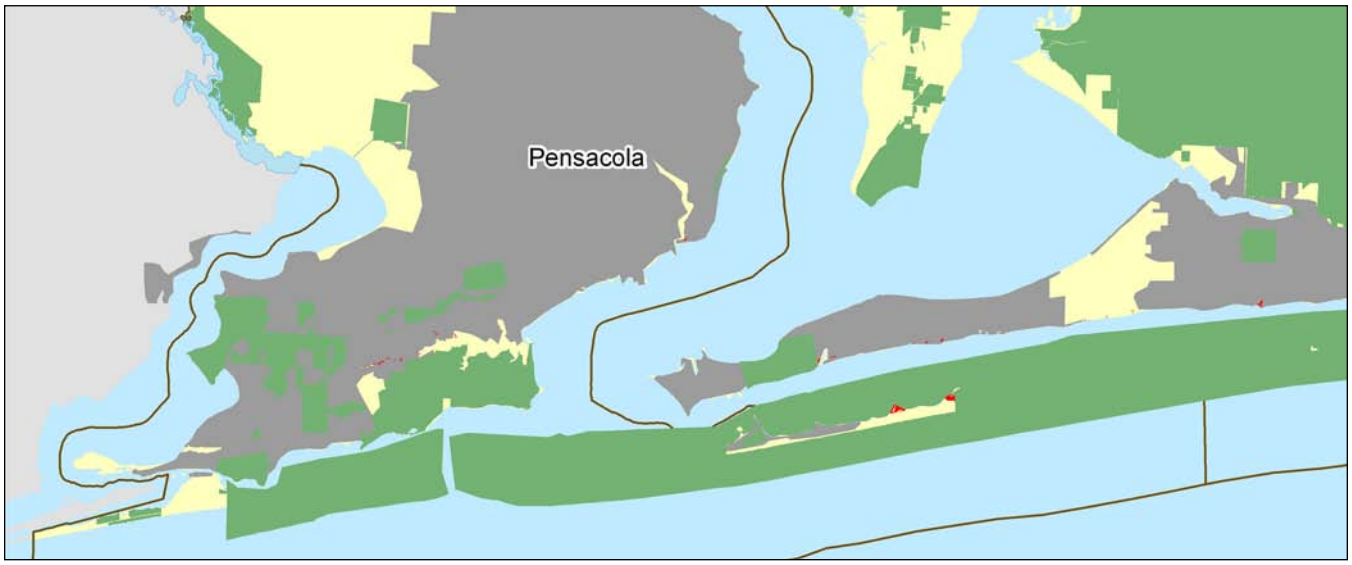

Figure 56 *Proposed Strategic Habitat Conservation Areas for Louisiana Seaside Sparrow.*

For each seaside sparrow subspecies we ran two PVA models, one on all potential habitat and one on only potential habitat located on managed lands. The PVA for Scott's Seaside Sparrow identified three discrete, independent populations when run on all potential habitat and four populations when run based on managed lands only. Results from the PVA using both models for Scott's Seaside Sparrow indicated the probability of extinction or decline in abundance during the next 100 years was 0% under baseline demographic parameters.

For the Louisiana Seaside Sparrow, there were only 192 ha of potential habitat, 143 ha (75%) of which were on managed lands. The PVA for the Louisiana Seaside Sparrow indicated that the probability of extinction in the next 100 years under the baseline demographic parameters was 3% using all potential habitat and 7% when we ran the model using only managed lands. The risk of a 50% decline in abundance was 7% for all potential habitat and 12% for only potential habitat on managed lands over the next 100 years.

For the MacGillivray's Seaside Sparrow, the probability of extinction or decline over the next 100 years under baseline demographic parameters was 0% for both models. A little more than 9,000 of the 20,000 ha (45%) of potential habitat is located on managed lands. The risk of a decline was very small under baseline parameters (<5% probability of a 20% decline

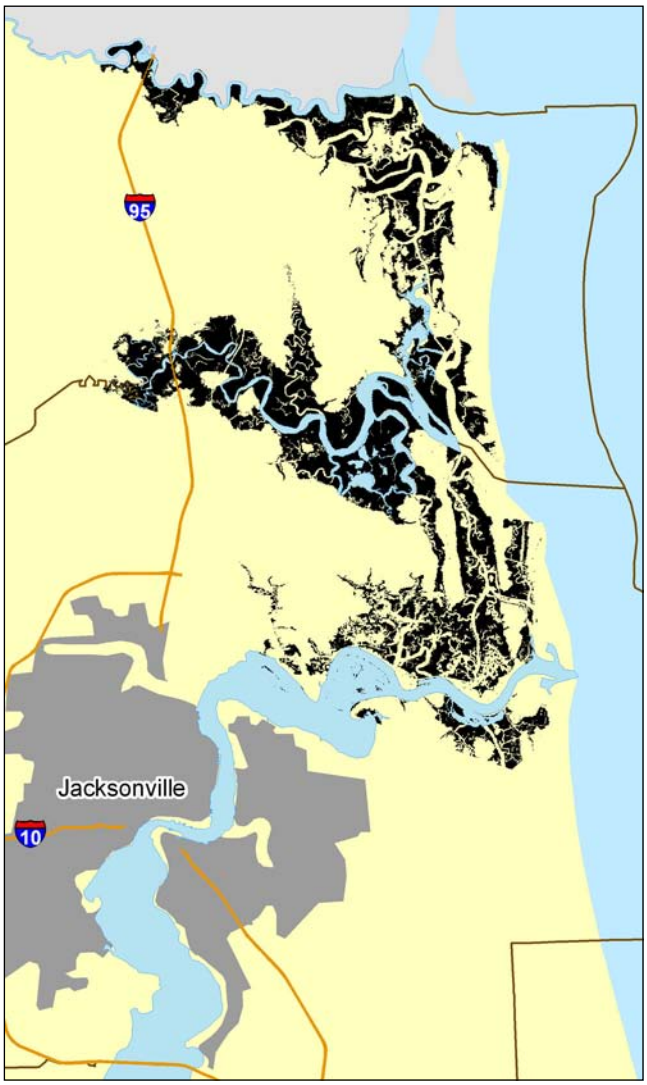

Figure 57 *Potential-habitat map for MacGillivray's Seaside Sparrow.*

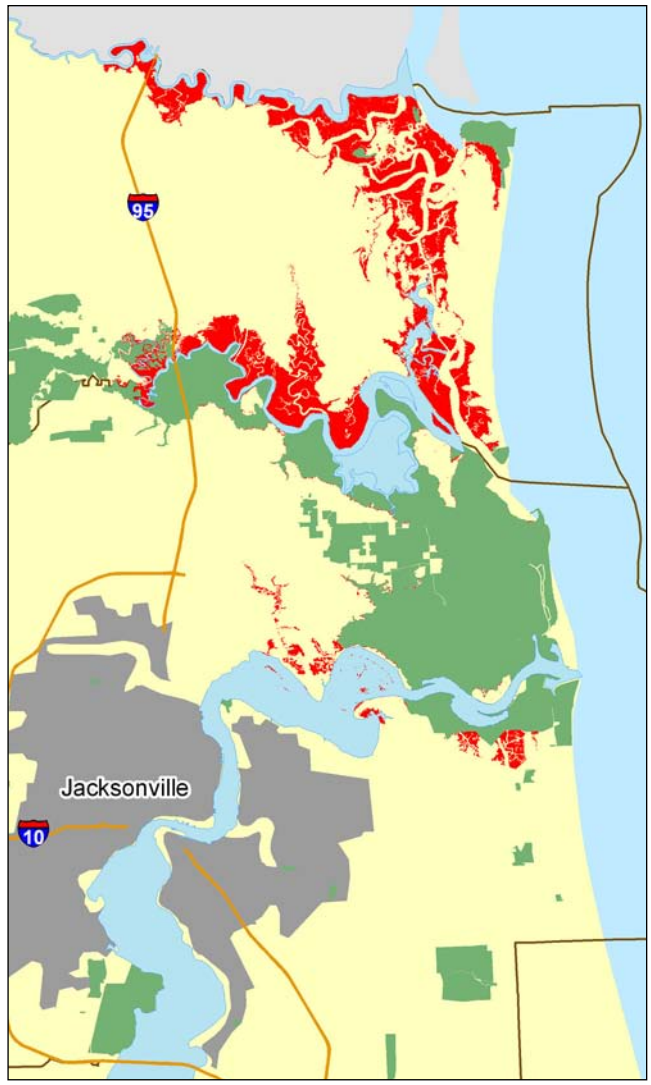

Figure 58 *Proposed Strategic Habitat Conservation Areas for MacGillivray's Seaside Sparrow.*

in abundance in the next 100 years). Abundance on potential habitat on managed lands was approximately 50% of that on all potential habitat, although the risks of a decline or extinction were quite similar in both models.

Although results from the PVA indicated a negligible threat of extinction or decline in abundance, we decided to identify SHCA because of the limited habitat range for each subspecies and the sensitivity of this habitat to catastrophic storm events and development along Florida's coasts. Strategic Habitat Conservation Areas include all potential habitat identified that did not occur on managed lands (Figures 54, 56, 58). Some manual cleanup of the SHCA map was necessary because of data incompatibility and digitizing errors in the FLMA database.

SHORT–TAILED HAWK

Ashok Khosla

The Short-tailed Hawk (*Buteo brachyurus*) occurs principally in South America; however, a disjunct population is found in the Florida peninsula. Short-tailed Hawks have been characterized as one of the rarest and least studied avian species in the United States (Miller and Meyer, 2002). Short-tailed Hawks inhabit a broad range of habitats, including mixed woodland and savanna. They nest and roost in patches of forest and forage over prairies and open country. Systematic statewide surveys are lacking, so population size and trends are unknown (Millsap, 1996b). Millsap (1996b) reported that the greatest threat to Short-tailed Hawks in Florida is loss of habitat to agricultural and residential development. Nevertheless, the Short-tailed Hawk is not currently listed by the FWC.

We limited our analysis of the Short-tailed Hawk's potential habitat to areas within EMAP hexagons with confirmed breeding activity or with documented nests. Breeding-range hexagons were identified from BBA blocks that contained records indicating confirmed or probable breeding activity (n = 25); from FLEO database records (n = 46); or from WildObs database records (n = 46) that indicated breeding behavior or nest sites. Nesting data was provided by Dr. Ken Meyer (n = 49). Within the EMAP hexagons, large patches (>400 ha) of nesting habitat (mixed hardwood–pine forest, hardwood hammock and forest, cabbage palm–live oak hammock, tropical hardwood hammock, bay swamp, cypress swamp, cypress/pine/cabbage palm, mixed wetland forest, hardwood swamp, hydric hammock, and bottomland hardwood forest) and adjacent foraging habitat (xeric oak scrub, sand pine scrub, sandhill, dry prairie, freshwater marsh and wet prairie, sawgrass marsh, salt marsh, shrub and brushland, and improved and unimproved pasture) were isolated from the FWC 2003 land-cover image (Figure 59). The resultant map probably overestimates available habitat within its range; however, because of the lack of habitat-use information for the species, important habitats are likely to be identified where Short-tailed Hawks are known to have nested. The potential habitat for this species includes over 1.6 million ha, of which more than 996,000 ha are on managed lands (~60%).

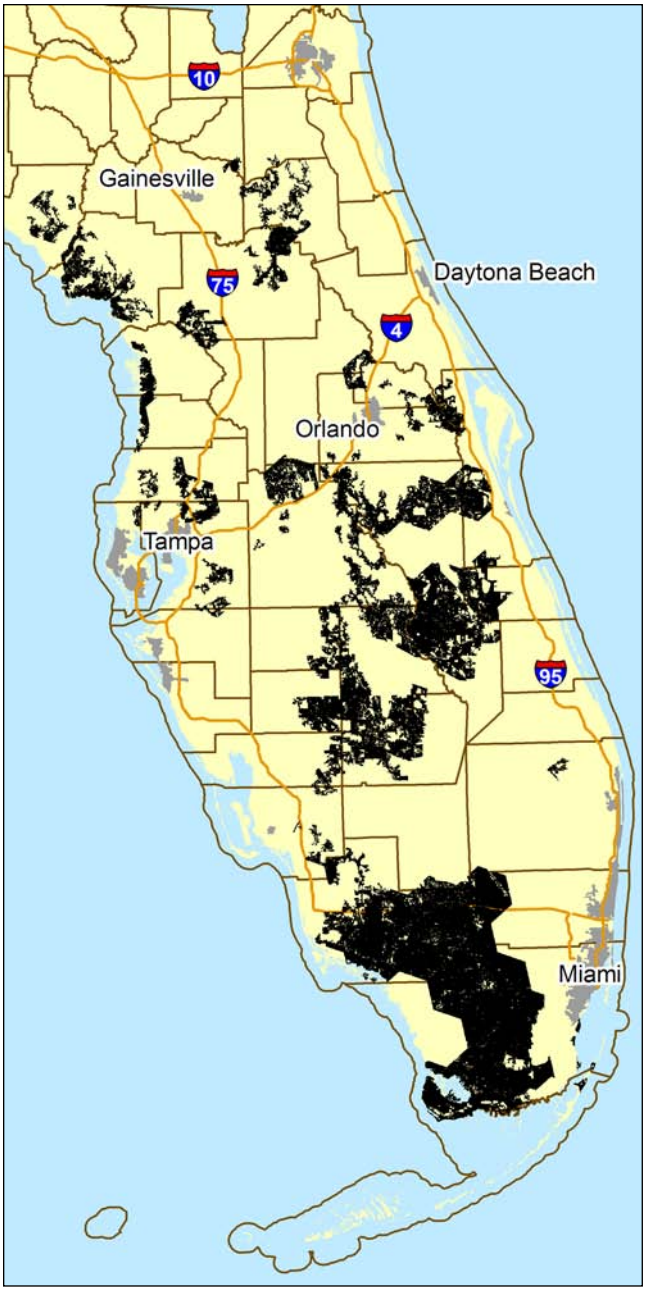

Figure 59 *Potential-habitat map for Short-tailed Hawk.*

Two PVA models were analyzed, one on all potential habitat and one on potential habitat located on managed lands only. The result from the PVA run on all potential habitat indicated the probability of extinction in the next 100 years under baseline demographic parameters was 24%, and the probability of a decline in abundance was high (*i.e.*, 89% probability of a 50% decline). About 60% of the potential habitat was

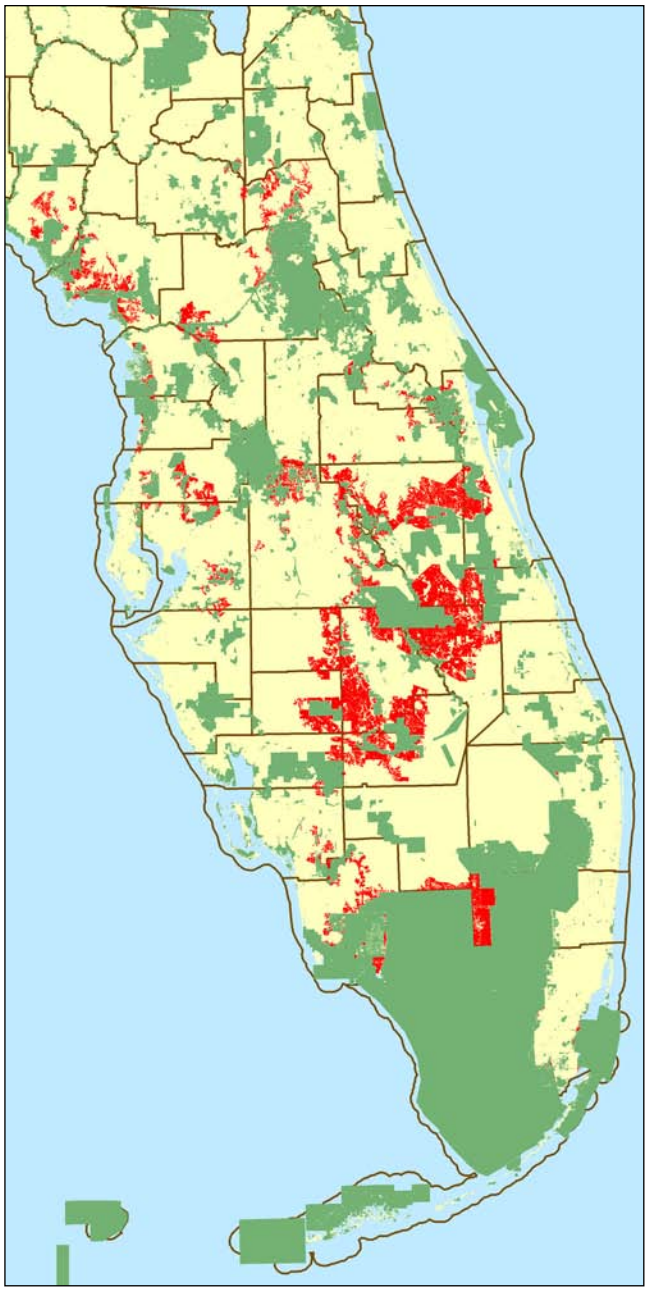

Figure 60 *Proposed Strategic Habitat Conservation Areas for Short-tailed Hawk.*

on managed lands, resulting in a smaller abundance with a 69% chance of extinction in the next 100 years and a high risk of decline (96% probability of a 50% decline in abundance).

Our PVA assessment was based on an earlier version of the habitat map that did not incorporate the nesting data provided by Dr. Ken Meyer. The new nesting information led to inclusion of additional habitat; however, the percentage of habitat on managed lands remained the same (~60%). It was not feasible for us to rerun the PVA, so we based our assessment to identify SHCA on the existing PVA. Although the PVA analyses were conducted on habitat maps that had approximately 25% less habitat than the final map, we developed SHCA because of the extremely high risks of extinction and decline in abundance. Additionally, adult survival was identified as the most influential parameter, with only a 5% reduction in adult survival increasing the risk of extinction to 93%. Strategic Habitat Conservation Areas were identified for this species by identifying all potential habitat that did not occur on managed lands (Figure 60).

SOUTHEASTERN AMERICAN KESTREL

USFWS

The southeastern subspecies of American Kestrel (*Falco sparverius paulus*) historically occurred throughout mainland Florida, but it no longer occurs in southern Florida. Southeastern American Kestrels were historically restricted to longleaf pine (*Pinus palustris*)–turkey oak (*Quercus laevis*) sandhill communities, where periodic disturbances, such as fire, created open patches suitable for foraging and large pine snags suitable for nesting cavities (Smallwood and Bird, 2002). With the introduction of nest boxes, South-

Figure 61 *Potential-habitat map for Southeastern American Kestrel.*

eastern American Kestrels are currently able to breed in a variety of areas that have had adequate foraging habitat but have not contained nest cavities. But despite this gain, the conversion of natural habitats to agriculture, silviculture, and urbanization has reduced the number of available nesting cavities, which is believed to be the principal reason for the population's decline in Florida (Collopy, 1996). Because of this decline, the FWC currently lists Southeastern American Kestrels as threatened.

We identified the potential habitat for Southeastern American Kestrels within the known breeding range (Figure 61). The breeding range was determined by identifying the EMAP hexagons where Florida BBA blocks contained records indicating confirmed or probable breeding activity (n = 226) or by identifying the FLEO (n = 97) and WildObs database records (n = 47) that indicated breeding behavior or nest sites. EMAP hexagons were also included within the breeding range if at least four adjacent hexagons contained evidence of

breeding activity. Within this range, we identified primary habitats (sandhill, dry prairie, and unimproved pasture) from the FWC 2003 land-cover image. Secondary habitats (cabbage palm–live oak hammock, grassland, and improved pasture) within 200 m of primary habitat were also identified. Both primary and secondary habitats were combined in depicting the potential habitat for Southeastern American Kestrels. The potential-habitat map included 1,054,123 ha, of which only 254,022 ha (24%) occurred on managed lands.

We ran two PVA models, one on all potential habitat and one on potential habitat located on managed lands only. Results from both PVAs indicated the metapopulation's probability of extinction during the next 100 years under baseline demographic parameters was 0%. The probability of declines in abundance was also very small in both models. Because of the low probabilities of extinction and low probabilities of large declines in abundance, we determined that SHCA were not warranted for this species. However, management efforts that aid Southeastern American Kestrels, such as the installation and maintenance of nest boxes, should continue.

SOUTHERN BALD EAGLE

USFWS

The Southern Bald Eagle (*Haliaeetus leucocephalus*) is a high-profile raptor that may be best known as the national symbol. Although recently delisted from the state and federal threatened-species lists, nesting and foraging habitat loss resulting from Florida's rapidly growing human population and the associated urbanization (Wood *et al.,* 1989), especially near the waterfront, remains a major concern for the eagle. Current efforts to protect Southern Bald Eagles are around nest sites, concentrating on curtailing activities that disrupt nesting, egg-laying, and rearing of young. Most strategies and guidelines employed by the USFWS (USFWS, 1987) and state agencies involve restricting humans from entering protective zones around nest sites during the nesting season. However, outside the nesting season, protection efforts are more lax, and human encroachment into the nesting area may result in the eagles' subsequent abandonment of the area.

Florida hosts approximately 11% of the nesting population in the continental U.S.; only Alaska and Minnesota are home to more Bald Eagles than Florida (FWC, 2008a). The greatest concentration of nesting pairs occurs in the central peninsula, near lacustrine areas (S. Nesbitt, personal communication). However, nests are also found in the Keys, southwestern Florida, and a scattering in the eastern Panhandle; most are situated along the Panhandle coast. Southern Bald Eagles live near large bodies of water (lakes, seacoasts, rivers, marshes, reservoirs) where tall trees are available for nesting and roosting. In Florida, especially the central and northern parts, Southern Bald Eagles tend to nest in pine trees (Wood *et al.,* 1989) but will use other suitable trees if they are of the correct size or form, have a good viewing platform, and clear flight paths. In southern Florida, cypress trees are commonly used for nesting, whereas those nests near Florida Bay, where there are few tall trees, are sometimes found in mangrove patches (Curnutt and Robertson, 1994; S. Bass, D. Jansen, and L. Oberhofer, personal communications). Breeding Southern Bald Eagles are territorial and defend an area around their nests from intrusion by other eagles; they will become alert or defensive in response to anthropogenic disturbances (Gerrard and Bortolotti, 1988).

Proximity to water is a decisive factor when eagles set up new nests. Breeding pairs require open water for foraging and rarely establish nests far from large bodies of water (Watts *et al.,* 1993). Watts *et al.* (1994) found that 95% of historic nests in Virginia were within 3 km of a waterway at least 250 m wide. Similarly, in Florida nearly all nests are within 3 km of open water (McEwan and Hirth, 1979; Wood *et al.,* 1989). However, eagles may build more than one nest per territory in order to maximize space usage in proximity to other eagles and food resources.

To identify areas that would serve as potential habitat for southern bald eagles, we first used the FWC 2003 land-cover image to identify open-water areas >10 ha. Then we buffered each open water area by 3 km. Within each 3-km area we identified salt marsh, freshwater marsh, and wet prairie land-cover types from the FWC 2003 land cover as foraging habitat. We identified and included pinelands, hardwood hammock and

Figure 62 *Potential-habitat map for Southern Bald Eagle.*

forests, cypress swamp, cypress/pine/cabbage palm, mixed wetland forest, hardwood swamp, hydric hammock, and bottomland hardwood forest as land-cover types that could provide primary nesting habitat. Secondary nesting-habitat types, including areas that are not necessarily forested but may provide isolated nest trees, were also identified (this included sand pine scrub, sandhill, dry prairie, grasslands, improved and unimproved pastures, Australian pines, and extractive land-cover categories). Mangroves were identified separately because they are used by Southern Bald Eagles mostly in south Florida.

To include all occupied habitat outside of the 3 km areas for analysis, we used Southern Bald Eagle nest-location data. The FWC surveys Southern Bald Eagle nests statewide annually (Nesbitt *et al.,* 2005), and nests that were active in any year from 1998 to 2003 (n = 1,450) were used to distinguish occupied territories. Within 3 km of each nest location, the same four components (listed as foraging, primary, secondary, and mangroves) were identified as potential habitat. The majority of the potential habitat identified from nest data (approxi-

mately 80%) had already been mapped during the primary analysis described above. The areas identified from the nest locations and the open-water analysis were merged in the final potential-habitat map (Figure 62). The areas identified using the open-water criterion included nearly all the nest sites and gave the final map more continuity than did using just nest location data.

There is a large area of potential habitat just west of Miami around Tamiami Trail (SR 90) that may not have the appropriate nesting structures because it is principally foraging habitat (expansive marsh). However, nesting habitat does occur in Everglades National Park on its southern edge and in the Big Cypress National Preserve on its western coast. In the northern part of the state, potential habitat occurrence along rivers is debatable. In rivers, the "open water" is linear and may be too narrow for eagles to actually forage in.

Nesting data from the 2004 and 2005 nesting season were used to corroborate the potential-habitat map. Several nest locations that were new, or active in 2004, were located in areas identified as potential habitat in the model. Additionally, Everglades National Park nests identified in 2005 are in potential habitat.

Potential habitat for this species includes more than 4.2 million ha, of which more than 1.4 million ha (or 34%) are on managed lands. The number of active territories has remained relatively constant, ranging from 1,043 in 1999 to 1,218 in 2007 (S. Nesbitt, personal communication). We ran two PVA models, one on all potential habitat and one on potential habitat located on managed lands. Baseline models for both metapopulations (with baseline growth rate of 1.0789) indicated that the probability of extinction was 0%. However, a large reduction in abundance occurred when considering only managed habitat. This was not surprising because it reflects the large reduction in carrying capacity when considering only managed habitat. When we reduced adult survival, fecundity, or carrying capacity in our model by 10%, the resulting risk of extinction remained 0%, and there was very little chance of even a small decline. This species, under these demographic conditions, appeared to be able to handle relatively large habitat changes with minimal effect on the long-term risks. In our PVA, both populations occupied the entire area for the next 100 years. In light of these results, no SHCA were identified. However, the long-term conservation of Florida's Southern Bald Eagles will be best achieved by working toward and meeting the conservation objectives defined in the Southern Bald Eagle management plan.

SWALLOW–TAILED KITE

The Swallow-tailed Kite (*Elanoides forficatus forficatus*) breeds throughout most of Florida and in parts of

FWC

South Carolina, Georgia, Alabama, Mississippi, Louisiana, and Texas (Meyer, 1995). Foraging habitat includes various combinations of pine forest, hydric pinelands with understories of wetland plants, pine fringe of floodplain and hardwood swamp forests, cypress swamp, wet prairies, freshwater and brackish marshes, hardwood hammocks, tall trees edging sloughs and bayous, mixed cypress–hardwood swamp forest, and mangrove forest (Meyer, 1995). Preferred nesting habitat is mixed-species swamp forest and both managed and unmanaged pineland. Although forest edges probably aid foraging kites by deflecting wind upwards to provide the birds lift and aerodynamic advantage, continuous forest is apparently a much more important feature of Swallow-tailed Kite foraging habitat than previously thought (Swan *et al.*, 2003). Meyer and Collopy (1996) reported that the greatest threat to the Swallow-tailed Kite in the U.S. is habitat destruction from conversion of preferred habitat to agriculture and by urbanization, combined with the large proportion of nesting effort on nonpublic lands. Some timberland owners are cooperating in developing and applying management recommendations (K. Meyer, personal communication). Swallow-tailed Kites are not currently listed by the FWC.

We limited our analysis of the potential habitat of the Swallow-tailed Kite to EMAP hexagons where breeding activity has been documented. Breeding-range hexagons were identified by using the BBA blocks that indicated confirmed or probable breeding activity (n = 453) or where FLEO database records (n = 43) or WildObs database records (n = 115) indicated breeding behavior or nest sites. EMAP hexagons were also included within the breeding range if at least four adjacent hexagons contained evidence of breeding activity. Within the identified EMAP hexagon breeding

Figure 63 *Potential-habitat map for Swallow-tailed Kite.*

range, primary nesting and foraging habitats (mixed pine–hardwood forest, hardwood hammocks and forest, pinelands, mixed wetland forest and cypress and hardwood swamp) were isolated from the FWC 2003 land cover to identify potential habitat (Figure 63).

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The results of the models indicated that the probability of extinction in the next 100 years under baseline demographic parameters was 1% for the model incorporating all potential habitat and about 8% for the model containing only managed-lands habitat. However, a high risk of a large decline (*i.e.*, 95% probability of a 50% decline) occurred in abundance in analyses of all potential habitat and an 82% reduction in overall abundance when considering only managed-lands potential habitat.

Because of the high risk of a large decline in abundance, we determined that SHCA were required for this species. To identify SHCA, we first excluded any area

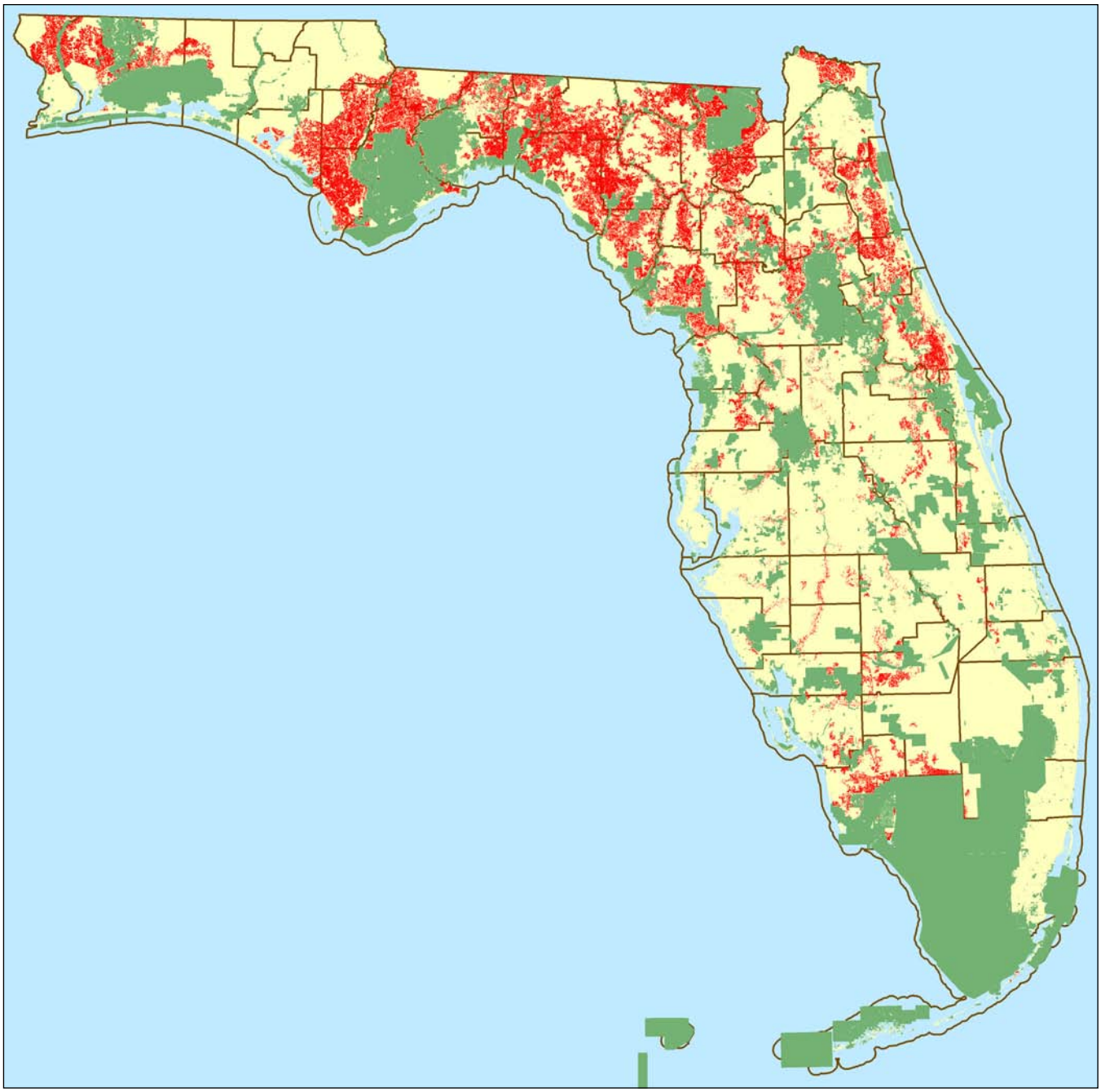

Figure 64 *Proposed Strategic Habitat Conservation Areas for Swallow-tailed Kite.*

identified as developed land by using the FNAI 2004 developed lands data set. Next, we identified all areas of primary importance to the Swallow-tailed Kite in Florida. These areas include a 5-mi (8.0-km) buffer around all known Swallow-tailed Kite nesting areas (locations provided by Dr. Ken Meyer) and a 2-mi (3.2-km) buffer around all bottomland hardwood forest and hardwood swamp habitats (identified from the FWC 2003 land-cover data set) associated with the major stream networks throughout the state (identified using a major rivers data set). In these areas, we identified all privately owned potential-habitat patches >1 ha as SHCA. For all areas outside these areas, SHCA were limited to potential-habitat patches >400 ha. This was done to remove small habitat patches outside known nesting and primary foraging areas and focus SHCA identification in these areas to the larger blocks of available habitat (Figure 64).

WADING BIRDS

Clockwise from upper left: USFWS; Jay Exum; USFWS; USFWS

Clockwise from upper left: NBII; Jay Exum; USFWS; USFWS

"Wading birds" is a term commonly used to describe a group of avian species closely associated with a variety of freshwater and saltwater wetland habitats. Such species nest, forage, and breed close to wetlands. This close association has led to the use of wading birds as indicators of wetland quality and water-resource health (Bildstein *et al.,* 1991). Our group of wading birds included Great Egret (*Ardea alba*), Snowy Egret (*Egretta thula*), Reddish Egret (*Egretta rufescens*), Tricolored Heron (*Egretta tricolor*), Little Blue Heron (*Egretta caerulea*), White Ibis (*Eudocimus albus*), Roseate Spoonbill (*Platalea ajaja*), and Wood Stork (*Mycteria americana*).

We created the model of potential habitat for wading birds by using breeding colony location data, the FWC 2003 land-cover image, and data from the National Wetlands Inventory (USFWS, 2000; Figure 65). Our goal was to identify habitat near colonies and wetlands that might be important to these wading birds. Although all of these species are similar in their ecological requirements, two species differ from the others in terms of foraging behavior and habitat use. Wood Storks may travel much farther from the colony during daily forage flights than do other species in this group. Conversely, Reddish Egrets do not commonly travel as far while foraging as do the other wading bird species. Therefore, we separated these two species during a portion of the modeling process.

The FWC conducted a statewide survey of wading bird colonies in 1999. We combined these data (n = 481) with colony location information from the FLEO database (n = 254) and the WildObs database (n = 2,824) to create a database of locations of wading bird colonies (n = 3,559). We divided these data into locations of Wood Stork colonies (n = 42), Reddish Egret colonies (n = 8), and "other wading birds" (n = 3,207). In the original databases, colonies were occasionally identified as made up of "mixed species" if more than one species occurred in that colony. If Wood Storks were sighted in a "mixed species" colony, then that colony was identified as a Wood Stork colony for our modeling purposes. Otherwise, we included mixed-species colonies in the "other wading birds" group.

FWC

We classified data from the FWC 2003 land-cover image as nesting habitat and foraging habitat. Land-cover types representing cypress/pine/cabbage palm, mixed wetland forest, hardwood swamp, salt marsh, mangrove swamp, and scrub mangrove were identified as nesting habitat. Researchers have suggested pro-

Figure 65 *Potential-habitat map for wading birds.*

tection zones near wading bird colonies to avoid disturbing nest sites. In our group of wading birds, Wood Storks have the largest suggested protection buffer (approximately 60–65 m) around nest sites (Rodgers and Smith, 1995). We doubled that area, retaining all potential nesting habitat within 130 m of all colony locations for further use in our model.

Our foraging habitat data was created by reclassifying the FWC 2003 land-cover image. We identified 12 land-cover types (Table 4) as foraging habitat. Many wading birds in this group commonly forage less than 15 km from the colony site each day (Custer and Osborn, 1978). However, Reddish Egrets forage less than 10 km from the nest site (Cox *et al.*, 1994), whereas Wood Storks commonly forage as far as 30 km from the colony (Bryan and Coulter, 1987). Wetland foraging habitats within 10 km of Reddish Egret colonies, 30 km of Wood Stork colonies, or 15 km of all other wading-species colonies were identified as potential foraging habitat. Researchers report that wading birds are sensitive to disturbances close to wetland foraging sites and have suggested a protection buffer of 100 m around for-

Table 4 *FWC land-cover classes identified as foraging habitat for wading birds.*

Class	Description
12	Freshwater marsh and wet prairie
13	Sawgrass marsh
14	Cattail marsh
15	Shrub swamp
16	Bay swamp
17	Cypress swamp
18	Cypress/pine/cabbage palm
19	Mixed wetland forest
20	Hardwood swamp
23	Salt marsh
24	Mangrove swamp
25	Scrub mangrove
26	Tidal flats
27	Open water

aging sites (Rodgers and Smith, 1997). We included all foraging habitat within 200 m of identified potential foraging habitat. All potential foraging habitat was combined with all potential nesting habitat to create this model of potential habitat for our wading birds group.

The potential-habitat map for the wading birds included almost 3 million ha, of which almost 1.9 million ha (63%) are on managed lands. Because these species have great dispersal ability (most of them are migratory species) the entire habitat layer was treated in the model as containing a single population. We did, however, run a set of models to compare the effects of low (~200 females), moderate (~15,000 females), and high (~35,000 females) carrying capacities to mimic the range of abundance among the different species.

We ran two PVA models, one on all potential habitat and one on potential habitat located only on managed lands. Results of the PVA indicated that the probability of extinction in the next 100 years under baseline demographic parameters was 0% and the probability of a decline was low (*i.e.*, 6% probability of a 20% decline) for the model run on all potential habitat. For the metapopulation containing only managed habitat, the abundance was smaller than for the metapopulation with all potential habitat, but the risks were quite similar: no chance of extinction in the next 100 years and a small risk of a decline (*i.e.*, 7% probability of a 20% decline). Therefore, no SHCA were created for this group of species.

WHITE–CROWNED PIGEON

The White-crowned Pigeon (*Patagioenas leucocephala*) is an obligate frugivore whose continental United States breeding range is restricted to the Florida Keys

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and the southern tip of mainland Florida (Bancroft and Bowman, 2001) but may be found farther north to Fort Pierce during the nonbreeding season. The primary habitat requirement for the species is the co-occurrence of nearshore mangrove islands for nesting and fruit-producing hardwood forest for foraging. Neither habitat suffices in itself. Intense development of upland forest habitat appears to be the major threat to the species, especially in the Florida Keys (Bancroft, 1996). White-crowned Pigeons are listed as a threatened species by the FWC.

Potential-habitat analysis was confined to White-crowned Pigeon breeding range in Florida (Figure 66). We identified this range by isolating EMAP hexagons that contained a Florida BBA block with at least one record that indicated confirmed or probable breeding activity (n = 73) or where FLEO database records (n = 168) indicated breeding behavior or nest sites. We used the FWC 2003 land-cover image to isolate mangrove swamp, tropical hardwood hammock, and hardwood hammock and forest within the species' breeding range.

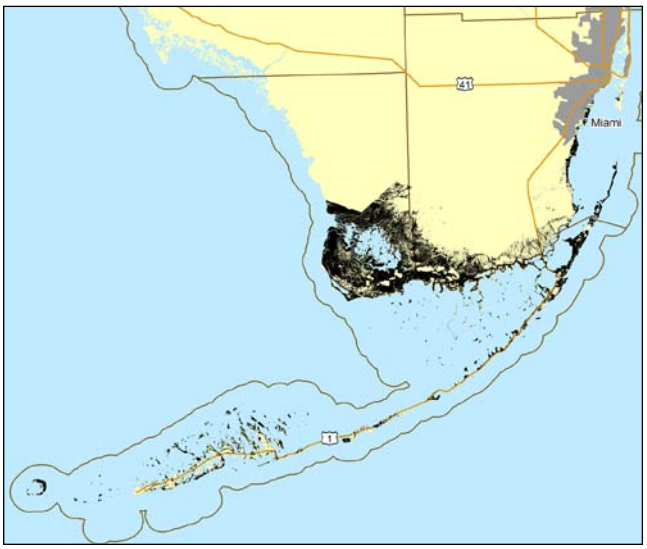

Figure 66 *Potential-habitat map for White-crowned Pigeon.*

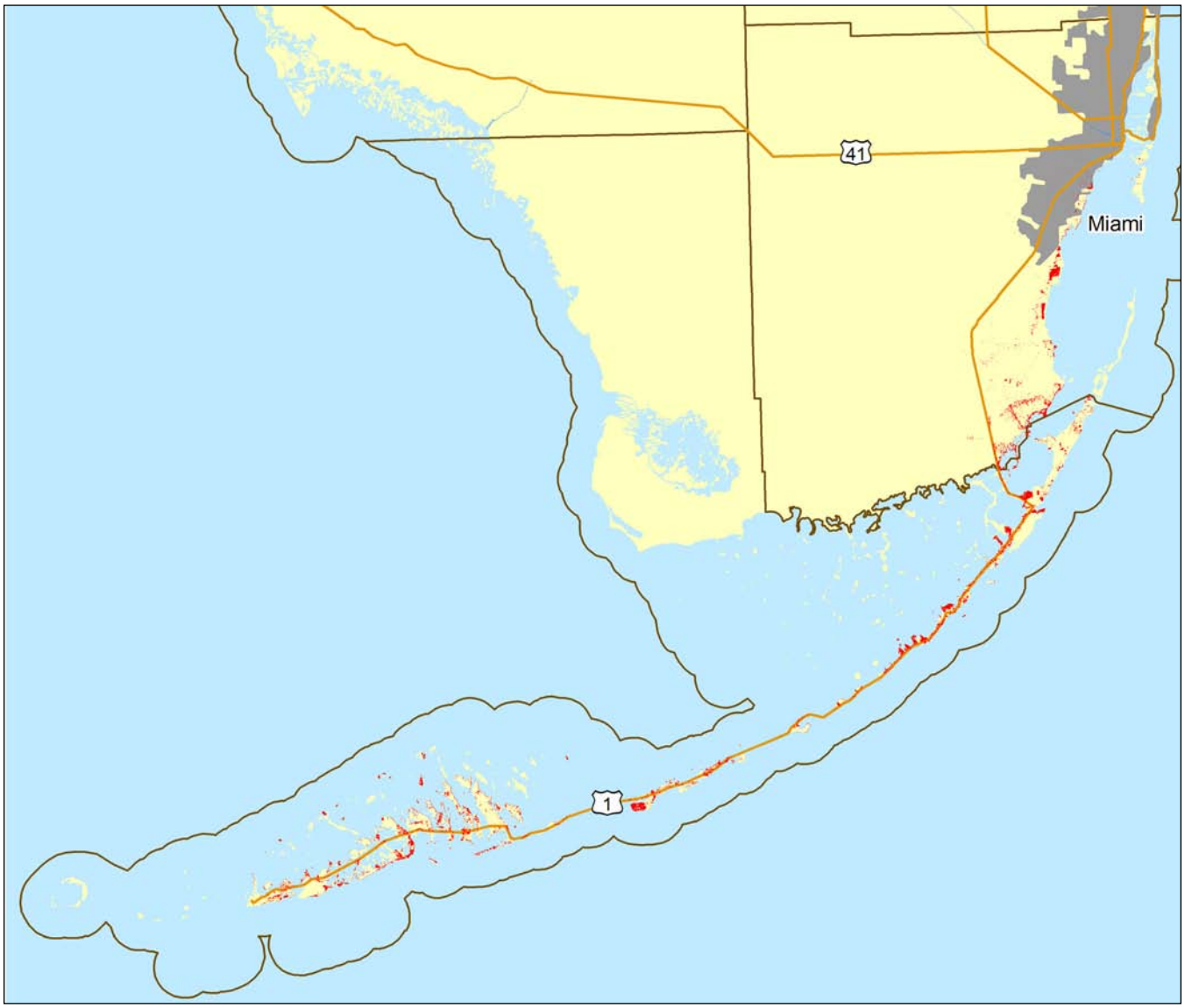

Figure 67 *Proposed Strategic Habitat Conservation Areas for White-crowned Pigeon.*

The potential habitat we identified for the White-crowned Pigeon included over 104,133 ha of habitat, of which 94,564 ha (91%) occurred on managed lands. This species can fly over 45 km to forage. We selected a dispersal distance of 20 km to delineate demographically distinct populations. Because of the spatial arrangement of the habitat, the potential habitat formed a single population.

Results from the PVA indicated that the probability of extinction of the population in the next 100 years under the baseline demographic parameters was 0% when all potential habitat was considered as well as when only managed-land habitat was considered. A large probability of a substantial decline was evident (*i.e.*, 77% probability of a 60% decline in abundance in the next 100 years). Since most of the potential habitat was managed, only a slight reduction in the abundance occurred when only managed habitat was considered. Given the moderately high probability of decline in abundance when considering only managed habitat, we identified SHCA for the White-crowned Pigeon. For this species, unprotected habitats in the Florida Keys are most important (K. Meyer, personal communication). Therefore, SHCA include any unprotected potential habitat in the Florida Keys. We limited SHCA on mainland Florida to 1-ha or larger patches of privately owned potential habitat (Figure 67).

Mammals

BATS

The gray bat (*Myotis grisescens*) and southeastern bat (*Myotis austroriparius*) are colonial species that breed, roost, and overwinter in large groups at sites such as caves, bridges, buildings, hollow trees, culverts, drainpipes, storm sewers, and bat houses. In Florida, these species live principally in caves. This makes them especially vulnerable to human disturbance, habitat loss, pesticide contamination, environmental calamities, and other threats. Survival of both species is dependent on availability of adequate roost sites, especially maternity roosts. Many of the maternity caves that are currently in use in Florida are not adequately protected, and some are frequently vandalized (Gore and Hovis, 1994).

GRAY BAT

USFWS

The FWC lists *Myotis grisescens* as endangered. It occurs in central and eastern states where there is karst topography with limestone caves. Northern Florida is the southernmost extent of their summer range. Colonies have been found only in Jackson County, although small colonies may be located in other northern counties (Gore, 1996; J. Gore, personal communication). In general, gray bats that summer in Florida migrate north to Alabama or Tennessee where caves with cold, stable temperatures exist, for winter hibernation (Gore, 1996).

Occurrence records (n = 12) were from the FLEO database (n = 8, 1957–1994) and WildObs (n = 4, 1986–1987) database. One FLEO record from 1957 and two from 1976 were individual sightings with no known cave nearby and were therefore omitted from the analysis. The remaining nine points were used in the gray bat habitat map.

The potential-habitat map created for this species identified from the FWC 2003 land-cover image all mixed hardwood–pine forest, hardwood hammocks and forests, freshwater marsh and wet prairie, bay swamp, cypress swamp, cypress/pine/cabbage palm, mixed wetland forest, hardwood swamp, hydric hammock, and bottomland hardwood forest within 25 km of an occurrence record (Figure 68). Twenty-five km is the maximum foraging distance for this species (LaVal *et al.*, 1977). Based on the potential-habitat map, only about 10% of the potential habitat occurred on managed lands.

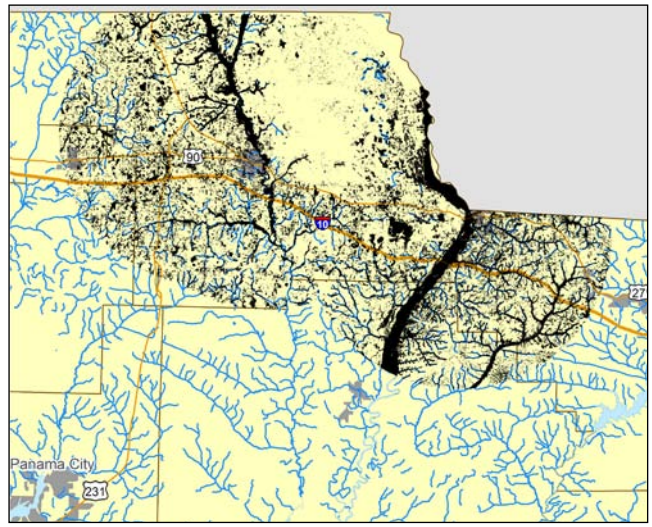

Figure 68 *Potential-habitat map for gray bat.*

Results of the PVA indicated that the probability of extinction of the gray bat in Florida in the next 100 years under the baseline demographic parameters was 0% but that the probability of a large decline was moderate (*i.e.*, 33% probability of a 50% decline). About 34% of the potential habitat is on managed lands, resulting in a much lower abundance although the risks were the same (extinction, 0%; decline, 35% probability of a 50% decline).

We consulted experts on this species to determine the current status, trend, and most appropriate conservation actions. In the past several years, no summer gray bats have been seen in Florida; possibly they are absent. The winter colony has numbered <200 bats for several years and <10 individuals have been counted in the past three years (J. Gore, personal communication). Scientists have not determined the cause(s) of the declining Florida population. Catastrophic events such as flooding are one possible cause. Given that a PVA excludes catastrophic events, the results could grossly underestimate the extinction probabilities. This is especially true for species, such as the gray bat, that have temporal/spatial concentrations. Based on recent population declines, the geographic isolation of gray bat potential habitat, and the low percentage of potential habitat on managed lands, we identified SHCA. The SHCA created for this species include all potential habitat existing outside of managed lands (Figure 69). In addition to habitat protection for this species, conservation efforts should focus on protecting roost-site locations from disturbance.

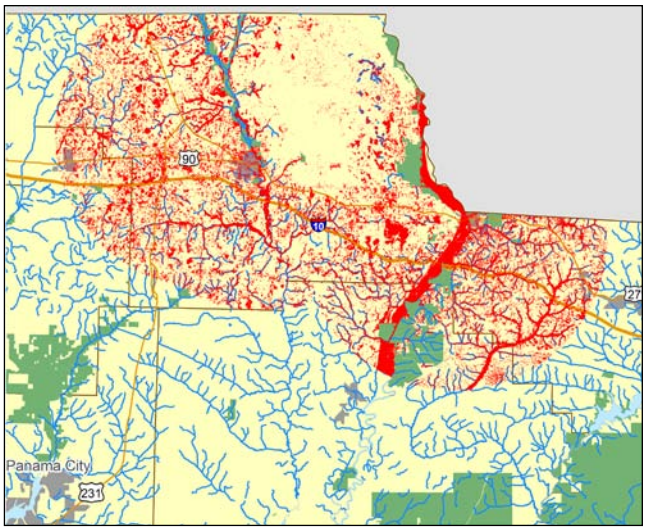

Figure 69 *Proposed Strategic Habitat Conservation Areas for gray bat.*

SOUTHEASTERN BAT

Mike Sheppard

Myotis austroriparius is not listed by the FWC or USFWS, but its status is under review by the USFWS, and it might eventually be listed because of threats to maternity caves. The southeastern bat has a wide range in the southeastern U.S. and is a year-round resident in Florida. Currently, southeastern bats inhabit caves and other structures in the Panhandle and down the peninsula to Sumter County. Historically, they ranged as far south as Manatee County. The Panhandle and peninsular populations are considered ecologically distinct because of differing reproduction and hibernation patterns (Rice, 1955). In the Panhandle, southeastern bats mate in fall and hibernate during winter, emerging and foraging when the weather is temperate (Rice, 1955; Humphrey and Gore, 1992). In the peninsula, populations mate in the spring and may hibernate for a few weeks if the weather becomes very cold.

We collected occurrence records (n = 52) from the FLEO (n = 27, 1955–1999) and WildObs (n = 25, 1987–1992) databases. Five records that were not in or near a maternity cave were omitted from the WildObs data set for this analysis.

The potential-habitat map is based principally on occurrence records, focusing on maternity caves and their associated foraging areas. The potential-habitat map identified from the FWC 2003 land-cover image all mixed hardwood–pine forest, hardwood hammocks and forests, freshwater marsh and wet prairie, bay swamp, cypress swamp, cypress/pine/cabbage palm, mixed wetland forest, hardwood swamp, hydric hammock, and bottomland hardwood forest habitats within 25 km of a location

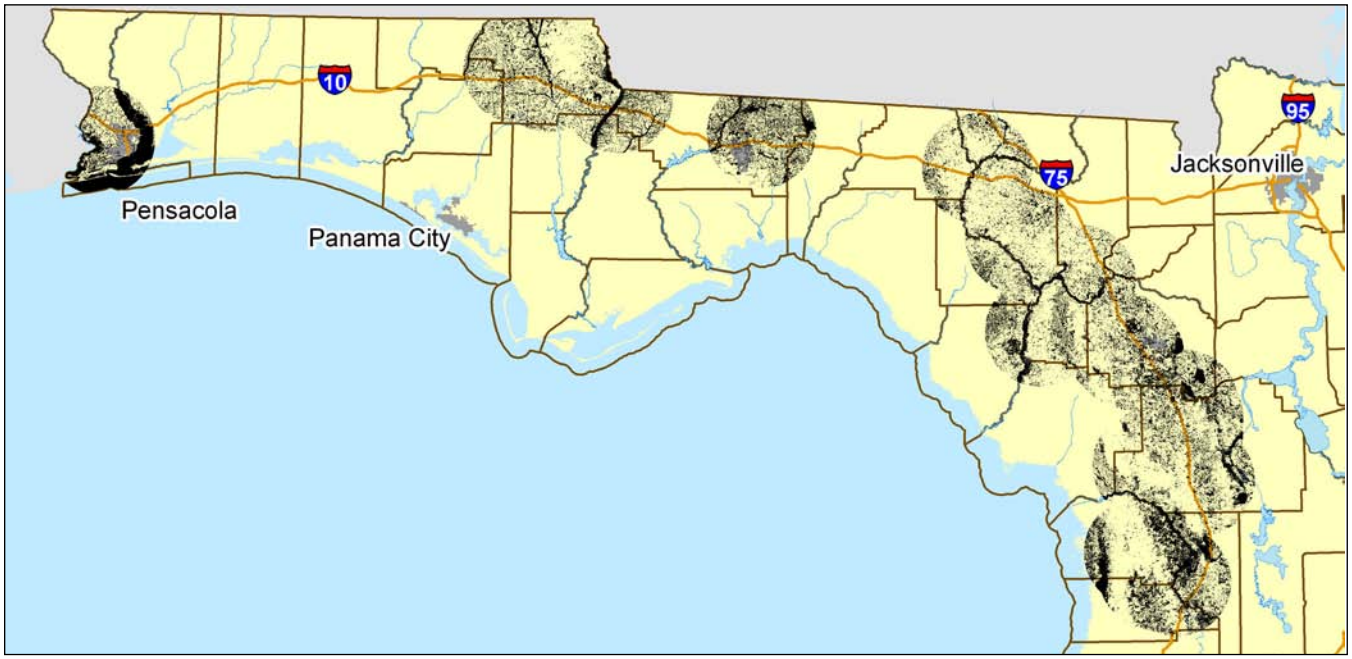

Figure 70 *Potential-habitat map for southeastern bat.*

record (Figure 70). Twenty-five km is the maximum foraging distance for this species (LaVal *et al.,* 1977).

The southeastern bat is probably more widespread than the map suggests (J. Gore, personal communication). However, despite the number of caves in Florida, the southeastern bat occurs in low densities. Results of the PVA indicated that under baseline demographic parameters, the probability of extinction in the next 100 years was 0% and that the probability of a decline was low (*i.e.,* 7% probability of a 50% decline). For the analysis conducted on only potential habitat existing on managed lands, the abundance was smaller than for the analysis on all potential habitat, but the risks were quite similar (no chance of extinction in the next 100 years and a 5% probability of a 50% decline in abundance). Given the results of the PVA, no SHCA were created for this species.

The PVA may grossly underestimate extinction probabilities for colonial species, such as the southeastern bat. The analysis does not account for the temporal and/or spatial concentration of the colonial species. Nor does the PVA account for the increased vulnerability of colonial species to catastrophic events. The largest known colony of this species was recently lost in a flood. This one event may have reduced the statewide number of adults >25% (J. Gore, personal communication).

BEACH MICE

USFWS

The Anastasia Island (*Peromyscus polionotus phasma*), Choctawhatchee (*Peromyscus polionotus allophrys*), Southeastern (*Peromyscus polionotus niveiventris*), and St. Andrews beach mice (*Peromyscus polionotus peninsularis*) are four of six subspecies of oldfield mouse that are found in beach-associated habitats in Florida. The Anastasia Island subspecies, listed as endangered by FWC and USFWS, historically ranged from approximately the Duval–St. Johns county line southward to Anastasia Island. Habitat loss caused by beachfront development has restricted current populations principally to portions of Anastasia Island and to a reintroduced population in the Guana River Wildlife Management Area. However, uncommon and incidental evidence indicates that this species may exist in limited numbers on some parcels of private land. The Choctawhatchee subspecies, listed as endangered by the FWC and the USFWS, historically ranged along Florida's gulf coast from East Pass, Choctawhatchee Bay, to Shell Island in Bay County. Habitat loss caused by beachfront development has reduced its current range to 20% of its original size. Known populations are currently found in small areas of Topsail Hill, Shell Island, and a translocated population in Grayton Beach State Recreation Area. The Southeastern subspecies, listed as threatened by the FWC and USFWS, historically occurred in sand dune habitats along the coast from Volusia County to Broward County. Habitat loss caused by beachfront development has restricted known populations to managed land in Volusia, Brevard, Indian River, and St. Lucie counties. The St. Andrews subspecies, listed as endangered by the FWC and USFWS, historically ranged along Florida's gulf coast from Crooked Island east to Bay County and to Indian Peninsula in Gulf County. Habitat loss caused by beachfront development and predation by introduced animals has reduced its current range. Populations currently occur at Tyndall Air Force Base and along the St. Joseph Peninsula, including in small areas of St. Joseph Peninsula State Park and B. J. Rish County Park.

FWC

Beach mice are commonly found on sand dunes in vegetation and on bare sandy areas, and in woody vegetation of the adjoining coastal strand (Ivey, 1949; Pournelle and Barrington, 1953; Humphrey and Barbour, 1981; Extine and Stout, 1987). Vegetation in these areas includes sea oats (*Uniola peniculata*), little blue stem (*Schizachyrium scoparium*), bunch grass, scrubby oaks, and dwarf magnolias (*Magnolia grandiflora*). Principal food items include the seeds of sea oats, dune panic grass (*Panicum amarulum*), and invertebrates found in sand dune habitats.

ANASTASIA ISLAND BEACH MOUSE

The potential-habitat map was created using the FWC 2003 land-cover image, FLMA database, and 2004 DOQQ. We identified land-cover types representing coastal strand, sand/beach and shrub and brushland as suitable habitat classes. Using the 2004

DOQQ, we created a polygon enveloping all beach, sand, and shrub areas on Anastasia Island. All habitat within the boundaries of Guana River WMA, Anastasia State Park, Fort Matanzas National Monument, and the Anastasia Island polygon were retained as potential habitat (Figure 71).

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Results of the PVAs indicated that there was no probability of extinction or declines in the next 100 years under baseline demographic parameters. Approximately 67% of the potential habitat was on managed lands. For the habitat on managed lands, the metapopulation abundance was smaller than for the metapopulation on all potential habitat, but the risks were similar (0% probability of extinction or decline in abundance in the next 100 years). However, because of its limited range, this subspecies is particularly susceptible to catastrophic events such as hurricanes, human encroachment and beachfront development, and impacts from feral and domesticated dogs and cats. Therefore, we decided to develop SHCA

Figure 71 *Potential-habitat map for Anastasia Island beach mouse.*

Figure 72 *Proposed Strategic Habitat Conservation Areas for Anastasia Island beach mouse.*

for this species (Figure 72). Because of the limited range and available habitat identified for this species, SHCA consist of all potential habitat outside of existing managed lands.

SOUTHEASTERN BEACH MOUSE

The potential-habitat map was created using the FWC 2003 land-cover image and the county-boundary layer of Florida. We identified land-cover types representing coastal strand, sand/beach, and shrub and brushland as suitable habitat classes (Figure 73). Proposed management recommendations have included identifying all coastal areas in Indian River, St. Lucie, and Martin counties that currently provide or could provide habitat (USFWS, 1999c), as well as the New Smyrna Dunes area south to the Volusia County line. Additionally, Blair (1951) determined that young beach mice disperse an average of 432 m from the natal area. Therefore, we retained all areas of the suitable habitat classes within 432 m of the coast within those counties.

We ran two PVA models, one on all potential habitat and one on potential habitat occurring on

Figure 73 *Potential-habitat map for Southeastern beach mouse.*

Figure 74 *Proposed Strategic Habitat Conservation Areas for Southeastern beach mouse.*

managed lands. Results of the PVAs indicated a 0% probability of extinction or declines in the next 100 years under baseline demographic parameters. Approximately 55% of the potential habitat is on managed lands. For the metapopulation on managed-lands habitat only, the abundance was smaller than for the metapopulation with all potential habitat, but the risks were similar (0% probability of extinction or declines in the next 100 years). However, because of its limited range, this species is particularly susceptible to catastrophic events such as hurricanes, human encroachment and beachfront development, and impacts from feral and domesticated dogs and cats, none of which were considered in this PVA. Additionally, recent trapping and genetic analysis suggest that this species (usually considered the most stable of the listed subspecies) is declining (M. Tucker, personal communication). Therefore, we decided that SHCA were warranted for this species (Figure 74). Because of the limited range and available habitat identified for this species, SHCA consist of all potential habitat outside of existing managed lands.

CHOCTAWHATCHEE BEACH MOUSE

This potential-habitat model was created by the USFWS using methods described in Endangered and Threatened Wildlife and Plants; Critical Habitat for the Perdido Key Beach Mouse, Choctawhatchee Beach Mouse, and St. Andrew Beach Mouse; Proposed Rule (USFWS, 2005) (Figure 75).

We ran two PVA models, one on all potential habitat and one only on managed-lands habitat. Results of the PVAs indicated that there was no probability of extinction or declines in the next 100 years under baseline demographic parameters. Approximately 78.5% of the potential habitat is on managed lands. For the managed-lands-only metapopulation analysis, the abundance was smaller than for the metapopulation on all potential habitat, although the risks were similar (0% probability of extinction or decline in abundance in the next 100 years). Because of its limited range, this species is particularly susceptible to threats such as hurricanes, human encroachment and beachfront development, and impacts from feral and domesticated dogs and cats. Therefore, we decided to create SHCA for this species (Figure 76). Because of the limited range and available habitat identified for this species, SHCA consist of all potential habitat outside of existing managed lands.

Figure 75 *Potential-habitat map for Choctawhatchee beach mouse.*

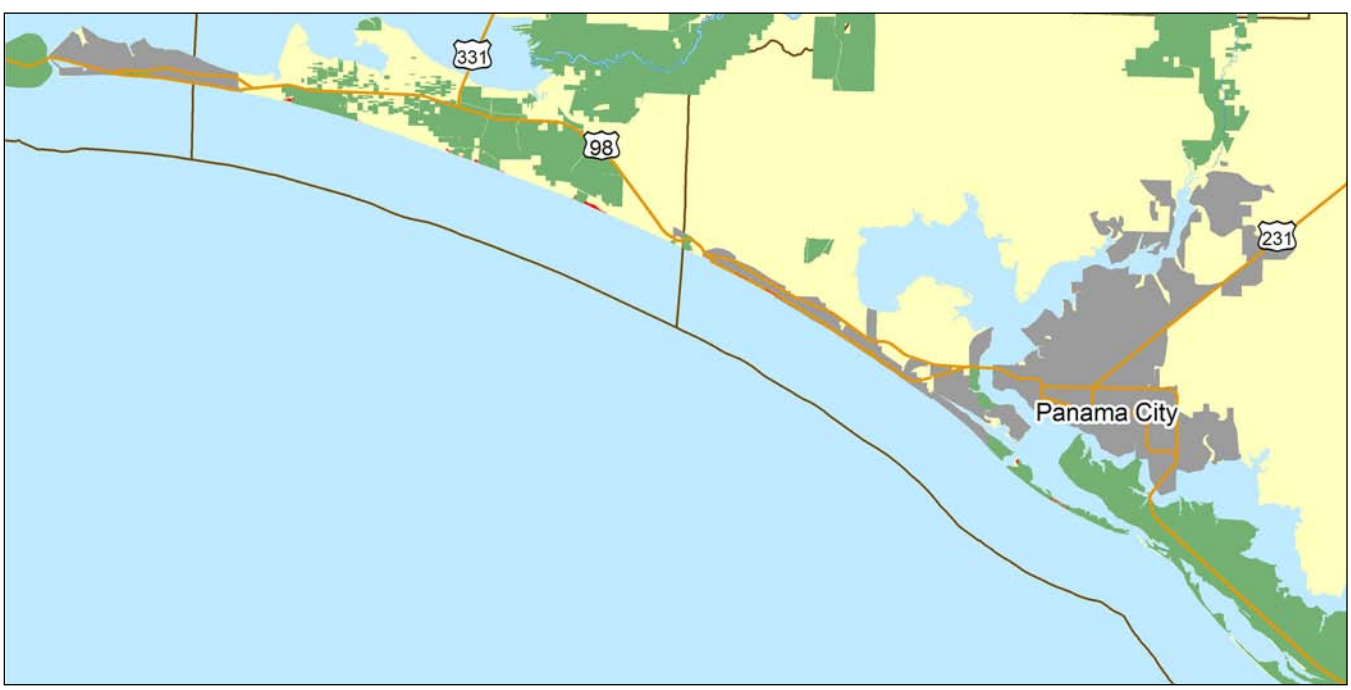

Figure 76 *Proposed Strategic Habitat Conservation Areas for Choctawhatchee beach mouse.*

Figure 77 *Potential-habitat map for St. Andrews beach mouse.*

Figure 78 *Proposed Strategic Habitat Conservation Areas for St. Andrews beach mouse.*

ST. ANDREWS BEACH MOUSE

This potential-habitat model was created by the USFWS using methods described in Endangered and Threatened Wildlife and Plants; Critical Habitat for the Perdido Key Beach Mouse, Choctawhatchee Beach Mouse, and St. Andrew Beach Mouse; Proposed Rule (USFWS, 2005) (Figure 77).

We ran two PVA models, one on all potential habitat and one on managed-lands habitat. Results of the PVAs indicated there was 0% probability of extinction or decline in abundance in the next 100 years under baseline demographic parameters. Approximately 69% of the potential habitat is on managed lands. For the managed-lands-only metapopulation, the abundance was smaller than for the metapopulation with all potential habitat, but the risks were similar (0% probability of extinction or decline in abundance in the next 100 years). Because of its limited range, this species is particularly susceptible to threats such as hurricanes, human encroachment and beachfront development, and impacts from feral and domesticated dogs and cats. Therefore, we decided to create SHCA for this species (Figure 78). Because of the limited range and available habitat identified for this species, SHCA consist of all potential habitat outside of existing managed lands.

FLORIDA BLACK BEAR

Jay Exum

The black bear (*Ursus americanus*) ranges throughout the United States, northern Mexico and Canada. The Florida black bear (*Ursus americanus floridanus*) is a subspecies found only in Florida, southern Georgia, and Alabama. Bears require a variety of forested areas and maintain large home ranges. A 2004 estimate of 2,042–3,213 bears statewide was generated with mark-recapture models using DNA analysis (Simek *et al.*, 2005). The FWC currently lists the Florida black bear as threatened, in large part because of habitat fragmentation from habitat loss and conversion.

Dr. Tom Hoctor of the Geoplan Center at the University of Florida was contracted to create the potential-habitat map for Florida black bears. Four habitat groupings were identified by using the FWC 2003 land-cover image and FLUCCS and FLMA databases, and potential habitat was mapped based on rules established for each grouping. The four habitat groupings were primary habitat (Table 5), secondary habitat (Table 6), traversable matrix (Table 7), and mangrove. For primary habitats, only pineland cover that did not overlap with pine plantations in the FLUCCS database or was within lands identified in the FLMA database was included in the pineland land-cover category as potential primary habitat. For secondary habitats, only pineland cover that overlapped with pine plantations in the FLUCCS database and was not within lands identified in the FLMA database was also included in the pineland land-cover category as potential sec-

Table 5 *FWC 2003 land-cover classes identified as Florida black bear primary habitat.*

Class	Description
3	Xeric oak scrub
4	Sand pine scrub
7	Mixed hardwood–pine forest
8	Hardwood hammocks and forest
9 (modified)	Natural pinelands
10	Cabbage palm–live oak hammock
16	Bay swamp
17	Cypress swamp
18	Cypress/pine/cabbage palm
19	Mixed wetland forest
20	Hardwood swamp
21	Hydric hammock
22	Bottomland hardwood forest
40	Brazilian pepper

Table 6 *FWC 2003 land-cover classes identified as Florida black bear secondary habitat.*

Class	Description
1	Coastal strand
5	Sandhill
6	Dry prairie
9 (modified)	Commercial pinelands
11	Tropical hardwood hammock
12	Freshwater marsh and wet prairie
15	Shrub swamp
25	Scrub mangrove
28	Shrub and brushland
37	Exotic plants
38	Australian pine
39	Melaleuca

Table 7 *FWC land-cover classes identified as Florida black bear traversable matrix.*

Class	Description
2	Sand/beach
13	Sawgrass marsh
14	Cattail marsh
23	Salt marsh
24	Mangrove
25	Scrub mangrove
26	Tidal flat
29	Grassland
30	Bare soil/clearcut
31	Improved pasture
32	Unimproved pasture
33	Sugar cane
34	Citrus
35	Row/field crops
36	Other agriculture

Figure 79 *Potential-habitat map for Florida black bear.*

ondary habitat. In addition to the land-cover categories listed in Table 7, the traversable matrix also included narrow water gaps defined as less than 120 m in width. Furthermore, because bears cross roads and other potentially narrow zones of intensive land uses, all urban and extractive land uses less than 120 m wide were also added to the traversable matrix.

For primary habitat, we identified all patches of primary habitat greater than 15 ha based on the methods used in Cox *et al.* (1994). Additionally, all primary habitat patches less than 15 ha and all secondary habitat within 1 km (*Cox et al.,* 1994) and connected to the 15-ha patches (including by suitable land types) were identified. Mangrove-forest cover identified from the FWC 2003 land cover within 10 km of and contiguous with primary or secondary habitats was identified. We selected the 10-km distance by determining the distance needed to encompass all telemetry locations of bears within the mangrove zones within southwest Florida.

Figure 80 *Proposed Strategic Habitat Conservation Areas for Florida black bear.*

Areas dominated by intensive urban land uses were deleted from consideration as potential habitat by identifying all blocks of intensive urban land use that were within 60 m of each other and eliminating small or narrow patches of potential habitat or traversable habitat within these areas.

The final step of the potential-habitat mapping was to retain all viable land available for wildlife use containing greater than 4,000 ha of primary or secondary designated habitats (Figure 79). This was done to identify areas that are more likely to be large enough to serve as minimally functional habitat units for Florida black bears (Hellgren and Maehr, 1992). The identified potential habitat totals almost 7 million ha, of which less than 2.4 million ha (34%) were on managed lands.

We ran two PVA models, one including all potential habitat and one limited to potential habitat occurring on managed lands. In both models, the PVAs identified a single population in Florida. The baseline growth rate for both models was 1.0138, which made

them moderately sensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years under baseline demographic parameters was 0%. Using all potential habitat, the probability of a decline was low (*i.e.,* 2% probability of a 20% decline). Abundance in the model using only managed habitat was smaller (11% probability of a 20% decline).

The results of the PVA indicate that no SHCA are needed for this species. However, relevant information suggests that the PVA did not capture the major threats to the Florida subspecies. Treating Florida bears as a single population, the PVA overlooks some of the more fine-scaled population effects. Eason (2003) described the population and habitat status of bears in Florida as follows:

> "The primary range of bears in Florida has been restricted to 6 large (Apalachicola, Big Cypress, Eglin, Ocala, Osceola, and St. Johns) and 2 small (Chassahowitzka and Glades/Highlands) populations. These populations range in abundance from a few individuals to several hundred bears and vary significantly in distribution, habitats occupied, and threats to extinction…
>
> …because of their fragmented distribution, the individual populations are more vulnerable to adverse impacts than a single large population of similar total size would be."

Habitat fragmentation increases a bear's vulnerability to roadway mortality and is the mechanism that has isolated Florida bear populations from one another. Dixon *et al.* (2007) identified significant genetic differences between geographically close subpopulations in Florida.

Given the anticipated conversion of native range to more intensive land uses, habitat loss, fragmentation, and degradation will continue in Florida. The state is predicted to lose an additional 0.93 million ha of Florida black bear habitat by 2060 (FWC, 2008b). If this loss occurs, the subpopulations of bears in the state will probably become concentrated and locked in by intensely populated urban areas.

We designated SHCA for bears because of the increased risks of habitat loss and fragmentation. To identify SHCA, we used a Florida black bear predictive habitat model (Hoctor, 2006). First, we selected all habitat that had a >50% probability of use by Florida black bears. Within the existing primary and secondary range of Florida black bears, we retained all patches of selected habitat >28 km^2 (2,800 ha). Twenty-eight km^2 is the average summer female home range estimated by the FWC. Beyond the existing range of Florida black bears, we retained all selected patches > 300 km^2 (30,000 ha). The 300 km^2 estimate strives to identify those areas potentially large enough to support a self-sustaining bear population and was derived by estimating the habitat size of the Chassahowitzka primary bear range, which is currently our smallest bear population. We then used the FWC 2003 land-cover image to remove the following areas from the selected habitat: agriculture, exotic plants, urban and mining, coastal strand, sand/beach, tidal flats, open water, and bare soil/clearcut. The final step removed all publicly owned lands (Figure 80).

The SHCA identify parcels that would enlarge existing conservation lands surrounding the Florida black bear subpopulation centers. The SHCA also identify blocks of good-quality-but-unoccupied habitat that are large enough to support a small population of Florida black bears. These areas do not directly address the need for travel corridors; however, some of the areas identified as SHCA would help connect current population centers. Other existing data sets such as the Florida Greenways layer (Florida Geographic Data Library, 2006) would be appropriate for identifying potential travel corridors.

FLORIDA KEY DEER

FWC

Endemic to the Florida Keys, the Florida Key deer (*Odocoileus virginianus clavium*) is the smallest subspecies of the North American white-tailed deer (Hardin *et al.,* 1984). The Key deer has shorter legs, a shorter and wider skull (Klimstra *et al.,* 1991), smaller antlers, fewer antler points, lower birth rates, lower productivity (Folk and Klimstra, 1991), and a higher tolerance of salt water (Jacobson, 1974) than other deer. Their current range extends from Big Pine Key to Sugarloaf Key, which includes approximately 20–26 islands (Folk, 1991). Approximately 75% of the Key deer are found on two islands: Big Pine and No Name keys (Lopez, 2001).

The Florida Key deer can be found in a variety of habitat types, including pinelands (pine flatwoods and pine rocklands), hardwood hammocks, buttonwood and mangrove wetlands, and freshwater marshes. Permanent sources of fresh water, often found in the pine

Figure 81 *Potential-habitat map for Florida key deer.*

Figure 82 *Proposed Strategic Habitat Conservation Areas for Florida key deer.*

rockland areas, are critical to the Key deer (USFWS, 1999d). The majority of the pine rocklands occur on five keys: Big Pine, Little Pine, Sugarloaf, Cudjoe, and No Name keys. Key deer can easily swim between keys, using all islands for either foraging or resting during the wet season.

In 1967, the USFWS listed the Key deer as endangered because of loss of its habitat to commercial and residential development and because of its high human-related mortality, particularly roadkills. The Key deer population has been well studied, with various researchers working on recovery plans, long-term species protection, and its habitat requirements (USFWS, 1985, 1999d, 2003). In 2001, the Key deer population was estimated at 400–500 individuals (Lopez *et al.,* 2004).

Data sets used for building the potential-habitat map included the FLEO database (n = 16, 1978–1991) and the FWC 2003 land-cover image. From the land-cover map, we selected the following potential habitat within the known range of the Key deer: pinelands, tropical hardwood hammock, freshwater marsh and wet prairie, mangrove swamp, and scrub mangrove (Folk, 1991; Figure 81).

The baseline population model for key deer was based on Lopez (2001, 2004). The results of the PVA for all potential habitat indicated that only 13 populations were of sufficient size to support at least 30 females (*i.e.,* 75 ha). These populations were most likely to remain occupied throughout the next 100 years, suggesting that the smaller populations will not persist for long without occasional dispersal. Only 55.3% of the potential habitat is categorized as managed, which reduced the carrying capacity by close to half. This reduction in-

creases the risk of a 50% decline from 0% to 11%. Using more conservative demographic parameters (Haverson *et al.,* 2004), the risk of extinction increased to 19% in the next 100 years, even with all potential habitat available. The baseline growth rate for these models was stable (*i.e.,* near 1.0), which means that slight changes have noticeable effects on the final abundance and the risk of a decline.

Because the Key deer's geographic range is narrow and its reproductive performance is low, it is susceptible to extinction (USFWS, 1999d). We agree with the habitat recovery actions outlined in the Multi-Species Recovery Plan for South Florida (USFWS, 1999d) in that increasing and maintaining available habitat is essential to Key deer survival. Therefore, we concluded that Florida Key deer currently lack the desired habitat protection. We identified all areas of potential habitat within the 13 larger metapopulations that were located on privately owned lands as SHCA (Figure 82). The majority of the areas identified as SHCA are within the boundaries of two Florida Forever projects (Florida Keys Ecosystem Florida Forever Board of Trustees Project and Coupon Bight/Key Deer Florida Forever Board of Trustees Project). The USFWS has prepared a Land Protection Plan to acquire unprotected Key deer habitat.

FLORIDA MOUSE

Jim Austin

The endemic Florida mouse (*Podomys floridanus*) is a ground dwelling mammal distinguished by the presence of five plantar tubercles on the hind feet (versus 6 or 7; Layne, 1992). This species is restricted to sandhill and scrub-associated xeric upland habitats (Layne and Jackson, 1994). Although *P. floridanus* may occasionally use the burrows of other animals, it is most often found occupying gopher tortoise burrows, particularly in sandhill sites (Layne, 1992; Layne and Jackson, 1994). The major threats to Florida mouse survival are habitat loss and degradation caused by development, agricultural uses, and fire repression. Furthermore, the species may not persist in sites where gopher tortoises have been extirpated. FWC lists the Florida mouse as a species of special concern. Element occurrence records exist in both FLEO (n = 96) and WildObs

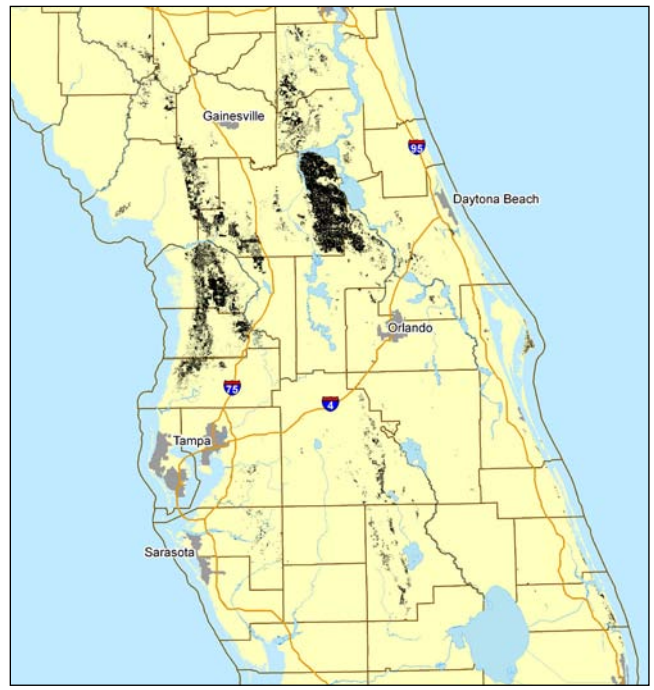

Figure 83 *Potential-habitat map for Florida mouse.*

(n = 29) databases. The range for the analysis includes the counties listed by FNAI, which is mostly the northern 2/3 of the peninsula, and one county (Franklin) in the Panhandle.

Dry soils were isolated within the FNAI range using STATSGO (excessively well, somewhat excessively well and moderately well drained soils) and SSURGO (Hydrologic group A or A/D) data. We identified all areas of sandhill, xeric oak scrub, and sand pine scrub from the FWC 2003 land cover that occur on our dry soils layer as potential habitat (Figure 83).

Model verification was not conducted. The element occurrence points aligned nicely with the potential habitat but were not used for verification because they are somewhat dated. However, areas where known populations exist are represented in the potential-habitat map.

We identified >278,000 ha of potential habitat for this species, of which 53% is on managed lands. Both baseline models performed with all potential habitat and with only managed-lands habitat had a baseline growth rate of 1.003. Both models indicated a 1% probability of extinction in the next 1,000 months but showed rather large probabilities of decline. There was a 70% and 74% probability of a 50% decline in abundance for the two model types respectively. Sensitivity and elasticity analyses indicate that adult and juvenile survival rates were the most influential parameters in the model.

This endemic species is vulnerable to habitat loss because of its specific habitat requirements. In light of this and the above PVA results, we identified all po-

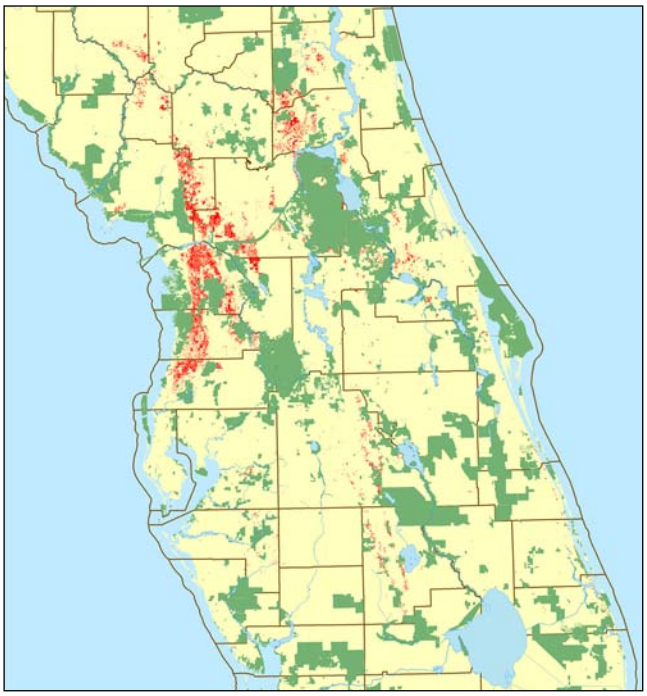

Figure 84 *Proposed Strategic Habitat Conservation Areas for Florida mouse.*

tential habitat that does not occur on public lands as SHCA for the Florida mouse (Figure 84). Additional research on survival rates and fecundity would help to assess the risks facing this species. Further, the effect of habitat fragmentation on Florida mouse populations is unknown. Therefore, actions directed toward conserving larger contiguous patches of Florida mouse habitat may be more beneficial to the long-term success of the species.

FLORIDA PANTHER

USFWS

The Florida panther (*Puma concolor coryi*) is the last known extant subspecies of mountain lion in the eastern U. S. (Maehr, 1992b). This subspecies is believed to have once ranged throughout the southeastern coastal plain from Arkansas to eastern Tennessee and east to South Carolina (Hall, 1981), but it now exists only as a remnant population limited to the southern portion of the Florida peninsula. The current population size is estimated to be 80–100 subadults and adults (Land and Lacy, 2000; McBride, 2003; Kautz *et al.,* 2006). Florida panthers use a variety of habitats within their range, which generally include forested uplands and wetlands interspersed with more open habitats such as freshwater wetlands, dry prairie, old fields, pasture lands, and agricultural land. Kautz *et al.* (2006) and Land *et al.* (2008) found that panther home ranges contained a higher proportion of forested habitat types than expected; however, unforested habitats are likely to be important for hunting and maintaining prey species. The openings may also serve as travel corridors between resting sites (Comiskey *et al.,* 2002; Land *et al.,* 2008). Current threats to this species include habitat loss caused by development, vehicular mortality, intraspecific aggression, genetic depression, environmental toxins, and disease (*i.e.,* feline leukemia). The FWC and USFWS list Florida panthers as endangered.

To identify potential habitat of Florida panthers, we limited analysis to within EMAP hexagons where radio-telemetry locations (FWC, unpublished data) have been recorded. Within this area, upland forest,

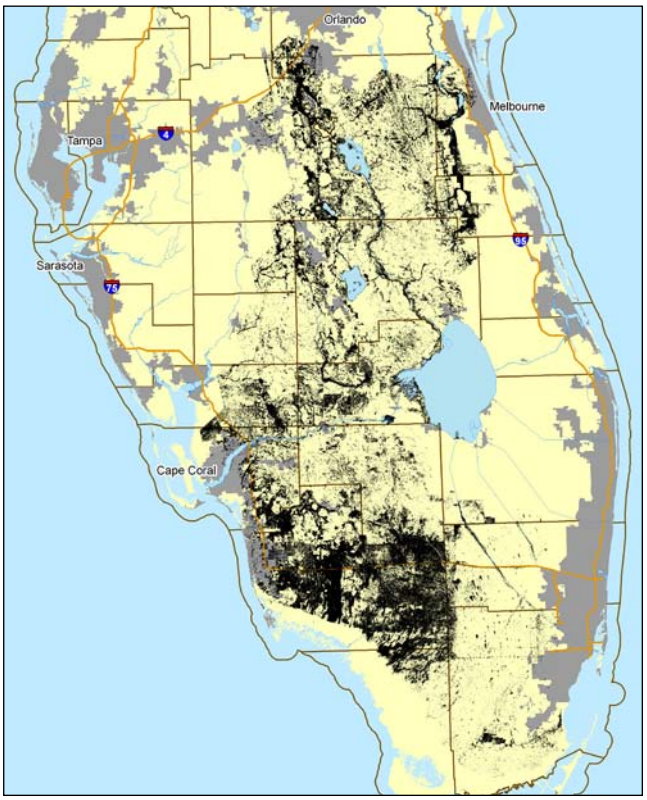

Figure 85 *Potential-habitat map for Florida panther.*

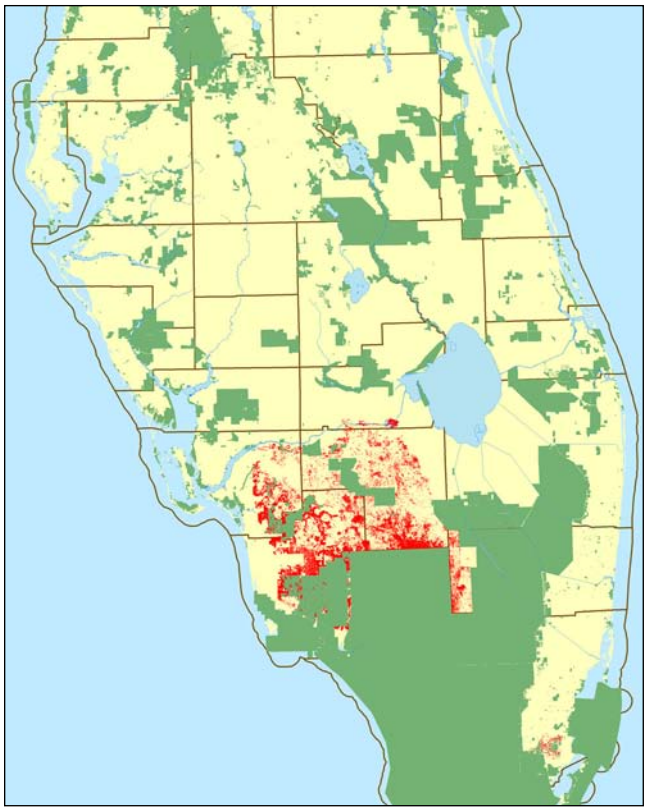

Figure 86 *Proposed Strategic Habitat Conservation Areas for Florida panther.*

forested wetlands, and pinelands were isolated from the FWC 2003 land-cover image. Habitat patches encompassing >2 ha of these habitats were identified as potential habitat (Figure 85). Of the 865,561 ha of potential habitat, approximately 49% are currently under management.

Results from the PVA including all potential habitat indicated the probability of extinction in the next 100 years under baseline demographic parameters was 0%, and the chance of a decline was also 0%. For the population on managed lands, the abundance was considerably less, but the risks did not increase noticeably. However, sensitivity analysis indicated that a 10% reduction in adult (stage 3) survival led to a steady decline in abundance. The risk of extinction rose to 100% in the next 100 years, and a large decline was probable (97% probability of an 80% decline in abundance). Although results from the PVA analysis indicated a negligible threat of extinction or population decline, we identified SHCA because the small population is vulnerable to losses of any individuals and because of the variety of threats that individuals face. The SHCA consist of privately owned potential habitat within the primary, secondary, and dispersal zones identified by Kautz *et al.* (2006; Figure 86).

FLORIDA SALT MARSH VOLE

USFWS

The endangered Florida salt marsh vole (*Microtus pennsylvanicus dukecampbelli*) occupies salt marsh habitat where saltgrass (*Distichlis spicata*) is a dominant species (Woods, 1992; Raabe and Gauron, 2005). It is likely that the vole was broadly distributed along the gulf coast in the late Pleistocene when sea levels were 25 m lower than now (Blackwelder *et al.,* 1979) and suitable habitats extended 100 km west of the current coastline. Only one population was recorded in coastal Levy County (recorded in the FLEO database) until recent work discovered the vole in the southern portion of the Lower Suwannee National Wildlife Refuge (LSNWR; USFWS, 2004). In the spring of 2004, personnel captured three individuals at LSNWR, located north and west of the original site. This was the first new population of voles discovered in over 20 years. Known from only two sites in Florida, the vole is highly susceptible to catastrophic events such as hurricanes and rising sea levels. Current models predict a future sea level rise of 13–30 cm by the end of the 21st century (Meehl *et al.,* 2005). This rise could precipitate

Figure 87 *Potential-habitat map for Florida salt marsh vole.*

change in coastal habitats, especially in these low-lying marsh regions.

The potential-habitat map for the Florida salt marsh vole identified all salt marsh habitat (based on the FWC 2003 land-cover image) southeast of Horseshoe Beach and northwest of the Waccasassa River (Figure 87). The potential-habitat map probably overestimates potential habitat because it cannot distinguish *D. spicata*-dominated salt marsh microhabitats (*i.e.,* lumps all salt marsh into a single category). The USGS mapped potential-habitat sites based upon the presence of saltgrass, but the analysis included only areas in and around the Lower Suwannee National Wildlife Refuge. Because extending the USGS analysis to encompass all areas within the range of the salt marsh vole was not feasible, the results could not be used to identify potential habitat range-wide.

Of the 9,185 ha of potential habitat for the Florida salt marsh vole, 92.5% is located on managed lands. We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The baseline growth rate for the populations in both models was 1.0656, which made them relatively insensitive to small changes in survival and fecundity. Assuming no changes, the probability of extinction in the next 100 years under these baseline demographic parameters was 0%, and there was little chance of a decline forecast by both models, even though the metapopulation on managed lands had a slightly lower abundance. However, these results might not accurately portray the security of this species. It is estimated that roughly 20% of the salt marsh identified in the potential-habitat map is the *D. spicata*-dominated variety favored by *M. pennsylvanicus* (T. Doonan, personal communication). Therefore, the PVA is likely to be overestimating the security of this species.

Figure 88 *Proposed Strategic Habitat Conservation Areas for Florida salt marsh vole.*

Because this species is known from only two locations, one of which is currently not under any type of conservation protection, we have identified SHCA (Figure 88). The SHCA consist of >1 ha patches of potential habitat that are currently unprotected. Some manual cleanup of the SHCA map in the coastal areas was necessary because of data incompatibility and digitizing errors in the FLMA database. Securing the original locality for this species should be one priority of land protection. Additional conservation efforts should focus on proper management and enhancement of habitat for this species on existing managed lands.

FOX SQUIRRELS

FWC

BIG CYPRESS FOX SQUIRREL

The Big Cypress fox squirrel (*Sciurus niger avicennia*) is the smallest of the three subspecies of fox squirrel found in Florida (Moore, 1956). The color phase of this subspecies varies considerably but typically is an agouti or blackish-agouti on the back; a buff venter; white toes, nose, lips, and eartips; and a black or blackish crown. The Big Cypress fox squirrel is restricted to southwestern Florida south of the Caloosahatchee River and west of the Everglades. The FWC currently lists it as threatened.

Habitat requirements for this subspecies are complex and poorly understood (Humphrey and Jodice, 1992). The Big Cypress fox squirrel uses most types of forest occurring in its range, but it prefers open habitats, where it spends most of its time traversing open ground. Fragmentation of the fox squirrel's primary habitat is evident because upland pines are prime

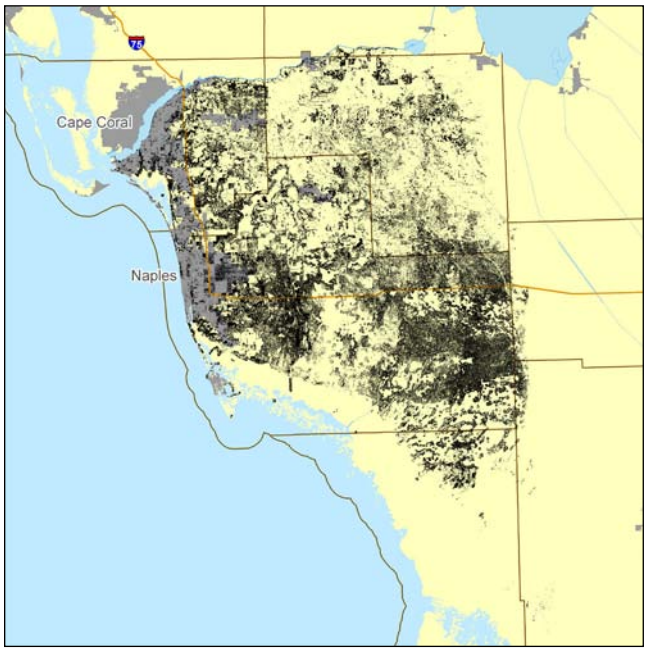

Figure 89 *Potential-habitat map for Big Cypress fox squirrel.*

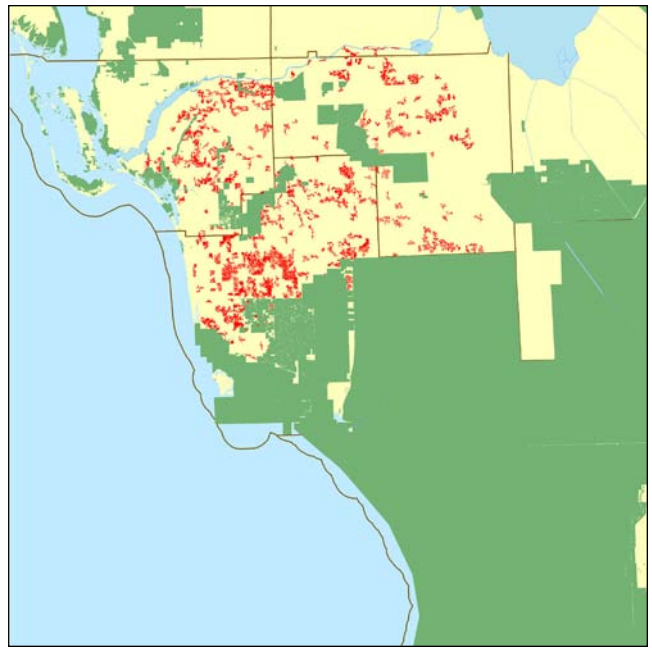

Figure 90 *Proposed Strategic Habitat Conservation Areas for Big Cypress fox squirrel.*

land for both residential and commercial development. The species also occurs in cypress swamps, pine flatwoods, tropical hardwood forests, live oak woods, mangrove forests, and suburban habitats such as golf courses, parks, and residential areas that include natural vegetation. Many Big Cypress fox squirrels have taken up residence on golf courses. Some of these populations on golf courses in Naples are now completely isolated because of human development (Collier County, 2005). Mangrove forests and cypress stands appear to be used only marginally (Williams and Humphrey, 1979). Dense interiors of cypress domes and strands are rarely used.

To map potential habitat, we identified all dry prairie and pinelands within the current range of the Big Cypress fox squirrel from the FWC 2003 land-cover image. We identified as secondary habitat those areas of mixed hardwood–pines, hardwood hammocks and forests, and cypress/pine/cabbage palm that were <300 m away from dry prairie or pinelands. To capture the less frequently used mangrove and cypress swamps as fringe components, we included these two land-cover types in the habitat map only when they were <300 m away from the previously identified land-cover types (Figure 89).

The four FLEO database records for Big Cypress fox squirrels occur on potential habitat. In addition, location records that were available on a paper map were reviewed and found to fall within areas of potential habitat. Areas mapped as potential habitat along old US 41 and along SR 29 south of I-75 are composed mostly of cypress swamp surrounding small pockets of hardwood hammocks and small isolated pine islands. These areas are not ideal because they lack adjacent open, drier areas.

Potential habitat for this subspecies includes approximately 285,800 ha, of which almost 55% is on managed lands. We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. The baseline growth rate for both models was 0.9725. This means that small changes in the model greatly affect population trends. The probability of extinction in the next 100 years under baseline demographic parameters was 0% assuming no changes. However, the risk of very large declines in abundance was quite large in both models. The probability of a 95% decline in abundance in the next 100 years was about 50% for the model analyzing all potential habitat and more than a 90% chance of a 95% decline for the model analyzing only managed-lands habitat.

The sensitivity analysis of the model indicated that 46% of the variability in the population growth rate was attributable to changes in the adult survival value. Although the model predicted a slow decline in abundance, the risk of extinction is relatively low. A slight reduction in the adult survival (5%) increased the probability of extinction to 3% and increased the risk of a large decline (*i.e.,* nearly 100% probability of a 95% decline in abundance). Similarly, a 5% reduction in adult fecundity increased the risk of a large decline (*i.e.,* 94% probability of a 95% decline in abundance) but had little impact on the risk of extinction. A 10% re-

duction in carrying capacity had the same risks of extinction or decline as the baseline model with all potential habitat.

In light of these results, and the restricted range of Big Cypress fox squirrels in Florida, we identified SHCA for this species (Figure 90). These areas were identified by isolating patches of primary and secondary habitats that formed a contiguous patch of >50 ha. Because of the considerable fragmentation of the remaining suitable habitat, conservation of this species may require acquisition of altered areas that are currently unsuitable but could be restored.

SHERMAN'S FOX SQUIRREL

Sherman's fox squirrel (*Sciurus niger shermani*) is the largest of the three subspecies of fox squirrel found in Florida (Moore, 1956). Overall, the color phase of this subspecies ranges from black to gray, but the top of the head is consistently black and the nose and ears are usually white or tan (Ehrhart, 1992). Sherman's fox squirrel can be distinguished from the other two subspecies because the feet are tan or buff rather than white. Fox squirrels prefer open woods or park-like settings. The *shermani* subspecies uses sandhill, mixed hardwood pine, mature pine forests, pine flatwoods, cypress domes, and the ecotone between bayheads and pine flatwoods. They will avoid monoculture stands (Kantola and Humphrey, 1990; Wooding, 1997; Perkins and Connor, 2004). They depend mostly on pine seeds for food in the summer and acorns the remainder of the year. Because of habitat loss from development or agricultural conversion, the FWC currently lists Sherman's fox squirrel as a species of special concern.

For our analysis, we modified the range presented in Ehrhart (1992). The range we selected extends from north of the Caloosahatchee River to the Georgia state line and west to the Apalachicola River. The Big Cypress fox squirrel (*Sciurus niger avicennia*) occurs south of the Caloosahatchee River and the Southern fox squirrel (*Sciurus niger niger*) occurs west of the Apalachicola River.

To map potential habitat, we started by identifying appropriate primary upland habitats within the range of the species. The primary upland habitats we selected are sandhill, dry prairie, and mixed hardwood–pine forests identified in the FWC 2003 land-cover image. We also selected a modified pinelands layer. To create the modified pinelands, we started with the pinelands in the FWC 2003 land-cover image and first excluded all commercial pineland using the FLUCCS database. Second, we identified only those pinelands on dry soils (obtained by using the STATSGO database and selecting all Hydrologic groups except C or D). Following the merging of all upland habitats, we removed all habitat patches <10 ha to reduce the effect of alignment errors associated with the FWC 2003 land-cover image and the commercial pineland layer. To include secondary upland habitat contiguous with primary uplands, we buffered the primary upland habitats layer by 200 m, identified and merged all xeric oak scrub, sand pine scrub, sandhill, dry prairie, mixed hardwood–pine forest, hardwood hammocks and forest, cabbage palm–live oak hammock, shrub and brushland, and improved pasture habitats in the FWC 2003 land-cover image with the primary upland habitats layer, and removed all patches <10 ha. The next step was to include cypress as a fringe habitat component in the map. We took the primary and secondary upland habitat map and buffered it by 200 m. All xeric oak scrub, sand pine scrub, sandhill, dry prairie, mixed hardwood–pine forest, hardwood hammocks and forest, cabbage palm–live oak hammock, cypress swamp, cypress/pine/cabbage palm, shrub and brushland, and improved pasture habitats in the FWC 2003 land-cover image were identified and merged with the primary and secondary upland habitats layer. The final step in creating the habitat map removed all habitat patches less than 50 ha (Figure 91).

Figure 91 *Potential-habitat map for Sherman's fox squirrel.*

Potential habitat for this species includes approximately 2.7 million ha, of which less than 800,000 ha (~30%) occur on managed lands. We ran two PVA models, one on all potential habitat and one on potential habitat occurring on managed lands. Baseline models for both metapopulations (with baseline growth rate of 1.0034) indicated no probability of extinction in the next 100 years and only a small chance of a large decline (*i.e.,* the probability of a 50% decline was ap-

proximately 10%). For the metapopulation containing only managed-lands habitat, the abundance was considerably smaller, although the risks were quite similar (0% probability of extinction in the next 100 years).

Sensitivity analyses on these baseline models indicated that adult survival was the most influential parameter on population growth. A 5% decrease in adult survival led to a dramatic increase in the risk of a large decline (*i.e.,* 98% probability of a 50% decline), but the risk of extinction remained 0%. A 5% reduction in fecundity similarly resulted in an increased risk of a large decline in abundance (*i.e.,* 89% probability of a 50% decline), but the risk of extinction remained 0%. A decrease in carrying capacity of 10% did not noticeably increase the risk of extinction or the risk of a large decline over baseline conditions.

Based on the PVA, no SHCA were developed for this species. Research and management for Sherman's fox squirrel should focus on adult survival because it was the most influential determinate of long-term population trends.

LOWER KEYS MARSH RABBIT

Phil Frank

The Lower Keys marsh rabbit (*Sylvilagus palustris hefneri*) is one of three subspecies of marsh rabbit (*Sylvilagus palustris*). The metapopulation inhabits wetlands in Florida's Lower Keys (Faulhaber, 2003). The Lower Keys extend over 60 km from Little Duck Key to Key West and are separated from the Middle Keys by Moser Channel, measuring nearly 11 km. This channel probably geographically isolates the subspecies (Lazell, 1984). The majority of the Lower Keys marsh rabbit populations are found on four main keys: Boca Chica, Saddlebunch, Lower Sugarloaf, and Big Pine (Forys *et al.,* 1996). The Lower Keys marsh rabbit typically occurs in small patches of salt marsh–buttonwood transition zones, freshwater marshes, and coastal-strand vegetation. In 1990, the USFWS listed the Lower Keys marsh rabbit as endangered (USFWS, 1990), citing habitat loss and fragmentation. More recently, it has been identified that mortality caused by domestic cats may be the most significant threat to future existence of this species (N. Perry, personal communication). Other threats include vehicles, mowing, invasive exotic plant species, raccoons, fire ants, and habitat damage caused by off-road vehicles.

Data used for building the potential-habitat map included FLEO database records (n = 18, 1984–1993, majority from 1988), the FWC 2003 land-cover image, additional sighting locations (n = 51; C. Faulhaber, personal communication), and delineated Lower Keys marsh rabbit habitat patches from Faulhaber (2003) (Figure 92). The delineated patches represent occupied and potential reintroduction habitat as identified by direct observation, pellet surveys, and presence of suitable plant communities. Within these patches we identified pineland, tropical hardwood hammock, freshwater marsh and wet prairie, salt marsh, mangrove swamp, scrub mangrove, and tidal flat from the FWC 2003 land cover as potential Lower Keys marsh rabbit

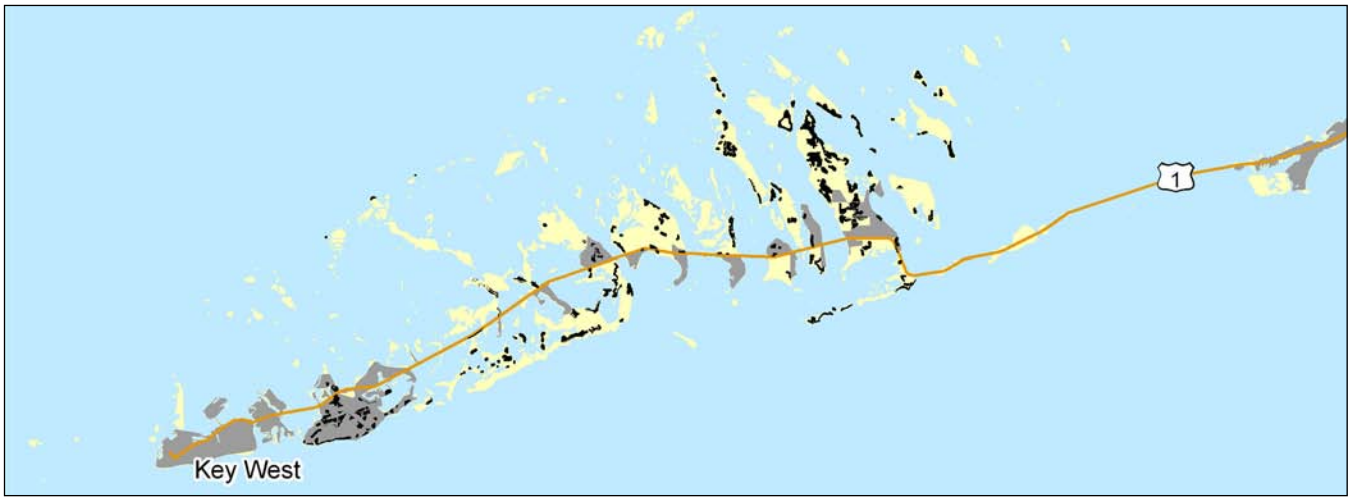

Figure 92 *Potential-habitat map for Lower Keys marsh rabbit.*

Figure 93 *Proposed Strategic Habitat Conservation Areas for Lower Keys marsh rabbit.*

habitat. The Lower Keys marsh rabbit uses a home range of approximately 1.2 ha (Faulhaber, 2003). All suitable habitat within 60 m (the radius of a 1.2-ha circular patch) of the delineated habitat patches was retained as potential habitat.

The results of the PVA show that there are 95 distinct populations on all potential habitat and 69 populations on managed-lands habitat. Approximately 66% of all potential habitat is on managed lands. The probability of extinction in the next 100 years under baseline demographic parameters was 1% for a model including all potential habitat and 6% for potential habitat using only potential habitat on managed lands. For the model using only managed lands, the carrying capacity was reduced by more than half. This reduction increased the risk of 50% decline from 13% to 20%. There are 22 populations that could support at least 20 females, of which only 4 are sufficiently large enough to support a population of 100 individuals.

Because of its endangered status, geographic isolation, and low number of stable populations, we concluded that the Lower Keys marsh rabbit lacks the minimum level of habitat protection desired. Additionally, because of its classic metapopulation dynamics, the marsh rabbit relies on the recolonization of vacant habitat patches for survival (Forys *et al.*, 1996). All potential habitat located outside of existing conservation lands were identified as SHCA (Figure 93). This conclusion is in agreement with the USFWS recovery plan for the Lower Keys marsh rabbit which states that all remaining occupied and unoccupied suitable habitat should be protected (USFWS, 1999e). As is the case with the Key deer, the majority of the SHCA for the Lower Keys marsh rabbit fall within identified Florida Forever projects.

Although future land acquisitions containing suitable habitat for this species will aid in population stability and security, the current greatest threat to the Lower Keys marsh rabbit may be high mortality from cats (N. Perry, personal communication). As a result, many areas of suitable habitat are devoid of the Lower Keys marsh rabbit. The USFWS (1999e) has identified several actions within the Lower Keys marsh rabbit recovery plan to control or eliminate free-roaming cat populations near rabbit habitat.

RICE RATS

Phil Frank

SANIBEL ISLAND RICE RAT

The palest form of this widespread species, the Sanibel Island rice rat (*Oryzomys palustris sanibeli*) is found only on Sanibel Island in Lee County, Florida (Hamilton, 1955). The FWC lists this subspecies as a species of special concern, principally because of its very restricted range.

Habitats used by rice rats include coastal and fresh-

water marshes (Wolfe, 1982) because rice rats are semi-aquatic (Esher *et al.,* 1978; Forys and Dueser, 1993); however, populations can also be found in transitional habitats and areas that have moderate-to-abundant herbaceous cover. This species can wander considerably from the marsh environment and inhabit drier areas (R. Rose, personal communication). Occasionally, they also live in or use forested areas (Kruchek, 2004). These non-marsh types of habitat provide possible dispersal routes, short-term refugia (especially in extreme flooding events), winter foraging, or temporary escape from low winter temperatures in the wet environments.

Land managers and biologists for Sanibel Island have captured the Sanibel Island rice rat predominately in spartina (*Spartina* spp.) marsh. The population status and distribution of this rice rat on the island is unclear (R. Loflin, personal communication) and warrant a more systematic sampling effort to obtain current data.

We used the FWC 2003 land-cover image to construct the potential-habitat map. We limited all analyses to Sanibel Island. We identified all salt marsh, freshwater marsh and wet prairie, hardwood hammock and forest, tropical hardwood hammock, mixed wetland forest, mangrove swamp, shrub and brushland, and grassland habitats within 60 m of salt marsh and freshwater marsh and wet prairie as potential habitat (Figure 94).

The potential habitat for this species consists of approximately 250 ha. The potential-habitat patches are concentrated in the central part of the island, south of Captiva Road and west of Rabbit Road. The patches are in proximity to Legion Curve and near what is known as the "botanical site." Rice rats were trapped at the "Bailey tract," which is also mapped as potential habitat.

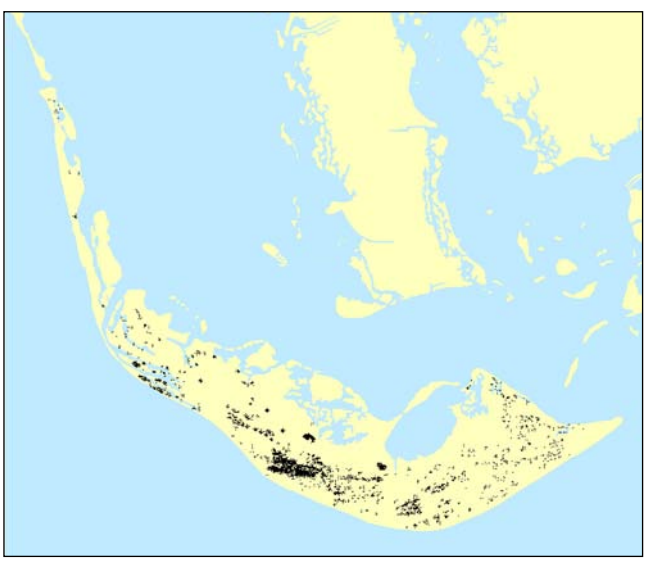

Figure 94 *Potential-habitat map for Sanibel Island rice rat.*

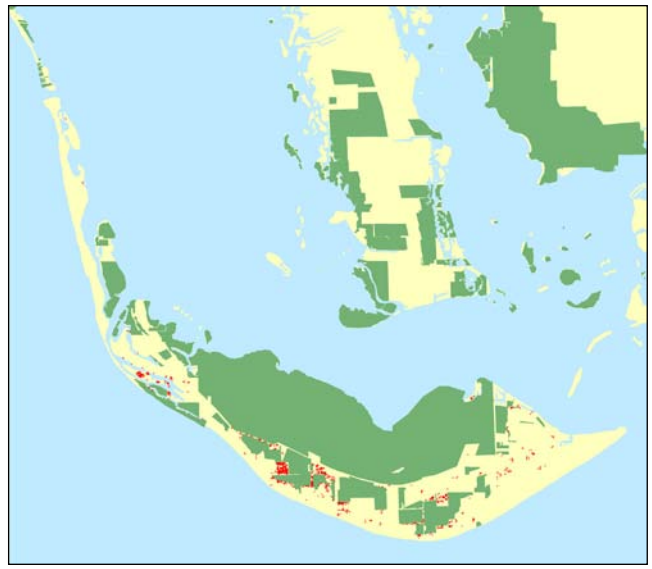

Figure 95 *Proposed Strategic Habitat Conservation Areas for Sanibel Island rice rat.*

Wetland restoration efforts on Sanibel Island through the removal of invasive species (*i.e.,* Brazilian pepper) have contributed to the return of interior marshes (R. Loflin, personal communication), which may help increase the population size of this species.

We ran two PVA models, one on all potential habitat and one on potential habitat located only on managed lands. Under baseline parameters, the models were very pessimistic. A 70% probability of extinction in the next 100 years was evident when considering all potential habitat and an 84% risk for the model run only with managed lands (approximately 51.0% of all potential habitat). The growth rate under these demographic parameters was 0.9965. The probability of a large decline was very high, showing an 86% probability of a 90% drop in abundance. The model was quite sensitive to small changes in the demographic parameters (*i.e.,* >5%) even under assumptions of static habitat quality and no catastrophes. The PVA estimated 22 populations on all potential habitat and 15 populations on managed-lands habitat only.

Sensitivity analyses indicated that juvenile survival and subadult fecundity were the most influential parameters. Slight declines in the subadult fecundity or juvenile survival (*i.e.,* >5%) further increased the probability of extinction to 95.4% and 99.7% in the next 100 years, highlighting the importance of these parameters for research and management.

We identified SHCA for this subspecies because of its restricted range, high vulnerability to catastrophic storm events, and PVA results. The SHCA include all potential habitat that does not occur on managed lands (Figure 95). Some private lands on or

adjacent to housing and recreational areas (mainly golf courses) were removed after inspection using 2004 DOQQ. As a result, approximately 67 ha of the almost 250 ha of potential habitat are considered SHCA.

SILVER RICE RAT

The sliver rice rat (*Oryzomys palustris natator*) is a small semiaquatic rodent that inhabits islands in the Lower Keys of Florida. It is known to occur on 12 islands in the Lower Keys: Little Pine, Howe, Water, Middle Torch, Big Torch, Summerland, Raccoon, Johnston, Cudjoe, Upper Sugarloaf, Lower Sugarloaf, and Saddlebunch keys (Goodyear, 1987; Forys *et al.,* 1996; Mitchell, 1996). The silver rice rat has been found in a wide range of wetland habitat types, including mangrove, low salt marsh, and transitional buttonwood/salt marsh. Freshwater areas are important because in saltwater habitats the animals cannot effectively concentrate urine to meet their metabolic needs (Dunson and Lazell, 1982; Goodyear, 1987). Silver rice rats have larger home ranges and are found at lower densities than other marsh rice rats (Forys *et al.,* 1996; Mitchell, 1996), which might be due to limited food and freshwater resources. The primary threats to this subspecies are loss of habitat to residential and commercial development, predation, competition, and habitat modification. The species' small population size and isolation within a small geographic range make it vulnerable to extinction. The USFWS listed it as an endangered species in 1991 (USFWS, 1991).

Data sets used for building the potential-habitat map included the FLEO database records (n = 9, 1981–1986), the FWC 2003 land-cover image, the Advanced Identification of Wetlands (ADID) data (McGarry MacAulay *et al.,* 1994), and land-parcel data identified through ground surveys as containing suitable habitat (obtained from Neil Perry). Areas of suitable FWC 2003 land-cover types (freshwater marsh and wet prairie, salt marsh, mangrove swamp, scrub mangrove, and tidal flat) within the land-parcel data were identified as potential habitat. Additionally, within the land-parcel data, areas of freshwater hardwoods from the ADID data that were classified as tropical hardwood hammock in the FWC 2003 land-cover image were included as potential habitat. We combined the latter two data sets to create the final map showing potential habitat of the silver rice rat (Figure 96).

We ran two PVA models, one on all potential habitat and one on potential habitat located only on managed lands. The growth rate under baseline demographic parameters was slightly below 0.9965, making the model quite sensitive to small changes in the demographic parameters even under the assumptions of static habitat quality and no catastrophes. The model had a 4% probability of extinction in the next 100 years when considering all potential habitat and an 8% risk if potential habitat located only on managed habitat was considered. Approximately 59% of all potential habitat occurs on managed lands. The probability of a large decline was very high in both models. There was a 70% probability of a 90% decline in abundance if all potential habitat was included and a 100% chance of a 50% decline if potential habitat only on managed lands was included. Only four populations on existing conservation lands contain enough potential habitat to support a population large enough to persist for more than 70 years.

Figure 96 *Potential-habitat map for silver rice rat.*

Figure 97 *Proposed Strategic Habitat Conservation Areas for silver rice rat.*

Because of these results, we concluded that the current level of protection does not meet minimum standards to adequately protect the subspecies. We identified areas containing six larger rice rat populations on privately owned lands as SHCA (Figure 97). Our conclusions are consistent with the silver rice rat recovery plan (USFWS, 1999e). The plan states that the persistence of the species is dependent upon the amount of suitable habitat available, and that it is important to maintain the integrity of the larger wetlands.

Chapter 7
Aggregate Map of SHCA

Comparison of SHCA 1994 to 2009

We combined the SHCA identified for each focal species to create an aggregate map of all SHCA in Florida (Figure 98). This binary representation of SHCA and non-SHCA allows us to better understand the scope and significance of our results and to identify the relationship of our results to those of the *Closing the Gaps* project. Managers and biologists could use our results to influence their decision-making processes at the local level and to evaluate how these local decisions align with regional and statewide wildlife conservation efforts.

Areas identified as SHCA in 2009 are substantially different from those identified in 1994. In the current study, more land is identified as SHCA, the type and area of land-cover classes identified as SHCA are different, and the area and distribution of SHCA within counties are different. This is expected given the differences in data, techniques, and procedures used in the two projects.

In 2009, the SHCA are designated for 34 of the 62 focal species (Table 8), composing more than 3.5 million ha, roughly 23% of the total land area in Florida. These areas spanned 32 land-cover types (Table 9), although pinelands dominated with nearly 32% (1.1 million ha) of the total SHCA area. Another 30% was divided almost equally between improved pasture (361,000 ha), hardwood swamp (349,000 ha), and mixed wetland forest (315,000 ha). Other classes that accounted for >5% included cypress swamp with 246,000 ha (7%), hardwood hammock and forest with 228,000 ha (6%), and mixed hardwood pine forest with 196,000 ha (5.5 %). All other classes contributed less than 4% each of the total SHCA area. Not included in any SHCA were sugar cane, citrus, row/field crops, other agriculture, exotic plants, Australian pine, melaleuca, Brazilian pepper, high impact urban, low impact urban, and extractive. Each of the 67 counties in Florida has some portion identified as SHCA (Table 10). The total percentage of county area identified as SHCA ranges from 1.29% (Palm Beach County) to 70.13% (Gulf County). The mean percentage of each county identified as SCHA is 25.69% (SE = 1.8%). If all lands identified as SHCA were combined with the 4.5 million ha currently under public management, nearly 8.1 million ha (53% of the total non-water area of Florida) would be available for species and habitat conservation.

The 1994 study designated approximately 1.7 million fewer hectares as SHCA (1.9 million ha total). The primary land-cover types contained in the 1994 SHCA were 400,000 ha (20%) of pineland, 250,000 ha (13%) of cypress, 215,000 ha (11%) of mixed hardwood swamp, 200,000 ha (10%) of freshwater marsh, 192,000 ha (10%) of grass and agriculture, 161,000 ha (8%) of dry prairie, 139,000 ha (7%) of shrub and brush, and 107,000 ha (5%) of upland hardwood forest (see Cox *et al.,* 1994, table 21). Each of the other land-cover types covered areas of less than 60,000 ha in the 1994 SHCA.

All 67 Florida counties experienced a change in the total area identified as SHCA from 1994 to 2009 (Table 10). Most (n = 55) counties had more area identified as SHCA in 2009. In 25 counties, at least 20% more total area was identified as SHCA in the 2009 study than in the 1994 study; however, in five counties 20% less area was identified as SHCA in 2009 than in 1994. Overall percentage change in area identified as SHCA ranged from 56.01% (Gulf County) to –27.39% (Collier County). Mean change in percentage of county area identified as SHCA was 13.88% (SE = 2.2%).

When a county experienced a large net loss in SHCA, it is usually due to large land parcel acquisitions since the 1994 report. The 1994 report used a public lands database that identified 2.81 million ha of public lands, which were estimated to include >98% of all public lands at the time (Cox *et al.,* 1994). The current database of public lands maintained by FNAI includes 4.8 million ha, of which 4.0 million is not situated over open water. This is a nearly 71% increase in the public lands system, 42% if you only consider lands not situated over open water. For example, in Collier County the reduction in total SHCA identified in the county is due to the creation of Picayune Strand State Forest and large additions to Big Cypress National Preserve, Fakahatchee Strand Preserve State Park, and Ten Thousand Islands National Wildlife Refuge since the 1994 report.

A large net gain in SHCA within a county is due to a variety of reasons, some of which include shifting habitat conservation priorities or identification of important lands overlooked in the original assessment. For example, the change in total area of SHCA in Gulf County is predominantly the result of SHCA identified for the black bear in the current report that were not identified as SHCA in 1994. This change in identified SHCA is indicative of the bear's expanding range in the state (Simek *et al.,* 2005).

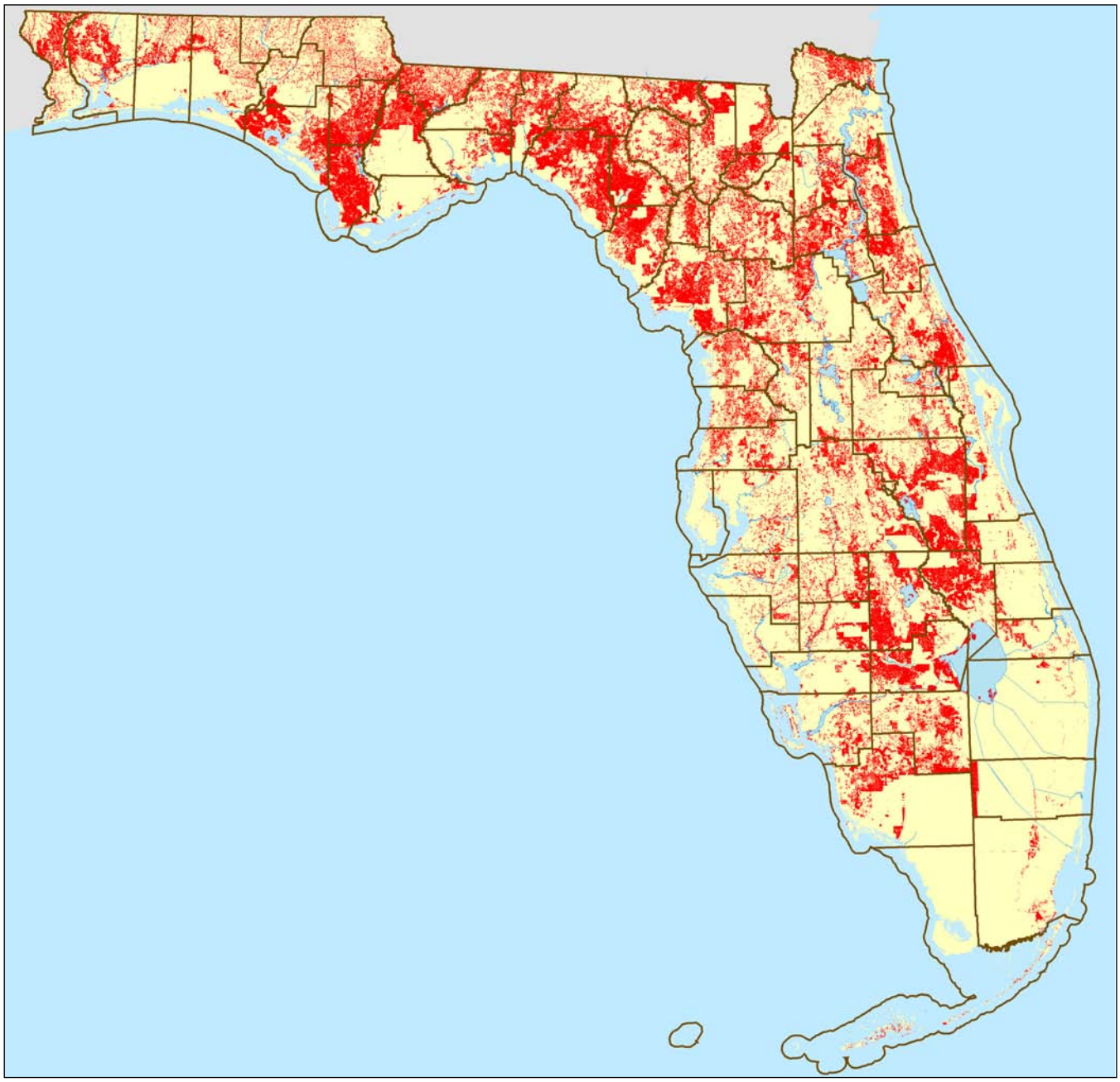

Figure 98 *Aggregate map of all proposed Strategic Habitat Conservation Areas for Florida.*

The number of individual species identified as needing SHCA was similar between the two studies, 30 species in the 1994 study and 34 species in the 2009 study (Table 8). There are 21 species (11 birds, 7 mammals, 3 reptiles) that were evaluated in both studies and were found to need SHCA in 1994 and 2009. However, important differences emerge in the species that were evaluated and the corresponding results between the two studies. Strategic Habitat Conservation Areas were created for 9 species (8 bird species and 1 amphibian species) in 1994 that were deemed unnecessary in 2009 based on PVA results. This difference may be the result of public land additions between 1994 and 2009. Additionally, a better understanding of the life history of these species and more location data may have contributed to the difference. Two species (1 bird, 1 amphibian) evaluated in 1994 did not warrant SHCA at the time, but they did warrant SHCA in the 2009 evaluation. This difference could be the result of habitat loss or fragmentation, as well as better life history information. Eleven species (1 bird, 7 mammals, 1 reptile, and 2 amphibians) that were evaluated and warranted

Table 8 *Species for which Strategic Habitat Conservation Areas were created in 1994 and 2009. Species in bold were unique to their respective years.*

1994	2009
American crocodile	American crocodile
Anastasia Island beach mouse	Anastasia Island beach mouse
Atlantic salt marsh snake	Atlantic salt marsh snake
Black-whiskered Vireo[1]	Big Cypress fox squirrel
Big Cypress fox squirrel	Choctawhatchee beach mouse
Bog frog[1]	**Cooper's Hawk**[2]
Choctawhatchee beach mouse	Cuban Snowy Plover
Crested Caracara[1]	Florida black bear
Cuban Snowy Plover	**Florida Burrowing Owl**
Florida black bear	Florida Grasshopper Sparrow
Florida Grasshopper Sparrow	**Florida mouse**[2]
Florida panther	Florida panther
Florida Sandhill Crane[1]	**Florida salt marsh vole**[2]
Florida Scrub-Jay	Florida Scrub-Jay
Gulf salt marsh snake	**Gray bat**[2]
Limpkin[1]	Gulf salt marsh snake
Louisiana Seaside Sparrow	**Key deer**[2]
Mangrove Cuckoo	Louisiana Seaside Sparrow
Mottled Duck[1]	**Lower Keys marsh rabbit**[2]
Red-cockaded Woodpecker[1]	Mangrove Cuckoo
Scott's Seaside Sparrow	**Pine barrens tree frog**
Short-tailed Hawk	**Sand skink**[2]
MacGillivray's Seaside Sparrow	**Sanibel Island rice rat**[2]
Snail Kite	Scott's Seaside Sparrow
Southeastern American Kestrel[1]	**Seal salamander**[2]
Southeastern beach mouse	Short-tailed Hawk
Southern Bald Eagle[1]	**Silver rice rat**[2]
St. Andrews beach mouse	MacGillivray's Seaside Sparrow
Swallow-tailed Kite	Snail Kite
White-crowned Pigeon	Southeastern beach mouse
	St. Andrews beach mouse
	Striped newt[2]
	Swallow-tailed Kite
	White-crowned Pigeon

[1] Species did not require SHCA in 2009. [2]Species not evaluated in 1994.

SHCA in the 2009 study were not included in the 1994 study. Inclusion of additional species in 2009 was based on current data indicating low or declining population status or changes in the species listing status. However, the total area of SHCA from these additional species did not contribute greatly to the differences in total area between the aggregate SHCA maps in 1994 and 2009 because of the extremely limited range of many of these species (*e.g.,* rice rats, gray bat, sand skink, seal salamander, striped newt, and those species found principally in the Florida Keys).

However, one particular species had a substantial impact on the overall difference in the aggregate SHCA maps. The Swallow-tailed Kite is a wide-ranging species that uses a diverse mix of wetland and pine habitats. The 1994 study identified SHCA for the Swallow-tailed Kite based around 12 areas in Florida that were identified as critically important to maintaining core populations of Swallow-tailed Kites. For a number or reasons, we did not limit our SHCA identification in this way. First, our PVA results identified that even with all potential habitat protected for this species minimum

Table 9 *FWC 2003 land-cover classes in the 2009 Strategic Habitat Conservation Areas.*

Class	Area (ha)	% of Total in FL
Coastal strand	578	10
Sand/beach	2,165	16
Xeric oak scrub	15,967	27
Sand pine scrub	11,329	14
Sandhill	122,090	40
Dry prairie	139,161	28
Mixed hardwood–pine forest	195,929	54
Hardwood hammock and forest	228,125	58
Pineland	1,126,814	43
Cabbage palm–live oak hammock	1,500	38
Tropical hardwood hammock	1,493	24
Freshwater marsh and wet prairie	139,385	16
Sawgrass marsh	7,697	3
Cattail marsh	6,040	23
Shrub swamp	89,948	21
Bay swamp	41,508	50
Cypress swamp	245,869	39
Cypress/pine/cabbage palm	5,461	29
Mixed wetland forest	314,590	53
Hardwood swamp	348,514	47
Hydric hammock	1,873	13
Bottomland hardwood forest	10,955	32
Salt marsh	29,970	17
Mangrove swamp	19	8
Scrub mangrove	730	28
Tidal flat	406	7
Open water	7,278	0.2
Shrub and brushland	74,285	11
Grassland	835	3
Improved pasture	361,639	30
Unimproved pasture	14,975	26

conservation goals are not met. Second, we coordinated our SHCA identification with Dr. Ken Meyer, an expert on Swallow-tailed Kites in Florida. The results of our collaborative effort helped identify our best estimate of the conservation needs for the Swallow-tailed Kite in Florida. Our 2009 study resulted in SHCA for this species that include more than 48% (~1.7 million ha) of the 2009 aggregate SHCA map. Forty-nine percent (125,000 ha) of the area identified as SHCA in 2009 that was not identified as SHCA in 1994 can be attributed to this species. The difference in the SHCA model for Swallow-tailed Kite was a major contributor to the differences in the conservation areas identified between the two studies.

Further differences between the 1994 and the 2009 SHCA maps originated from differences in potential-habitat modeling techniques and criteria used in determining SHCA for a given species. The potential-habitat maps produced in the original 1994 report were based almost exclusively upon species-occurrence records (*i.e.,* individual locations) in constructing the potential-habitat maps. Relying upon these records limited the amount of potential habitat included in the SHCA identified for a species to the area immediately surrounding each location. In this study, modelers used, among other techniques, range maps, soils maps, E-map hexagons, and survey units from the National Breeding Bird survey to identify areas of potential habitat. Potential habitat was included from a much larger area, increasing the amount of potential habitat included in each SHCA that contributed to the differences in total area between the 1994 and 2009 data sets.

Differences in the habitat data used in each study may also account for differences between the aggregate

Table 10 *Percent change in total area identified as Strategic Habitat Conservation Areas (SHCA) from 1994 to 2009, by county.*

County	% SHCA 1994	% SHCA 2009	% Change	County	% SHCA 1994	% SHCA 2009	% Change
Alachua	3.7	30.1	26.4	Lake	16.0	12.7	–3.3
Baker	30.1	24.2	–6.0	Lee	21.3	13.7	–7.7
Bay	3.4	38.1	34.7	Leon	5.6	28.7	23.1
Bradford	0.3	19.4	19.1	Levy	16.6	41.0	24.4
Brevard	9.9	12.3	2.4	Liberty	16.3	29.5	13.2
Broward	0.5	5.6	5.1	Madison	8.2	37.4	29.2
Calhoun	10.6	61.2	50.6	Manatee	2.6	13.6	10.9
Charlotte	27.8	6.9	–20.9	Marion	9.8	24.7	14.9
Citrus	11.3	26.7	15.4	Martin	7.2	9.9	2.7
Clay	4.0	27.9	23.9	Monroe	2.4	2.2	–0.2
Collier	41.6	14.2	–27.4	Nassau	7.0	29.9	22.9
Columbia	10.6	33.3	22.7	Okaloosa	2.6	14.7	12.1
Dade	1.8	2.5	0.7	Okeechobee	14.7	40.0	25.3
De Soto	17.1	20.7	3.6	Orange	6.3	14.1	7.8
Dixie	10.6	44.2	33.6	Osceola	18.5	40.9	22.4
Duval	4.2	12.7	8.5	Palm Beach	1.8	1.3	–0.5
Escambia	0.1	26.8	26.7	Pasco	7.1	22.3	15.2
Flagler	59.2	38.4	–20.8	Pinellas	1.6	2.0	0.5
Franklin	31.2	9.6	–21.5	Polk	18.4	18.8	0.4
Gadsden	0.7	48.6	47.8	Putnam	27.7	37.1	9.4
Gilchrist	6.7	37.7	31.0	Santa Rosa	4.2	23.9	19.8
Glades	61.0	37.3	–23.8	Sarasota	2.9	4.3	1.4
Gulf	14.1	70.1	56.0	Seminole	5.9	17.4	11.5
Hamilton	4.8	39.7	34.9	St. Johns	7.2	37.2	30.0
Hardee	7.7	25.9	18.2	St. Lucie	6.7	3.7	–3.0
Hendry	38.1	28.5	–9.6	Sumter	5.6	20.2	14.6
Hernando	3.1	27.5	24.3	Suwannee	1.8	27.9	26.1
Highlands	21.6	37.5	15.9	Taylor	13.8	54.7	41.4
Hillsborough	4.7	11.6	6.9	Union	0	48.8	48.8
Holmes	1.2	15.4	14.2	Volusia	24.0	26.7	2.7
Indian River	6.2	12.9	6.7	Wakulla	6.0	20.2	14.3
Jackson	3.2	23.7	20.5	Walton	14.6	16.1	1.5
Jefferson	20.3	42.0	21.8	Washington	11.8	16.8	5.0
Lafayette	4.2	56.0	51.8				

SHCA maps. The authors of the 1994 study used the FWC 1985–1989 land-cover data set that employed 26 land-cover categories as the primary habitat data. Although these data were the latest at that time, changes in imaging and classification techniques led to the production of a new land-cover data set in 2003 consisting of 43 land-cover categories. Conversion of land to different land-cover types through habitat loss and/or restoration would change areas identified as potential habitat as well. Areas previously identified as habitat may no longer be classified as a land-cover class used by the species in question. Conversely, areas previously identified as non-habitat may now be deemed suitable because of greater accuracy and precision in modeling land-cover types. Additionally, species location and range data have changed in the time since the original study. Species may now be found in areas not previously identified as habitat, potentially increasing their known range and amount of potential habitat used in assessing population stability and SHCA creation. Conversely, they may no longer be found in areas identified as suitable habitat in the 1994 study.

In both studies, habitat was assessed to estimate the level of protection it provided to the focal species.

The 1994 study accomplished this principally by identifying sufficient potential habitat to sustain a minimum of 10 populations of 200 individuals. In this study, we conducted analyses to determine the probability of a population declining to a certain level within a given time period. In most cases, we identified areas that could support the population abundance target for each species by using PVA techniques to determine the optimal population size and persistence set for each species in our study. Based on these models, a general threshold (*i.e.,* a minimum number of females) was required to mitigate the effects of demographic stochasticity over the long term, regardless of the species. Results of the analyses indicated that those species requiring SHCA would require all areas identified as potential habitat to get close to meeting the criteria for persistence outlined in the PVA. Based on the analyses, even if all potential habitat was placed under conservation protection, most of the species still will not meet our minimum population persistence goals and will face threats of continued population decline or extinction. This is an alarming phenomenon and one that warrants additional research to identify whether Florida truly has reached a threshold of increasing species extinctions or declines in abundance caused by existing and continued habitat loss and fragmentation. In a few cases, the SHCA were created using criteria explained in each species account.

These key differences in assessing population viability affected our SHCA map in terms of the amount, distribution, and configuration of habitat required to meet those population goals. In both studies, the goal of SHCA was to identify sufficient areas of privately owned land that would, in combination with existing conservation lands, increase the long-term security of each species. Generally, areas identified as SHCA in 1994 were a subset of all identified potential habitat on privately owned lands. The areas included as SHCA were selected based on several criteria, including habitat suitability, habitat connectivity, patch size, proximity to existing conservation lands, and the likelihood of protecting other species. However, in most cases in 2009, all privately owned potential habitat was required to meet the conservation goals for species whose PVA results indicated high probability of population decline and was thus identified as SHCA. Therefore, single pixels or groups of disjunct pixels were assessed for their total contribution to meeting the goals of the PVA. Inclusion of these small patches of habitat in the 2009 SHCA contributes to the scattered appearance of habitats (Figure 98).

Finally, the amount and distribution of public and private lands has changed significantly in the 15 years between studies. Since 1994, 33% (646,000 ha) of areas identified as SHCA have been placed in public management. Any land placed under public protection since 1994, whether or not it was previously identified as SHCA, would also be excluded from SCHA creation in the 2009 study, resulting in a change in the amount of land eligible for inclusion in an SHCA data set. These changes have contributed to large differences between the amount and distribution of SHCA from 1994 to 2009. However, we believe that the improvements in modeling techniques, species location and land-cover data, and the use of population viability analyses provide a better picture of the amount and type of habitat required to protect Florida's wildlife biodiversity.

Prioritizing SHCA

The composite map of SHCA identifies an extraordinary amount of potential habitat in the state (Figure 98). The state of Florida is a leader among states regarding the various conservation efforts conducted within its borders. However, the amount of money and resources needed to adequately protect all the SHCA that we have identified is far greater than what is available for conservation efforts. Therefore, we prioritized the SHCA to highlight those areas in need of more immediate protection while still recognizing the habitat protection needs of all the species with SHCA. Our prioritized SHCA map provides users with the option to decide what level of SHCA priority they consider important for their purposes.

Our prioritized SHCA map identifies five classes of SHCA (Figure 99) based upon Heritage ranking criteria developed by The Nature Conservancy, the Natural Heritage Program Network, and the FNAI (Table 11). This methodology was originally developed as part of the Critical Lands & Waters Identification Project (CLIP; Century Commission for a Sustainable Florida, 2008). There are two possible ranks used to prioritize a species' SHCA: (1) the global rank based on a species' worldwide status, and (2) the state rank based upon the species' status in Florida. The state and global ranks are based upon many factors such as known occurrence locations, estimated abundance, range, amount of habitat currently protected, perceived levels of threats towards the species, and ecological fragility. Table 12 lists how each species with SHCA was ranked in the prioritization, and Table 13 summarizes the total amount of area identified in each priority class.

With our ranked SHCA map, we believe that priorities 1 and 2 adequately capture the needs of high-risk species statewide. Priority 1 includes species with very specific habitat requirements such as the Florida Grasshopper Sparrow and/or species with extremely

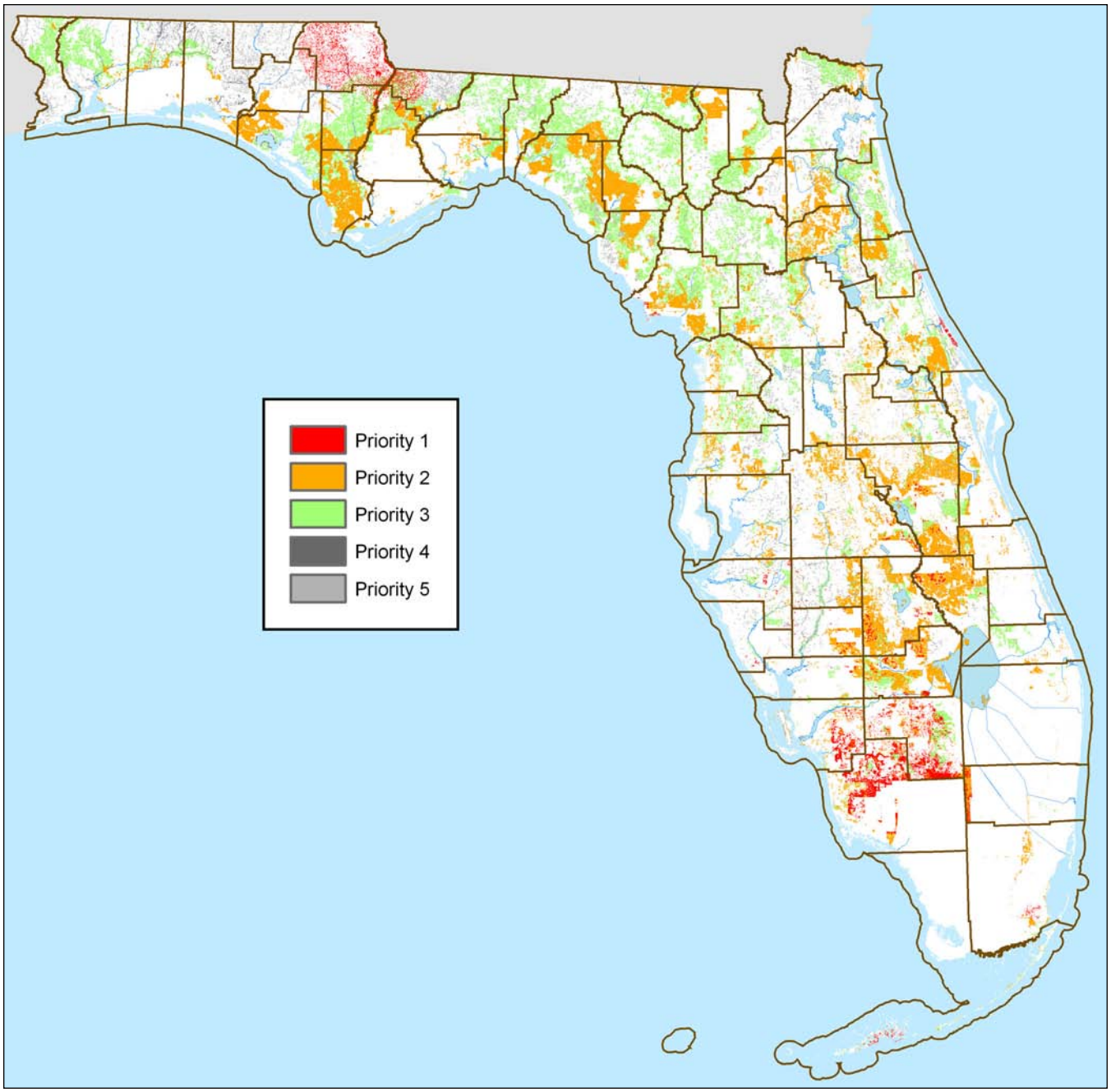

Figure 99 *Prioritized Strategic Habitat Conservation Areas for Florida.*

Table 11 *Classification of Heritage ranking criteria into Strategic Habitat Conservation Areas Priority Class.*

SHCA Priority Class	Heritage Rank
Priority 1	State Rank 1 **and** Global Rank 1–3
Priority 2	State Rank 1 **and** Global Rank 4–5 *or* State Rank 2 **and** Global Rank 2–3
Priority 3	State Rank 2 **and** Global Rank 4–5 *or* State Rank 3 **and** Global Rank 3
Priority 4	State Rank 3 **and** Global Rank 4
Priority 5	State Rank 3 **and** Global Rank 5 *or* State Rank 4 **and** Global Rank 4

Table 12 *Priority classification of species with Strategic Habitat Conservation Areas based upon Heritage ranking criteria.*

Species Common Name	Species Scientific Name	State Status	Global Status
Priority 1			
Florida Grasshopper Sparrow	*Ammodramus savannarum floridanus*	S1	G5T1
Florida salt marsh vole	*Microtus pennsylvanicus dukecampbelli*	S1	G5T1
Florida Key deer	*Odocoileus virginianus clavium*	S1	G5T1
Sanibel Island rice rat	*Oryzomys palustris sanibeli*	S1	G5T1
Choctawhatchee beach mouse	*Peromyscus polionotus allophrys*	S1	G5T1
St. Andrews beach mouse	*Peromyscus polionotus peninsularis*	S1	G5T1
Anastasia Island beach mouse	*Peromyscus polionotus phasma*	S1	G5T1
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	S1	G5T1
Florida panther	*Puma concolor coryi*	S1	G5T1
Lower Keys marsh rabbit	*Sylvilagus palustris hefneri*	S1	G5T1
Atlantic salt marsh snake	*Nerodia clarkii taeniata*	S1	G4T1
Gray bat	*Myotis grisescens*	S1	G3
Priority 2			
Louisiana Seaside Sparrow	*Ammodramus maritimus fisheri*	S1	G4T4
Short-tailed Hawk	*Buteo brachyurus*	S1	G4
Cuban Snowy Plover	*Charadrius alexandrinus*	S1	G4
Seal salamander	*Desmognathus monticola*	S1	G5
Florida Scrub-Jay	*Aphelocoma coerulescens*	S2	G2
American crocodile	*Crocodylus acutus*	S2	G2
Sand skink	*Neoseps reynoldsi*	S2	G2
Striped newt	*Notophthalmus perstriatus*	S2	G2
MacGillivray's Seaside Sparrow	*Ammodramus maritimus macgillivraii*	S2	G4T2
Florida Snail Kite	*Rostrhamus sociabilis plumbeus*	S2	G4T3
Silver rice rat	*Oryzomys palustris natator*	S2	G5T2
Big Cypress fox squirrel	*Sciurus niger avicennia*	S2	G5T2
Florida black bear	*Ursus americanus floridanus*	S2	G5T2
Priority 3			
Swallow-tailed Kite	*Elanoides forficatus forficatus*	S2	G5
White-crowned Pigeon	*Patagioenas leucocephala*	S3	G3
Florida mouse	*Podomys floridanus*	S3	G3
Scott's Seaside Sparrow	*Ammodramus maritimus peninsulae*	S3	G4T3
Florida Burrowing Owl	*Athene cunicularia floridana*	S3	G4T3
Priority 4			
Pine barrens tree frog	*Hyla andersonii*	S3	G4
Gulf salt marsh snake	*Nerodia clarkii clarkii*	S3	G4T4
Priority 5			
Cooper's Hawk	*Accipiter cooperii*	S3	G5
Mangrove Cuckoo	*Coccyzus minor*	S3	G5

limited ranges in the state such as beach mice, Florida salt marsh vole, Florida Key deer, and the Atlantic salt marsh snake. The priority 1 class also contains the SHCA for the Florida panther, which is one of the most endangered mammals on earth and symbolizes the principle issues facing wildlife: habitat loss, degradation, and fragmentation. Priority 2 includes a wider variety of imperiled species. The class includes coastal species (*e.g.,* seaside sparrows, Cuban Snowy Plover, American crocodile), wetland species (*e.g.,* Florida Snail Kite, seal salamander, striped newt), scrub specific species (*e.g.,* Florida Scrub-Jay and sand skink), and habitat generalist (*e.g.,* Florida black bear and Short-tailed Hawk).

Table 13 *Area summary of Strategic Habitat Conservation Areas priority classes.*

SHCA Priority Class	Hectares
Priority 1	237,100
Priority 2	1,525,700
Priority 3	1,357,900
Priority 4	23,100
Priority 5	422,500

By recommending priorities 1 and 2, we do not intend to disregard priorities 3, 4, and 5. Conservation of areas identified in all classes should certainly be pursued, and we should take advantage of opportunities to do so as they arise. However, because of their overlapping nature, numerous areas identified in priorities 1 and 2 will also aid species classified in the remaining priorities. For example, large amounts of SHCA identified for the Florida black bear, a priority 2 species, will also benefit the Swallow-tailed Kite (priority 3) and Cooper's Hawk (priority 5). Strategic Habitat Conservation Areas identified for the Short-tailed Hawk, a priority 2 species, encompasses many areas identified as SHCA for the Florida Burrowing Owl, a priority 3 species. Priority 3–5 species found in the Keys, such as Mangrove Cuckoo and White-crowned Pigeon, have SHCA that are also represented by numerous species classified in priorities 1 and 2, like the Florida Key deer and American crocodile. The priority 3–5 species SHCA least encompassed by priority 1 and 2 SHCA are Gulf salt marsh snake, Scott's Seaside Sparrow, and pine barrens tree frog. The Gulf salt marsh snake and Scott's Seaside Sparrow both inhabit the salt marshes of the Gulf of Mexico. The pine barrens tree frog is found in acid seepage bogs in the western Panhandle.

We hope that the information contained within this document assists in the continued conservation and appropriate management of Florida wildlife and habitats. This report summarizes and prioritizes the habitat and conservation needs of many of our most imperiled species, ultimately presenting the results on a single map. It enables people who are interested in wildlife conservation issues to more effectively address imperiled species' habitat needs.

Our SHCA recommendations are intended to be used as a guide. Land development and ownership in Florida is ever-changing and priority areas identified as SHCA might already have been significantly altered by development or acquired into public ownership. On-site surveys, literature reviews, and coordination with FWC biologists remain essential steps in documenting the presence or absence of rare and imperiled species and habitats within the project area. Be sure to check the status of all lands prior to making any decisions based upon the information contained in this document.

Chapter 8
Regional Planning Councils

West Florida Region

Often referred to as the Emerald Coast, this region contains beach resorts and communities such as Crestview, Destin, Navarre, Niceville, Panama City, Pensacola, Sandestin, Santa Rosa Beach, and Seaside. Biologically, this region is an often overlooked and forgotten part of Florida, but the region has garnered more and more attention in recent years. The possible discovery of the Ivory-billed Woodpecker in the Choctawhatchee River drainage may be one of biggest biological finds in many decades if reports can be substantiated. Portions of the region have been identified as a "biological hotspot" because they contain many rare species found only in small areas in the Florida Panhandle (Klein *et al.,* 2000). The unique seepage ravines and bogs in the region contain the southernmost extents of many species of amphibians, a number of which are geographically isolated from other populations along the Atlantic Seaboard. Numerous endemic species occur in the region, including the bog frog, Choctawhatchee beach mouse, Perdido Key beach mouse, and St. Andrews beach mouse. A major population of the Florida black bear occurs in the region, and recent surveys have found flatwoods salamander larvae at Garcon Point (Santa Rosa County) and Holley Outlying Landing Field (Santa Rosa County). The region also has many miles of relatively unspoiled and undeveloped beaches and coastline important to a variety of wildlife, including numerous listed species such as the Cuban Snowy Plover, beach mice, and others.

Twenty-five percent of the region is included within lands managed for conservation (Table 14; Figure 100). The largest publicly owned land in the region is Eglin Air Force Base (formerly Choctawhatchee National Forest). Other publicly owned lands in the region include the Blackwater and Point Washington state forests; the Lower Escambia, Yellow, Econfina, and Choctawhatchee River Water Management Areas; and the Gulf Islands National Seashore.

Conversion of natural lands to agriculture is prevalent in the northern portion of the region, which contains soils appropriate for crops such as cotton, soybeans, peanuts, watermelons, and corn (Figure 101). Natural and agricultural land-conversion to urban uses occurred predominantly along and south of Interstate 10. The metropolitan areas of Pensacola and Panama City are growing, as are many communities along the gulf coast, especially those in the greater Destin and Gulf Breeze areas. Bay County is planning the construction of a new airport. Completion of the proposed project will probably trigger a significant increase in new urban development and tourism. The human population of the region grew 20% between 1990 and 2000, and the population continues to grow (U.S. Census Bureau, 2006).

All five SHCA priority classes are represented in this region (Figure 102). Priority 1 SHCA are identified

Table 14 *Area summary of managed lands, Strategic Habitat Conservation Areas (SHCA), and land-use conversion by Regional Planning Council (RPC).*

RPC	Percentage of RPC that is Managed Land	Percentage of RPC that is SHCA	Percentage of Loss of Natural to Urban and Agriculture
Apalachee	31.89	35.41	6.21
Central	15.52	27.31	10.92
East Central	24.63	22.24	12.36
North Central	13.35	39.56	9.60
Northeast	20.98	29.01	8.63
South	70.86	3.17	2.02
Southwest	33.97	18.26	9.19
Tampa Bay	14.90	13.86	11.58
Treasure Coast	27.02	4.63	7.53
West	25.55	21.92	7.66
Withlacoochee	30.23	28.83	7.11

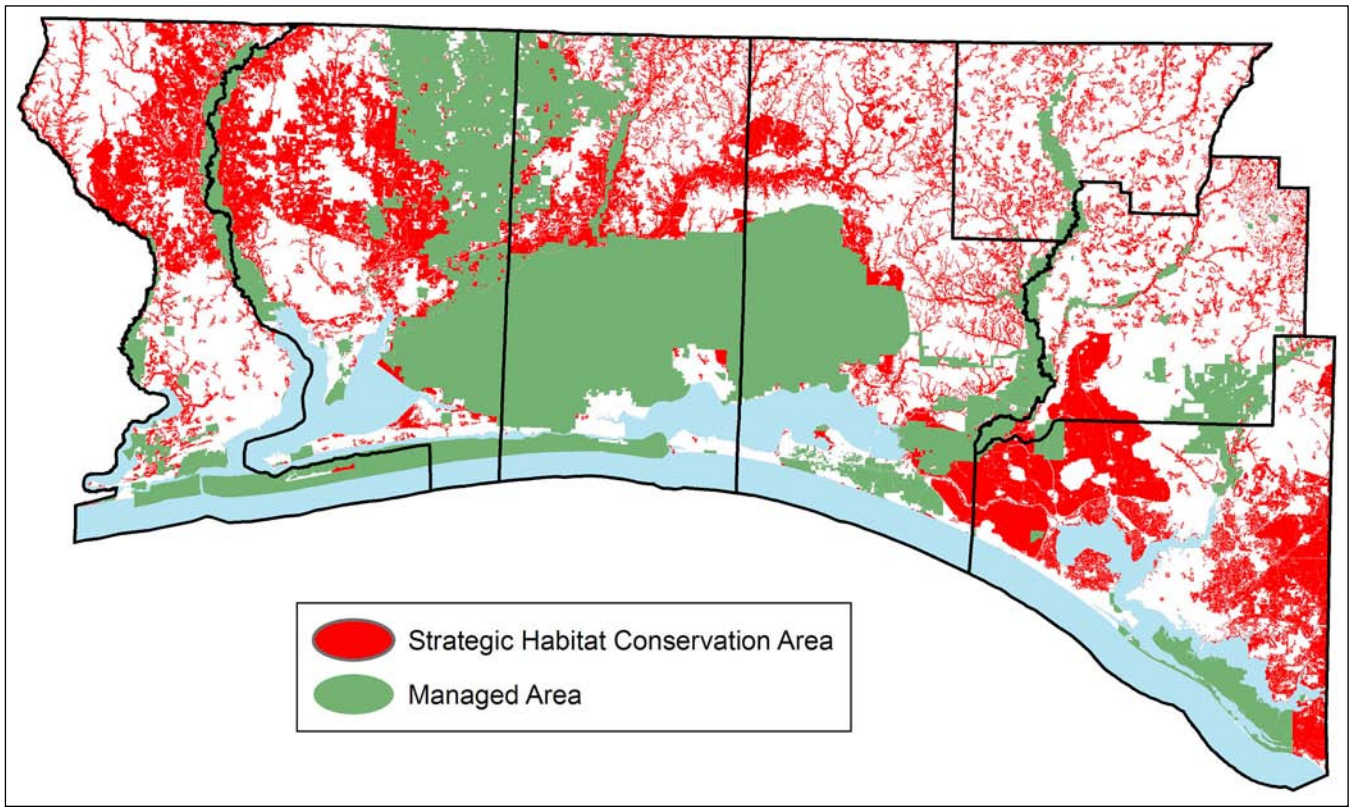

Figure 100 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the West Florida Regional Planning Council.*

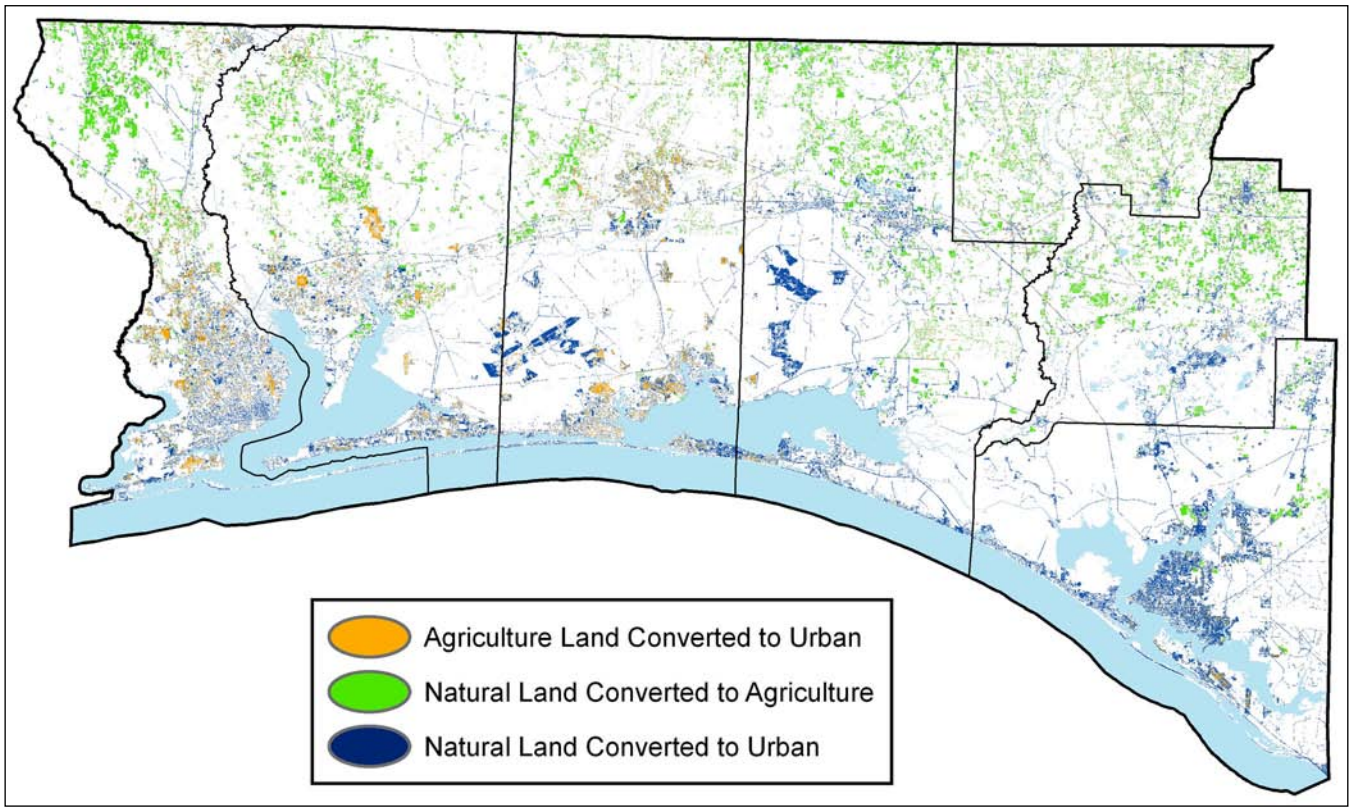

Figure 101 *Land-use conversion between 1985–1989 and 2003 in the West Florida Regional Planning Council.*

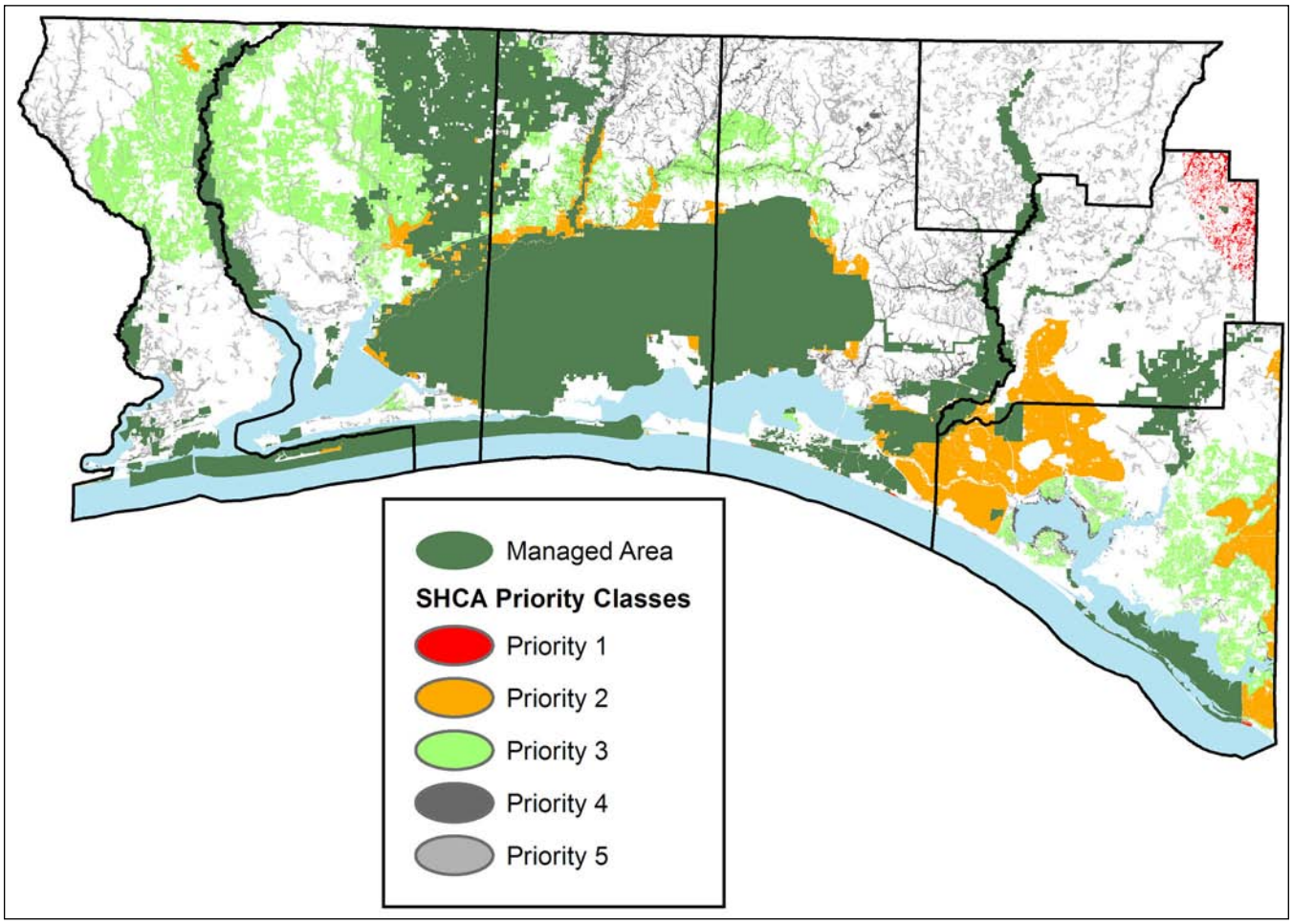

Figure 102 *Prioritized Strategic Habitat Conservation Areas for the West Florida Regional Planning Council.*

for the Choctawhatchee beach mouse, St. Andrews beach mouse, and gray bat. Priority 2 SHCA are identified for the Cuban Snowy Plover, Florida black bear, Louisiana Seaside Sparrow, and seal salamander. A significant portion of SHCA identified in this region is situated around river drainages and their associated habitats (Figure 100). Hardwood tree species dominate the river drainages in this region, and the SHCA were identified for Cooper's Hawk, gray bat, pine barrens tree frog, seal salamander, and Swallow-tailed Kite. The SHCA identified for the seal salamander are vital because this species is known from only five unprotected, small, spring-seepage ravines in northern Escambia County. Despite extensive sampling for it elsewhere in the state, these five spring seepages are the only confirmed locations for this species (B. Means, personal communication). Strategic Habitat Conservation Areas were identified for many coastal species occurring in the region, including the Gulf salt marsh snake, Scott's and Louisiana seaside sparrows, Cuban Snowy Plover, and St. Andrews and Choctawhatchee beach mice. The region was hit hard in recent years by hurricanes that altered or destroyed dune habitats and affected beach mouse populations. Habitat used by beach mice needs increased protection in order to reduce the chances that catastrophic events will push this animal toward extinction. The remainder of SHCA consists principally of unprotected pinelands identified for the Florida black bear and Swallow-tailed Kite. The SHCA identified for the Florida black bear help identify high quality lands to bridge the connection between Eglin and Apalachicola bear populations.

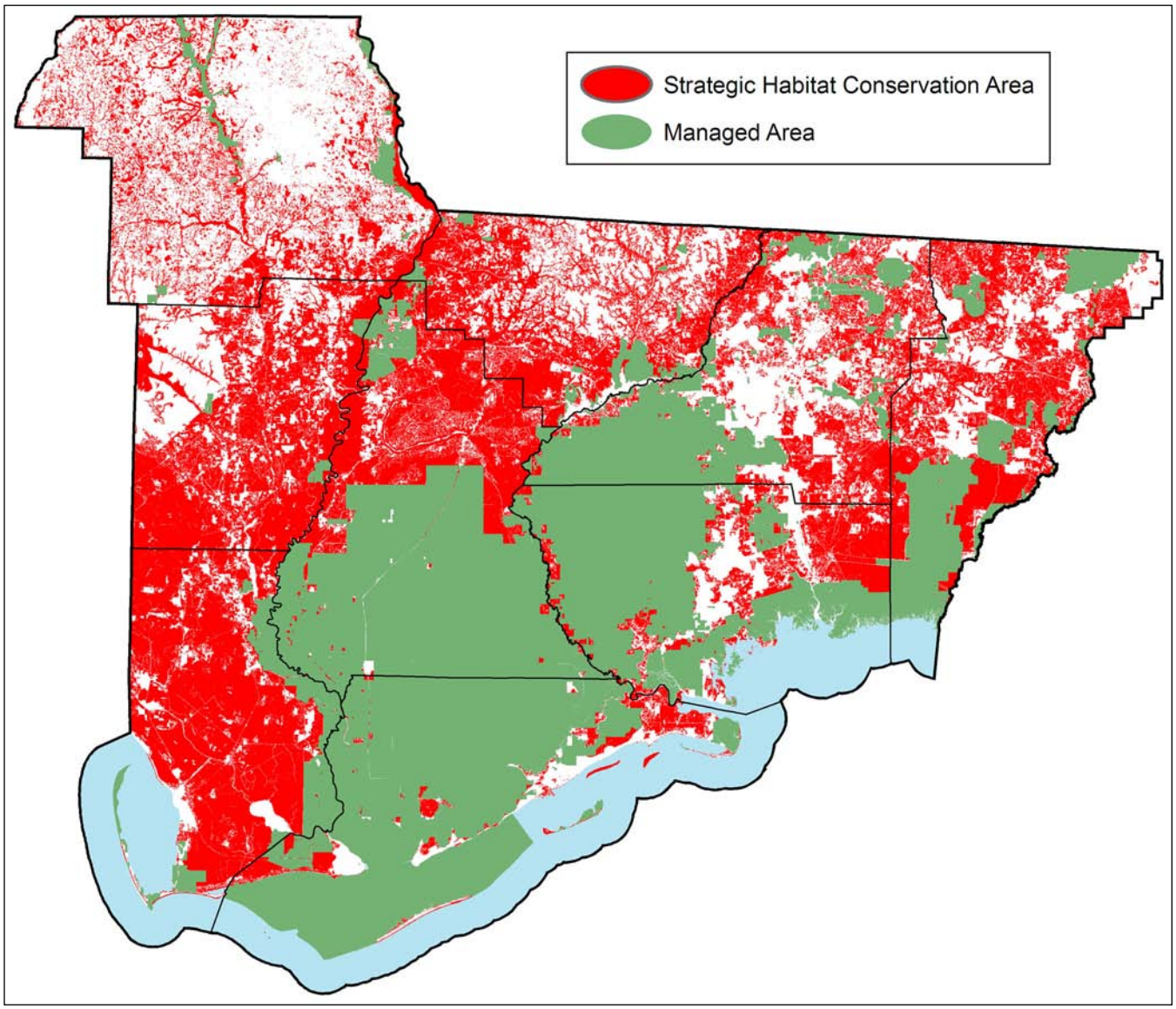

Figure 103 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the Apalachee Regional Planning Council.*

Apalachee Region

The Apalachee Region is significant biologically because it contains the Apalachicola River drainage basin, which supports more reptile and amphibian species than any other place in the U.S. and Canada (Apalachicola National Estuarine Research Reserve, 2006). Portions of the region have been identified as "biological hotspots" because they contain many rare species that occur only in small areas in the Florida Panhandle (Klein *et al.,* 2000). More than 30% of the Apalachee Region is under conservation protection because it contains some of the largest tracts of managed lands in Florida, such as the Apalachicola National Forest and protected lands associated with the Apalachicola River, Tates Hell State Forest, St. Marks National Wildlife Refuge, and Aucilla Wildlife Management Area (Table 14; Figure 103). Since *Closing the Gaps* was published in 1994, there have been significant acquisitions to the Aucilla WMA and Tates Hell State Forest. The region also contains numerous conservation easements in northern Leon and Jefferson counties, including Tall Timbers Research Station Inc., which maintains its own conservation easements and manages numerous conservation easements for private individuals and entities.

Continued development of the coastline and expansion of the Tallahassee metropolitan area have caused recent loss of habitat in this region. The region experienced a 21.9% increase in human population

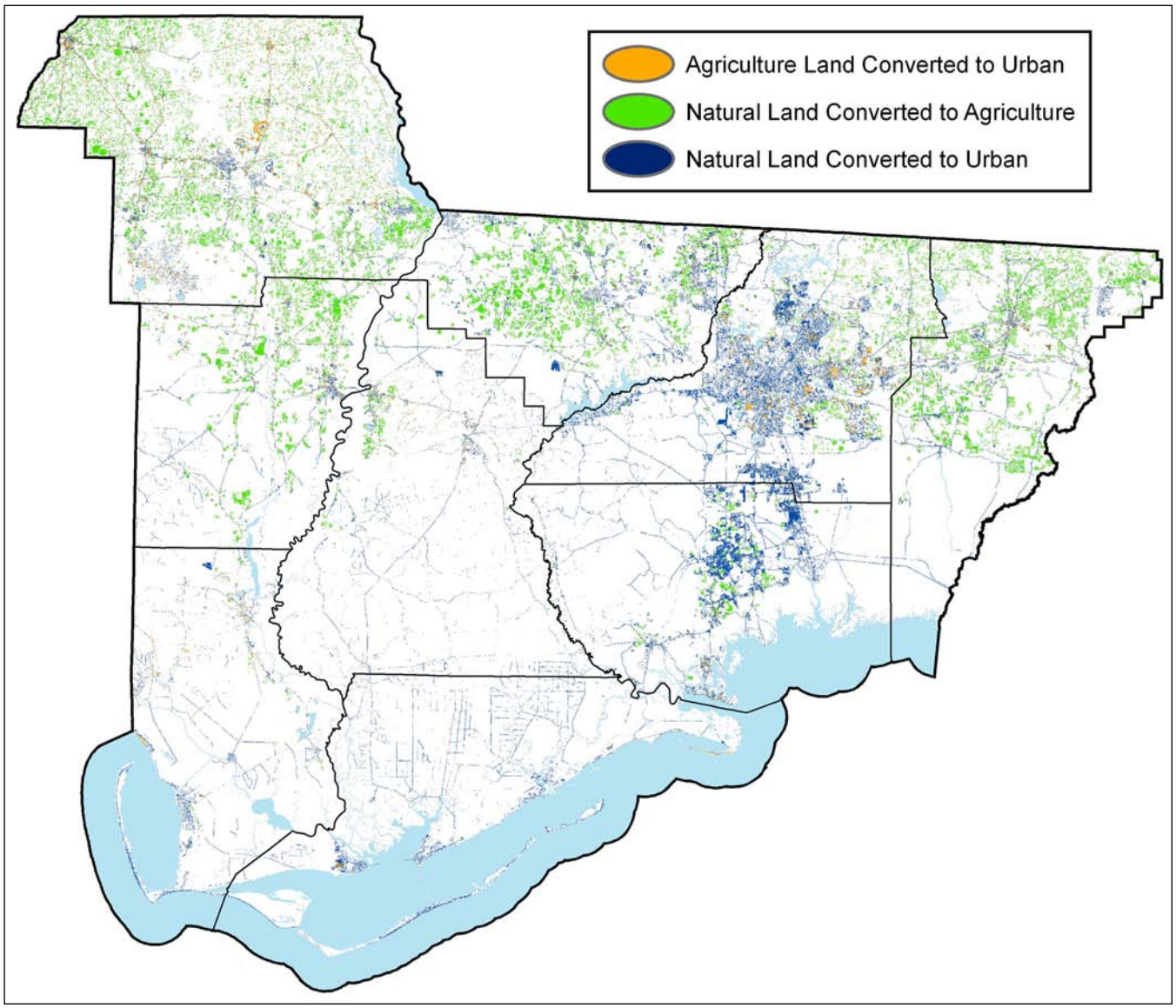

Figure 104 *Land-use conversion between 1985–1989 and 2003 in the Apalachee Regional Planning Council.*

from 1990 to 2000, greatly exceeding the national average of 13.2% but falling just under the Florida average of 23.5% (U.S. Census Bureau, 2006). This growth was concentrated in Leon and Wakulla counties. Numerous road improvements have been made to the corridors connecting Wakulla County to Tallahassee, which will no doubt help sustain the continued development of Wakulla County. The largest landowner in the state, The St. Joe Company, has evolved from a timber company into a land-development entity and is actively developing many of its properties in the region, especially along the coast. Furthermore, numerous land-development plans have been proposed for Gadsden and Jefferson counties, which suggests increasing development in these counties.

By comparing the FWC 1985–1989 and 2003 land-cover images, the Apalachee Region has lost more than 6% of natural lands to urban development and conversion to agriculture (Figure 104). The majority of the urban development has been in Leon and Wakulla counties, and the majority of agriculture conversion has occurred in Gadsden, Jefferson, Calhoun, and Jackson counties.

Strategic Habitat Conservation Areas have been identified on 35% of land in the Apalachee Region (Table 14; Figure 103), and all SHCA priority classes are represented in the region (Figure 105). The majority of SHCA are due to three species; the Florida black bear, Swallow-tailed Kite, and Cooper's Hawk. The priority 2 SHCA identified for bears in this region help to bol-

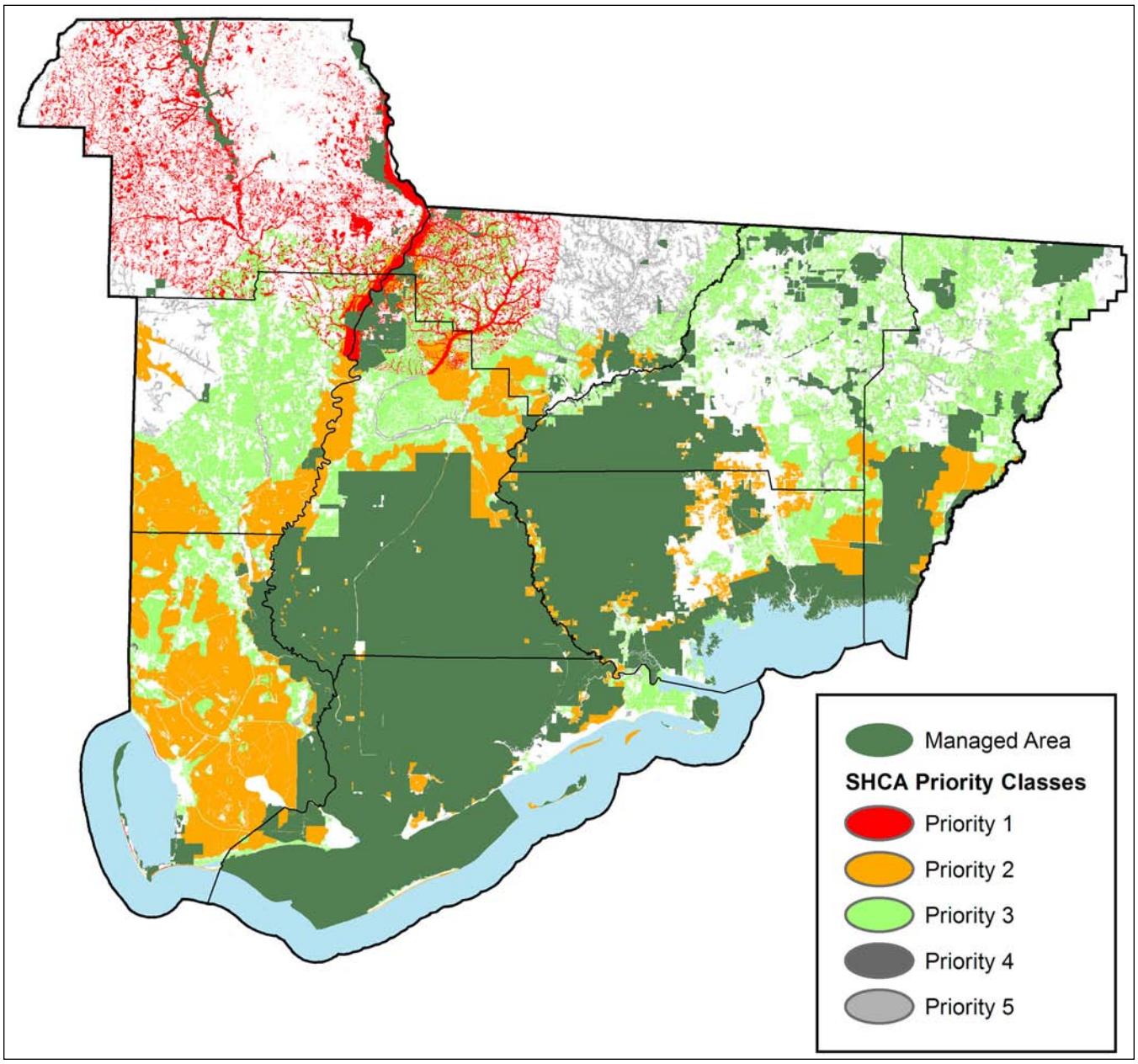

Figure 105 *Prioritized Strategic Habitat Conservation Areas for the Apalachee Regional Planning Council.*

ster the protected lands around Apalachicola National Forest and Aucilla Wildlife Management Area. The SHCA identified for the Swallow-tailed Kite consist of the majority of pinelands in the region. Additional species that have SHCA identified in the region include the Cuban Snowy Plover (priority 2), Florida mouse, gray bat (priority 1), Gulf salt marsh snake, St. Andrews beach mouse (priority 1), Scott's Seaside Sparrow, and striped newt (priority 2). The habitat identified for the striped newt is important because the population found in Leon and Wakulla counties is isolated from the other newt populations in the peninsula, and this area is experiencing significant development pressure. The coastal development ongoing in the Apalachee Region has the potential to adversely affect Cuban Snowy Plover and St. Andrews beach mouse habitats. The gray bat is situated principally in this region, known to occur only in Jackson County. Given the large amount of SHCA identified for this region, many of which are priority 1 and 2 species, appropriate planning and conservation measures are important to prevent development from occurring at the expense of wildlife.

North-Central Florida Region

The North-Central Florida Region is characterized by its abundant natural resources, which include the Suwannee River, marshlands along the gulf coast, numerous cypress swamps, and extensive pinelands. A large portion of the region is used for agricultural purposes, and many of the existing pinelands have been modified for the commercial harvest of timber. Since *Closing the Gaps* was published in 1994, the amount of managed lands in the region has doubled (Figure 106). However, the percentage of managed lands in the North-Central Florida Region is just over 13%, which is the smallest percentage in any of the regions (Table 14). Some of the significant public lands managed for conservation in the region include portions of the Osceola National Forest, Big Bend Wildlife Management Area, Lower Suwannee National Wildlife Refuge, Paynes Prairie Preserve State Park, and various protected lands along the Suwannee River.

By comparing the 1985–1989 and 2003 land-cover images, the North-Central Florida Region has lost roughly 9% of its natural land cover to urban or agricultural uses, with the majority being lost to agriculture (Table 14; Figure 107). The agricultural expansion is most evident in Suwannee, Gilchrist, lower Columbia, and western Alachua counties. Agriculture in the region comprises mainly field crops and livestock. The cities of Gainesville, Live Oak, Lake City, Perry, and the areas affected by the PCS phosphate mine in Hamilton County show evidence of urban expansion. The region has experienced a human population increase of

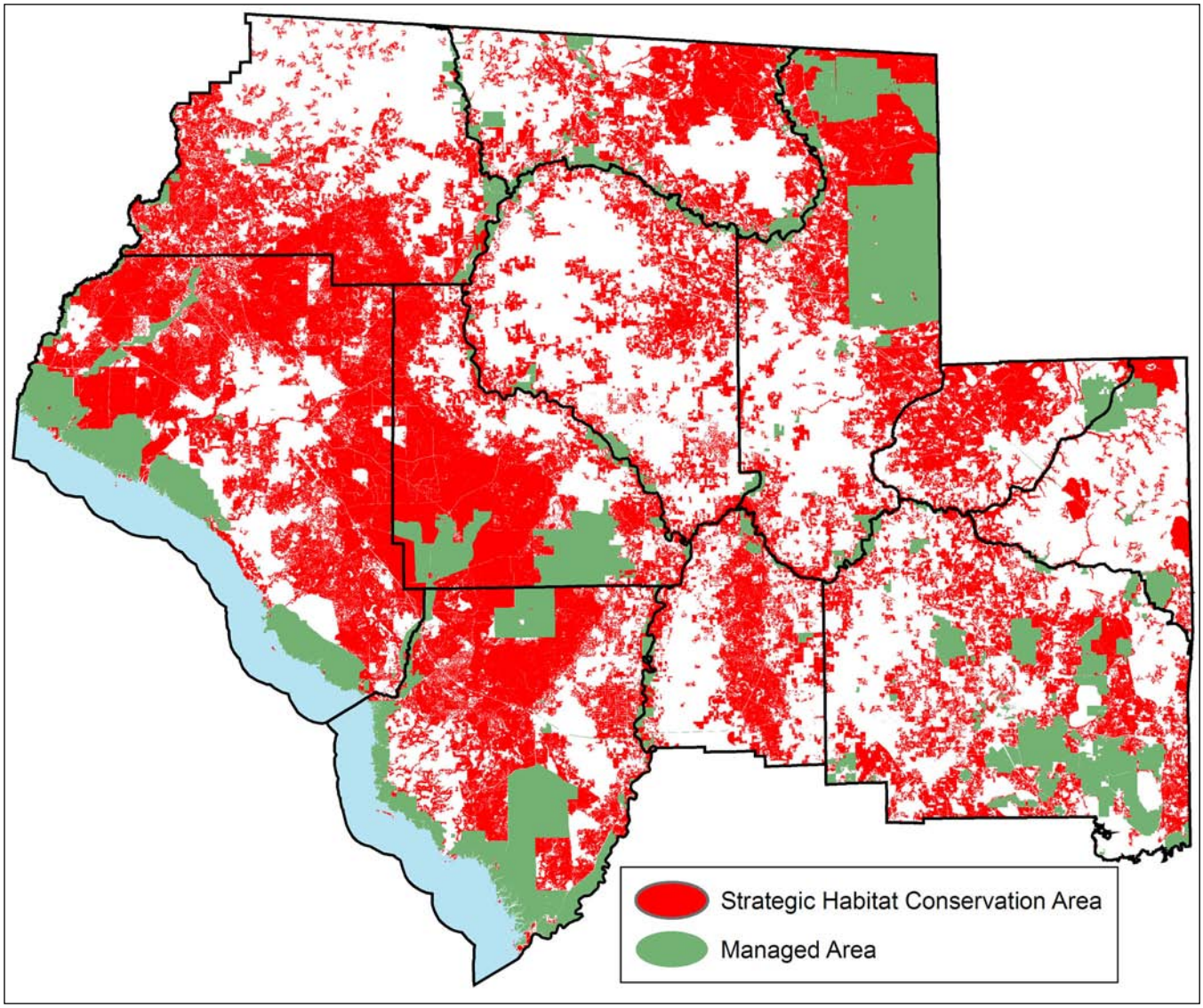

Figure 106 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the North-Central Florida Regional Planning Council.*

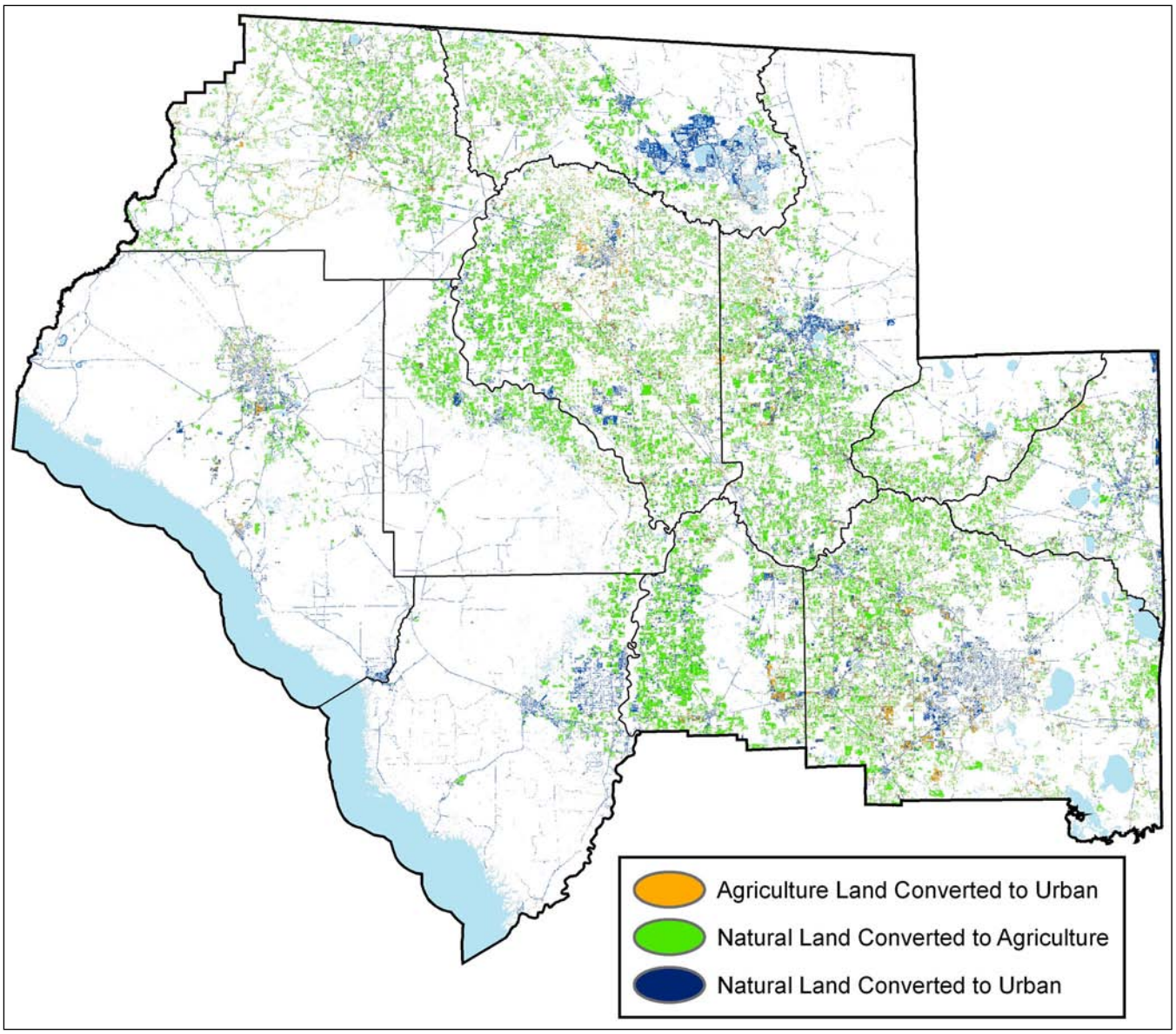

Figure 107 *Land-use conversion between 1985–1989 and 2003 in the North-Central Florida Regional Planning Council.*

22.9%, which is similar to the Florida average of 23.5% (U.S. Census Bureau, 2006). Eighty percent of the total change in this region has occurred in Alachua, Columbia, Gilchrist, and Suwannee counties (U.S. Census Bureau, 2006).

Thirty-nine percent of this region has been identified as SHCA (Table 14; Figure 106). This includes habitats important to the Florida Burrowing Owl, Cooper's Hawk, Florida black bear, Florida mouse, Florida salt marsh vole, Gulf salt marsh snake, Scott's Seaside Sparrow, Short-tailed Hawk, striped newt, and Swallow-tailed Kite. In this region, priority 1 SHCA are identified only for the Florida salt marsh vole; priority 2 SHCA are identified for the Florida black bear, Short-tailed Hawk, and striped newt (Figure 108). The vast majority of SHCA can be attributed to habitat needed by three species; the Cooper's Hawk, Florida black bear, and Swallow-tailed Kite. The Swallow-tailed Kite has the most SHCA identified in this region, encompassing the vast majority of large area pine and cypress habitats. Strategic Habitat Conservation Areas identified for the Florida black bear help to bolster the conservation lands around Osceola National Forest and along the big bend region of Florida. The North-Central Florida Region is the northernmost extent of the range of the Short-tailed Hawk and Florida mouse, and the SHCA identified for these species help to bolster habitat protection, which could lead to range expansion.

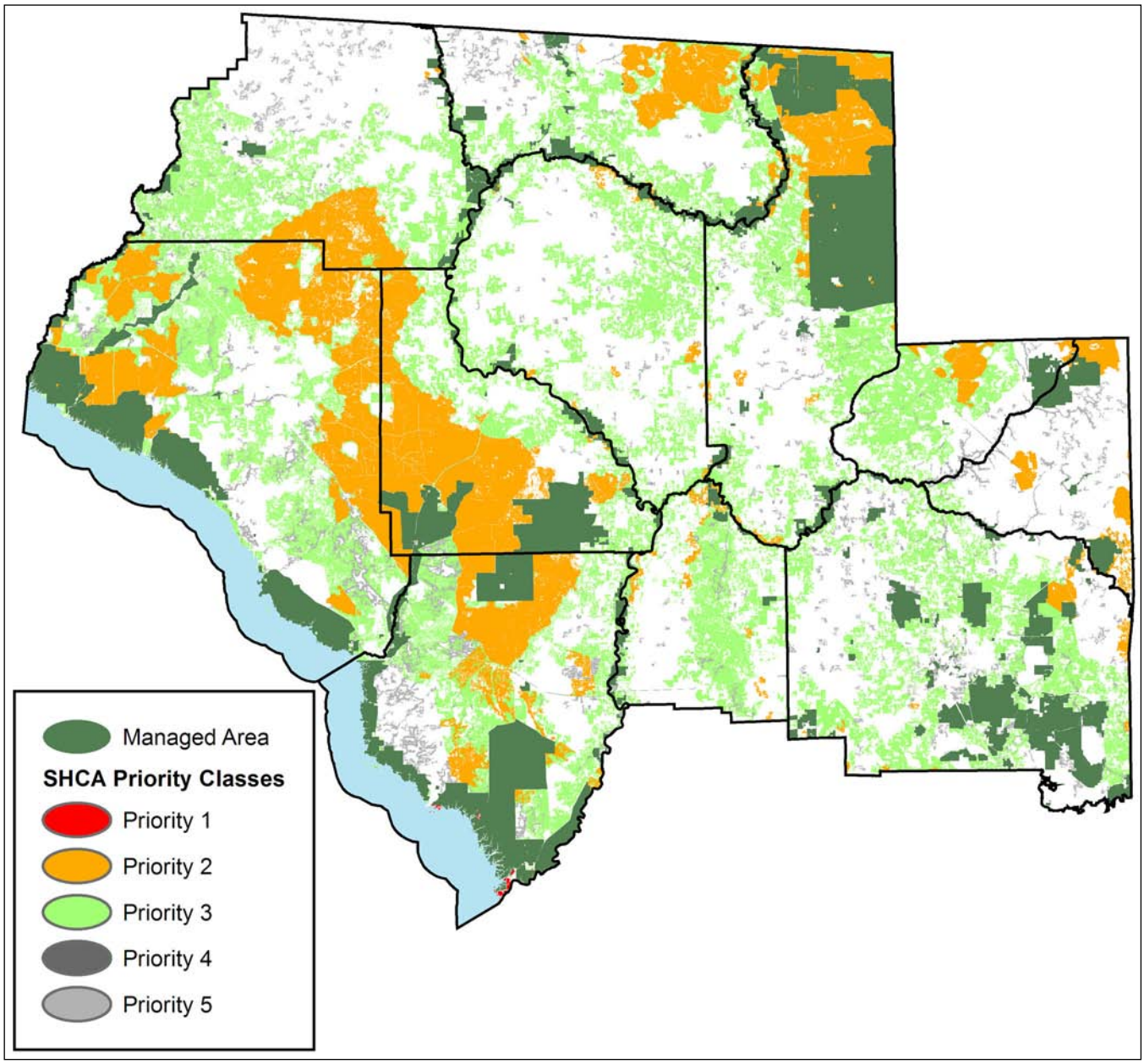

Figure 108 *Prioritized Strategic Habitat Conservation Areas for the North-Central Florida Regional Planning Council.*

Northeast Florida Region

Dominated by the St. Johns River, the Northeast Region contains important wetland and swamp habitats and a variety of upland habitats including scrub, sandhill, and extensive tracts of pineland. Twenty percent of the region is currently managed for conservation (Table 14; Figure 109). Managed lands include Osceola National Forest, Camp Blanding, Timucuan Preserve, Twelve Mile Swamp, Jennings State Forest, Caravelle Ranch Wildlife Management Area, and a variety of conservation lands along the coast.

The Northeast Region lost 8% of its natural land-cover to urban or agricultural uses (Table 14; Figure 110), according to a comparison of the 1985–1989 land-cover image with the FWC 2003 land-cover image. The majority of natural land-cover loss in the region was to urban uses, principally in areas surrounding the city of Jacksonville and along the coast. Putnam County also shows significant urban conversion associated with the city of Palatka and the expansion of residential communities in the western part of the county. The human population in the Northeast Region grew 22% from 1990 to 2000 (U.S. Census Bureau, 2006).

Twenty-nine percent of this region has been identified as SHCA (Table 14; Figure 109). Priority 1 and 2 SHCA species are abundant in this region (Figure 111). Priority 1 SHCA species in this region include the Anastasia Island beach mouse and Atlantic salt marsh snake. Priority 2 SHCA species in this region include the Cuban Snowy Plover, Florida black bear, Florida Scrub-Jay, MacGillivray's Seaside Sparrow, sand skink, Short-tailed Hawk, and striped newt. Habitat needed for the Cooper's Hawk, Florida black bear, and Swallow-tailed Kite once again accounted for the majority of SHCA. Strategic Habitat Conservation Areas identified for two species, MacGillivray's Seaside Sparrow and Anastasia Island beach mouse, are found only in this region. In Florida, MacGillivray's Seaside Sparrow is found only in the salt marshes of Nassau and Duval counties, and management efforts should be directed at protecting this habitat. The SHCA for the Anastasia Island beach mouse are the strip of coastal beach from Anastasia State Recreation Area to Fort Matanzas. Although protected lands exist for this endemic species, additional habitat protection would help ensure its security. In this region, SHCA have also been identified for the Florida mouse.

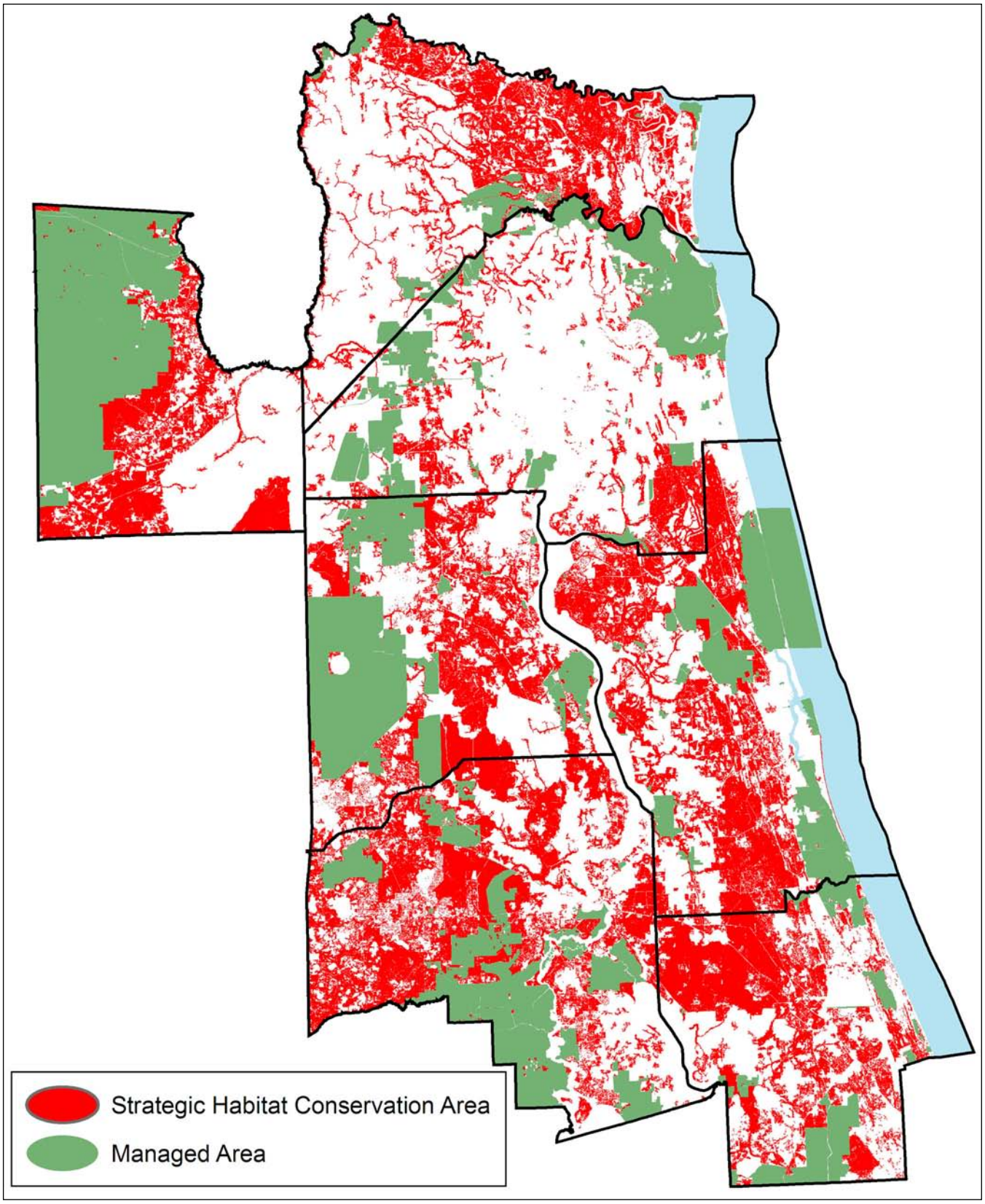

Figure 109 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the Northeast Florida Regional Planning Council.*

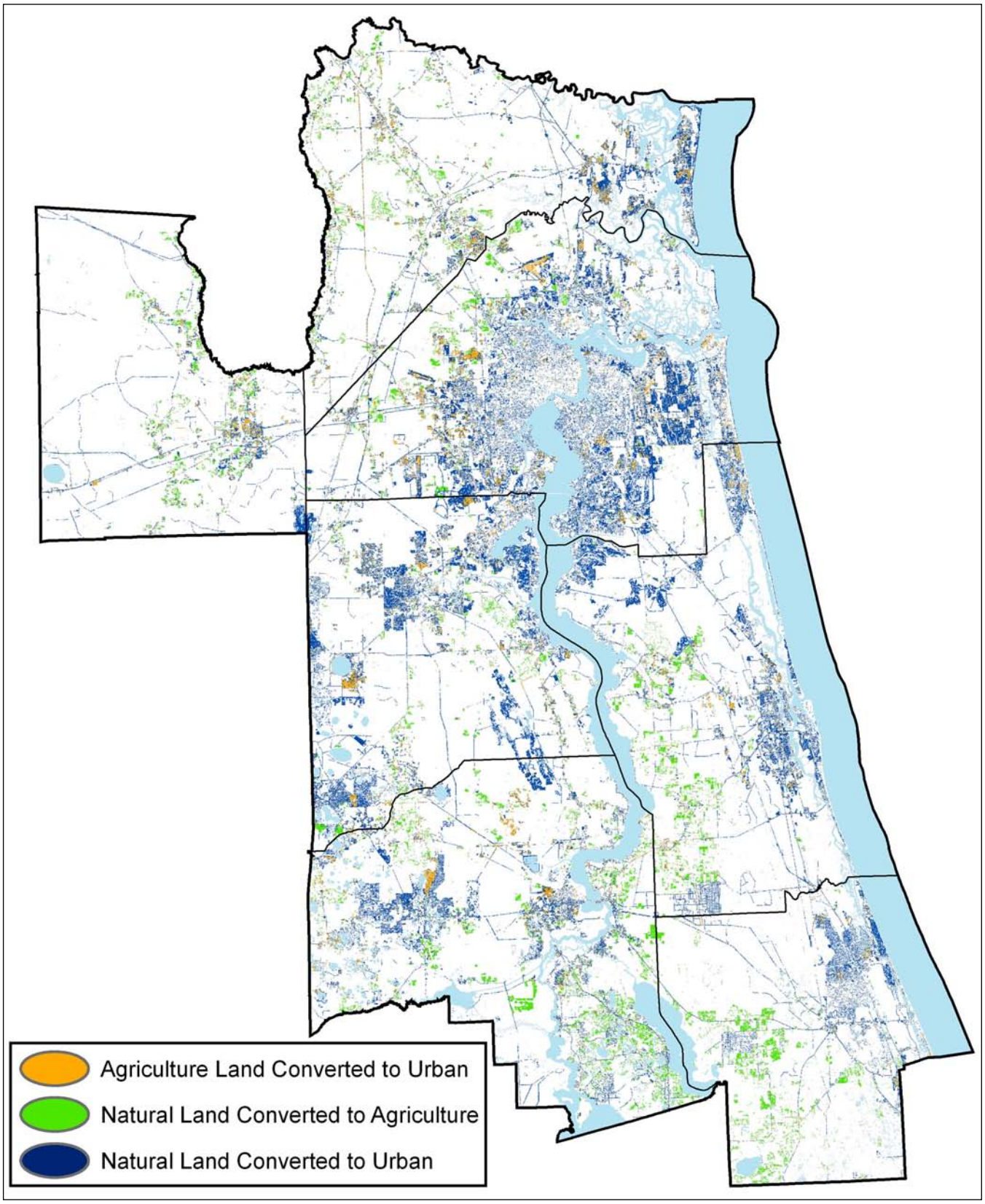

Figure 110 *Land-use conversion between 1985–1989 and 2003 in the Northeast Florida Regional Planning Council.*

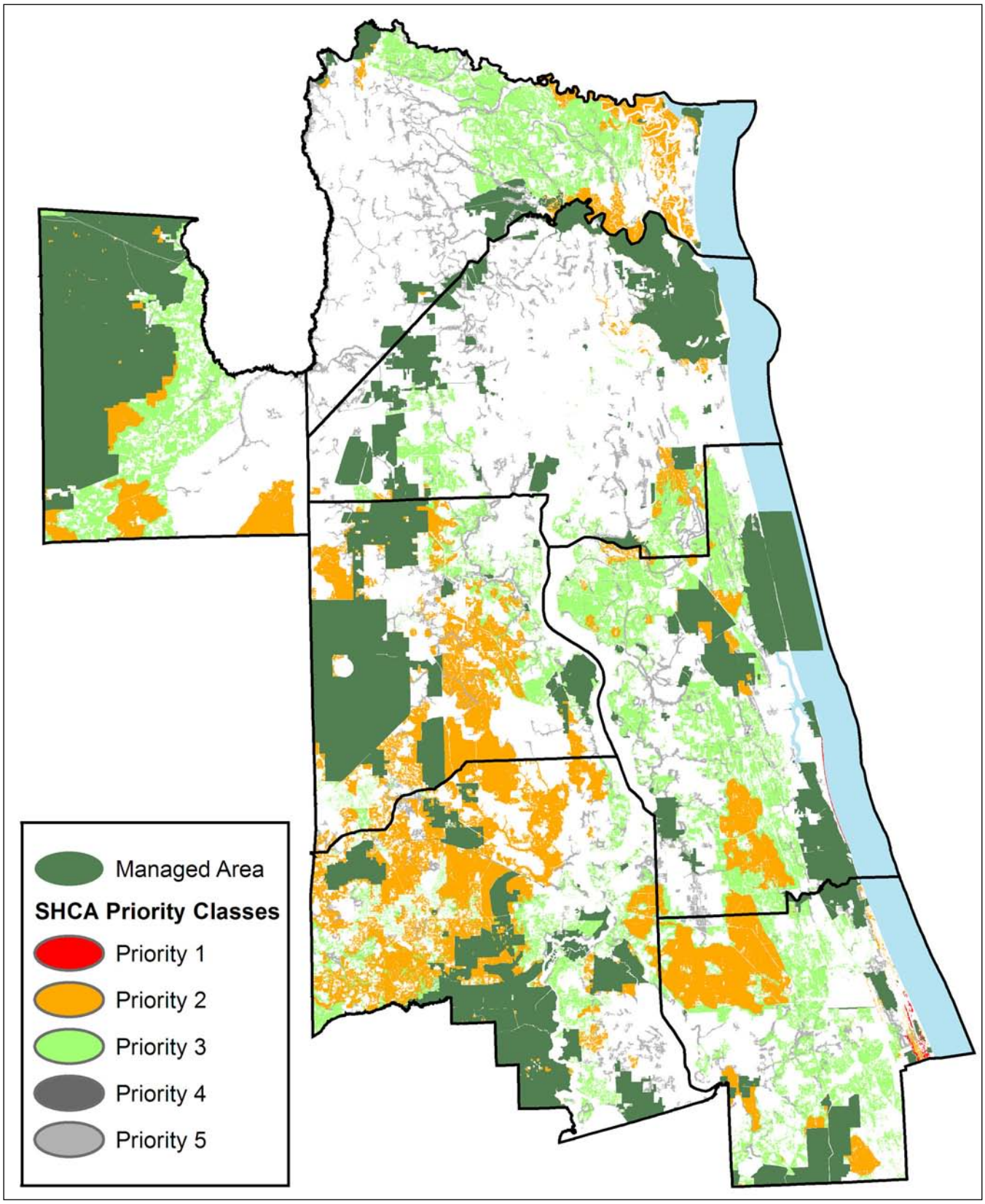

Figure 111 *Prioritized Strategic Habitat Conservation Areas for the Northeast Florida Regional Planning Council.*

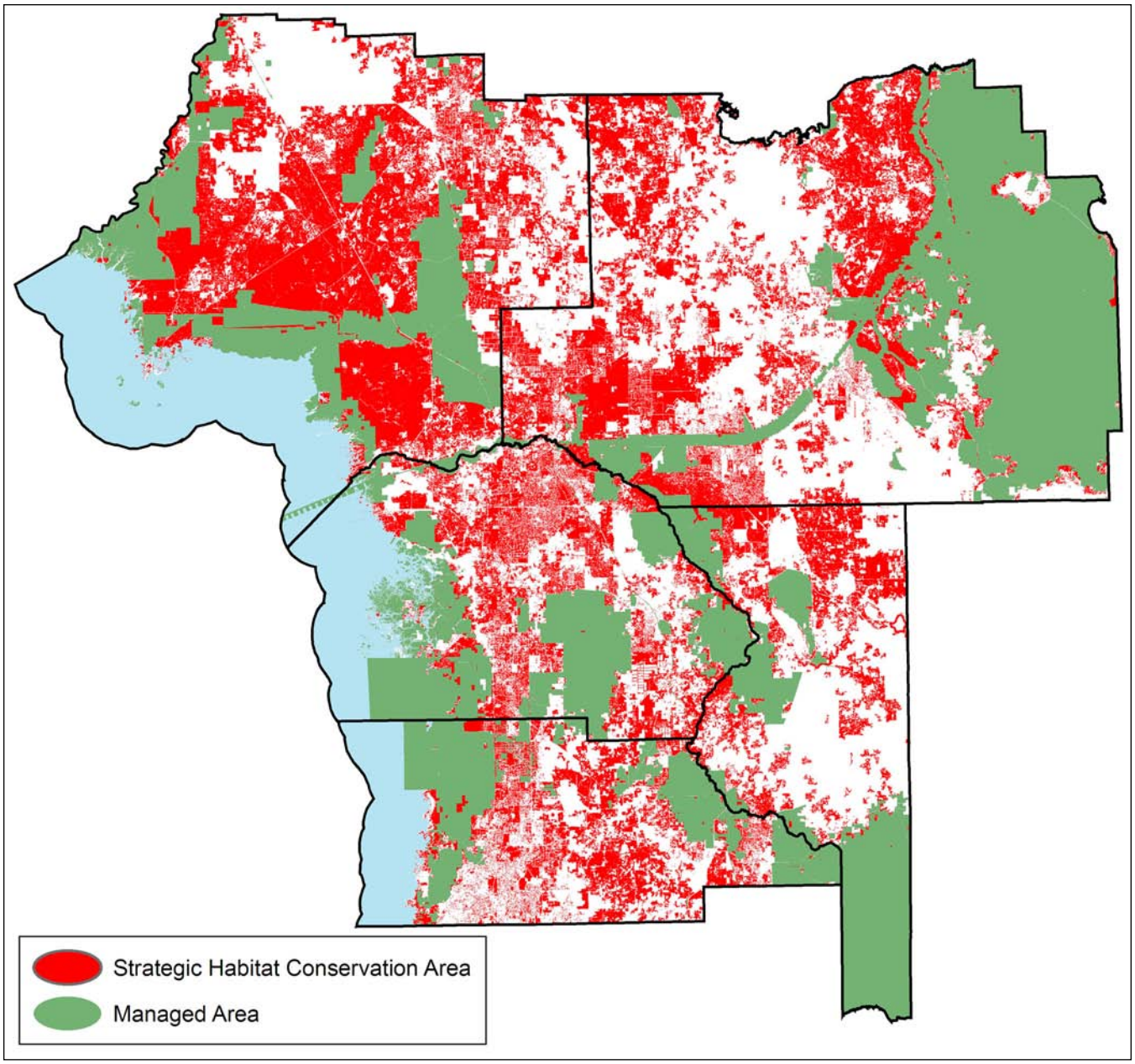

Figure 112 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the Withlacoochee Regional Planning Council.*

Withlacoochee Region

The Withlacoochee Region contains large tracts of priority conservation habitats such as sandhill and scrub. Although many tracts are currently protected—*e.g.*, the Cedar Key Scrub Preserve, Ocala National Forest, and Withlacoochee State Forest—others are vulnerable to habitat loss. Thirty percent of the Withlacoochee Region is managed for conservation (Table 14; Figure 112). In addition to the previously mentioned public lands, the region also contains the Green Swamp, Chassahowitzka Wildlife Management Area, Goethe State Forest, Waccasassa Bay Preserve State Park, Lower Suwannee and Chassahowitzka National Wildlife Refuges, Crystal River Preserve State Park, and numerous conservation easements. The coastline habitats in this region are well protected because nearly all the salt marsh and hardwood swamp are publicly owned.

Comparison of the 1985–1989 and 2003 land-cover images depicted that the region lost 7% of natural land cover to urban and agricultural land uses (Table 14; Figure 113). The human population in the region experienced a growth rate of 33.3% from 1990 to 2000, the largest population growth rate for any region in Florida

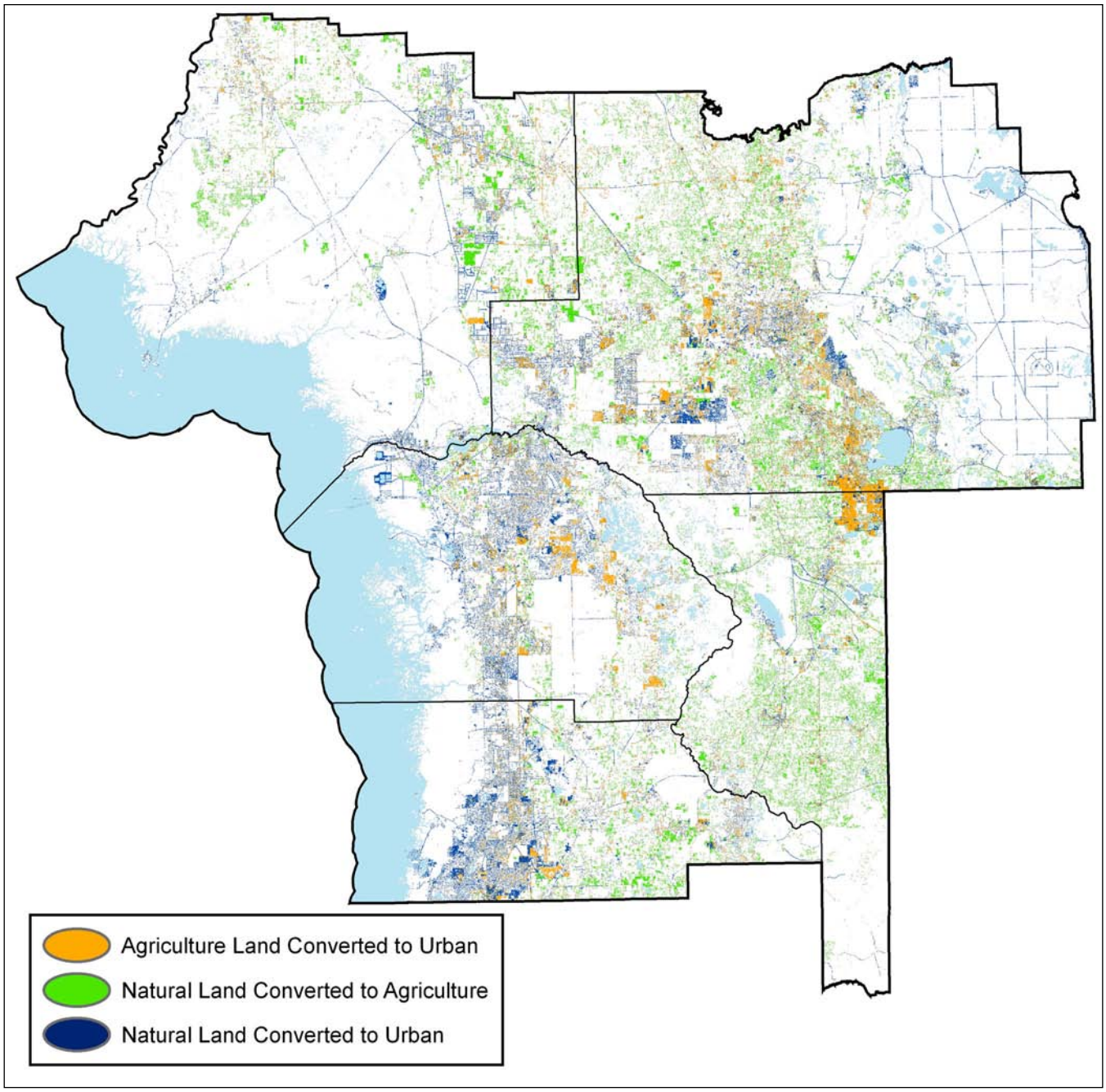

Figure 113 *Land-use conversion between 1985–1989 and 2003 in the Withlacoochee Regional Planning Council.*

(U.S. Census Bureau, 2006). The majority of urban conversion is evident in Hernando and Citrus counties along the U.S. 19 and Suncoast Parkway corridors. Similarly, the conversion of agricultural lands to urban land uses along the U.S. 441 corridor south of Ocala is the result of several newly established residential communities. Conversion of natural lands to agriculture is evident in eastern Levy, western Marion, eastern Hernando, and Sumter counties. Cattle ranching is the dominant agricultural practice and watermelon the primary crop, but peppers, squash, cucumbers, cantaloupes, and sweet corn are also farmed in the region. Additionally, the region is rich in timber and forest resources, and a well-established marine fishery is present along the coast.

Strategic Habitat Conservation Areas are identified throughout the entire region and encompass the full diversity of natural habitats (Figure 112). Twenty-eight percent of the region is identified as SHCA for 12 different species (Table 14). The only priority 1 SHCA are

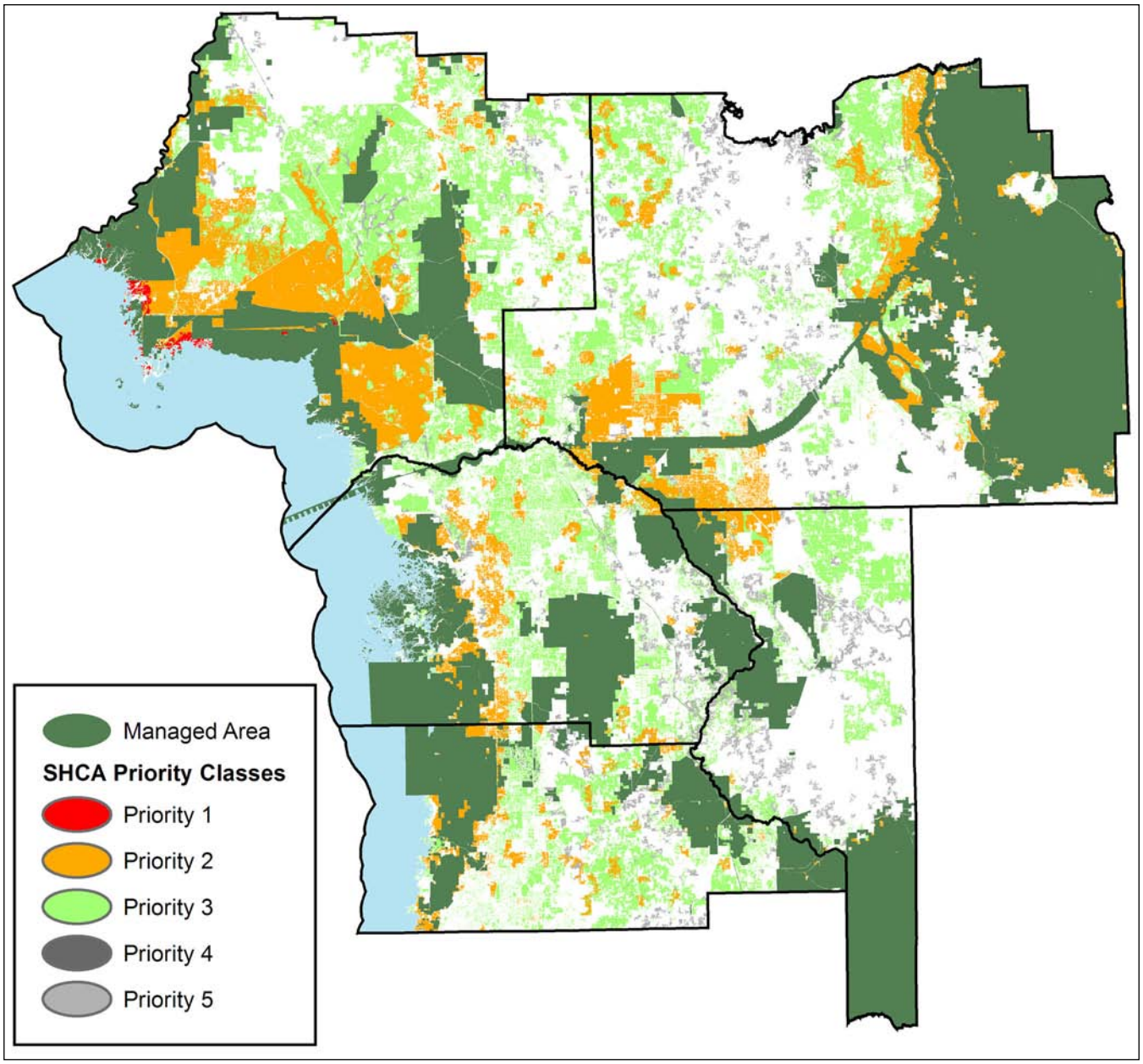

Figure 114 *Prioritized Strategic Habitat Conservation Areas for the Withlacoochee Regional Planning Council.*

identified for the Florida salt marsh vole; priority 2 SHCA have been identified for the Florida black bear, Florida Scrub-Jay, sand skink, Short-tailed Hawk, and striped newt (Figure 114). Nearly 18% of the region is identified as SHCA for the Swallow-tailed Kite alone. Strategic Habitat Conservation Areas identified for the Florida black bear include lands in proximity to Ocala National Forest, Chassahowitzka National Wildlife Refuge, and lands inland from Waccasassa Bay Preserve State Park and the Lower Suwannee National Wildlife Refuge. Many of the unprotected sandhill and scrub tracts are identified as SHCA for the Florida mouse, Florida Scrub-Jay, sand skink, and striped newt. Several tracts of improved pasture were identified as SHCA for Florida Burrowing Owls in the region. Hardwood swamps, hardwood hammocks, and mixed hardwood–pine forests in Levy County are identified as SHCA for the Short-tailed Hawk. Strategic Habitat Conservation Areas are identified for Cooper's Hawks throughout the entire region, and the unprotected salt marshes along the coast are identified as SHCA for the Florida salt marsh vole, Gulf salt marsh snake, and Scott's Seaside Sparrow. The SHCA identified for the Florida salt marsh vole include the original location where the vole was first discovered, which remains unprotected.

East-Central Florida Region

The East-Central Florida Region has experienced tremendous growth over the past half century, in part because of the establishment of Walt Disney World in 1971. Additionally, the region contains the cities of Orlando and Daytona Beach, making this region a world-class destination for tourism. Human population in this region increased 28.6% from 1990 to 2000, exceeding both the Florida average (23.5%) and the U.S. average (13.2%; U.S. Census Bureau, 2006). Despite the rapid growth of this region, it still contains many habitats important for wildlife. It contains extensive freshwater marshes and forested wetlands, the upper St. Johns River system, and large areas of native dry prairie. More than 24% of this region is publicly owned, including Merritt Island National Wildlife Refuge, Canaveral National Seashore, Lake Woodruff National Wildlife Refuge, Lake George State Forest, Three Lakes Wildlife Management Area, portions of Ocala National Forest, and numerous protected lands along the St. Johns River (Table 14; Figure 115). Slightly more than 22% of the total land area of the East-Central Florida Region is identified as SHCA.

Comparisons of the FWC 1985–1989 and 2003 land-cover images showed that the East-Central Florida Region has lost more natural land cover (over 12%) to urban and agricultural uses than any other region (Table 14; Figure 116). The majority of lands converted to urban uses were in the greater Orlando area, including the communities of Deltona, Sanford, the entire Central Florida Greenway corridor (Route 417), and areas surrounding the various theme parks southwest of Orlando. Urban development is also prominent around the coastal cities of Daytona Beach, Cocoa, and Melbourne/Palm Bay. Conversion to agriculture is prominent throughout the entire region west of the St. Johns River. Much of the agriculture in this region is in the form of citrus groves, cattle pasture, and plant nurseries.

Strategic Habitat Conservation Areas identified in this region encompassed habitats needed for the Atlantic salt marsh snake, Florida Burrowing Owl, Cooper's Hawk, Florida black bear, Florida mouse, Florida Scrub-Jay, Florida Grasshopper Sparrow, sand skink, Short-tailed Hawk, Florida Snail Kite, southeastern beach mouse, striped newt, and Swallow-tailed Kite (Figure 115). Priority 1 SHCA are identified for the Atlantic salt marsh snake, Florida Grasshopper Sparrow, and southeastern beach mouse (Figure 117). Priority 2 SHCA are identified for the Florida black bear, Florida Scrub-Jay, Florida Snail Kite, sand skink, Short-tailed Hawk, and striped newt (Figure 117). Large blocks of improved pasture and dry prairie were identified as SHCA for the Florida Burrowing Owl and Short-tailed Hawk. These SHCA could provide opportunities for agreements with landowners that would allow them to carry out their land-use activities while protecting and conserving the habitat requirements for these species. Freshwater marsh/wet prairie and cypress swamp were identified as SHCA for the endangered Florida Snail Kite throughout the southern half of the region. The Florida Snail Kite has experienced significant population declines in Florida (Martin *et al.*, 2006), and additional habitat protection would help reduce these declines. The East-Central Florida Region contains the majority of SHCA for the endangered Atlantic salt marsh snake.

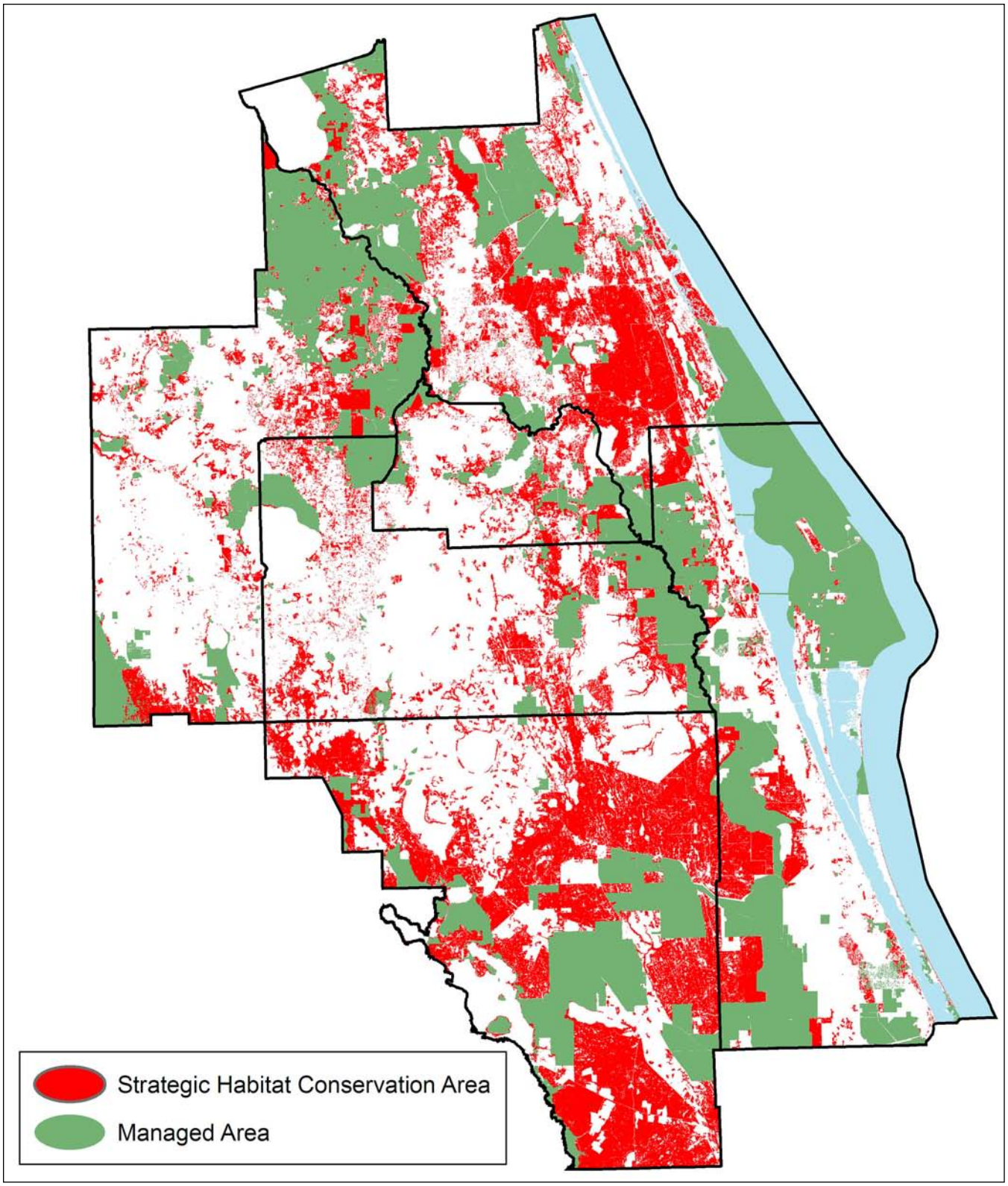

Figure 115 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the East-Central Florida Regional Planning Council.*

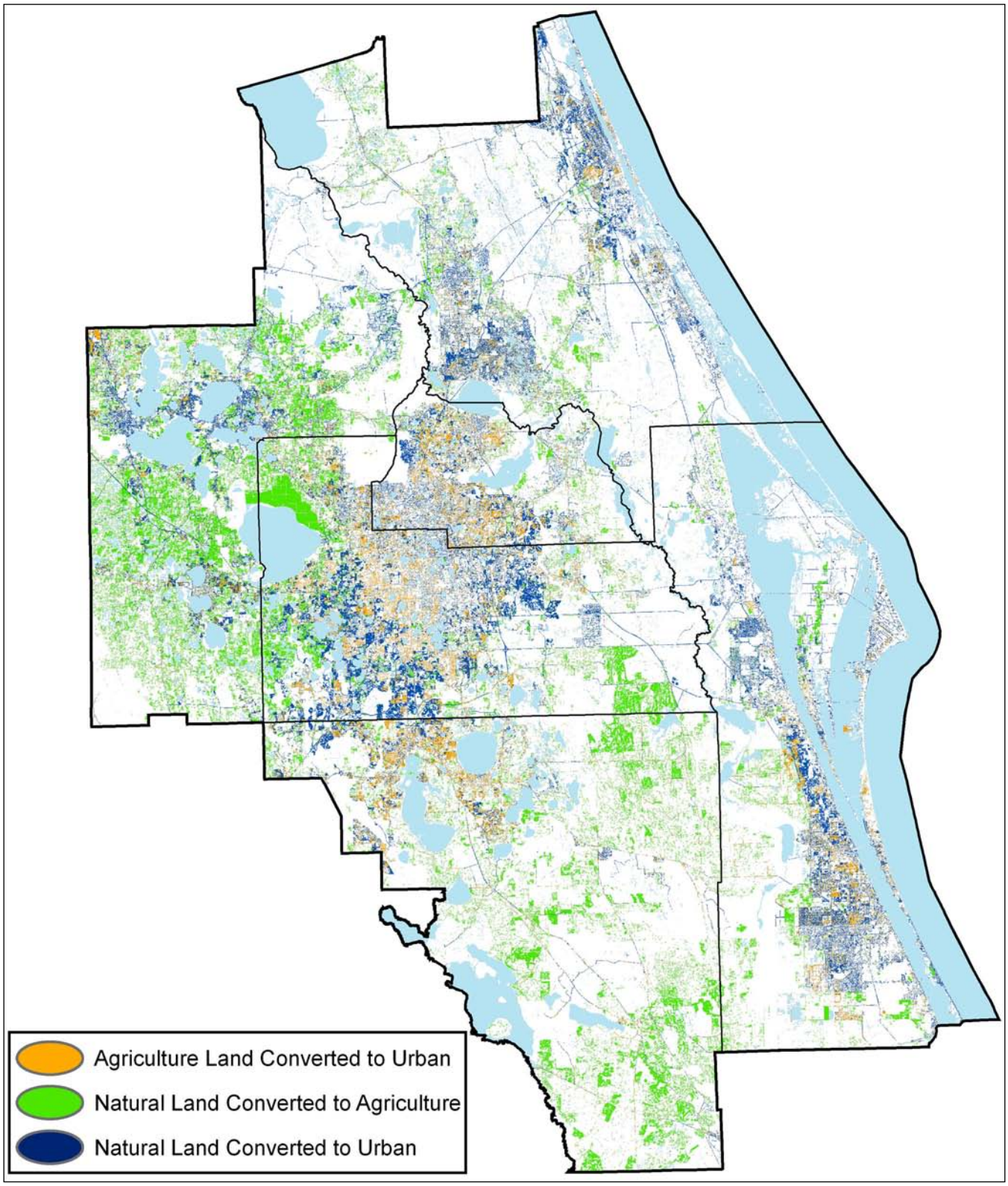

Figure 116 *Land-use conversion between 1985–1989 and 2003 in the East-Central Florida Regional Planning Council.*

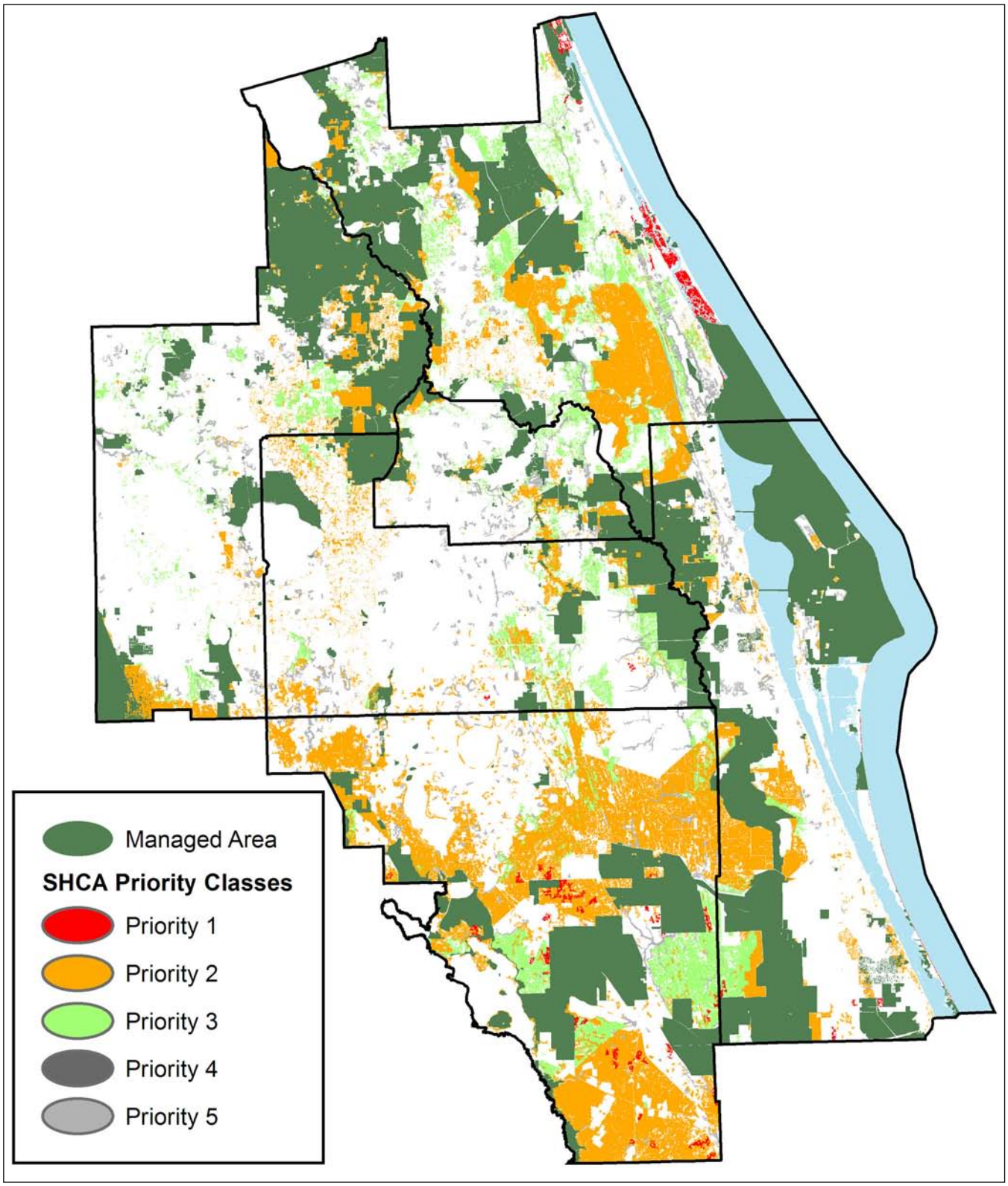

Figure 117 *Prioritized Strategic Habitat Conservation Areas for the East-Central Florida Regional Planning Council.*

Tampa Bay Region

Although the Tampa Bay Region does not contain any of the large public land areas found in Florida, 15% of the region is managed for conservation (Table 14; Figure 118). Portions of the Green Swamp, Withlacoochee State Forest, numerous state parks, and many lands managed by the Southwest Florida Water Management District are in the Tampa Bay Region. Like many regions in the state, the Tampa Bay Region has experienced tremendous growth in human population. The region's population grew 16.1% from 1990 to 2000, exceeding the national average of 13.2% but below the state average of 23.5% (U.S. Census Bureau, 2006).

At 12%, the Tampa Bay Region is second in terms of natural areas lost to agriculture and urban land uses (Table 14; Figure 119). Conversion to urban use is evident along the corridors of U.S. 19 in Pasco County and along the Suncoast Parkway by the growth of Tampa out into agricultural areas and by the growth of the metropolitan areas of Bradenton and Sarasota in Manatee and Sarasota counties. Conversion to agriculture is most evident by the mix of rangeland for cattle, citrus, and vegetable crops in rural Manatee and southern Hillsborough counties. Additionally, central Pasco County experienced conversion of natural areas to agriculture, much of it converted to improved pasture.

Nearly 14% of the region is identified as SHCA (Table 14; Figure 118). Strategic Habitat Conservation Areas for the Florida Burrowing Owl, Cooper's Hawk, Short-tailed Hawk, and Swallow-tailed Kite account for the majority of SHCA, but the Cuban Snowy Plover, Florida black bear, Florida mouse, Florida Scrub-Jay, Mangrove Cuckoo, Scott's Seaside Sparrow, and striped newt also have SHCA identified in this region. Priority 1 SHCA are identified only for the Florida Grasshopper Sparrow; priority 2 SHCA are identified for the Cuban Snowy Plover, Florida black bear, Florida Scrub-Jay, Short-tailed Hawk, and striped newt (Figure 120). The SHCA identified for the Cuban Snowy Plover in this region encompass a major population area for this species and one that faces significant threats by humans. The beach and dune habitats used by plovers are also those areas widely sought by humans for recreation. Freedom from disturbance and additional protection of plover nesting sites are needed to ensure the viability of this species in Florida.

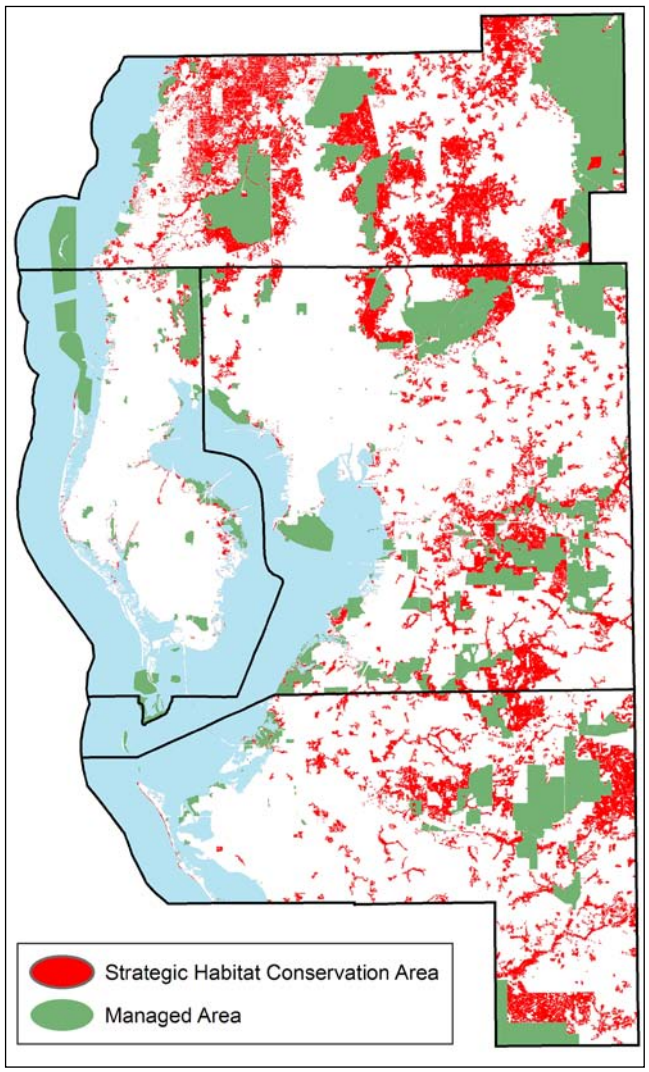

Figure 118 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the Tampa Bay Regional Planning Council.*

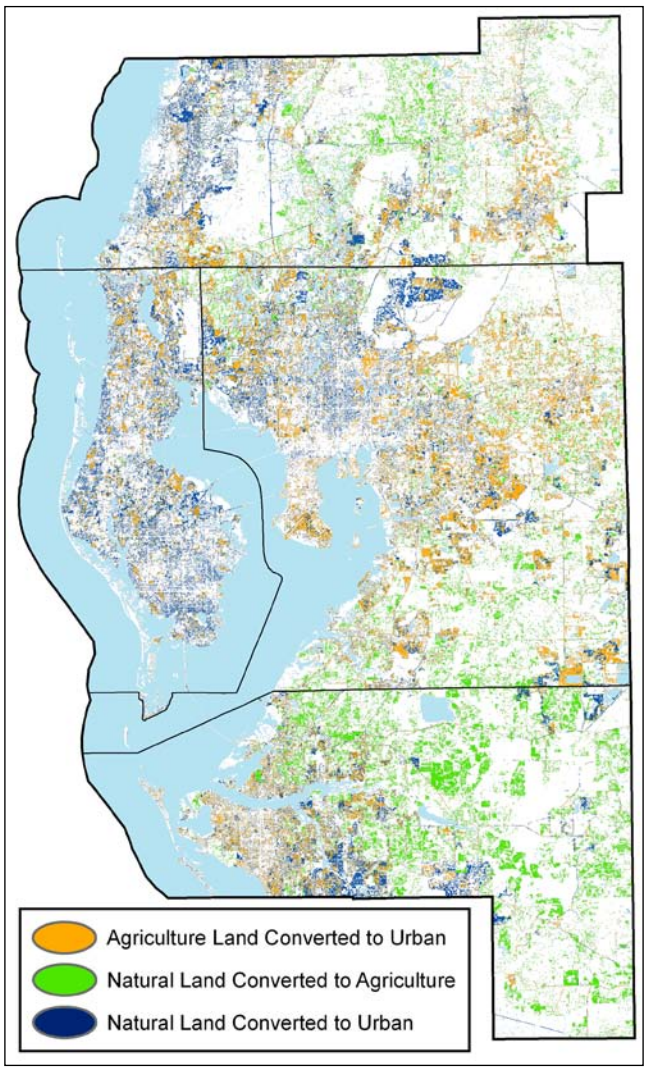

Figure 119 *Land-use conversion between 1985–1989 and 2003 in the Tampa Bay Regional Planning Council.*

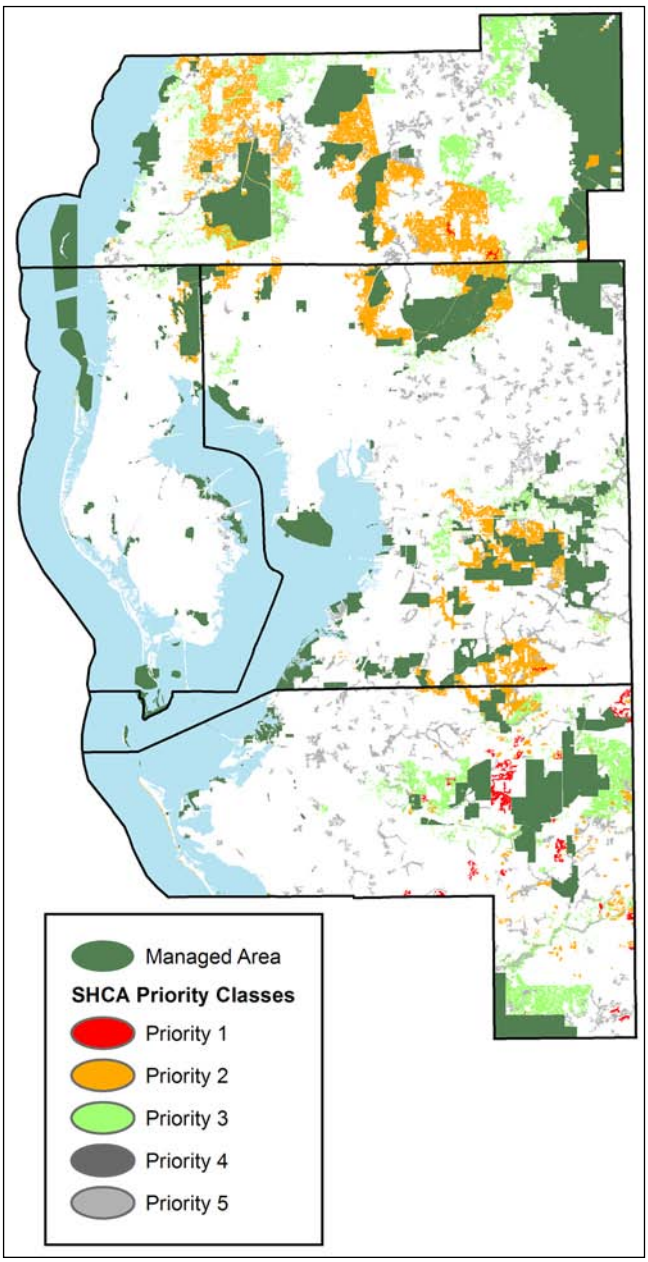

Figure 120 *Prioritized Strategic Habitat Conservation Areas for the Tampa Bay Regional Planning Council.*

Central Florida Region

The Central Florida Region includes one of the smallest percentages of managed lands (15%) in the state and the largest percentage of lands identified as SHCA (27%; Table 14; Figure 121). Only the North-Central Florida Region has a lower percentage of managed lands (12%). Because the region contains some biologically rich areas that support many of Florida's endemic species, it is not unexpected that a large percentage of the region has been identified as SHCA. The many geological ridges found in this region, such as the Lake Wales, Winter Haven, and Lakeland ridges, contain some of the last remaining scrub habitats in the state. Managed lands in the region include Avon Park Air Force Range, Lake Kissimmee and Kissimmee Prairie Preserve state parks, Lake Wales Ridge State Forest, and portions of Hilochee Wildlife Management Area. Additionally, numerous conservation easements have been established in this region.

At 21.9%, the region experienced a change in population slightly less than the state average (23.5%), but this change greatly exceeded the U.S. average (13.2%; U.S. Census Bureau, 2006). Comparison of the FWC 1985–1989 and 2003 land-cover images revealed that 11% of the natural land cover present in the 1985–1989 land cover had been converted to urban or agricultural uses by 2003 (Table 14; Figure 122). The majority of this loss (8%) was most evident in DeSoto and Highlands counties, where formerly natural land cover often now supports agricultural uses such as citrus and rangeland for cattle. The majority of natural-land conversion to urban use has occurred around the cities of Lakeland, Avon Park/Sebring, Okeechobee, and along the U.S. 17 corridor.

Strategic Habitat Conservation Areas identified in this region encompasses habitats needed for the Florida Burrowing Owl, Cooper's Hawk, Florida black bear, Florida mouse, Florida Scrub-Jay, Florida Grasshopper Sparrow, sand skink, Short-tailed Hawk, Florida Snail Kite, and Swallow-tailed Kite (Figure 121). Priority 1 SHCA species in this region is only the Florida Grasshopper Sparrow; priority 2 SHCA species include the Florida black bear, Florida Scrub-Jay, sand skink, Short-tailed Hawk, and Florida Snail Kite (Figure 123). The Central Florida Region contains the majority of SHCA identified for the Florida Grasshopper Sparrow, an endangered species with very specific habitat requirements. Strategic Habitat Conservation Areas identified for the Florida Burrowing Owl and Short-tailed Hawk include large blocks of improved pasture and dry prairie in Okeechobee and Highlands counties. Perhaps all that is needed for many of these agricultural areas would be agreements with landowners that would allow them to carry out their normal activities on the land but protect and conserve the areas used by wildlife. Numerous habitats associated with the Kissimmee chain of lakes in this region have been identified as SHCA for the endangered Florida Snail Kite. This species has been experiencing progressive and dramatic population decreases (Martin *et al.,* 2006), and additional habitat protection for Florida Snail Kites would help in the recovery of this species. Any scrub sites available for protection should be acquired, because this would provide additional protection to Florida Scrub-Jays, Florida mice, sand skinks, and other scrub-dependent wildlife and plants.

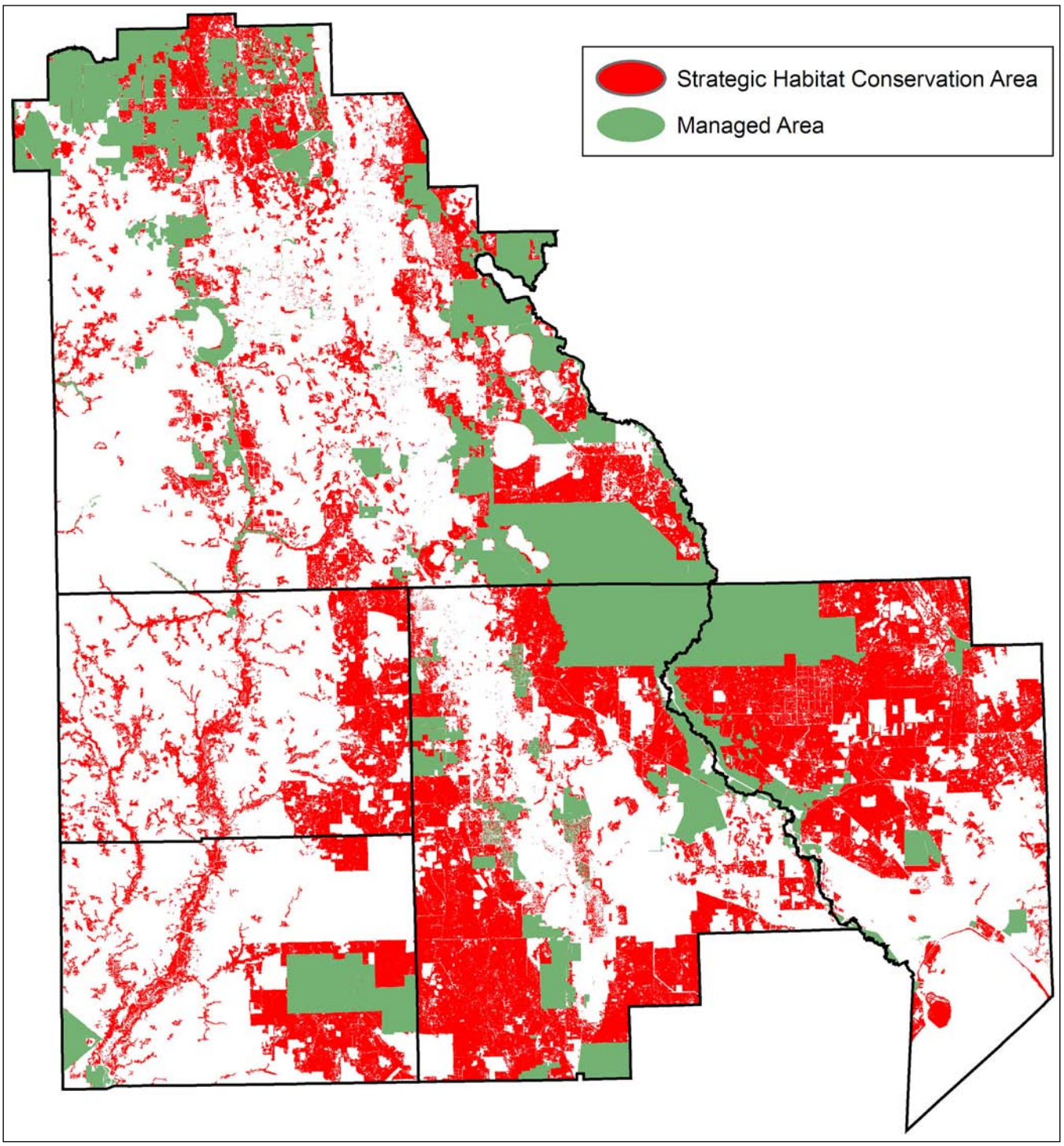

Figure 121 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the Central Florida Regional Planning Council.*

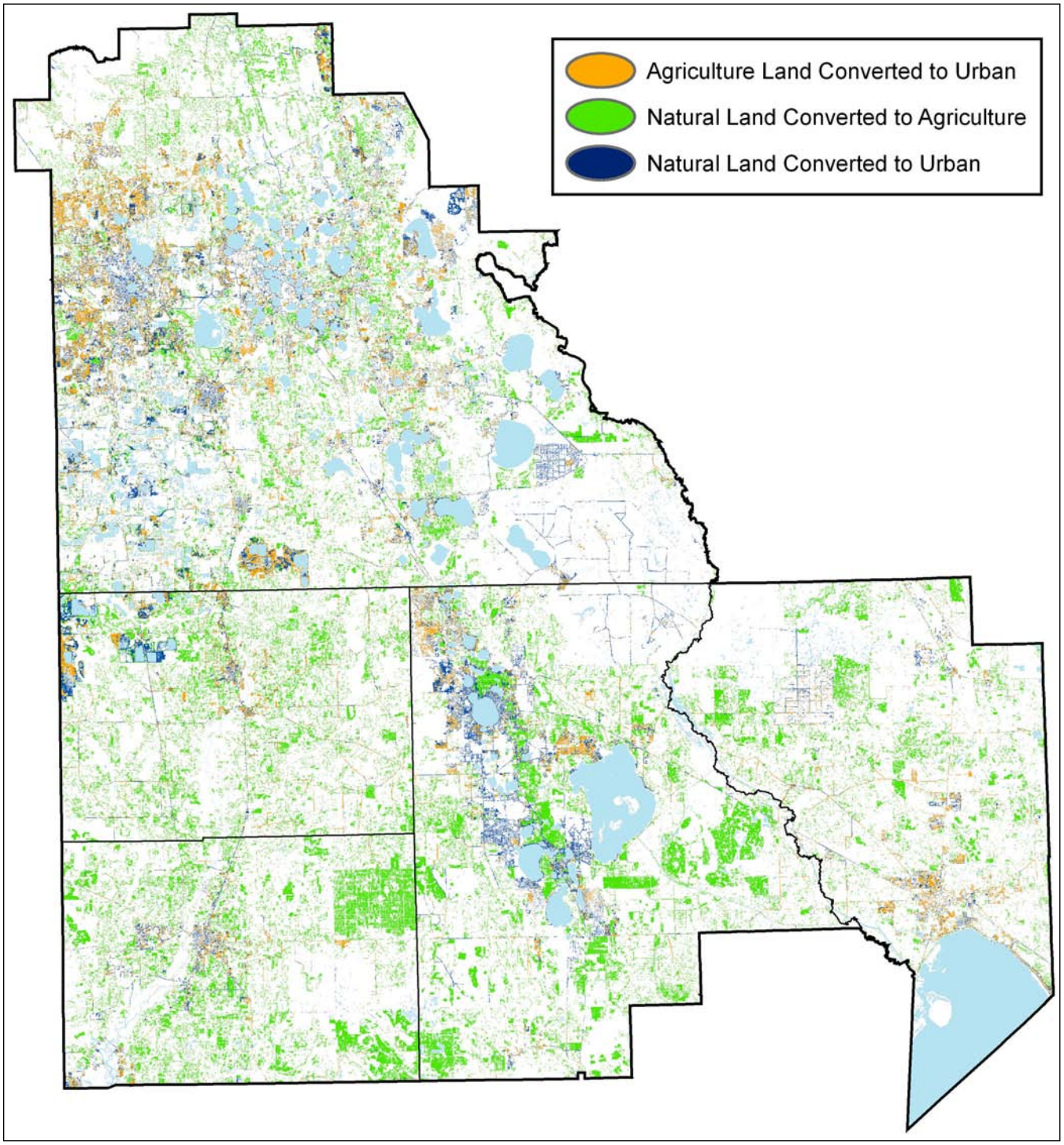

Figure 122 *Land-use conversion between 1985–1989 and 2003 in the Central Florida Regional Planning Council.*

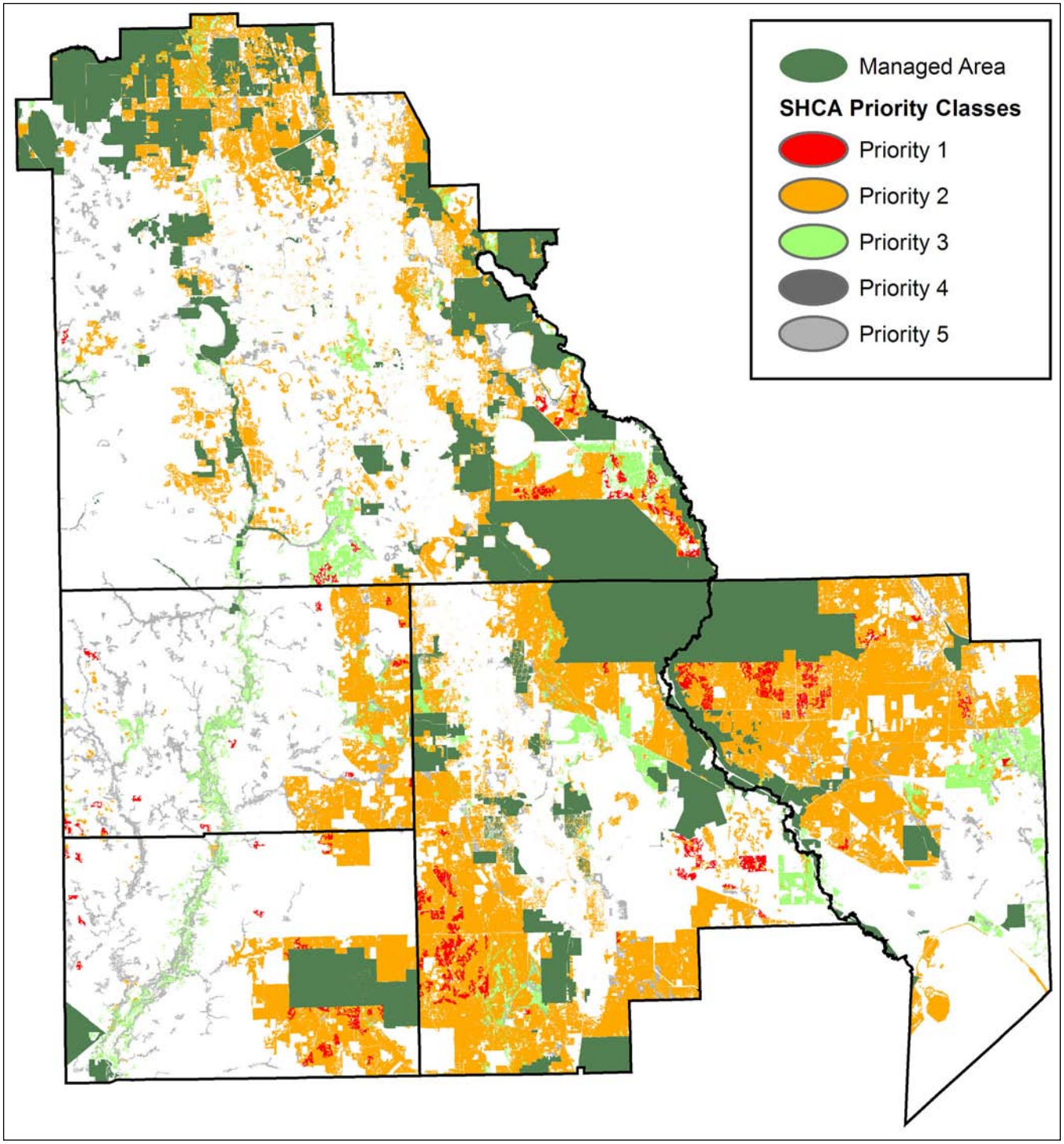

Figure 123 *Prioritized Strategic Habitat Conservation Areas for the Central Florida Regional Planning Council.*

Treasure Coast Region

The Treasure Coast Region includes large portions of land that have been converted to urban and agricultural uses. This region contains the majority of the intensive agriculture zone south of Lake Okeechobee, a large portion of land dedicated for citrus, and one of the most rapidly expanding human populations in Florida and the nation, yet many biologically important areas are found in this region. Twenty-seven percent of the Treasure Coast Region is managed (Table 14). Many of these areas are water-conservation areas that protect south Florida's freshwater supply and buffer the effects of regional urban development on the Everglades. Some of the public lands include the Loxahatchee National Wildlife Refuge; Holey Land, Rotenberger, and J. W. Corbett wildlife management areas; Loxahatchee Slough State Preserve; Jonathan Dickinson State Park; St. Sebastian River State Park; Allapattah Flats State Preserve; and Blue Cypress Conservation Area (Figure 124).

Land-use change analysis shows that 7.5% of the natural lands in the area were converted to urban or agricultural uses between 1985–1989 and 2003 (Table 14). Urban development is evident along the entire coastline of the region but is most pronounced in the metropolitan areas of West Palm Beach, Port St. Lucie, and Vero Beach (Figure 125). The city of West Palm Beach has grown westward to support an increasing population, and in Palm Beach County, little area now remains for urban development. From 1990 to 2000, the Treasure Coast Region's population grew 29.8%, which is more than double the national average of 13.2% and well over the state average of 23.5% (U.S. Census Bureau, 2006). The city of Port St. Lucie had a growth rate of 60% in the 1990s and continues to expand. It had the nation's fastest growth rate among large cities (100,000 or more population) between July 1, 2003, and July 1, 2004 (U.S. Census Bureau, 2006). Natural-land conversion to agriculture has mostly affected dry prairie and pineland that were converted to citrus in the central parts of Indian River, St. Lucie, and Martin counties.

Strategic Habitat Conservation Areas encompass just under 5% of the region and are identified principally in Indian River and Martin counties, with smaller amounts in St. Lucie and West Palm Beach counties (Figure 124). Priority 1 SHCA are identified for the Florida Grasshopper Sparrow, Florida panther, and Southeastern beach mouse; priority 2 SHCA species include the Florida black bear, Florida Scrub-Jay, Florida Snail Kite, and Short-tailed Hawk (Figure 126). In Indian River County, there is a large Strategic Habitat Conservation Area just west of Fort Drum Marsh Conservation Area containing a mix of improved pasture, dry prairie, pineland, cypress, and hardwood swamp. This area has SHCA identified for the Short-tailed Hawk, Florida Burrowing Owl, Cooper's Hawk, Florida Snail Kite, and Florida Grasshopper Sparrow. A ridge-and-dune formation that was once a shoreline in the Pleistocene and Holocene epochs extends from southwestern St. Lucie County to northeastern Martin County. This area is now dominated by improved pasture but also has scrub, dry prairie, and a mix of wet-

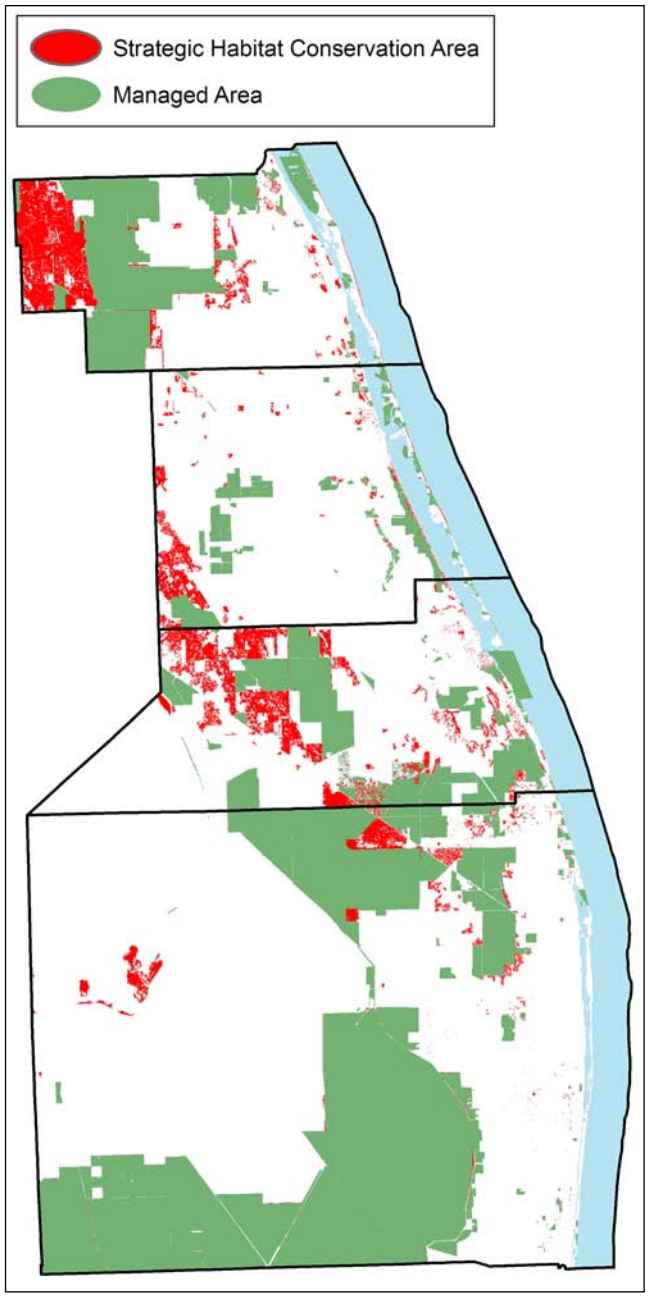

Figure 124 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the Treasure Coast Regional Planning Council.*

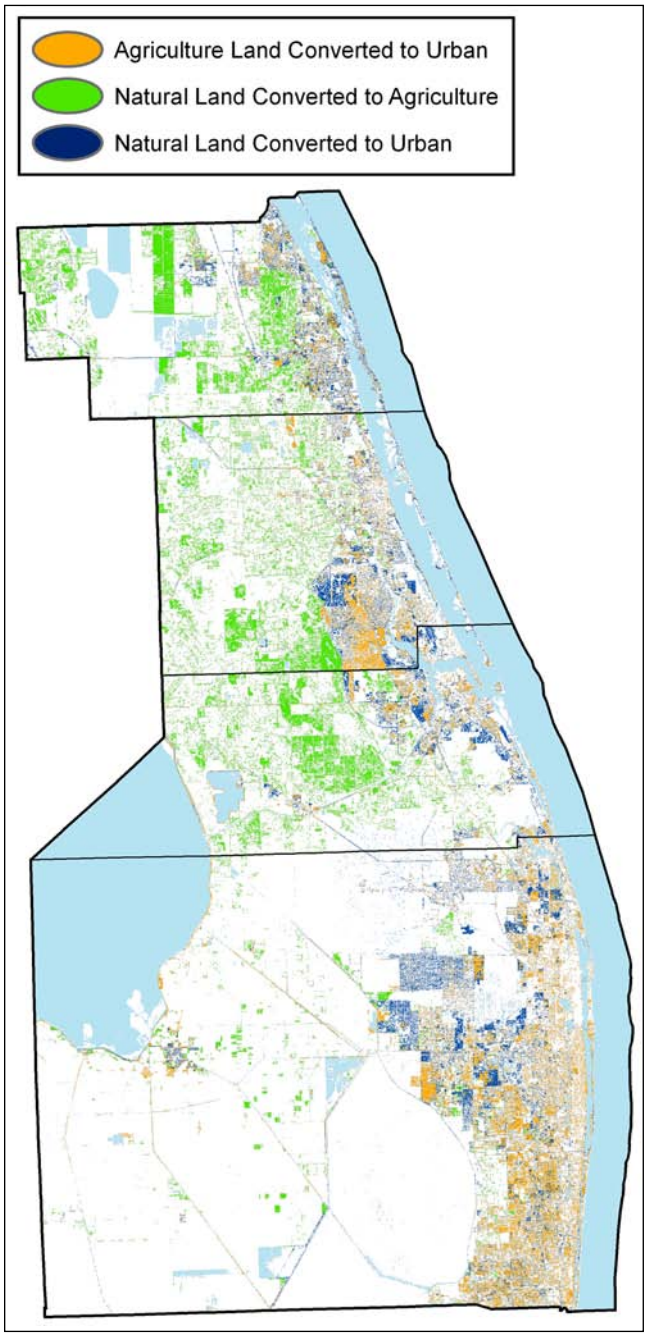

Figure 125 *Land-use conversion between 1985–1989 and 2003 in the Treasure Coast Regional Planning Council.*

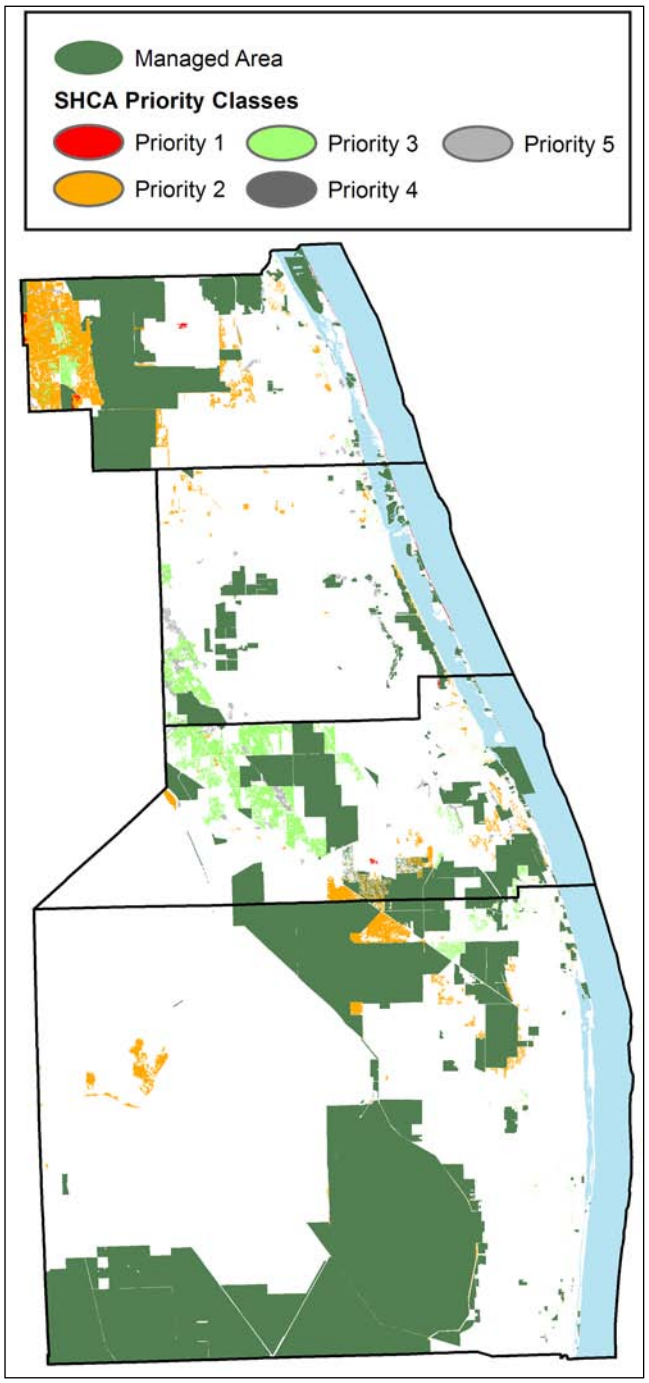

Figure 126 *Prioritized Strategic Habitat Conservation Areas for the Treasure Coast Regional Planning Council.*

land habitats in lower-lying areas. Along this formation, SHCA exist for the Florida mouse, Florida Burrowing Owl, Cooper's Hawk, and Florida Snail Kite. Dry prairie in central Indian River County along the I-95 corridor and coastal scrub throughout the entire region compose SHCA for the Florida Scrub-Jay. The SHCA identified for the Florida black bear are a component of a large block of contiguous habitat in and around J. W. Corbett Wildlife Management area. This area currently does not have Florida black bears present, but it is an appropriate size and type to support them should relocation to this site ever be considered. Beach habitats along the coast of Indian River, St. Lucie, and Martin counties are SHCA for the Southeastern beach mouse.

Southwest Florida Region

The Southwest Florida Region has experienced tremendous population growth in the past decade. From 1990 to 2000, the counties in the region experienced an average population growth of 32.7%; the U.S. average was 13.2% and the Florida average was 23.5% (U.S. Census Bureau, 2006). The Southwest Florida Region contains the only Florida panther population in the state, a population of Florida black bears, Florida Sandhill Cranes, rice rats, Florida Burrowing Owls, many wading-bird colonies, and the greatest concentration of Crested Caracaras in the United States. It is imperative that the rapid urban expansion (and subsequent fragmentation of natural areas) not come at the expense of wildlife. Currently 31% of the Southwest Florida Region is managed (Table 14). Some of the larger public lands in the region are the Big Cypress National Preserve, Fakahatchee Strand, Dinner Island and Babcock-Webb wildlife management areas, Fisheating Creek, Myakka River State Park, Charlotte Harbor Preserve State Park, and Rookery Bay National Estuarine

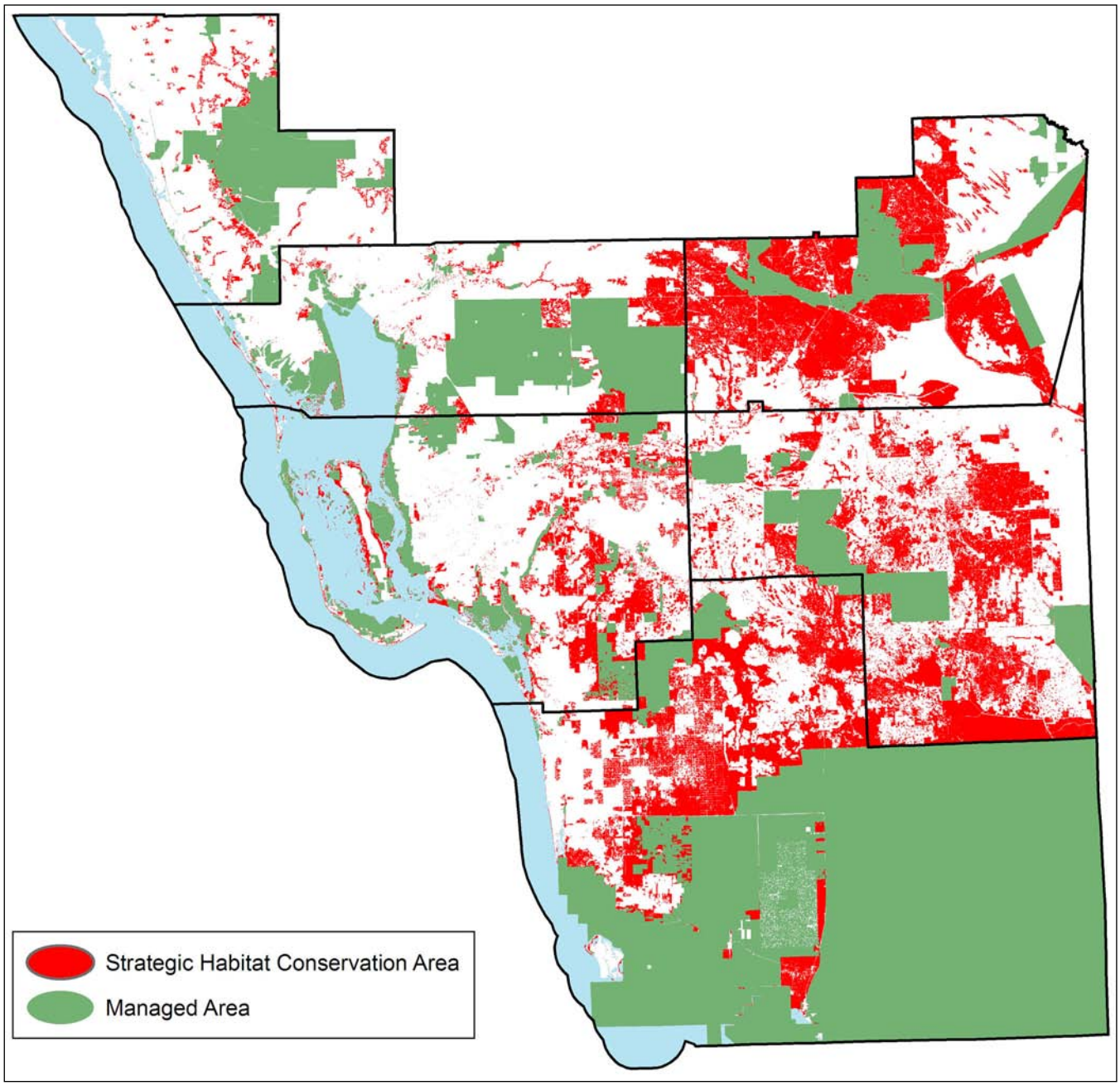

Figure 127 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the Southwest Florida Regional Planning Council.*

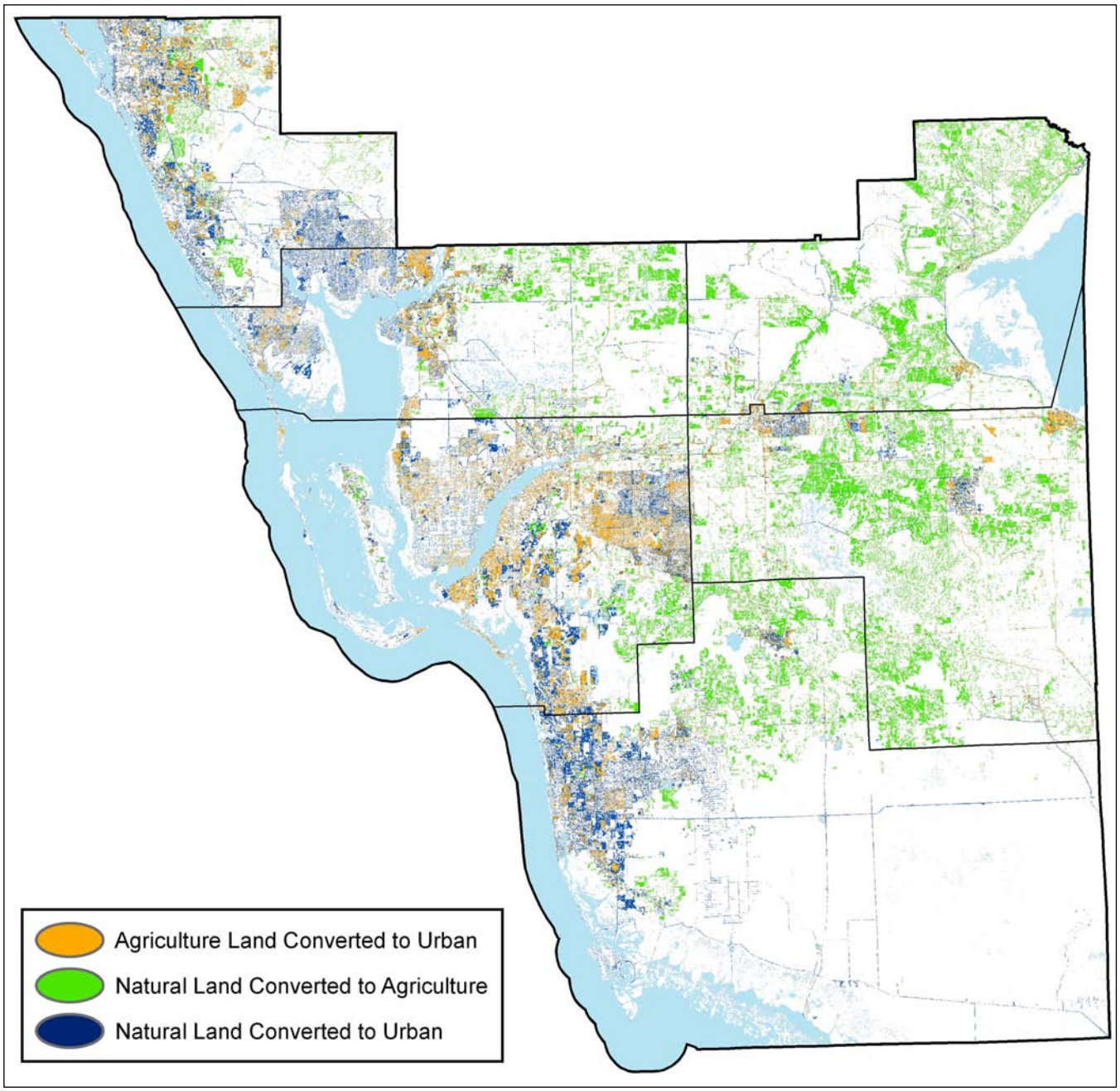

Figure 128 *Land-use conversion between 1985–1989 and 2003 in the Southwest Florida Regional Planning Council.*

Research Reserve (Figure 127). With the recent purchase of the Babcock Ranch, the region has gained an additional 29,540 ha of public ownership. This purchase will be a key component in expanding the range of the panther north of the Caloosahatchee River.

The Southwest Florida Region has lost 9% of its natural areas to urban and agriculture development in the past 14–18 years (Table 14; Figure 128). This was calculated by comparing the FWC 1985–1989 land-cover image with the FWC 2003 land cover. The urban expansion is evident around all of the major metropolitan coastal communities. Naples, Ft. Myers/Lehigh Acres area, and Port Charlotte/Punta Gorda areas in particular reveal substantial urbanization. The conversion of natural lands to agriculture has been extensive in Glades, Hendry, eastern Charlotte, and northern Collier counties. Much of this conversion was from dry prairie to improved pasture and to citrus groves.

Eighteen percent of the Southwest Florida Region is identified as SHCA for 14 different species (Table 14). Priority 1 SHCA are identified for the American crocodile, Florida Grasshopper Sparrow, Florida panther,

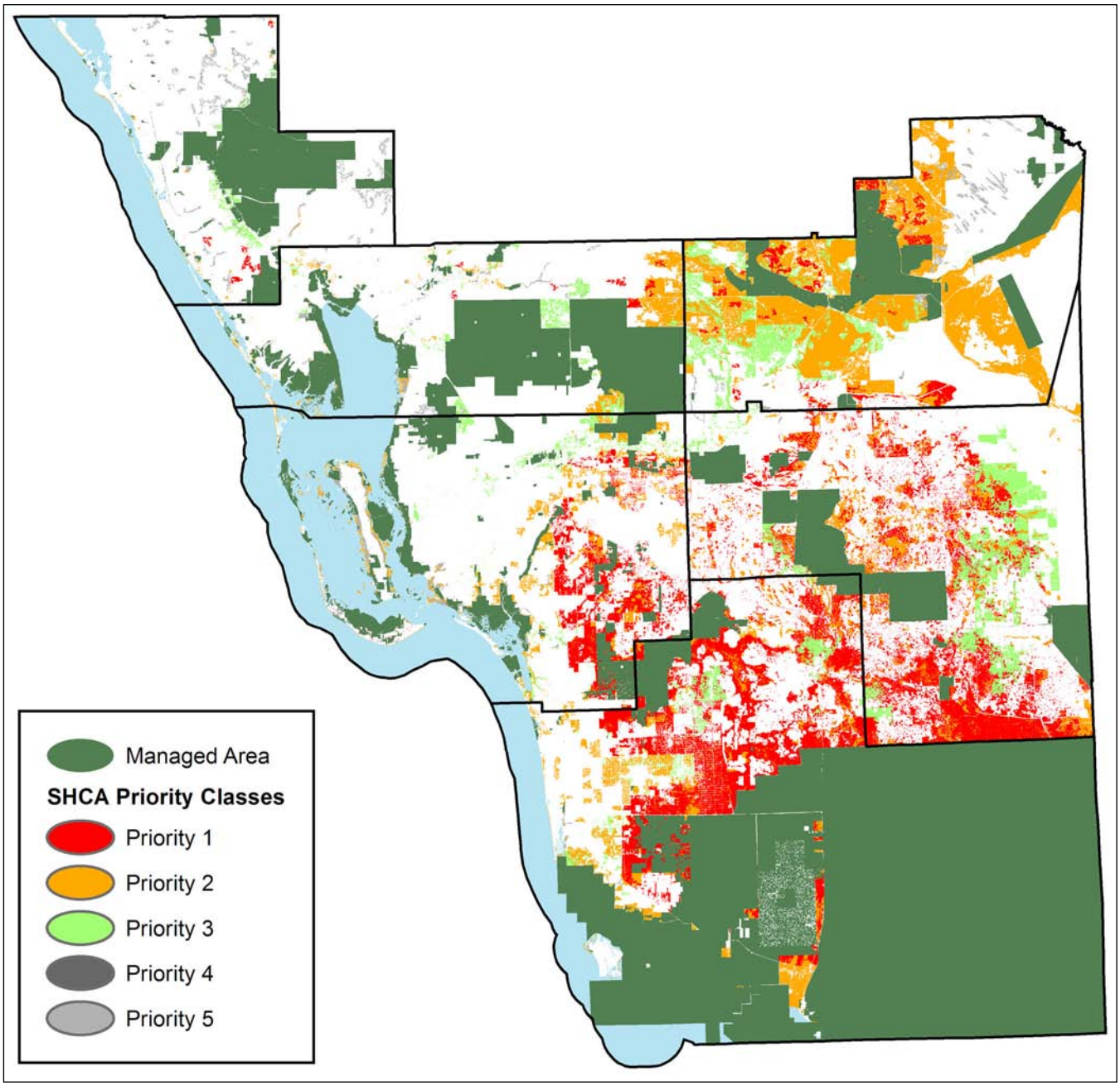

Figure 129 *Prioritized Strategic Habitat Conservation Areas for the Southwest Florida Regional Planning Council.*

and Sanibel Island rice rat; priority 2 SHCA species include the Big Cypress fox squirrel, Cuban Snowy Plover, Florida black bear, Florida Scrub-Jay, Florida Snail Kite, and Short-tailed Hawk (Figure 129). The remaining species with SHCA in this region are the Cooper's Hawk, Florida Burrowing Owl, Mangrove Cuckoo, and Swallow-tailed Kite (Figure 127). The SHCA identified for the Big Cypress fox squirrel and Sanibel Island rice rat occurs only in this region. Lands identified as SHCA for the Florida panther comprise the bulk of unprotected habitats within the core areas used by panthers in the state. In addition to the Florida panther, many of these areas are also identified as SHCA for the Florida black bear and Swallow-tailed Kite. In the eastern half of the region, wetland habitats used by the Florida Snail Kite are identified as SHCA. Throughout the region, unprotected dry prairie habitat is identified as SHCA for the Florida Burrowing Owl and Florida Grasshopper Sparrow. This region encompasses the southern extent of the Cuban Snowy Plover in Florida, and the remaining undeveloped Beach and Coastal Strand habitats are identified as SHCA for this species.

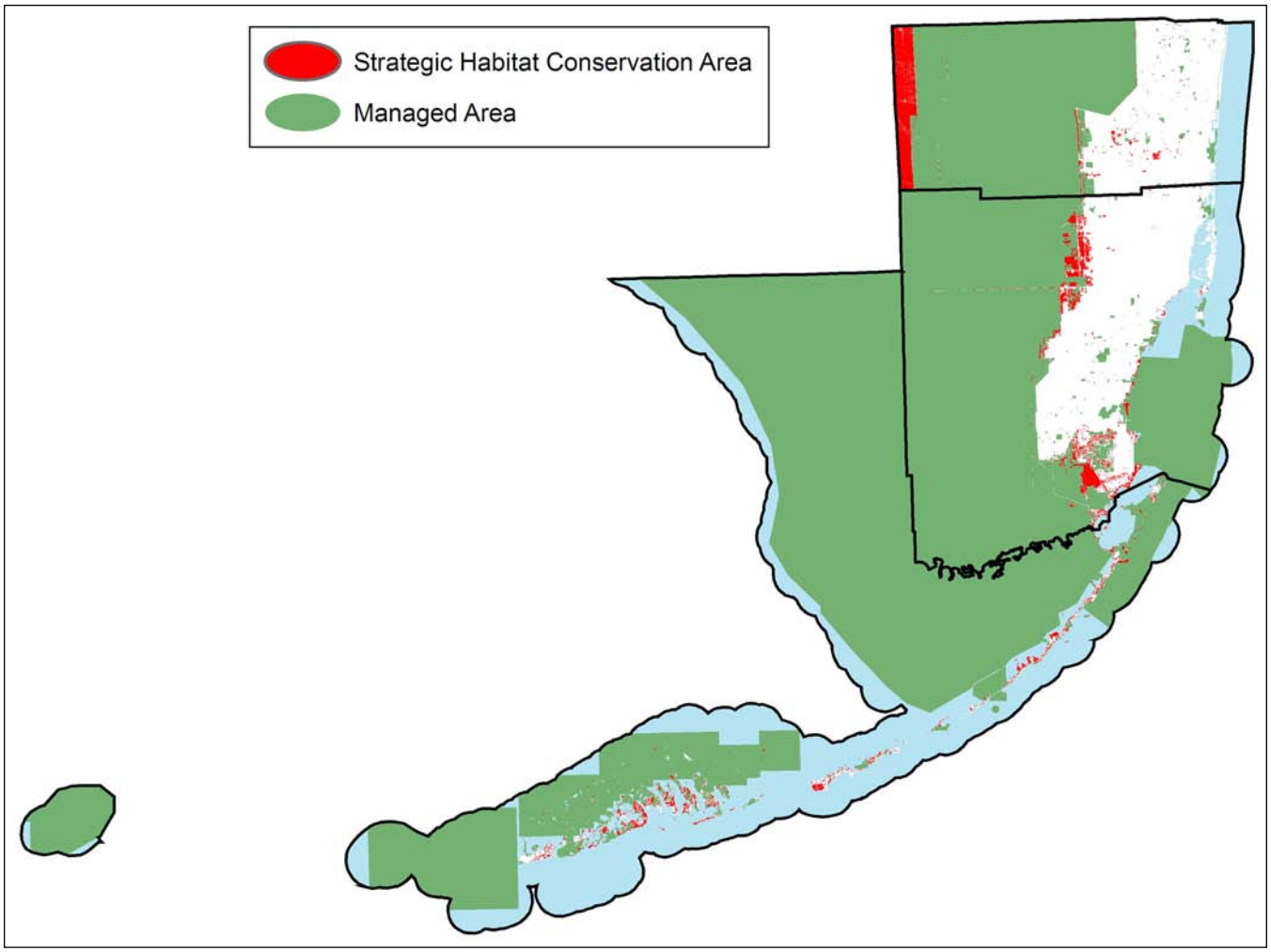

Figure 130 *Aggregated Strategic Habitat Conservation Areas and Managed Areas for the South Florida Regional Planning Council.*

South Florida Region

The South Florida Region contains many large public land areas including Everglades National Park, Everglades and Francis S. Taylor wildlife management areas, Biscayne National Park, John Pennekamp State Park, and the Great White Heron National Wildlife Refuge (Figure 130). All combined, managed lands in the region accounted for nearly 70% of the total land area (Table 14). Thus, it would seem that the South Florida Region has an adequate level of wildlife habitat protection, but this is not the case. If its unique collection of flora and fauna, including numerous endemic species occupying the Florida Keys, is to persist, then additional habitat protection is warranted. Furthermore, the rare pine rockland community type occurs only in the South Florida Region and has been identified by the Wildlife Legacy Initiative as being "of greatest conservation need" (FWC, 2005a).

Land-cover change identified by comparing the 1985–1989 and 2003 land-cover images revealed that 2% of the South Florida Region's natural lands were converted to agriculture or urban use (Table 14; Figure 131). An additional 3% was converted from agriculture to urban use. This urban expansion occurred in areas principally west of Ft. Lauderdale and Miami and was associated with the continuing westerly expansion of this major metropolitan area. From 1990 to 2000, the human population in the region grew 21%, slightly less than the Florida average (23.5%) but more than the U.S. average (13.2%) (U.S. Census Bureau, 2006). In many locations, the urban expansion now abuts the conservation lands west of the cities. Conversion of natural lands to agriculture is evident in and around the city of Homestead, which supports thriving agriculture

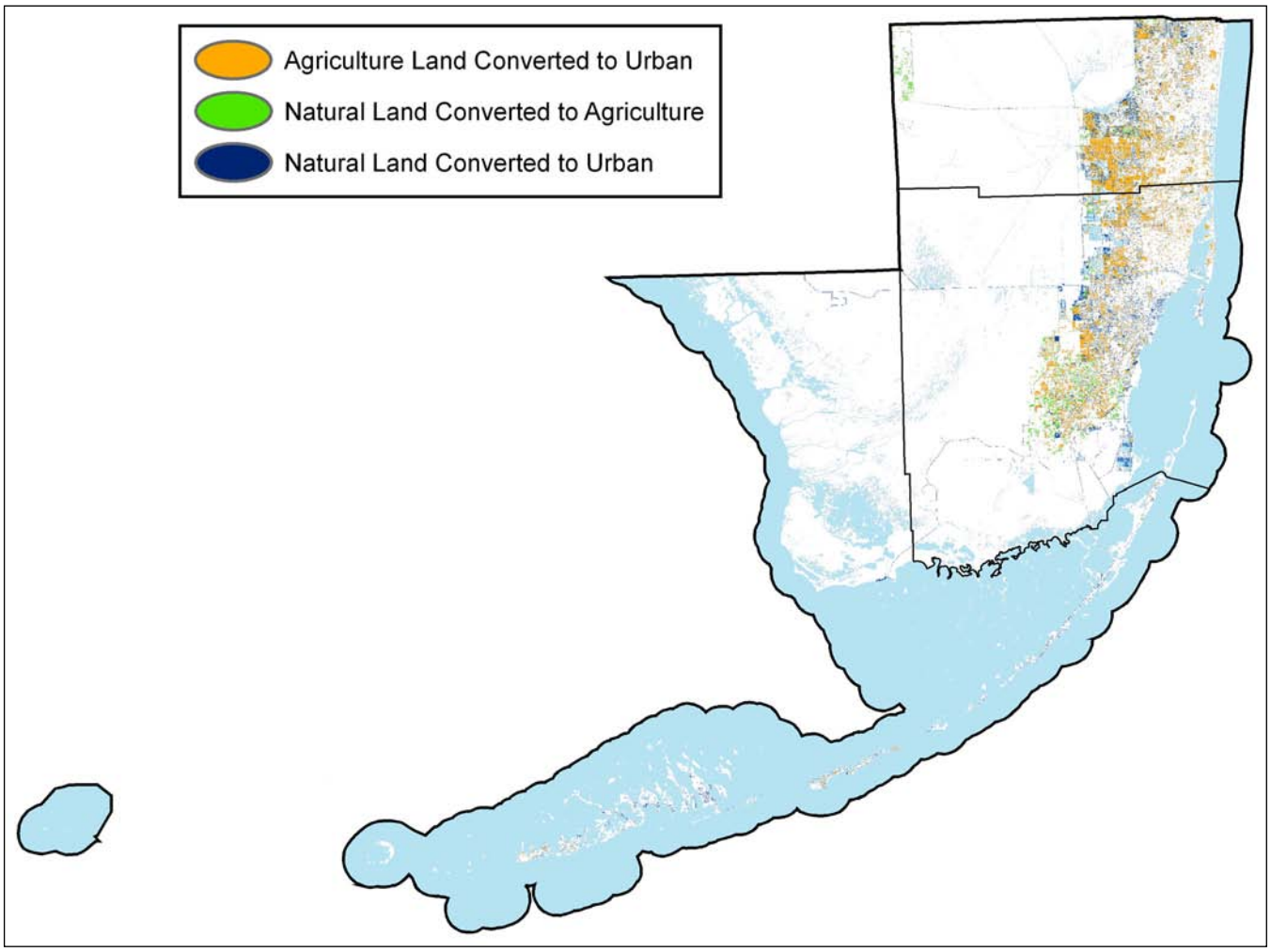

Figure 131 *Land-use conversion between 1985–1989 and 2003 in the South Florida Regional Planning Council.*

that has a nearly $1 billion annual local economic impact (Homestead Chamber of Commerce, 2006). Agriculture in this region is dominated by plant nurseries and greenhouses but also comprises some row crops and livestock.

Approximately 3% of the land in this region has been identified as SHCA (Table 14; Figure 130). Priority 1 SHCA are identified for the American crocodile, Florida Key deer, Florida panther, and Lower Keys marsh rabbit; priority 2 SHCA species include the Florida black bear, Florida Snail Kite, Short-tailed Hawk, and silver rice rat (Figure 132). The majority of SHCA identified in western Broward County are part of the Miccosukee Indian Reservation. Collectively, these SHCA are identified for the Florida black bear, Florida panther, Short-tailed Hawk, Florida Snail Kite, and Swallow-tailed Kite. Large blocks of SHCA for the Florida Snail Kite are also evident just west of Miami. For the Florida panther, SHCA have been identified in the mix of cypress swamp, pineland, hardwood swamp, and tropical hardwood hammock directly south and east of Homestead. Many of these areas are threatened by the urban and agricultural expansion of Homestead and by exotic plants such as melaleuca and Brazilian pepper. Therefore, in addition to needed protection, many of these areas probably require restoration. The South Florida Region has the most species that have SHCA only within a single region. There are 4 species with SHCA only in the Florida Keys. These species include the Florida Key deer, Lower Keys marsh rabbit, silver rice rat, and White-crowned Pigeon. Additional SHCA have been identified in the South Florida Region for the Florida Burrowing Owl and Mangrove Cuckoo.

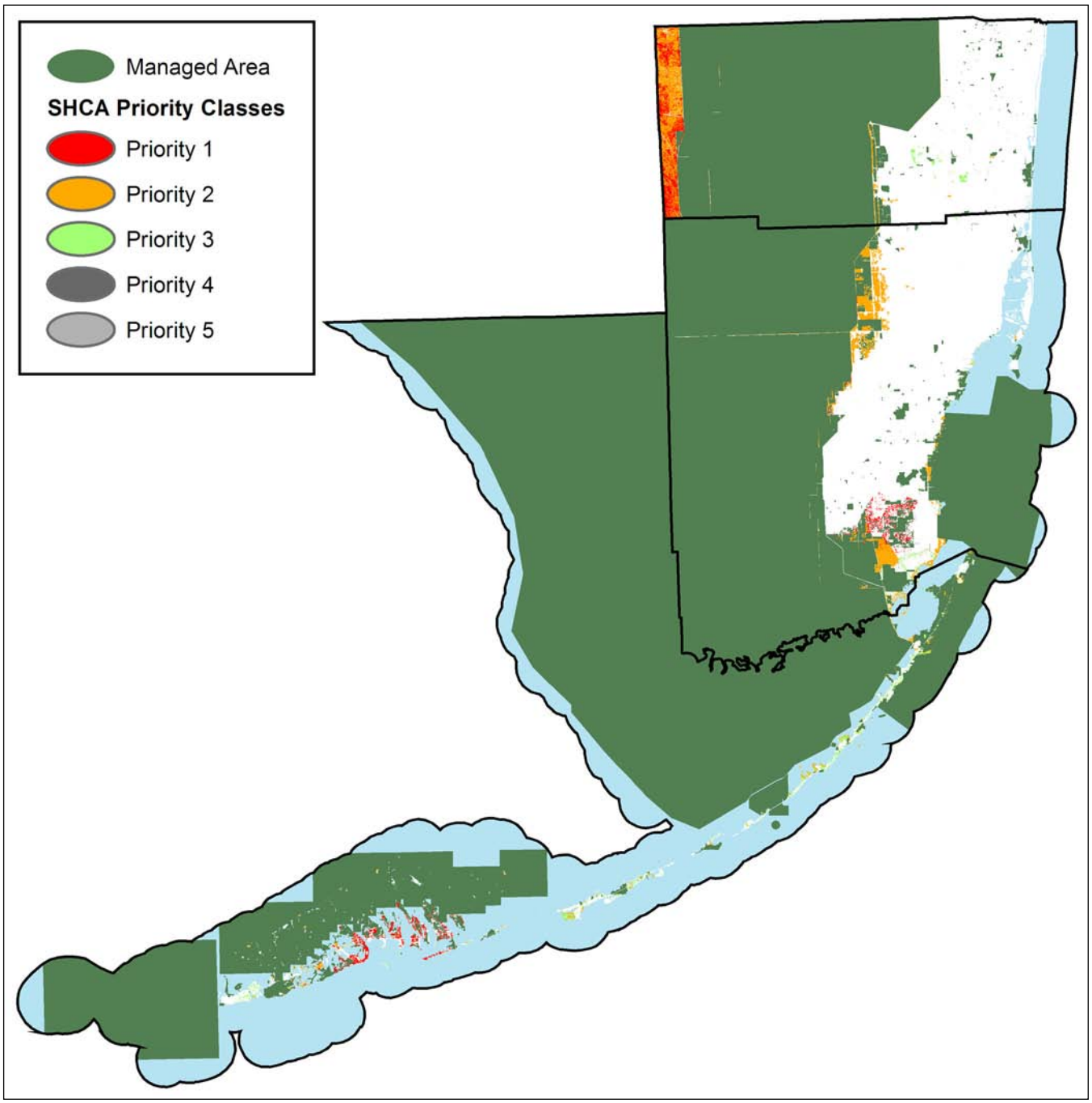

Figure 132 *Prioritized Strategic Habitat Conservation Areas for the South Florida Regional Planning Council.*

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APPENDICES

Appendix A

FWC 2003 Vegetation and Land-Cover Class Descriptions

Upland Plant Communities

Coastal Uplands

COASTAL STRAND

Randy Kautz

Coastal strand occurs on well-drained sandy soils and typically includes the zoned vegetation of the upper beach, nearby dunes, or coastal rock formations. This community generally occurs in a long, narrow band parallel to the open waters of the Atlantic Ocean or Gulf of Mexico and along the shores of some saline bays or sounds in both north and south Florida. This community occupies areas formed along high-energy shorelines and is strongly affected by wind, waves, and salt spray. Vegetation within this community typically consists of low-growing vines, grasses, and herbaceous plants, with very few small trees or large shrubs. Pioneer or early successional herbaceous vegetation characterizes the foredune and upper beach, whereas a gradual change to woody-plant species occurs in more protected areas landward. Typical plant species include beach morning glory, railroad vine, sea oats, saw palmetto, Spanish bayonet, yaupon holly, wax myrtle, sea grape, cocoplum, and other tropicals in southern Florida. The coastal-strand community includes only the zone of early successional vegetation that lies between the upper beach and more highly developed communities landward. Adjacent or contiguous community types such as xeric oak scrubs, pinelands, or hardwood forests would therefore be classified and mapped accordingly.

BEACH/SAND

FWC

This land-cover class consists of barren land with little or no vegetation. Coastal areas that are constantly affected by wave and tidal action and areas of dune sands and other areas of bare sands along the coast are included in this class.

Xeric Uplands

XERIC OAK SCRUB

Steven Christman

Xeric oak scrub is a xeric hardwood community typically consisting of clumped patches of low-growing oaks interspersed with bare areas of white sand. This community occurs on areas of deep, well-washed, sterile sands, and it is the same understory complex of scrubby oaks and other ground cover species that occurs in the sand pine scrub community. This condition frequently occurs when several severe fires within a relatively short period of time completely remove the sand pine as an overstory species. Also included in this category are sites within the Ocala National Forest

that have been clear-cut and are sometimes dominated during the first one to five years by the xeric oak scrub association. The xeric oak scrub community is dominated by myrtle oak, Chapman's oak, sand-live oak, scrub holly, scrub plum, scrub hickory, rosemary, and saw palmetto. Fire is important in setting back plant succession and maintaining viable oak scrubs.

SAND PINE SCRUB

Randy Kautz

Sand pine scrub occurs on extremely well-drained, sorted, sterile sands deposited along former shorelines and islands of ancient seas. This xeric-plant community is dominated by an overstory of sand pine and has an understory of myrtle oak, Chapman's oak, sand-live oak, and scrub holly. Ground cover is usually sparse to absent, especially in mature stands, and rosemary and lichens occur in some open areas. Sites within the Ocala National Forest that have an overstory of direct-seeded sand pine and an intact understory of characteristic xeric scrub oaks are also included in this category. Fire is an important ecological management tool and commonly results in even-aged stands within regenerated sites. The distribution of this community type is almost entirely restricted to the state of Florida.

SANDHILL

Randy Kautz

Sandhill communities occur in areas of rolling terrain on deep, well-drained, white to yellow, sterile sands. This xeric community is dominated by an overstory of scattered longleaf pine with an understory of turkey oak and bluejack oak. The park-like ground cover consists of various grasses, including wiregrass, and herbs, including partridge pea, beggars tick, milk pea, and queen's delight. Fire is an important factor in controlling hardwood competition and other aspects of sandhill ecology. Although many of these sites throughout the state have been modified through the selective or severe cutting of longleaf pine, these areas are still included in the sandhill category.

Mesic Uplands

DRY PRAIRIE

Randy Kautz

Dry prairies are large native grasslands and shrublands occurring on very flat terrain in which scattered cypress domes and strands, bayheads, isolated freshwater marshes, and hardwood hammocks are interspersed. This community is characterized by many species of grasses, sedges, herbs, and shrubs, including saw palmetto, fetterbush, staggerbush, tar flower, gallberry, blueberry, wiregrass, carpet grasses, and various bluestems. The largest areas of these treeless plains historically occurred just north of Lake Okeechobee, and they were subject to annual or frequent fires. Many of these areas have been converted to improved pasture.

Randy Kautz

In central and southern Florida, palmetto prairies, which consist of former pine flatwoods where the overstory trees have been thinned or removed, are also included in this category. These sites contain highly

scattered pines that cover less than 10%–15% percent of an area.

MIXED HARDWOOD–PINE FOREST

Randy Kautz

This community is the southern extension of the Piedmont southern mixed hardwoods and occurs mainly on the clay soils of the northern Panhandle. Younger stands may be predominantly pines, but a complex of various hardwoods become codominants as the system matures over time through plant succession. The overstory consists of shortleaf and loblolly pine, American beech, mockernut hickory, southern red oak, water oak, American holly, and dogwood.

Also included in this category are other upland forests that occur statewide and contain a mixture of conifers and hardwoods as the codominant overstory component. These communities contain longleaf pine, slash pine, and loblolly pine in mixed association with live oak, laurel oak, and water oak, together with other hardwood species characteristic of the upland hardwood hammocks and forests class.

HARDWOOD HAMMOCK AND FOREST

Randy Kautz

This class includes the major upland hardwood associations that occur statewide on fairly rich sandy soils. Variations in species composition and the local or spatial distributions of these communities are due in part to differences in soil-moisture regimes, soil type, and geographic location within the state. Mesic and xeric variations are included within this association.

The mesic-hammock community represents the climax vegetation type within many areas of northern and central Florida. Characteristic species in the extreme north include American beech, southern magnolia, Shumard oak, white oak, mockernut hickory, pignut hickory, sourgum, basswood, white ash, mulberry, and spruce pine. Mesic hammocks of the peninsula are less diverse because of the absence of hardwood species that are adapted to more northerly climates and are characterized by laurel oak, hop hornbeam, blue beech, sweetgum, cabbage palm, American holly, and southern magnolia.

Xeric hammocks occur on deep, well-drained, sandy soils where fire has been absent for long periods. These open, dry hammocks contain live oak, sand-live oak, bluejack oak, blackjack oak, southern red oak, sand-post oak, and pignut hickory.

PINELAND

Randy Kautz

Randy Kautz

The pinelands category includes north and south Florida pine flatwoods, south Florida pine rocklands, and commercial pine plantations. Pine flatwoods occur

on flat, sandy terrain where the overstory is characterized by longleaf pine, slash pine, or pond pine. Generally, flatwoods dominated by longleaf pine occur on well-drained sites, those dominated by pond pine are found in poorly drained areas, and slash pine occupies intermediate or moderately moist areas. The understory and ground cover within these three communities are somewhat similar and include several common species, such as saw palmetto, gallberry, wax myrtle, and a wide variety of grasses and herbs. Generally, wiregrass and runner oak dominate longleaf pine sites; fetterbush and bay trees are found in pond pine areas; and saw palmetto, gallberry, and rusty lyonia occupy slash pine flatwoods sites. Cypress domes, bayheads, titi swamps, and freshwater marshes are commonly interspersed in isolated depressions throughout this community type, and fire is a major disturbance factor. An additional pinelands forest type occurs in extreme southern Florida on rocklands, where the overstory is the south Florida variety of slash pine, and tropical hardwood species occur in the understory. Scrubby flatwoods is another pineland type that occurs on drier ridges and on or near old coastal dunes. Longleaf pine or slash pine dominates the overstory, and the ground cover is similar to the xeric oak scrub community. We also reluctantly include commercial pine plantations in the pinelands association. This class includes sites predominately planted to slash pine, although longleaf pine and loblolly pine tracts also occur. Sand pine plantations, which have been planted on severely site-prepared sandhill sites in the Florida Panhandle, are also included in this category. An acceptable, accurate separation of areas of densely stocked native flatwoods and older planted pine stands with a closed canopy was not consistently possible.

CABBAGE PALM–LIVE OAK HAMMOCK

FNAI

This plant community is characterized by cabbage palms and live oaks occurring in small clumps within prairie communities. These hammocks typically have an open understory that may include species such as wax myrtle, water oak, and saw palmetto. Cabbage palm-live oak hammocks are often found bordering large lakes and rivers and are distributed throughout the prairie region of south-central Florida and extend northward in the St. Johns River basin. Cabbage palms often form a fringe around hardwood "islands" located within improved pastures.

TROPICAL HARDWOOD HAMMOCK

Randy Kautz

These upland hardwood forests occur in extreme southern Florida and are characterized by tree and shrub species on the northern edge of ranges that extend southward into the Caribbean. These communities are sparsely distributed along coastal uplands south of a line from about Vero Beach on the Atlantic coast to Sarasota on the gulf coast. They occur on many tree islands in the Everglades and on uplands throughout the Florida Keys. This cold-intolerant tropical community has very high plant-species diversity, sometimes containing more than 35 species of trees and about 65 species of shrubs. Characteristic tropical plants include strangler fig, gumbo-limbo, mastic, bustic, lancewood, ironwood, poisonwood, pigeon plum, Jamaica dogwood, and Bahama lysiloma. Live oak and cabbage palm are also sometimes found within this community. Tropical hammocks in the Florida Keys may also contain several plants, including lignum vitae, mahogany, thatch palms, and manchineel, which are extremely rare within the United States.

Wetland Plant Communities

Palustrine (Freshwater Wetlands)

FRESHWATER MARSH AND WET PRAIRIE

These wetland communities are dominated by a wide assortment of herbaceous plant species that grow on sand, clay, marl, and organic soils in areas of variable water depths and inundation regimes. Generally, fresh-

Randy Kautz

water marshes occur in deeper, more strongly inundated soils and are characterized by tall emergent and floating-leaved species. Freshwater marshes occur within flatwoods depressions; along broad, shallow lake and river shorelines; and scattered in open areas within hardwood and cypress swamps. Also, other portions of freshwater lakes, rivers, and canals that are dominated by floating-leaved plants such as lotus, spatterdock, duck weed, and water hyacinths are included in this category. Wet prairies commonly occur in shallow, periodically inundated areas and are usually dominated by aquatic grasses, sedges, and their associates. Wet prairies occur as scattered, shallow depressions within dry prairie areas and on marl prairie areas in southern Florida. Also included in this category are areas in southwestern Florida that contain scattered dwarf cypress with less than 20 percent canopy coverage and a dense ground cover of freshwater marsh plants. Various combinations of pickerel weed, sawgrass, maidencane, arrowhead, fire flag, cattail, spike rush, bulrush, white water lily, water shield, and various sedges dominate freshwater marshes and wet prairies. Many marsh or wet prairie types, such as sawgrass marsh or maidencane prairie, have been described and named based on their dominant plant species.

SAWGRASS MARSH

Boyd Thompson

Freshwater marshes dominated by sawgrass. This class was targeted so that we could identify its presence within the South Florida/Everglades system.

CATTAIL MARSH

Larry Busby

Freshwater marsh areas dominated by cattails. This class was targeted so that we could identify its presence within the South Florida/Everglades system and other large wetlands systems that may contain large stands of cattail.

SHRUB SWAMP

Randy Kautz

Shrub swamps are wetland communities dominated by dense, low-growing, woody shrubs or small trees. Shrub swamps are usually characteristic of wetland areas that are experiencing environmental change and are early- to mid-successional in species complement and structure. These changes are a result of natural or man-induced perturbations caused by increased or decreased hydroperiod, fire, clear-cutting or land-clearing, or siltation. Shrub swamps statewide may be dominated by one species, such as willow, or by an array of opportunistic plants that may form a dense, low canopy. Common species include willow, wax myrtle, primrose willow, buttonbush, and saplings of red maple, sweetbay, black gum, and other hydric tree species indicative of wooded wetlands. In northern Florida, some shrub swamps are a fire-maintained subclimax of bay swamps. These dense, shrubby areas are dominated by black titi, swamp cyrilla, fetterbush, sweet pepperbush, doghobble, large gallberry, and myrtle-leaf holly.

BAY SWAMP

FNAI

These hardwood swamps contain broadleaf evergreen trees that occur in shallow, stagnant drainages or depressions often found within pine flatwoods or at the base of sandy ridges, where seepage maintains constantly wet soils. The soils, which are usually covered by an abundant layer of leaf litter, are mostly acidic peat or muck that remains saturated for long periods during which water level fluctuates a little. Overstory trees within bayheads are dominated by sweetbay, swamp bay, and loblolly bay. Depending on the location within the state, other species, including pond pine, slash pine, blackgum, cypress, and Atlantic white cedar, can occur as scattered individuals, but bay trees dominate the canopy and characterize the community. Understory and ground-cover species may include dahoon holly, wax myrtle, fetterbush, greenbriar, royal fern, cinnamon fern, and sphagnum moss.

CYPRESS SWAMP

FWC

These regularly inundated wetlands form a forested border along large rivers, creeks, and lakes or occur in depressions as circular domes or linear strands. These communities are strongly dominated by either bald cypress or pond cypress, with scattered specimens of black gum, red maple, and sweetbay. Understory and ground cover are usually sparse because of frequent flooding but sometimes include such species as buttonbush, lizard's-tail, and various ferns.

CYPRESS/PINE/CABBAGE PALM

USGS–SOFIA

This community includes cypress, pine, and/or cabbage palm in combinations in which none of the species dominate. This assemblage forms a transition between moist upland and hydric sites.

MIXED WETLAND FOREST

USFWS

This category includes mixed wetland forest communities in which neither hardwoods nor conifers achieve dominance. The mix can include hardwoods with pine or cypress and can represent a mixed hydric site or a transition between hardwoods and conifers on hydric/mesic sites.

HARDWOOD SWAMP

These wooded wetland communities are composed of either pure stands of hardwoods or a mixture of hardwoods and cypress where hardwoods achieve dominance. This association of wetland-adapted trees occurs throughout the state on organic soils and forms the forested floodplains of non-alluvial rivers, creeks,

FNAI

and broad lake basins. Tree species include a mixed overstory containing black gum, water tupelo, bald cypress, dahoon holly, red maple, swamp ash, cabbage palm, and sweetbay.

HYDRIC HAMMOCK

FNAI

Hydric hammocks occur on poorly drained soils. This association is a still-water wetland, flooded less frequently and for shorter periods of time than mixed hardwood and cypress swamps. Outcrops of limestone are common in the gulf coastal area. Typical plant species include laurel oak, live oak, cabbage palm, southern red cedar, and sweetgum. Canopy closure is typically 75-90%. The subcanopy layer and ground layer vegetation is highly variable between sites. Wax myrtle is the most frequent shrub in hydric hammock. Other shrubs include yaupon, dahoon, and swamp dogwood. Ground cover may be absent or consist of a dense growth of ferns, sedges, grasses, and greenbriars. Sites are usually between mesic hammocks or pine flatwoods and river swamp, wet prairie, or marsh. This hammock type is found in a narrow band along parts of the gulf coast and along the St. Johns River where they often extend to the edge of coastal salt marshes.

BOTTOMLAND HARDWOOD FOREST

FNAI

These wetland forests are composed of a diverse assortment of hydric hardwoods that occur on the rich alluvial soils of silt and clay deposited along Panhandle rivers such as the Apalachicola, Choctawhatchee, and Escambia. These communities are characterized by an overstory that includes water hickory, overcup oak, swamp chestnut oak, river birch, American sycamore, red maple, Florida elm, bald cypress, blue beech, and swamp ash.

Marine and Estuarine

SALT MARSH

Randy Kautz

These herbaceous and shrubby wetland communities occur statewide in brackish waters along protected low-energy estuarine shorelines of the Atlantic and gulf coasts. The largest continuous areas of salt marsh occur north of the range of mangroves and border tidal creeks, bays, and sounds. Salt marshes are sometimes interspersed within mangrove areas and also occur as a transition zone between freshwater marshes and mangrove forests, such as occur in the Ten Thousand Islands area along the southwestern Florida coast.

Plant distribution within salt marshes is largely dependent on the degree of tidal inundation, and many large areas are completely dominated by one species. Generally, smooth cordgrass occupies the lowest elevations immediately adjacent to tidal creeks and pools, while black needlerush dominates less frequently inundated zones. The highest elevations form transitional areas characterized by glasswort, saltwort, saltgrass, sea oxeye daisy, marsh elder, and saltbush. For the purposes of this project, cordgrass, needlerush, and transitional or high salt marshes are collectively mapped as a single category.

MANGROVE SWAMP

NBII

These dense, brackish-water swamps occur along low-energy shorelines and in protected, tidally influenced bays of southern Florida. This community is composed of freeze-intolerant tree species that are distributed south of a line from Cedar Key on the gulf coast to St. Augustine on the Atlantic coast. These swamp communities are usually dominated by red, black, and white mangroves that progress in a sere from seaward to landward areas, respectively, while buttonwood trees occur in areas above high tide. Openings and transitional areas in mangrove swamps sometimes contain glasswort, saltwort, and other salt marsh species. All three major species of mangroves are mapped as a single class with no effort made to differentiate these species into separate zones.

SCRUB MANGROVE

FWC

Areas sparsely vegetated with small, stunted mangroves (Keys only).

TIDAL FLATS

Larry Busby

Areas composed of that portion of the shore environment protected from wave action and principally composed of mud transported via tidal channels.

Aquatic

OPEN WATER

Randy Kautz

This class is composed of the open-water areas of inland freshwater lakes, ponds, rivers, and creeks and the brackish and saline waters of estuaries, bays, tidal creeks, the Gulf of Mexico, and the Atlantic Ocean.

Disturbed Communities

Transitional

SHRUB AND BRUSHLAND

Larry Busby

This association includes situations where natural upland community types have been recently disturbed through the clear-cutting of commercial pinelands, land-clearing, or fire and are recovering through natural successional processes. This type could be characterized as an early condition of old-field succession, and various shrubs, tree saplings, and some grasses and herbs dominate the community. Common species include wax myrtle, saltbush, sumac, elderberry, saw palmetto, blackberry, gallberry, fetterbush, staggerbush, broomsedge, dog fennel, oaks, and pines.

GRASSLAND

FTA

These are upland communities where the predominant vegetative cover is very low-growing grasses and forbs. This very early successional category includes all sites with herbaceous vegetation during the time between when it was bare ground and when shrub and brush colonize. It also includes areas that may be maintained in this stage through periodic mowing, such as along dikes or levees.

BARE SOIL/CLEARCUT

Larry Busby

Areas of bare soil representing recent timber-cutting operations, areas devoid of vegetation as a consequence of recent fires, natural areas of exposed bare soil (*e.g.,* sandy areas within xeric communities), or bare soil exposed because vegetation has been removed for unknown reasons.

Agriculture

IMPROVED PASTURE

USFWS

Land that has been cleared, tilled, reseeded with specific grass types, and periodically improved with brush control and fertilizer application.

UNIMPROVED/WOODLAND PASTURE

FWC

Cleared land with major stands of trees and brush, where native grasses have been allowed to develop. Normally, unimproved pastures are not managed with brush control or fertilizer application.

SUGAR CANE

UF–IFAS

Agricultural lands planted with sugar cane.

CITRUS

FWC

Agricultural lands planted with groves of citrus (*e.g.*, oranges, grapefruit, lemons).

ROW/FIELD CROPS

USFWS

Row crops are agricultural fields in which rows remain well defined even after crops have been harvested. Typical row crops in Florida include corn, tomatoes, potatoes, cotton, and beans. Field crops are agricultural croplands not planted in rows. Typical field crops in Florida include hay and grasses.

OTHER AGRICULTURE

Larry Busby

Agricultural lands other than pasture land, sugar cane fields, citrus groves, and croplands. Types of agricultural lands included in this category are peach orchards, pecan and avocado groves, nurseries and vineyards, specialty farms, aquaculture, fallow cropland, and unidentified agricultural uses.

Exotic Plants

EXOTIC PLANTS

Upland and wetland areas dominated by nonnative trees that were planted or have escaped and invaded native plant communities. These exotics include melaleuca, Australian pine, Brazilian pepper, and eucalyptus. This class includes sites known to be vegetated by these nonnative species but for which the actual species composition could not be determined.

AUSTRALIAN PINE

Larry Busby

Sites known through field inspection to be dominated by Australian pine.

MELALEUCA

Larry Busby

Sites known through field inspection to be dominated by melaleuca.

BRAZILIAN PEPPER

Larry Busby

Sites known through field inspection to be dominated by Brazilian pepper.

Urban

HIGH–IMPACT URBAN

Larry Busby

Unvegetated areas such as roads, residential and commercial buildings, and parking lots.

LOW–IMPACT URBAN

Larry Busby

Disturbed areas within urbanized areas that may or may not be vegetated. Examples of land uses included in this category are lawns, golf courses, road shoulders, grassy areas surrounding places such as airports, and park facilities. Many secondary roads, such as forest roads, are included in this category.

Mining

EXTRACTIVE

USFWS

These areas encompass surface and subsurface mining operations. Recently disturbed/barren areas within sand, gravel, and clay pits; phosphate mines, and limestone quarries. Industrial complexes where the extracted material is refined, packaged, or further processed may also be included in this category. Areas within mining operations that have reverted or been restored to natural communities are classified as the natural community type, not extractive.

Common and Scientific Names of Plants Appearing in Land-Cover Class Descriptions

Common Name	Scientific Name	Common Name	Scientific Name
Red maple	*Acer rubrum*	Manchineel	*Hippomane mancinella*
Broomsedge	*Andropogon virginicus*	Dahoon holly	*Ilex cassine*
Wiregrass	*Aristida stricta*	Large gallberry	*Ilex coriacea*
Black mangrove	*Avicennia germinans*	Gallberry	*Ilex glabra*
Carpet grass	*Axonopus* spp.	Myrtle-leaf holly	*Ilex myrtifolia*
Saltbush	*Baccharis halimifolia*	American holly	*Ilex opaca*
Saltwort	*Batis maritime*	Scrub holly	*Ilex opaca* var. *arenicola*
Tar flower	*Befaria racemosa*	Yaupon holly	*Ilex vomitoria*
River birch	*Betula nigra*	Railroad vine	*Ipomoea pes-caprae*
Beggar ticks	*Bidens* spp.	Beach morning glory	*Ipomoea stolonifera*
Sea oxeye daisy	*Borrichia frutescens*	Marsh elder	*Iva frutescens*
Water shield	*Brasenia schreberi*	Black needlerush	*Juncus roemerianus*
Gumbo-limbo	*Bursera simaruba*	Southern red cedar	*Juniperus virginiana*
Beautyberry	*Callicarpa americana*	White mangrove	*Laguncularia racemosa*
Blue beech	*Carpinus caroliniana*	Duckweed	*Lemna* spp.
Water hickory	*Carya aquatica*	Dog-hobble	*Leucothoe axillaris*
Scrub hickory	*Carya floridana*	Sweetgum	*Liquidambar styraciflua*
Pignut hickory	*Carya glabra*	Rusty lyonia	*Lyonia ferruginea*
Mockernut hickory	*Carya tomentosa*	Primrose willow	*Ludwigia peruviana*
Partridge pea	*Cassia chamaecrista*	Fetterbush	*Lyonia lucida*
Australian pine	*Casuarina* spp.	Staggerbush	*Lyonia* spp.
Buttonbush	*Cephalanthus occidentalis*	Bahama lysiloma	*Lysiloma latisiliquum*
Rosemary	*Ceratiola ericoides*	Southern magnolia	*Magnolia grandiflora*
Atlantic white cedar	*Chamaecyparis thyoides*	Sweetbay	*Magnolia virginiana*
Cocoplum	*Chrysobalanus icaco*	Mastic	*Mastichodendron foetidissimum*
Sawgrass	*Cladium jamaicense*		
Sweet pepper bush	*Clethra alnifolia*	Melaleuca	*Melaleuca quinquenervia*
Black titi	*Cliftonia monophylla*	Poisonwood	*Metopium toxiferum*
Pigeon plum	*Coccoloba diversifolia*	Mulberry	*Morus rubra*
Sea grape	*Coccoloba uvifera*	Wax myrtle	*Myrica cerifera*
Buttonwood	*Conocarpus erectus*	Lotus	*Nelumbo lutea*
Rosemary	*Conradina* spp.	Spatterdock	*Nuphar* spp.
American dogwood	*Cornus florida*	Water lily	*Nymphaea* spp.
Swamp dogwood	*Cornus foemina*	Water tupelo	*Nyssa aquatica*
Swamp cyrilla	*Cyrilla racemiflora*	Blackgum	*Nyssa sylvatica* var. *sylvatica*
Bustic	*Dipholis salicifolia*		
Saltgrass	*Distichlis spicata*	Lancewood	*Ocotea coriacea*
Water hyacinth	*Eichhornia crassipes*	Cinnamon fern	*Osmunda cinnamomea*
Spike rush	*Eleocharis* spp.	Royal fern	*Osmunda regalis*
Eucalyptus	*Eucalyptis robusta*	Hop hornbeam	*Ostrya virginiana*
Tropical ironwood	*Eugenia confusa*	Sourgum	*Oxydendron arboreum*
Dogfennel	*Eupatorium capillifolium*	Maidencane	*Panicum hemitomon*
American beech	*Fagus grandifolia*	Red bay	*Persea borbonia*
Strangler fig	*Ficus aurea*	Swamp bay	*Persea palustris*
White ash	*Fraxinus americana*	Shortleaf pine	*Pinus echinata*
Swamp ash	*Fraxinus caroliniana*	Slash pine	*Pinus elliottii*
Milk peas	*Galactia* spp.	Longleaf Pine	*Pinus palustris*
Loblolly bay	*Gordonia lasianthus*	Sand Pine	*Pinus clausa*
Lignum-vitae	*Guaiacum sanctum*		

(continued next page)

Common Name	Scientific Name	Common Name	Scientific Name
Spruce pine	*Pinus glabra*	Cabbage palm	*Sabal palmetto*
Pond pine	*Pinus serotina*	Arrowhead	*Sagittaria* spp.
Loblolly pine	*Pinus taeda*	Glasswort	*Salicornia* spp.
Jamaica dogwood	*Piscidia piscipula*	Florida willow	*Salix floridana*
American sycamore	*Platanus occidentalis*	Elderberry	*Sambucus canadensis*
Pickerel weed	*Pontederia cordata*	Lizards-tail	*Saururus cernuus*
Scrub plum	*Prunus geniculata*	Brazilian pepper	*Schinus terebinthifolius*
White oak	*Quercus alba*	Bulrush	*Scirpus* spp.
Bluejack oak	*Quercus incana*	Saw palmetto	*Serenoa repens*
Chapman's oak	*Quercus chapmanii*	Greenbriar	*Smilax* spp.
Southern red oak	*Quercus falcata*	Cordgrass	*Spartina* spp.
Sand live oak	*Quercus geminata*	Sphagnum moss	*Sphagnum* spp.
Laurel oak	*Quercus laurifolia*	A queen's delight	*Stillingia sylvatica* spp. *tenuis*
Turkey oak	*Quercus laevis*		
Overcup oak	*Quercus lyrata*	West Indies mahogany (mahogany)	*Swietenia mahagoni*
Sand post oak	*Quercus margaretta*		
Blackjack oak	*Quercus marilandica*	Pond cypress	*Taxodium ascendens*
Swamp chestnut oak	*Quercus michauxii*	Bald cypress	*Taxodium distichum*
Myrtle oak	*Quercus myrtifolia*	Fire flag	*Thalia geniculata*
Water oak	*Quercus nigra*	Thatch palm	*Thrinax* spp.
Runner oak	*Quercus pumila*	Basswood	*Tilia americana*
Shumard oak	*Quercus shumardii*	Cattail	*Typha* spp.
Live oak	*Quercus virginiana*	Florida elm	*Ulmus americana*
Red mangrove	*Rhizophora mangle*	Sea oats	*Uniola paniculata*
Sumac	*Rhus* spp.	Blueberry	*Vaccinium darrowii*
Blackberry	*Rubus* spp.	Spanish bayonet	*Yucca aloifolia*

Appendix B
Acronyms and Abbreviations

ADID	Advanced Identification of Wetlands
BBA	Breeding Bird Atlas
CLIP	Critical Lands and Waters Identification Project
CLO	Cornell Lab of Ornithology
DOQQ	Digital Orthophoto Quarter-Quadrangle
EMAP	Ecological Mapping and Assessment Program
FDEP	Florida Department of Environmental Protection
FDNR	Florida Department of Natural Resources
FDOT	Florida Department of Transportation
FLEO	Florida Element Occurrence
FLMA	Florida Managed Areas database
FLUCCS	Florida Land Use, Cover and Forms Classification System
FNAI	Florida Natural Areas Inventory
FWC	Florida Fish and Wildlife Conservation Commission
FTA	Florida Trail Association
GAP	Gap Analysis Program
GIS	Geographic Information Systems
IUCN	International Union for Conservation of Nature
Landsat ETM+	Landsat Enhanced Thematic Mapper Plus
NBII	National Biological Information Infrastructure
NCTC	National Conservation Training Center
NHD	National Hydrography Dataset
PVA	Population Viability Analysis
SHCA	Strategic Habitat Conservation Areas
SSURGO	Soil Survey Geographic database
STATSGO	State Soil Geographic database
UF/IFAS	University of Florida, Institute of Food and Agricultural Sciences
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

Appendix C
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Page 169 Bay swamp: FNAI, Paul Russo (also center panorama, front cover)
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