Lake Wales Ridge National Wildlife Refuge

Comprehensive Conservation Plan

U.S. Department of the Interior
Fish and Wildlife Service
Southeast Region

October 2010

Submitted by: _____ *Date:* 8/20/10
Charles Pelizza, Refuge Manager
Lake Wales Ridge NWR

Concur: _____ *Date:* 8/23/10
Layne Hamilton, Project Leader
Merritt Island NWR Complex

Concur: _____ *Date:* 9/21/10
for Elizabeth Souheaver, Refuge Supervisor
Southeast Region

Concur: _____ *Date:* Sept 22, 2010
Acting Regional Chief
Southeast Region

Approved by: _____ *Date:* SEP 23 2010
"for" *Cynthia K. Dohner, Regional Director*
Southeast Region

LAKE WALES RIDGE NATIONAL WILDLIFE REFUGE

Highlands and Polk Counties, Florida

COMPREHENSIVE CONSERVATION PLAN

U.S. Department of the Interior
Fish and Wildlife Service

Southeast Region
Atlanta, Georgia

October 2010

TABLE OF CONTENTS

APPENDICES

LIST OF FIGURES

LIST OF TABLES

I. Background

INTRODUCTION

The Lake Wales Ridge National Wildlife Refuge (NWR) is a unit of the Merritt Island National Wildlife Refuge Complex and is administered by and co-managed with Pelican Island and Archie Carr National Wildlife Refuges, colloquially termed the Pelican Island National Wildlife Refuge Complex (PIC) (Figure 1). Lake Wales Ridge NWR (Figure 2) is one of the first refuges of its kind in the National Wildlife Refuge System (Refuge System) to target community level conservation–specifically scrub habitat, a unique vegetation type largely restricted to the Central Florida ridge systems occurring on the remnants of ancient beach and sand dune systems from Ocala National Forest to southern Highlands County, Florida. At complete acquisition, the refuge is envisioned to significantly enhance the recovery of 13 federally listed threatened and endangered plants, to support the recovery of 13 additional plants that at the time were candidates for federal listing, and to enhance the recovery of four federally listed threatened vertebrate animals across approximately 19,630 acres [7,944 hectares (ha)] (U.S. Fish and Wildlife Service 1993). The refuge was authorized on February 15, 1994, and acquisition within the proposed approximate 19,630-acre acquisition boundary began in April 22, 1994. The U.S. Fish and Wildlife Service (Service) currently owns 1,843.9 acres (746.2 ha) across four management units within the 12-unit approved acquisition boundary: Flamingo Villas (1,039.1 acres/420.5 ha), Carter Creek (627.5 acres/253.9 ha), Lake McLeod (38 acres/15.4 ha), and Snell Creek (139.3 acres/56.4 ha).

The refuge manages lands on both the Lake Wales and Winter Haven ridges of the Central Florida highlands. Lake Wales Ridge is the predominant ridge of the Central Florida ridge system. An ancient beach and sand dune system composed of xeric uplands, flatwoods, wetlands, and lakes, the Lake Wales Ridge averages 7.3 miles [11.7 kilometers (km)] wide and 115.7 miles (186.3 km) long (Weekley, et al. 2008), stretching north to south through the center of the Florida peninsula. The approximately 20,900 hectare-Winter Haven Ridge (80.7 square miles) is located west of the Lake Wales Ridge in central Polk County, Florida, and is believed to be a remnant of previous widespread uplands (White 1970). Based on species distribution, the Winter Haven and Lake Wales ridges are biogeographically related (Christman 1988). The central Florida ridge ecosystem was formed approximately 2.5 million years ago when sea levels were much higher and occurred as an archipelago setting of large islands separated by sea from the ancient mainland. Atop these ancient islands evolved xeric habitats (most notably scrub) and species that persist even today. Because of their longer period of evolution, these interior “ancient” scrubs harbor numerous endemics (plants and animals found only in a particular site or region). This ecosystem has been disappearing very rapidly in recent decades. It is estimated that about 80,000 acres of Lake Wales Ridge scrub existed before the arrival of European settlers. By 1990, about 85 percent of the xeric upland communities had been lost (Weekley et al. 2008), or converted to agricultural (mainly citrus), residential, and commercial development. Many of the endemic plants found on the ridge face extinction.

This Comprehensive Conservation Plan (CCP) for Lake Wales Ridge NWR was prepared to guide management actions and direction for the refuge. Fish and wildlife conservation will receive first priority in refuge management and wildlife-dependent uses will be allowed and encouraged as long as they are compatible with and do not detract from the mission of the refuge or the purposes for which it was established.

Figure 1. Merritt Island NWR Complex

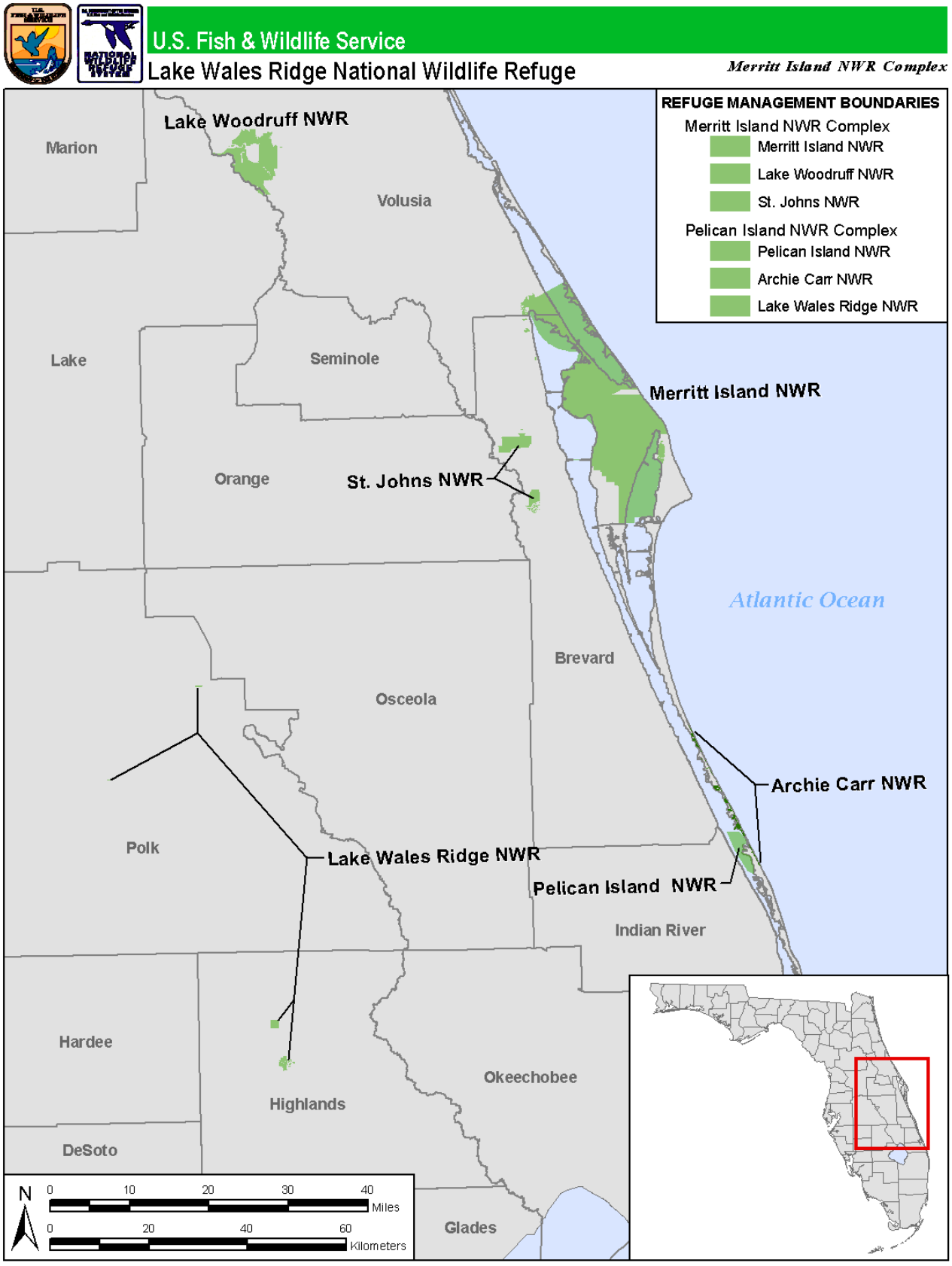
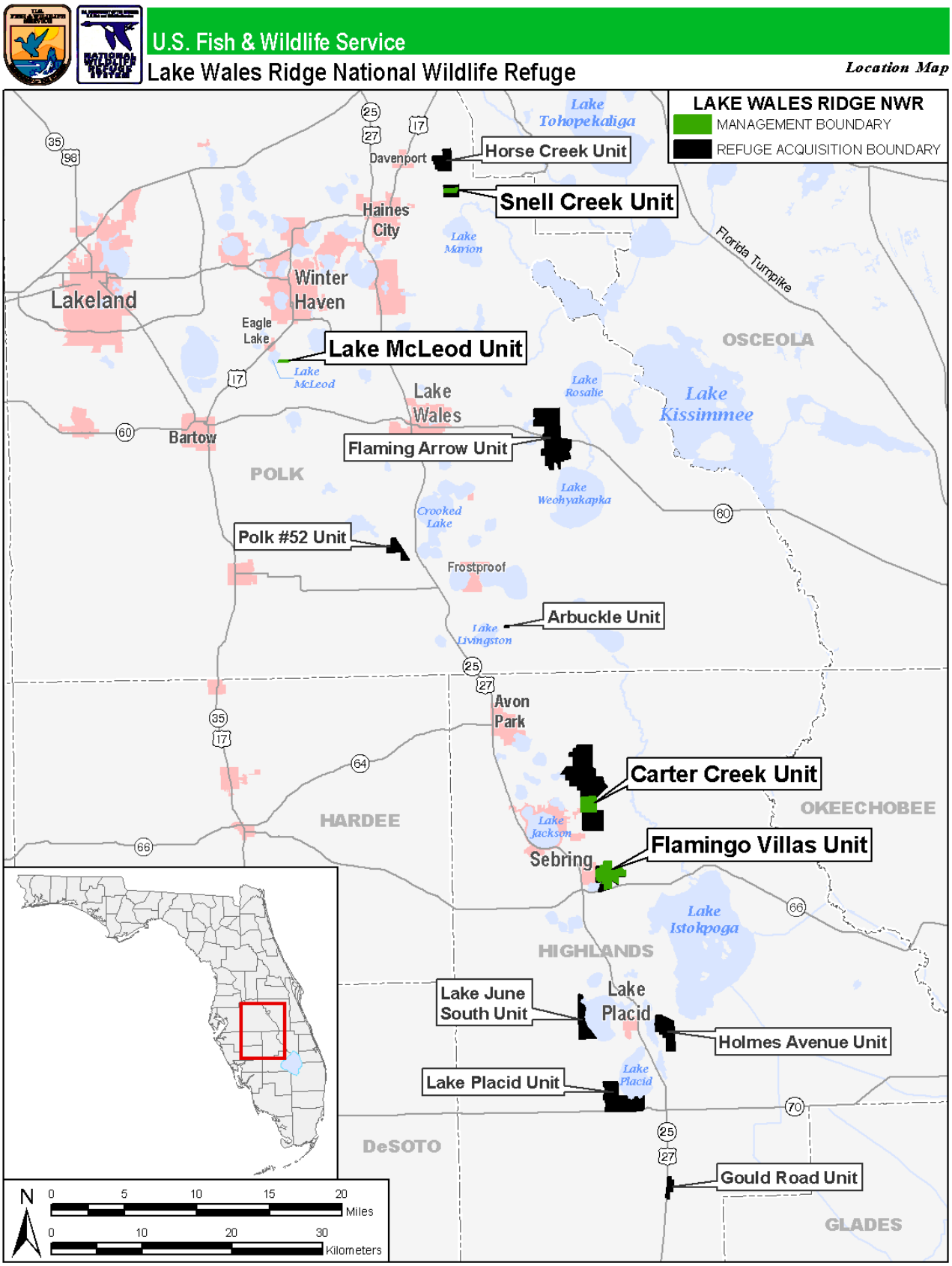


Figure 2. Lake Wales Ridge NWR management unit location and acquisition boundary



A planning team developed a range of alternatives that best met the goals and objectives of the refuge and that could be implemented within the 15-year planning period. The Draft Comprehensive Conservation Plan and Environmental Assessment (Draft CCP/EA) described the Service's proposed plan, as well as other alternatives considered and their effects on the environment. The Draft CCP/EA was made available to local, state, and federal agencies; non-governmental organizations; conservation partners; and the general public for review and comment. Substantive comments from and the Service's responses to them are provided in Appendix IV.

PURPOSE AND NEED FOR THE PLAN

The purpose of the CCP is to develop an action that best achieves the refuge's purposes; attains the vision and goals developed for the refuge; contributes to Refuge System mission; addresses key problems, issues, and relevant mandates; and is consistent with sound principles of fish and wildlife management.

Specifically, the CCP is needed to:

- Provide a clear statement of refuge management direction;
- Provide refuge neighbors, visitors, and government officials with an understanding of Service management actions on and around the refuge;
- Ensure that Service management actions, including land protection and recreation/education programs, are consistent with the mandates of the Refuge System; and
- Provide a basis for the development of budget requests for operations, maintenance, and capital improvement needs.

U.S. FISH AND WILDLIFE SERVICE

The Service traces its roots to 1871 and the establishment of the Commission of Fisheries involved with research and fish culture. The once-independent commission was renamed the Bureau of Fisheries and placed under the Department of Commerce and Labor in 1903.

The Service also traces its roots to 1886 and the establishment of a Division of Economic Ornithology and Mammalogy in the Department of Agriculture. Research on the relationship of birds and animals to agriculture shifted to delineation of the range of plants and animals so the name was changed to the Division of the Biological Survey in 1896.

The Department of Commerce, Bureau of Fisheries, was combined with the Department of Agriculture, Bureau of Biological Survey, on June 30, 1940, and transferred to the Department of the Interior as the Fish and Wildlife Service. The name was changed to the Bureau of Sport Fisheries and Wildlife in 1956 and finally to the Fish and Wildlife Service in 1974.

The Fish and Wildlife Service, working with others, is responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people through Federal programs relating to migratory birds, endangered species, interjurisdictional fish and marine mammals, and inland sport fisheries (142 DM 1.1).

As part of its mission, the Service manages more than 548 national wildlife refuges covering over 147 million acres (59 million hectares). These areas comprise the National Wildlife Refuge System, the world's largest collection of lands and waters set aside specifically for fish and wildlife. The majority of these lands, 77 million acres (31 million ha), occurs in Alaska, while 54 million acres (21.8 million

ha) are part of four marine national monuments in the Pacific Ocean. The remaining acres are spread across the other 49 states and several United States territories. In addition to refuges, the Service manages thousands of small wetlands, 37 wetland management districts, 69 national fish hatcheries, 64 fishery resource offices, and 81 ecological services field stations. The Service enforces federal wildlife laws, administers the Endangered Species Act, manages migratory bird populations, restores nationally significant fisheries, conserves and restores wildlife habitat, and helps foreign governments with their conservation efforts. It also oversees the Federal Aid program that distributes hundreds of millions of dollars in excise taxes on fishing and hunting equipment to state fish and wildlife agencies.

NATIONAL WILDLIFE REFUGE SYSTEM

The mission of the National Wildlife Refuge System, as defined by the National Wildlife Refuge System Improvement Act of 1997 is:

> "...to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans."

The National Wildlife Refuge System Improvement Act of 1997 (Improvement Act) established, for the first time, a clear legislative mission of wildlife conservation for the Refuge System. Actions were initiated in 1997 to comply with the direction of this new legislation, including an effort to complete comprehensive conservation plans for all refuges. These plans, which are completed with full public involvement, help guide the future management of refuges by establishing natural resources and recreation/education programs. Consistent with the Improvement Act, approved plans will serve as the guidelines for refuge management for the next 15 years. The Improvement Act states that each refuge shall be managed to:

- Fulfill the mission of the Refuge System;
- Fulfill the individual purposes of each refuge;
- Consider the needs of wildlife first;
- Fulfill requirements of comprehensive conservation plans that are prepared for each unit of the Refuge System;
- Maintain the biological integrity, diversity, and environmental health of the Refuge System;
- Recognize that wildlife-dependent recreation activities including hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation are legitimate and priority public uses; and
- Allow refuge managers authority to determine compatible public uses.

The following are just a few examples of your national network of conservation lands. Pelican Island National Wildlife Refuge, the first refuge, was established in 1903 for the protection of colonial nesting birds in Florida, such as the snowy egret and the brown pelican. Western refuges were established for American bison (1906), elk (1912), prong-horn antelope (1931), and desert bighorn sheep (1936) after over-hunting, competition with cattle, and natural disasters decimated once-abundant herds. The drought conditions of the 1930s Dust Bowl severely depleted breeding populations of ducks and geese. Refuges established during the Great Depression focused on waterfowl production areas (i.e., protection of prairie wetlands in America's heartland). The emphasis on waterfowl continues today but also includes protection of wintering habitat in response to a dramatic loss of bottomland hardwoods. By 1973, the Service had begun to focus on establishing refuges for endangered species.

National wildlife refuges connect visitors to their natural resource heritage and provide them with an understanding and appreciation of fish and wildlife ecology to help them understand their role in the environment. Wildlife-dependent recreation on refuges also generates economic benefits to local communities. According to the report, *Banking on Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation*, approximately 34.8 million people visited national wildlife refuges in Fiscal Year 2006, generating almost $1.7 billion in total economic activity and creating almost 27,000 private sector jobs producing about $542.8 million in employment income (Carver and Caudill 2007). Additionally, recreational spending on refuges generated nearly $185.3 million in tax revenue at the local, county, state, and federal levels (Carver and Caudill 2007). As the number of visitors grows, significant economic benefits are realized by local communities. In 2006, nearly 71 million people, 16 years and older, fished, hunted, or observed wildlife, spending $45.7 billion and generating $122.6 billion (Leonard 2008).

In a study completed in 2002 on 15 refuges, visitation had grown 36 percent in 7 years. At the same time, the number of jobs generated in surrounding communities grew to 120 per refuge, up from 87 jobs in 1995, pouring more than $2.2 million into local economies. The 15 refuges in the study were Chincoteague (Virginia); National Elk (Wyoming); Crab Orchard (Illinois); Eufaula (Alabama); Charles M. Russell (Montana); Umatilla (Oregon); Quivira (Kansas); Mattamuskeet (North Carolina); Upper Souris (North Dakota); San Francisco Bay (California); Laguna Atacosa (Texas); Horicon (Wisconsin); Las Vegas (Nevada); Tule Lake (California); and Tensas River (Louisiana) the same refuges identified for the 1995 study. Other findings also validate the belief that communities near refuges benefit economically. Expenditures on food, lodging, and transportation grew to $6.8 million per refuge, up 31 percent from $5.2 million in 1995. For each federal dollar spent on the Refuge System, surrounding communities benefited with $4.43 in recreation expenditures and $1.42 in job-related income (Caudill and Laughland 2003).

Volunteers continue to be a major contributor to the success of the Refuge System. In 2005, approximately 38,000 refuge volunteers donated more than 1.4 million hours. The value of their service was more than $25 million.

The wildlife and habitat vision for national wildlife refuges stresses that wildlife comes first; that ecosystems, biodiversity, and wilderness are vital concepts in refuge management; that refuges must be healthy and growth must be strategic; and that the Refuge System serves as a model for habitat management with broad participation from others.

The Improvement Act stipulates that comprehensive conservation plans be prepared in consultation with adjoining federal, state, and private landowners and that the Service develop and implement a process to ensure an opportunity for active public involvement in the preparation and revision (every 15 years) of the plans.

All lands of the Refuge System will be managed in accordance with an approved comprehensive conservation plan that will guide management decisions and set forth strategies for achieving refuge unit purposes. The plan will be consistent with sound resource management principles, practices, and legal mandates, including Service compatibility standards and other Service policies, guidelines, and planning documents (602 FW 1.1).

LEGAL AND POLICY CONTEXT

Administration of national wildlife refuges is guided by the mission and goals of the Refuge System, congressional legislation, presidential executive orders, and international treaties. Policies for management options of refuges are further refined by administrative guidelines established by the

Secretary of the Interior and by policy guidelines established by the Director of the Fish and Wildlife Service. Select legal summaries of treaties and laws relevant to administration of the Refuge System and management of the Lake Wales Ridge NWR are provided in Appendix C.

Treaties, laws, administrative guidelines, and policy guidelines assist the refuge manager in making decisions pertaining to soil, water, air, flora, fauna, and other natural resources; historical and cultural resources; research and recreation on refuge lands; and provide a framework for cooperation between the Lake Wales Ridge NWR and other partners, such as the Avon Park Air Force Range (APAFR), Florida Fish and Wildlife Conservation Commission (FWC), Florida Department of Environmental Protection (FDEP), Florida Park Service (FPS), Florida Department of Agriculture and Consumer Services (FDACS) Florida Division of Forestry (FDOF), South Florida Water Management District (SFWMD), Southwest Florida Water Management District (SWFWMD), Polk County, Highlands County, the Lake Wales Ridge Ecosystem Working Group (LWREWG), The Nature Conservancy (TNC), Archbold Biological Station (ABS), and private landowners.

Lands within the Refuge System are closed to public use unless specifically and legally opened. No refuge use may be allowed unless it is determined to be compatible. A compatible use is a use that, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. All programs and uses must be evaluated based on mandates set forth in the Improvement Act. Those mandates are to:

- Contribute to ecosystem goals, as well as refuge purposes and goals;
- Conserve, manage, and restore fish, wildlife, and plant resources and their habitats;
- Monitor the trends of fish, wildlife, and plants;
- Manage and ensure appropriate visitor uses as those uses benefit the conservation of fish and wildlife resources and contribute to the enjoyment of the public; and
- Ensure that visitor activities are compatible with refuge purposes.

The Improvement Act further identifies six priority wildlife-dependent recreational uses. These uses are: hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation. As priority public uses of the Refuge System, they receive priority consideration over other public uses in planning and management.

The Improvement Act directs the Service to ensure that the biological integrity, diversity, and environmental health of the Refuge System are maintained for the benefit of present and future generations of Americans (601 FW 3). The Biological Integrity Policy is an additional directive for refuge managers to follow while achieving refuge purpose(s) and the Refuge System mission. It provides for the consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on refuges and associated ecosystems. When evaluating the appropriate management direction for refuges, refuge managers will use sound professional judgment to determine their refuges' contribution to biological integrity, diversity, and environmental health at multiple landscape scales. Sound professional judgment incorporates field experience; knowledge of refuge resources; role of refuge within an ecosystem; applicable laws; and best available science, including consultation with others both inside and outside the Service.

NATIONAL AND INTERNATIONAL CONSERVATION PLANS AND INITIATIVES

Multiple partnerships have been developed among government and private entities to address the environmental problems affecting regions. There is a large amount of conservation and protection information that defines the role of the refuge at the local, national, international, and ecosystem levels. Conservation initiatives include broad-scale planning and cooperation between affected parties to address declining trends of natural, physical, social, and economic environments. The conservation guidance described below, along with issues, problems, and trends, was reviewed and integrated where appropriate into this CCP.

The CCP supports key national and international conservation plans and initiatives including the North American Bird Conservation Initiative, which includes the Partners-in-Flight (PIF) Bird Conservation Plan.

NORTH AMERICAN BIRD CONSERVATION INITIATIVE

Started in 1999, the North American Bird Conservation Initiative is a coalition of government agencies, private organizations, academic institutions, and private industry leaders in the United States, Canada, and Mexico working to ensure the long-term health of North America's native bird populations by fostering an integrated approach to bird conservation to benefit all birds in all habitats. The four international and national bird initiatives include the North American Waterfowl Management Plan, PIF, Waterbird Conservation for the Americas, and the U.S. Shorebird Conservation Plan.

PARTNERS-IN-FLIGHT BIRD CONSERVATION PLAN

Managed as part of the PIF Bird Conservation Plan, the peninsular Florida physiographic area represents a scientifically based land bird conservation planning effort that ensures long-term maintenance of healthy populations of native land birds, primarily non-game land birds. Non-game land birds have been vastly under-represented in conservation efforts, and many are exhibiting significant declines. This plan is voluntary and non-regulatory, and focuses on relatively common species in areas where conservation actions can be most effective, rather than the frequent local emphasis on rare and peripheral populations. The refuge is not specifically identified in the peninsular Florida physiographic area database of managed lands, but other naturally managed lands in close proximity to the refuge with similar habitats and species occurrences are including Lake Kissimmee State Park, Highlands Hammock State Park, Lake Wales Ridge State Forest, and Avon Park Air Force Range (PIF 2009).

RELATIONSHIP TO STATE WILDLIFE AGENCY

A provision of the Improvement Act, and subsequent agency policy, is that the Service shall ensure timely and effective cooperation and collaboration with other state fish and game agencies and tribal governments during the course of acquiring and managing refuges. State wildlife management areas and national wildlife refuges provide the foundation for the protection of species, and contribute to the overall health and sustainment of fish and wildlife species in the State of Florida.

State agency partners of the Lake Wales Ridge NWR include the FWC, FDEP, FDOF, SFWMD, and SWFWMD.

Management of state fish and wildlife resources is administered by FWC, FDACS, and FDEP for the long-term well-being and benefit of people. FWC protects and manages more than 575 species of wildlife, more than 200 native species of freshwater fish, and more than 500 native species of saltwater fish; while balancing these species' needs with the needs of more than 18 million residents (U.S. Census Bureau 2007) and the over 85 million annual visitors (FDOT 2008) who share the land and water with Florida's wildlife.

The FWC responsibilities include:

- Law Enforcement – to protect fish and wildlife, keep waterways safe for millions of boaters, and cooperate with other law enforcement agencies providing homeland security.
- Research – to provide information for the FWC and others to make management decisions based on the best science available involving fish and wildlife populations, habitat issues, and the human-dimension aspects of conservation.
- Management – to manage the state's fish and wildlife resources based on the latest scientific data to conserve some of the most complex and delicate ecosystems in the world along with a wide diversity of species.
- Outreach – to communicate with a variety of audiences to encourage participation and responsible citizenship and stewardship of the state's natural resources.

FWC, FDACS, and FDEP manage state lands and waters. FWC directly manages 1.4 million acres (0.57 million ha) and participates with other public land mangers on 2.9 million acres (1.2 million ha) and 220,000 acres (0.89 million ha) of private lands for recreation and conservation purposes. FDEP manages 150 state parks covering nearly 0.6 million acres (0.24 million ha) and 57 coastal and aquatic managed areas, totaling over 5 million acres (2 million ha) of submerged lands and coastal uplands.

FDOF manages over one million acres of state forests in Florida for multiple public uses including timber, recreation, and wildlife habitat. Operating from 15 field units throughout the state, FDOF maintains a mission to protect and manage the forest resources of Florida, ensuring that they are available for future generations. Wildfire prevention and suppression are key components in FDOF's efforts.

The SFWMD and SWFWMD are two of five state water management agencies. The districts are responsible for water management, water supply, and the conservation and protection of water resources while providing environmental, economic, and recreational benefits in all or part of 32 south and southwest Florida counties. Together, the SFWMD and SWFWMD along with their partners manage more than 1.05 million acres (0.43 million ha) (SFWMD 2009, SWFWMD 2010-2014) for the purposes of protecting, supplying, and conserving the region's water resources.

The state's participation and contribution throughout this planning process will provide for ongoing opportunities and open dialogue to improve the ecological sustainment of fish and wildlife in the State of Florida. An essential part of comprehensive conservation planning is integrating common mission objectives where appropriate.

II. Refuge Overview

INTRODUCTION

Located in Polk and Highlands Counties in the southern and central portion of Florida, Lake Wales Ridge NWR is one of three refuges (including Archie Carr and Pelican Island NWRs) managed as the Pelican Island National Wildlife Refuge Complex (PIC), which is part of the larger Merritt Island NWR Complex (Figure 1). The Lake Wales Ridge NWR is one of the first refuges of its kind in the Refuge System to target community level conservation. Establishment of the Lake Wales Ridge NWR emphasized the Service's commitment to the conservation of biological diversity, targeting "the greatest concentration of local endemics in eastern North America" (Service 1990). At the time, refuge establishment represented an unprecedented opportunity to protect not only a number of federally listed plants and animals, but also one of the rarest vegetation communities in the Southeast Region - Florida scrub - and enabled Service representation as a partner in a larger system of scrub preserves located throughout the central Florida ridge system. At complete acquisition, the refuge was envisioned to significantly enhance the recovery of 13 federally listed threatened and endangered plants, to support the recovery of 13 additional plants that at the time were candidates for federal listing, and to enhance the recovery of four federally listed threatened vertebrate animals across approximately 19,630 acres [7,944 hectares (ha)] (Figure 2) (Service 1993).

Currently, the refuge owns 1,843.9 acres (746.2 ha) across four management units within the 12-unit acquisition boundary: Flamingo Villas Unit (1,039.1 ac/420.5 ha), Carter Creek Unit (627.5 acres/253.9 ha), Lake McLeod Unit (38 acres/15.4 ha), and Snell Creek Unit (139.3 acres/56.4 ha) (Figure 2) where 17 federally listed plants and 7 federally listed/candidate wildlife species are known to occur. The refuge's acquisition boundary was updated through the Service's Realty Office boundary files. Further updates through the course of preparing this CCP determined an acquisition boundary of 17,353.1 acres (7,022.5 ha) for the 12 units (Table 1). The partners have acquired approximately 7,986 acres (3,231.8 ha) of this boundary. In total, approximately 9,829.9 acres (3,978 ha) or almost 57 percent of the lands within the acquisition boundary have been acquired by the Service and partners. The remaining lands are a mix of privately held inholdings and developed or planned easements, rights-of-way, and common areas. For fire management purposes and to meet operational, logistical, and safety requirements, the functional fire management boundary of the refuge is slightly larger at 2,108.8 acres (853.4 ha) due to the inclusion of private inholdings. The four units currently managed by the Service as the Lake Wales Ridge NWR are separated by 60 miles (96.5 km) of urban, rural, and natural lands between the central Florida town of Haines City to the outskirts of Sebring, Florida (Figure 2).

The refuge, administratively established on April 22, 1994, is relatively new to the Refuge System and was envisioned to protect the last remnants of scrub ecosystem of a once vast expanse of the central Florida highlands (ridge) ecosystems. The refuge manages lands within 2 of the 12 major highlands or "ridges" of central Florida - the predominant Lake Wales Ridge and smaller but similar Winter Haven Ridge. Weekley et al. (2008) define the Lake Wales Ridge as a 808-square-mile (2,092-square-kilometer) area of xeric uplands, flatwoods, wetlands, and lakes, which stretches 115.7 miles (186.3 km) from just south of Lake Harris in Lake County, Florida, to near the Highlands/Glades County line and averages 7.3 miles (11.7 km) in width (maximum width 11.3 miles/18.2 km) (Weekley et al. 2008). Though the name implies a single physiographic area, the Lake Wales Ridge actually consists of three elevated, sandy ridges that were once the beach and dune systems of Miocene, Pliocene, and early Pleistocene seas (Christman and Judd 1990). These relic dunes and the deep, sandy, well-drained soils support a number of plant communities that have adapted to xeric

conditions over millions of years. The approximately 80.7-square-mile (225-square-kilometer) Winter Haven Ridge is located west of the Lake Wales Ridge in central Polk County, Florida, and is believed to be a remnant of previous widespread uplands (White 1970). Based on species distribution, the ridges are biogeographically related (Christman 1988).

Due to the elevation and geologic age of the soils of Lake Wales Ridge scrubs, it has been estimated that the highest hill tops in this area have supported upland vegetation for about 2.5 million years. On the LWR, an estimated 200 ancient scrub islands have been identified (Christman and Judd 1990). Between ridges and the base of hills, soils become fine and compacted and often retain surface water, forming wetlands and lakes. Rainfall, seepage, and elevated water tables provide the sources of water for these aquatic systems. Combined with the aquatic and wetland communities that now exist between and within the ridges, this region consists of a complex mosaic of habitats, some unique to Florida (Service 1999).

Because of its complexity, the Lake Wales Ridge contains a wide diversity of plant and animal communities. However, it is the xeric upland plant and animal associations that constitute the majority of surface area. Although relatively common within the Lake Wales Ridge, these xeric communities are rare when compared to their relative distribution within the state and nation. Several major ecological communities found within the Lake Wales Ridge subregion provide important habitat for imperiled species. The most important of those are scrub, high pine, scrubby flatwoods, lakes, and freshwater marshes (Service 1999).

It is estimated that about 80,000 acres (32,374 ha) of Lake Wales Ridge scrub existed before the arrival of European settlers. Today, roughly 85 percent of Lake Wales Ridge scrub and sandhill habitats have been lost to development and agriculture (Turner et al. 2006). The ecosystem now harbors one of the highest concentrations of imperiled species in the United States (Turner et al. 2006), and many of the endemic plants found nowhere else on earth but the ridge ecosystems face extinction.

REFUGE PURPOSES AND HISTORY

REFUGE PURPOSES

Recognizing the need to protect the last vestiges of the Lake Wales Ridge, its plants, and wildlife, the Lake Wales Ridge NWR was administratively approved on February 15, 1994 and established on April 22, 1994, with a primary purpose provided for under the Endangered Species Act “to conserve (A) fish or wildlife which are listed as endangered species… or (B) plants…” (16 U.S.C. 1534, Endangered Species Act). The primary purpose applies to the entire refuge.

A secondary purpose has also been applied to the refuge: “conservation, management, and restoration of the fish, wildlife, and plant resources and their habitats for the benefit of present and future generations of Americans” [16 U.S.C. 668dd (a) (2)], (National Wildlife Refuge Administration Act).

REFUGE HISTORY

Recognizing the uniqueness of the Lake Wales Ridge physiographic area, TNC began purchasing ecologically sensitive sites along the ridge in the early 1980s. By the mid-1980s, the Florida Game and Freshwater Fish Commission (FWC) supported Steve Christman’s inventory of rare plants and animals of the Lake Wales Ridge, which further detailed its uniqueness, importance, and diversity. Momentum to establish a series of naturally managed lands throughout the Lake Wales Ridge came together in the late 1980s and early 1990s. John Fitzpatrick, Director, ABS, convened a meeting with scientists, botanists, and biologists from numerous federal and state agencies and non-profit

organizations familiar with the Lake Wales Ridge ecosystem, including the Service. The meeting was designed to focus attention on the uniqueness of the ridge ecosystem, its many endemic plants, and the alarming rate at which they were disappearing. Soon afterwards, a rapid and concerted effort of land acquisition among federal and state agencies and non-profit organizations began. The area conservation and land management partners formed the LWREWG in 1991, as a forum to share information and coordinate management activities. Also in 1991, ridge sites were submitted to the State's Conservation and Recreation Lands acquisition program (CARL).

By November 1993, the Service developed the Final Environmental Assessment (EA) and Land Protection Plan (LPP) that proposed establishment of the Lake Wales Ridge NWR. The original acquisition boundary included over 12 separate units, encompassing approximately 19,630 acres (7,944 ha) in Polk and Highlands Counties (Table 1 and Figure 2), to protect the remnants of this rare ecosystem containing an unusually high number of endemic plants and animals (Service 1993). In February 1994, the Service officially approved the refuge and it became a satellite refuge under the management authority of the Merritt Island NWR Complex due to its proximity to Lake Wales Ridge interests and its expertise in coastal scrub and fire management.

Concurrent with the establishment of the refuge, partner agencies and organizations also purchased tracts within the approved refuge acquisition boundary and along the Lake Wales Ridge, which helped fulfill many of the land acquisition priorities originally described in the refuge's LPP. The State of Florida through the CARL (now called the Florida Forever Program), FWC, and FDOF started purchasing lands in this area. Also, TNC increased its acquisition efforts on the LWR. This was later followed by Polk County through a proactive approach to acquire environmentally sensitive lands through bond referendums. Highlands County, SFWMD, and SWFWMD soon followed and became partners in protection of the Lake Wales Ridge. In a short period, there were more than a dozen entities buying lands on the Lake Wales Ridge and Winter Have Ridge for conservation.

Congress authorized funding for land acquisition by the Service in 1994. Working with the partners, the Service developed an acquisition strategy for five units within the approved acquisition boundary that remained unprotected: Flamingo Villas, Polk #52, Lake McLeod, Snell Creek, and Horse Creek (see Table 1 for current management and ownership status of the refuge's 12-Unit acquisition boundary). Between 1994 and 1997, the Service purchased lands within the Flamingo Villas, Lake McLeod, and Snell Creek acquisition boundaries. Working with the State of Florida and TNC, and as a result of unexpected funding opportunities, the Service opportunistically purchased 627.5 acres (253.9 ha) within the Carter Creek Unit acquisition boundary in 1998. Most of the Horse Creek Unit was acquired by the State of Florida, while the Polk #52 Unit is currently unprotected.

A further prioritization of the Service's land acquisition commitments, which takes into consideration the need to consolidate ownership and management efforts with partners of lands within the refuge's approved acquisition boundary, shifted land acquisition priorities from the five targeted units identified above to the four units where Service acquisition efforts had historically taken place - Flamingo Villas, Carter Creek, Lake McLeod, and Snell Creek. The acquisition of unprotected, private inholdings is the Service's highest acquisition priority. Over $3.48 million in federal funding has been used to acquire lands from willing sellers within the refuge's acquisition boundary, targeting the four refuge management units for habitat protection and management benefiting rare, threatened, and endangered species (Table 2).

Table 1. Management status of the Lake Wales Ridge NWR acquisition boundary

Unit Name	1993 LPP Acquisition Boundary (acres/ ha)	Service Realty Boundary File (acres/ha)	2009 Updated Acquisition Boundary* (acres/ha)	Service Owned Lands (acres/ha)	Partner Protected Lands (acres/ha)	Other (i.e. ROW Common Areas, Easements) (acres/ha)	Unprotected Lands (inholdings) (acres/ha)
Carter Creek	5,740a 2323h	5,563.4a 2,251.3h	5,506.1a 2,228.2h	627.5a 253.9h	2,376.5a 961.7h	338.1a 136.8h	2,164.0a 875.7h
Flamingo Villas	1,600a 647h	1,429.0a 578.3h	1,436.2a 581.2h	1,039.1a 420.5h	1.0a 0.4h	151.3a 61.2h	244.8a 99.1h
Gould Road	320a 129h	310.1a 125.5h	310.1a 125.5h		224.5a 90.9h	20.2a 8.2h	65.4a 26.5h
Holmes Avenue	1,260a 510h	1,297.8a 525.2h	1,297.8a 525.2h		493.5a 199.7h	264.2a 106.9h	540.1a 218.6h
Lake June South	1,030a 417h	935.8a 378.7h	935.8a 378.7h		834.4a 337.7h	28.7a 11.6h	72.7a 29.4h
Placid Lakes	2,560a 1,036h	2,179.3a 881.9h	2,179.3a 881.9h		1,858.9a 752.3h	26.9a 10.9h	293.5a 118.8h
Arbuckle	20a 8h	19.2a 7.8h	19.2a 7.8h		18.1a 7.3h	0.7a 0.3h	0.4a 0.2h
Flaming Arrow	5,430a 2,197h	3,728.0a 1,508.7h	3,728.0a 1,508.7h		1,249.8a 505.8h	75.9a 30.7h	2,402.3a 972.2h
Horse Creek	790a 320h	837.0a 338.7h	837.0a 338.7h		487.9a 197.4h	9.5a 3.8h	339.6a 137.4h
Lake McLeod	50a 20h	62.0a 25.1h	46.8a 18.9h	38.0a 15.4h		1.0a 0.4h	7.8a 3.2h
Polk # 52	510a 206h	573.4a 232.0h	573.4a 232.0		232.8a 94.2h		340.6a 137.8h
Snell Creek	320a 129h	484.2a 195.9h	483.4a 195.6	139.3a 56.4h	208.6a 84.4h	24.1a 9.8h	111.4a 45.1h
Total	**19,630a 7,944h**	**17,417.6a 7,049.1h**	**17,353.1a 7,022.5h**	**1,843.9a 746.2h**	**7,986.0a 3,231.8h**	**940.6a 380.6h**	**6,582.6a 2,663.9h**

** Acreages of the four refuge management units were updated using ArcGIS 9.3.1. The digital version of the acquisition boundary of the four refuge management units (in bold) were updated using a created digital image representation of the original, paper acquisition boundary from the 1993 LPP, 2007 Highlands and Polk County digital aerial imagery, the latest Service Division of Realty refuge boundary image files (from http://www.fws.gov/data/r4gis/boundary?Meta/lkwbnd.html 2009c) and the most recent parcel data from Highlands and Polk Counties. The remaining eight units were not updated as the refuge does not currently manage within these boundaries. Protected lands that are not the four refuge management units were identified using updated County parcel information and Florida Natural Areas Inventory (FNAI) Conservation Lands GIS coverage, (FNAI 2009a).*

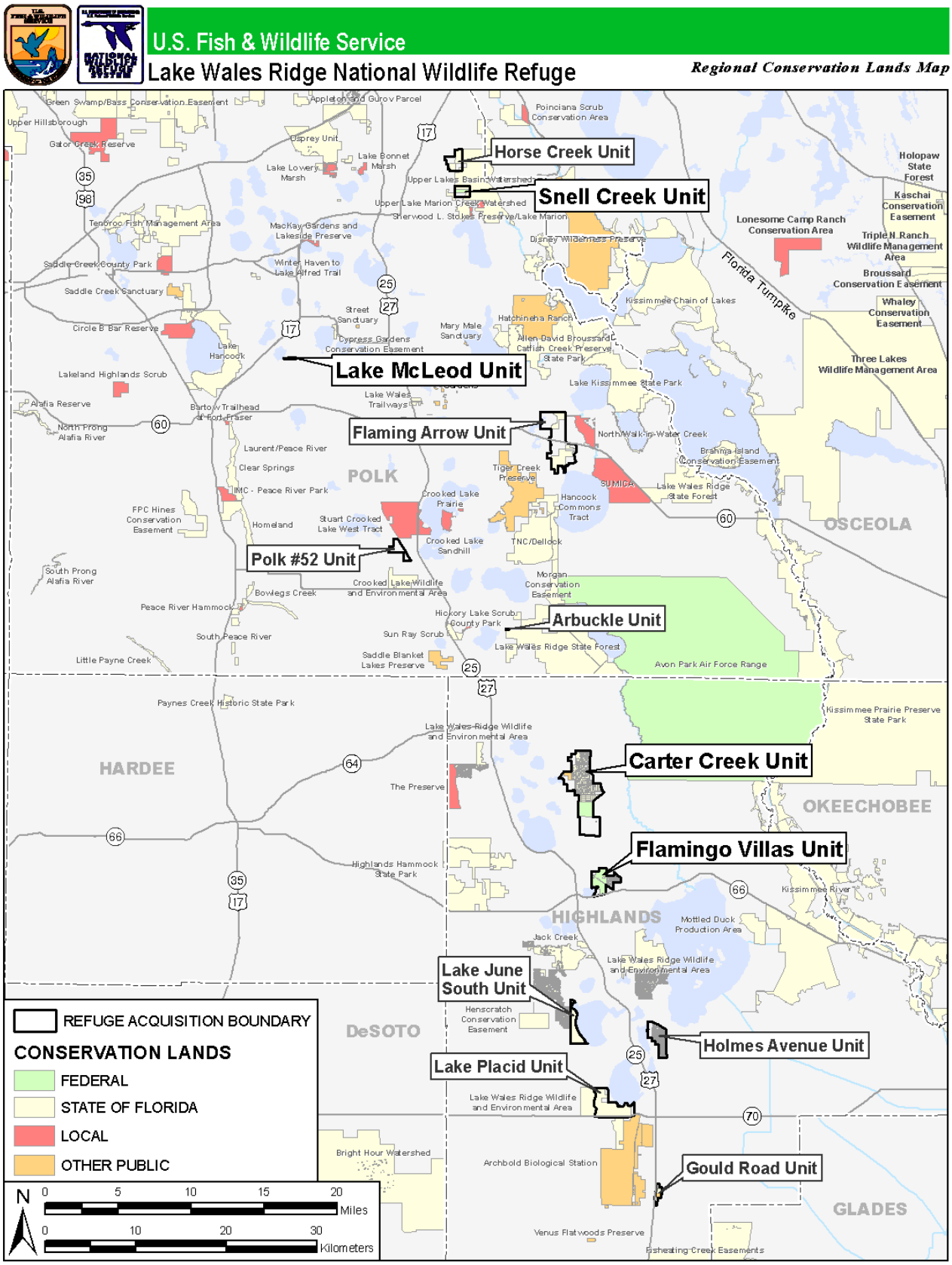
Table 2. Acquisition history of Lake Wales Ridge NWR CY 1994 through CY 2009

Date (CY)	Area*		Cost ($1,000)	Cost/Area ($1,000)	
	Acres	Hectares		Acres	Hectares
1994	65.3	26.4	$126.0	$1.9	$4.8
1995	311.9	126.2	$491.0	$1.6	$3.9
1996	282.8	114.4	$502.5	$1.8	$4.4
1997	27.6	11.2	$215.5	$7.8	$19.3
1998	629.1	254.6	$1,334.5	$2.1	$5.2
1999	518.2	209.7	$610.0	$1.2	$2.9
2000	5.5	2.2	$11.6	$2.1	$5.2
2001	0	0	N/A	N/A	N/A
2002	11.0	4.5	$22.0	$2.0	$4.7
2003	2.3	0.9	$4.5	$2.0	$5.0
2004	1.0	0.4	$5.5	$5.5	$6.0
2005	1.9	0.8	$22.5	$11.7	$28.9
2006	1.0	0.4	$12.4	$12.4	$31.0
2007	0.25	0.1	$8.0	$32.0	$79.1
2008	2.25	0.9	$72.0	$28.8	$71.2
2009	1.5	0.6	$46.0	$30.7	$75.8
TOTAL	**1,861.9**	**753.5**	**$3,486.5**	**Average $1.9**	**Average $4.6**

**Values based on Service's Annual Report of Lands Under Control of the U.S. Fish and Wildlife Service. GIS analysis provided in this Plan determined 1,843.9 acres (746.2 ha) using a combination of current Polk and Highlands County parcel data and 2007 aerial imagery. This discrepancy may be explained in part by spatial differences of parcels represented by the Service as compared with current local parcel data. For instance, a difference of over 20 acres between the data sets was identified for one of the larger parcels in the Flamingo Villas Unit. It is anticipated that mapping discrepancies may be rectified through the implementation of refuge boundary updates currently being conducted by the Services Division of Realty. However, these updates were not available for the development of this Plan. Therefore, staff utilized the most current representation of parcel data represented by local governments and recent aerials to determine refuge acreages, boundaries, and other spatial needs for the preparation of this Plan.*

Today, the refuge is an important part of a network of conservation lands located throughout the Central Florida ridge system, managed by a variety of land conservation partners including federal, state, and local agencies, and non-governmental organizations among others (Figure 3).

Figure 3. Area conservation lands



SPECIAL DESIGNATIONS

FLORIDA NATURAL AREAS INVENTORY NATURAL COMMUNITIES RANKING

The Florida Natural Areas Inventory (FNAI 1990) standard classification system of 81 natural communities in Florida ranks many of the natural communities that occur on the refuge as imperiled or rare on both a global and statewide basis, including sandhill (G3/S2), scrub (G2/S2), xeric hammock (G3/S3), depression marsh (G4/S4), scrubby flatwoods (G3/S3), baygall/bayhead (G4/S4), and mesic flatwoods (G4/S4). In addition, many of the rare, threatened and endangered plants and animals that occur or are thought to occur on the refuge have elemental global and state status as ranked by FNAI (see Table 6 for species of the upland habitats of the Lake Wales Ridge and definitions of rankings). As defined, a natural community is a distinct and recurring assemblage of populations of plants, animals, fungi, and microorganisms naturally associated with each other and their physical environment. Natural community types are hierarchically categorized by hydrology and vegetation, landform, substrate, soil moisture condition, climate, fire, and characteristic vegetation. FNAI uses several criteria to determine the relative rarity and threat to each community type which are translated or summarized into a global and a state rank, the G and S ranks respectively. Most G ranks are temporary pending comparison and coordination with other states using this methodology to classify and rank vegetation types. One of the advantages of the FNAI classification system is that it is flexible and dynamic, changing as additional data are accumulated which benefit management, particularly addressing species and ecosystem response to restoration management and as a result of climate change.

RIDGE SCENIC HIGHWAY

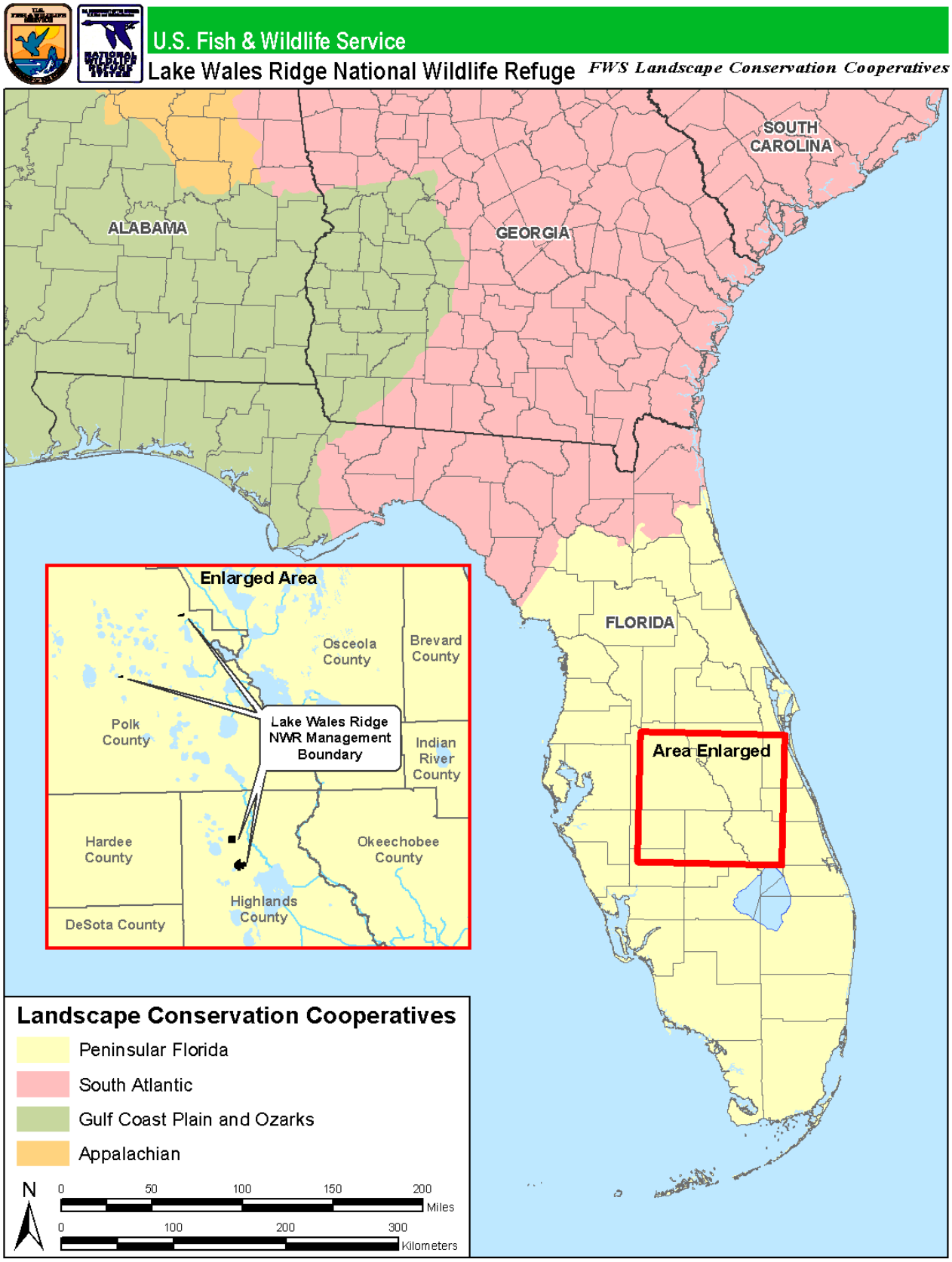
In February 2005, the FDOT officially designated State Road 17 in eastern Polk County a State Scenic Highway. Although the refuge units do not occur along the Highway 17 corridor now considered a State Scenic Highway, historic small towns, important natural areas and valuable citrus farms do, offering additional opportunities to promote awareness about the unique features of the ridge to travelers. The Ridge Scenic Highway extends 38.7 miles along the Lake Wales Ridge from its intersection with U.S. 27 south of Frostproof to its intersection with U.S. 17/92 in Haines City. The scenic highway corridor travels through the historic communities of Frostproof, Hillcrest, Babson Park, the Village of Highland Park, Lake Wales, Lake of the Hills, Dundee, Lake Hamilton, and Haines City. The scenic corridor introduces travelers to historic communities and rural agricultural central Florida, providing access to historical sites and communities that help promote and preserve the local culture. Winding along Lake Wales Ridge, State Road 17 provides scenic vistas and access to lakes, natural areas, citrus agricultural fields, and unique Florida attractions (Polk County 2009).

ECOSYSTEM CONTEXT

PENINSULAR FLORIDA LANDSCAPE CONSERVATION COOPERATIVE

The refuge lies within the Peninsular Florida LCC (Figure 4). Comprising one of the 16 delineated LCCs in the continental U.S., the Service's Peninsular Florida LCC includes several important areas with protective designations, including Ocala National Forest, Everglades National Park, Welaka National Fish Hatchery, and numerous national wildlife refuges. Various other local, state, and federal conservation areas are also located within the Peninsular Florida LCC. The Peninsular Florida LCC spans temperate and subtropical climates, numerous physiographic districts, and a wide variety of habitats. Barrier islands, xeric scrub, pine flatwoods, freshwater marshes, lakes, streams, springs, mixed hardwood/pine forests, cypress swamps and domes, dry prairies, maritime forests, hardwood hammocks, estuarine marshes, pine rocklands, sandhill woodlands, coastal strands,

Figure 4. Peninsular Florida Landscape Conservation Cooperative



sawgrass prairies, sloughs, and tree islands of the Peninsular Florida LCC serve a variety of native wildlife, including over 100 federally listed species, as well as interjurisdictional fishes, neotropical migratory birds, nongame waterbirds, and waterfowl.

The biggest problem facing the Peninsular Florida LCC is the loss of habitat through direct destruction and fragmentation, as well as through impacts from human activities. The predominant stresses for the Peninsular Florida LCC are human population growth; tourism; agriculture; silviculture; mining; water channelization; urbanization; aquifer depletion; fire suppression; exotic species; nonpoint source pollution; and point source pollution. The actions of the Peninsular Florida LCC are guided by two categories: trust resources and management issues. The trust resources include: migratory birds, anadromous fish, endangered species, and marine mammals. The management issues focus on habitat protection and management, habitat restoration, contaminants, regulatory compliance, law enforcement, and biodiversity.

Lake Wales Ridge NWR plays an important role in the Peninsular Florida LCC, especially with regard to the conservation of scrub habitat. The refuge has been managed primarily for the restoration and maintenance of habitat for rare, threatened, and endangered species. The Peninsular Florida LCC geography includes both the Lake Wales and Winter Haven ridges, where stakeholders have acquired thousands of acres of scrub habitat to protect these systems from a variety of stresses including loss of habitat resulting from urbanization and land conversion.

The South Florida Ecosystem represents a mixture of Caribbean-subtropical, southern temperate, and local influences, resulting in a wide variety of habitats that support substantial ecological, community, taxonomic, and genetic diversity, including the 8-mile-wide by 100-mile-long span of the Lake Wales Ridge. The Lake Wales Ridge feature occurs in the Kissimmee River Subregion of the South Florida Ecosystem and is characterized by the many diverse habitat types, including isolated patches of scrub islands imbedded in pine communities occurring on well-drained, sandy soils. The Kissimmee River Subregion extends for more than 100 miles from an area just south of Orlando to Lake Okeechobee and includes numerous interconnected lakes and the Kissimmee River. The drainage forms the headwaters of the Everglades and provides a critical water source for Lake Okeechobee. The Lake Wales Ridge rises sharply along the western edge of the Kissimmee River drainage basin and is connected hydrologically through numerous sinkhole lakes scattered along the 100-mile-long Lake Wales Ridge. These surface lakes recharge the aquifer and provide an important water source for the Kissimmee River system and Lake Okeechobee (Service 1998). The Lake Wales Ridge NWR is a vital component of the South Florida Ecoregion, especially with regard to the conservation of listed plants and the habitats they occupy.

REGIONAL CONSERVATION PLANS AND INITIATIVES

A variety of regional conservation plans and initiatives were reviewed in preparation of this CCP including recovery plans for federally listed species and the South Florida Ecosystem Plan, as well as state and local plans, including plans and initiatives from the State of Florida, TNC, ABS, Polk and Highlands Counties, and the Central Florida Regional Planning Council.

RECOVERY PLANS

The 1999 South Florida Multi-Species Recovery Plan is one of the first recovery strategies specifically designed to meet the needs of multiple species that do not occupy similar habitats. The refuge plays a role in the recovery of 17 federally listed plant species and is absolutely critical to the recovery of Florida ziziphus (*Ziziphus celata*), Garrett's mint (*Dicerandra christmanii*), and scrub lupine (*Lupinus aridorum*); six federally listed animal species, including Florida scrub-jay (*Aphelocoma coerulescens*),

sand skink (*Neoseps reynoldsi*), and bluetail mole skink (*Eumeces egregious lividus*), and the Highlands tiger beetle (*Cicindela highlandensis*), a federally listed candidate species.

The Service is required under Section 4 (c) (2) of the Endangered Species Act of 1973, as amended, to conduct reviews of each federally listed species. These 5-year reviews are conducted to determine if a federally listed species should be delisted, reclassified from endangered to threatened status or from threatened to endangered status, or status of the species should remain the same. The purpose of the 5-year review is to ensure that listed species have the appropriate level of protection under the Endangered Species Act. Many of the species identified in the plan have undergone recent 5-year reviews enabling the most up-to-date information concerning status and trends for many of the refuges listed species.

STATE WILDLIFE ACTION PLAN

As a requirement for participating in the Service's State Wildlife Grants Program, each state and territory created a Comprehensive Wildlife Conservation Strategy for conservation of a broad array of fish and wildlife. Throughout the development process, the objectives were to identify species of greatest conservation need and their habitats and to develop high-priority conservation actions to abate problems for those species and habitats. These objectives have been developed in a prudent effort to prevent declines before species become imperiled, thereby saving millions of tax dollars. In addition, the matching requirement has encouraged partnerships and cooperation among conservation partners. To meet the intent of the Service's State Wildlife Grants Program, the FWC created Florida's Wildlife Legacy Initiative (Initiative).

The goal of the Initiative was to develop a strategic vision for conserving all of Florida's wildlife. Florida's Comprehensive Wildlife Conservation Strategy (FCWCS) was completed and approved in 2005. The FCWCS emphasizes the building of partnerships with other agencies and the private sector, uses a habitat-based conservation approach, incorporates a broad definition of wildlife (to include invertebrates, aquatic species, and other species), and favors non-regulatory methods in its effort to reach conservation goals and objectives, many of which provided useful guidance in developing CCP benchmarks. The FCWCS identifies 118 state endangered, threatened, and species of special concern. Twenty-four projects have been identified in the FCWCS specific to interior scrub and sandhill taxa that utilize the refuge, including sand swimming reptiles and the Florida scrub-jay (FWC 2005). The refuge manages important scrub habitat which is specifically identified as one of eight habitats having the highest relative threat status of the 45 habitats identified.

FLORIDA'S ENDANGERED AND THREATENED SPECIES MANAGEMENT CONSERVATION PLAN

Florida's Endangered and Threatened Species Management and Conservation Plan and annual Progress Report provide management and conservation guidance as required under Section 5 of the Florida Endangered and Threatened Species Act of 1977 [372.072, Florida Statures (F.S.)]. The Act requires the preparation of an initial plan, and any subsequent revisions regarding the management and conservation of endangered and threatened species to be submitted annually. It addresses research and management priorities and FWC's citizen's awareness program, and it includes a progress report on agency actions for listed species. Many state-listed species are known to occur on the refuge, including Florida mouse (*Podomys floridanus*), Florida gopher frog (*Rana capito*) gopher tortoise (*Gopherus polyphemus*), Florida scrub lizard (Sceloporus woodi), black bear (*Ursus americana*), cutthroat grass (*Panicum abscissum*), scrub stylisma (*Stylisma abdita*), nodding pinweed (*Lechea cernua*), scrub bay (*Persea humilis*), and Curtiss' milkweed (*Asclepias curtissii*).

FLORIDA NATURAL AREAS INVENTORY

The Florida Natural Areas Inventory (FNAI) is a non-profit organization dedicated to gathering, interpreting, and disseminating information critical to the conservation of Florida's biological diversity. FNAI is the primary source for information on Florida's conservation lands with an interactive inventory database that includes boundaries and statistics for more than 1,600 federal, state, local, and private managed areas, provided directly by the managing agencies. FNAI was founded in 1981 as a member of TNC's international network of natural heritage programs. The databases and expertise of FNAI facilitate environmentally sound planning and natural resource management to protect the plants, animals, and communities that represent Florida's natural heritage. All refuge management units are included in the FNAI database.

FLORIDA FOREVER PROGRAM

The Florida Forever Program, created in 1999 by the Florida Legislature, follows in the footsteps of earlier successful land acquisition programs in the State of Florida by continuing to focus land acquisition efforts in several resource categories including natural communities, forest resources, plants, fish and wildlife, freshwater supplies, coastal resources, geologic features, historical resources, and outdoor recreational resources. All refuge management units lie within the boundaries of the Board of Trustees Land Acquisition Projects. Lands have been proposed for acquisition in the Florida Forever Program because of outstanding natural resources, opportunity for natural resources-based recreation, or historic and archaeological resources.

GREEN HORIZONS LAND TRUST

The Green Horizons Land Trust was created to preserve environmentally valuable or sensitive lands and open space in and around the central Florida ridge systems for the benefit of the general public, and to educate the public as to the importance of such lands and their preservation. Green Horizons is a local, nonprofit, 501(C)(3) Florida corporation incorporated in 1991 and governed by a Board of Directors consisting of local individuals from such diverse fields as business, law, banking, real estate, land planning, and conservation. Green Horizons uses a variety of creative methods to achieve its land conservation goals and to financially benefit donors. Conservation may be accomplished through outright purchases, bargain sales, donations, conservation easements, limited development agreements or similar techniques as landowners may be able to take advantage of income, estate, or property tax benefits that can help make land conservation affordable. The trust has acquired thousands of acres, mostly in Polk, Osceola, and Citrus Counties, and placed them in preservation for protection of habitat and for the enjoyment of the public in perpetuity. Some lands are managed directly by Green Horizons, but many have been acquired by donation or purchase then placed in the stewardship of cities, counties, or Florida water management districts for the benefit of the public. With the exception of properties that are inaccessible by roads, all are planned to be or are currently open to the public for low impact recreation such as hiking, biking, canoeing, bird watching, or environmental education (Green Horizons Land Trust 2009).

SOUTH FLORIDA WATER MANAGEMENT DISTRICT GENERAL MANAGEMENT PLANS

Lake Marion Creek/Reedy Creek Management Area Five-Year General Management Plan (2005-2010) identifies the Snell Creek Unit within the influence of its program. The Lake Marion/Reedy Creek Management Area is a Save Our Rivers project that lists management goals and objectives, provides historic and current site information, and describes specific management issues and activities relating to natural resources, public use, and project administration from 2005 through 2010. Natural resource management of Lake Marion/Reedy Creek Management Area includes

maintenance of natural vegetative communities, wildlife management, and the protection of threatened and endangered species. Current natural resource management activities focus on prescribed fire, vegetation management, and forest management, including exotic plant control, prescribed burning, and environmental restoration of these scrub sites (SFWMD 2005).

THE NORTHERN EVERGLADES AND ESTUARIES PROTECTION PROGRAM (NEEPP)

In May 2007, the Florida legislature passed the Northern Everglades and Estuaries Protection Program (NEEPP) which expanded the existing Lake Okeechobee Protection Act (LOPA) to include Caloosahatchee and the St. Lucie Rivers and Estuaries. The program promotes a comprehensive, interconnected watershed approach to protecting these systems and recognizes the importance and connectivity of the entire Everglades ecosystem from the Kissimmee Chain of Lakes south to Florida Bay. The Florida legislation charged the SFWMD, the FDEP, and the FDACS to effectively coordinate in order to create the NEEPP with the primary goal to restore and protect surface water resources by addressing water quality, quantity, and the timing and distribution of water to the natural system. Refuge managed units play a role in the surface water quality objectives identified through NEEPP as the Flamingo Villas, Snell Creek, and Carter Creek units are within the Kissimmee River Basin.

THE NATURE CONSERVANCY CONSERVATION ACTION PLAN FOR LAKE WALES RIDGE

The Nature Conservancy plays a vital role in conservation of the central Florida ridge system. The TNC's Lake Wales Ridge program, utilizing standards developed by the Conservation Measures Partnership–a partnership of 10 different biodiversity non-governmental organizations–developed a Conservation Action Plan (CAP) and associated Conservation Project Management Workbook, providing a straightforward and proven process for developing conservation strategies and measuring the effects of those strategies based on biodiversity interests, threats, stakeholder input, and habitat and species response outcomes. The interactive model identifies project scopes and targets; assesses the viability of conservation strategies; identifies stresses and sources of stress to the ecosystem; develops objectives, strategic actions, and action steps to take; and describes a monitoring plan to measure success of management practices – specifically for ridge species and habitats, including Florida scrub-jay, sand dwelling organisms, rare upland plants of concern, cutthroat grass communities, xeric uplands matrix, and Florida ziziphus populations. Identifying the viability and success of regional conservation projects is a key to the successful implementation of refuge management projects, especially in this setting of scattered naturally managed areas (TNC 2009a).

STATE OF THE SCRUB

Produced by ABS, written in 2006 by Will Turner, David Wilcove, and Hillary Swain, this document represents the most current information on conservation progress, management responsibilities, and land acquisition priorities for imperiled species of Florida's LWR (Turner et al. 2006). The report collates and synthesizes data on 36 of the ecosystem's rare and endemic species (Turner et al. 2006) and evaluates the success of land acquisition efforts in reducing threats to imperiled species using a new quantitative approach (Turner et al. 2006). In addition, the report estimates the effectiveness of the reserve network that is likely to result from planned and future acquisitions (Turner et al. 2006). The State of the Scrub identifies several species on the LWR that merit special attention from land managers, and quantification of the importance of each site to each of the rare species is provided, thereby highlighting those sites that are likely to the survival of particular species (Turner et al. 2006). Finally, high-priority sites are determined for future acquisition based on their biological value and cost-effectiveness (Turner et al. 2006). Based on the known occurrence data and as synthesized by Turner et al. (2006), the Lake Wales Ridge NWR management units contain 21 of the 36 reported species.

HEARTLAND 2060 INITIATIVE

Heartland 2060 is a collaborative, creative planning process sponsored by the Central Florida Regional Planning Council (CFRPC) designed to craft a shared regional vision and growth strategy for the future of the 7-county CFRPC region, which includes Highlands and Polk Counties. The CFRPC is a planning and public policy agency which works with public and private leadership in the central Florida region to achieve a healthy and sustainable future (CFRPC 2009). Through a participatory process, Heartland 2060 will develop a regional blueprint to guide growth and development over the next 50 years (CFRPC 2009). The process will establish priorities for protecting and enhancing conservation areas, natural resources, recreational areas, and open spaces and develop a host of social and economic initiatives, including guiding transportation corridors and planning future land-use within the 7-county central Florida region. The Service and refuge have participated in visioning sessions and regional conservation task force initiatives to participate in and foster partnerships with Heartland 2060 regional members.

HIGHLANDS COUNTY COMPREHENSIVE PLAN

Highlands County is a major contributor of natural area acquisition and protection in Highlands County, primarily through the vision and implementation of the Highlands County Comprehensive Plan. The Highlands County Comprehensive Plan identifies acquisition of natural resources including scrub and sandhill habitats (xeric habitats); endemic populations of threatened or endangered species, including species of special concern; wetlands and cutthroat seeps, and un-canalized freshwater estuaries feeding the lakes; important aquifer recharge functions; and unique scenic or natural resources through the plan's Natural Resources Element utilizing the Conservation Trust Fund account. Acquisition can be in the form of fee purchase, easements, donations, and other less than fee mechanisms) of natural resources listed above for the enhancement, required maintenance, and/or management of publicly owned conservation-valued lands, as determined by the Highlands County Board of County Commissioners (Board). The Conservation Trust Fund is funded through voluntary contributions, mitigation or impact fees, matching grants, and referendum while other sources of funding as recommended by the Highlands County Natural Resources Advisory Commission (NRAC) are considered by the Board. NRAC was established in 1991 by the Board whose members include 11 full-time residents of Highlands County, including environmental, developmental, agricultural, professional, and at-large representatives, who function as an advisory body to the Board on matters of natural resource protection, environmental clearance, and the stewardship of conservation efforts by, in, and for Highlands County (Highlands County 2009).

POLK COUNTY ENVIRONMENTAL LANDS PROGRAM

Polk County is a major contributor of natural area protection, acquiring more than 12,000 acres of diverse lands in the county through the Polk County Environmental Lands Program (Program). The Program accepts site nominations and then gathers pertinent information for each nomination. The Environmental Lands Criteria are used by the County's Technical Advisory Group and Conservation Land Acquisition Selection Advisory Committee (CLASAC) to rank sites and recommendations for or against acquisition of sites are forwarded to the Board of County Commissioners (BoCC) for consideration and approval. Costs for acquisition are shared with partners whenever possible. Once acquired, interim management begins and may include site security, debris removal, exotic species removal, and creation of visitor service amenities. A final management plan for each site is finalized and adopted by the BoCC based on evaluations of nature-based recreation opportunities and resource inventories to ensure compatibility with the site, and through input received via public review, CLASAC, and Polk County staff. Acquisition, management, and restoration of environmentally sensitive lands, water resources, and important

wildlife habitat in Polk County are funded through a 1994 bond referendum utilizing ad valorem taxes (0.2 mil) administered over a 20-year life span (Polk County 2009).

CRITICAL LANDS AND WATERS IDENTIFICATION PROJECT

The Critical Lands and Waters Identification Project (CLIP) is the Florida Century Commission's flagship project led by Thomas Hoctor, Ph.D., of the GeoPlan Center at the University of Florida and Jonathan Oetting of FNAI at Florida State University. CLIP uses science and the best available statewide spatial data to depict Florida's critical environmental resources in a database that can be used as a decision-support tool for collaborative statewide and regional conservation and land use planning to envision and ensure the sustainability of Florida's green infrastructure and vital ecosystem services (Century Commission for a Sustainable Florida 2010).

CLIP science recommendations will be vetted with rural landowners, state agencies, regional planning councils, and other stakeholders through the Cooperative Conservation Blueprint Initiative, led by FWC in partnership with the Century Commission and the Cooperative Conservation Blueprint steering committee. The goal is to develop a strategic plan for land and water conservation in Florida, using a new and broader range of conservation incentives with a shared view of the priorities.

CLIP priorities, depicting areas of opportunity for protecting biodiversity, landscapes, and water resources across the state, identified the Lake Wales Ridge NWR management units in a class of P1 lands–its highest priority as a result of high suitability for any G1S1 species (FNAI global rank) and multiple-less rare species. The Global (G) element rank is based on a species' worldwide status; the State (S) rank is based on the species' status in Florida (FNAI 2009); the 1 rank denotes species which are critically imperiled/extremely rare (five or fewer occurrences or less than 1,000 individuals) or extremely vulnerable to extinction.

ECOLOGICAL THREATS AND PROBLEMS

Lake Wales Ridge NWR faces major threats and various challenges resulting from the direct and indirect impacts of population growth and land development, including habitat loss and fragmentation, the spread of exotic plants and feral animals, illicit use of refuge resources, and added constraints on the ability to manage resources. Issues relating to a growing population are likely to increase in Highlands and Polk Counties as population growth is expected to increase by 126 and 75 percent respectively by 2060 (Zwick and Carr 2006).

Florida scrub habitat is ranked as the 15th most endangered ecosystem nationally (Noss and Peters 1995) and is identified as an "extreme risk" endangered ecosystem in the southeastern United States (FWC 2005). To date, roughly 85 percent of Lake Wales Ridge scrub and sandhill habitats have been lost to development and agriculture (Turner et al. 2006). Since 1945, land-use changes on the ridge have greatly reduced the native upland habitats of oaks and pines and the populations of plants and animals dependent on them (Menges et al. 1998).

The xeric upland habitats of Lake Wales Ridge harbor many rare and endemic species (Dobson et al. 1997, Chaplin et al. 2000 *in* Turner et al. 2006). Turner et al. (2006) reports that the LWR harbors one of the highest concentrations of imperiled species in the United States, including 29 species federally classified as endangered or threatened. Public and private institutions have invested substantial money and expertise over the past two decades to protect the remaining undeveloped areas on the Lake Wales Ridge, resulting in the acquisition of over 87 km^2 of scrub and sandhill habitat (Turner et al. 2006). These protected fragments are surrounded and impacted by residential neighborhoods, citrus groves, and other anthropogenic habitats, and they are managed by a variety

of state and federal agencies and private organizations, representing additional management challenges (Turner et al. 2006). Regionally, development of the remaining Lake Wales Ridge natural areas severely limits the ability of species to successfully migrate from one natural area to another–a life need central to species persistence and success. Throughout the Lake Wales Ridge, this notion is severely challenged as a result of land development and consequential habitat destruction. Specific to the Lake Wales Ridge NWR, conversion from proximal agriculture lands to residential uses challenges management options, including the ability to provide for a prescribed burning plan. Virtually all species investigated in the 2006 State of the Scrub depend upon some form of active management (most often prescribed fire) for their long-term persistence (Turner et al. 2006).

Fire management is essential for the recovery of the suit of endangered and threatened species found on the refuge. Increased development of lands proximal to refuge interests threatens the ability to provide necessary fire management activities. In addition, habitat fragmentation resulting from land development has degraded remaining undeveloped and unmanaged natural areas due to the reduction in the frequency and extent of wildfires (Turner et al. 2006). Mimicking natural frequencies to take the place of the loss of wildfire is therefore essential to the health and integrity of scrub/sandhill and ridge habitats (Turner et al. 2006).

The Heartland Coast to Coast Corridor and the Heartland Parkway are major transportation expressway systems proposed though the central Florida region. The path of the north-south and east-west expressways connect the central east coast of Florida (Fort Pierce) with the central west coast (Tampa area) and the southwest coast (Ft. Myers area) to central Florida's I-4 corridor (Lakeland) by way of new, multi-lane roads. The refuge and other natural areas throughout central Florida and the Lake Wales Ridge may be directly impacted by expressway construction and indirectly impacted by future development made possible by access to undeveloped lands provided by the expressway.

Most inholdings within the acquisition boundaries of the four refuge units are currently undeveloped. Flamingo Villas' inholdings are particularly susceptible to potential development with roughly 30 percent of the lots (316 lots) within the platted and approved Flamingo Villas subdivision currently undeveloped and privately owned (Figure 5.3.2). In 2005 and 2006, Highlands County sold tax deeds on approximately 125 lots within the Flamingo Villas Unit of the refuge. While none of the tax sale lots have been developed at this time, the sale has increased the potential for development. Due to underwriting requirements of title insurers, the Service has not been able to acquire any of the tax sale lots; however, the Service may purchase lots free of the tax deed title starting in the summer of 2010, and is in the process of preparing interest letters and purchase agreements for some of these parcels. Development of inholdings at Flamingo Villas would reduce the ability to manage the refuge for threatened and endangered species, specifically for prescribed fire planning and administration, the principle management action needed to recover listed species and maintain habitat structure and function.

Major utility and rail rights-of way exist or are proposed on or adjacent to the refuge. A railroad right-of-way exists through the Flamingo Villas Unit and major natural gas lines are proposed along the western border of the Carter Creek Unit. Florida Power and Light powerline easements exist on both the Carter Creek and Flamingo Villas Units. Further, roadway rights-of-way and undeveloped common areas exist on the eastern portion of Flamingo Villas. While all units are, or could be, adversely impacted by the consequences of urbanization, management of Lake McLeod is particularly challenged by the existence of residential development within its acquisition boundary and its adjacency to the surrounding urban interface.

The proliferation and impact of invasive plants on natural communities in Florida has been well documented (Simberloff et al. 1997). The most direct effect of invasive plants is the alteration of natural communities, either by changes in community structure or composition (Hutchinson et al. 2003). It appears that the xeric communities of the Lake Wales Ridge are not as susceptible to invasive plants as the more mesic communities are that lie to the east and west of the ridge (Hutchinson et al. 2003). However, refuge units provide a mix of habitat types, including pine flatwoods, cutthroat seeps, bayhead swamps, hammocks, and seasonal ponds which are all highly susceptible to invasive plants such as Old World climbing fern (*Lygodium microphyllum*), melaleuca (*Melaleuca quinquenervia*), downy rosemyrtle (*Rhodomyrtus tomentosa*), air potato (*Dioscorea bulbifera*), Brazilian pepper (*Schinus terebenthifolius*), Indian rosewood (*Dalbergia sissoo*), strawberry guava (*Psidium cattleianum*), para grass (*Urochloa mutica*), cogongrass (*Imperata cylindrica*), and other plants (Hutchinson et al. 2003). The refuge continues to treat non-native, invasive plants, but continued invasions are an on-going threat due to proximity to seed and spore sources. Maintenance of exotic invasive and feral species, including the feral hog (*Sus scrofa*), is necessary to conserve and manage for listed species and habitats.

Federally listed plants are provided some protection through the take and trade provisions of the Endangered Species Act and the preservation of native Flora of Florida Act. Protection from take (i.e., removal and reduce to possession) refers to species occurring on federal lands. Take on private lands is prohibited only in violation of state criminal trespass laws. Thus, neither act fully protects federally listed plants from destruction by private landowners (Service 1991). As the landscape continues to develop, these rare plants may become even rarer.

Other threats to the remaining scrub include off-road vehicle use and trash dumping. Off-road vehicle use may destroy the roots and underground stems of scrub vegetation and facilitate invasion of nonnative species. Dumping of domestic garbage in scrub areas is more of a nuisance, but may further degrade some sites (Service 1991).

PHYSICAL RESOURCES

CLIMATE

The climate for the central ridge of Florida is characterized by hot, humid summers and mild, dry winters. Average summer temperatures range from an average high of 91°F (33°C) to an average low of 70°F (21°C). Winter temperatures range from 48°F (9°C) to 75°F (24°C). Several freezes can be expected during the winter, with the coldest temperature recorded at ABS being 13°F (-11°C).

Average annual rainfall reported from Avon Park over the 30-year period from 1971 to 2000 is 49 inches (124.5 cm) (NOAA 2002). This rainfall tends to be seasonally distributed, with 60 percent occurring in the summer in the form of thunderstorms. Fall, winter, and spring precipitation are associated with cold fronts. These rains tend to be more widespread than the localized summer showers. Highest average monthly participation occurs in June with an average of 8.25 inches (21 cm). Lowest average precipitation occurs from October through April at between 2 and 3 inches (5.1 cm to 7.6 cm). Tropical cyclones also contribute to rainfall totals in some years. The 2004 hurricane season was very active, and the area between Lake Wales and Sebring received direct hits from three named storms, which did a great deal of damage to the area and to several of the refuge's management units.

GEOLOGY AND TOPOGRAPHY

Refuge lands in Polk and Highlands Counties are found on the Lake Wales and Winter Haven ridges' ecosystems characterized by hills and lakes. The highest elevation is over 300 feet [91.4 meters (m)], while the lowest elevation in the region is 40 feet (12.2 m) (Soil Survey Staff 1989). Slopes range from nearly level in the bayheads and flatwoods to 12 to 15 percent in the sandhills and sand ridges. Lakes in the region are generally sinkholes, formed by the dissolution and collapse of underlying limestone.

The Lake McLeod Unit in Polk County is the western-most property of the refuge and is located on the Winter Haven Ridge (Soil Survey Staff 1989). This area also has sinkhole lakes and rolling hills. The refuge property itself drops in elevation from east to west, eventually reaching Lake McLeod. Slopes on this unit are 0 to 5 percent. The Snell Creek Unit lies in Polk County as well and portions of it lie on the Lake Wales Ridge. The two other refuge management units, Flamingo Villas and Carter Creek, are located along the southern portion of the Lake Wales Ridge in Highlands County, which is underlain by the Avon Park Limestone formation from the Middle Eocene era. This is overlain by the Late Eocene Ocala Limestone formation and the Hawthorn Group from the Miocene period. This layer contains phosphate and is mined in many areas of central Florida. In the ridge section of the county, the Cypresshead Formation overlies the Hawthorne Group. It consists of sand, clay, and gravel that are generally red to orange in color. The top of this group is commonly exposed in clay pits along the ridge. Over most of the county, Pleistocene and Holocene sand and peat are found at the surface. These vary in thickness from 1 to 100 feet (30.5 m).

SOILS

The soils on the refuge can be grouped into uplands, flatwoods, and hydric classifications (Table 3). Upland soils are typically entisols, which are soils with very little profile development. These soils, which support sandhill and scrub vegetation, are well-drained to excessively well-drained. Usually, the watertable is 4 to 6 feet below the surface. These soils are very rarely flooded. Scrubby flatwoods are a type of scrub found on less xeric soils than sandhill or other types of scrub, but have drier soils than flatwoods soils.

Flatwoods soils are generally spodosols. These soils have a well-defined internal profile with a spodic horizon (a zone of accumulated organic matter, clay, and aluminum - a hardpan). The watertable is within a foot of the surface during the rainy season, and can be as deep as 40 inches (101.6 cm) during dry periods. Since the spodic horizon is relatively impermeable, perched watertables can occur. The native vegetation is slash and longleaf pine with gallberry, palmetto, and *Lyonia* spp. in the understory. The soils of the Basinger, St. Johns Placid soil complex are often associated with cutthroat seeps.

Hydric soils are found around lake edges, in bayheads, and in the depression marshes. Most of these soils have either a mollic epipedon (Mollisols) or are organic soils (Histosols). These soils remain flooded for most of the year. Native vegetation varies. In the bayheads, one can find bay trees, maples, and other hydric trees, while in the depression marshes the primary vegetation is grasses and forbs.

Menges et al. (2007) determined soil preferences for federally listed plants on the Lake Wales Ridge species by overlaying Global Positioning System (GPS) points on soil polygons in nine major protected areas on the ridge in Highlands County. This effort identified 1,173 GPS points representing 2,577 occurrences of 18 species of vascular plants and one terrestrial lichen (Menges et al. 2007). Menges et al. (2007) identified a continuous variation among species in degree and type of specialization for soil groups. Six species were specialized for xeric yellow sands, two species were specialists for xeric white sands, and one species specialized in xeric scrubby flatwoods (Menges et al. 2007). Ten species were

soil generalists (Menges et al. 2007). Xeric white sands (especially St. Lucie) supported the greatest number of occurrences of these listed species, but xeric yellow sands and satellite soils (supporting xeric scrubby flatwoods) were also important (Menges et al. 2007). Other scrubby flatwoods soils, flatwoods soils, and depressional soils were not important for these plants (Menges et al. 2007). Among the Highlands County locations surveyed, soil specialists (as compared to soil generalists) were less likely to be post-fire resprouters and had fewer occurrences, but had higher population sizes (Menges et al. 2007). Many locations of suitable soils are unoccupied by these species, most likely because of fire suppression and dispersal limitations (Menges et al. 2007).

Table 3. Soils of Lake Wales Ridge NWR

Soil Series	Order	Vegetation Types	Flamingo Villas	Carter Creek	Lake McLeod	Snell Creek
Adamsville Fine Sand	Entisol	Scrub land			X	
Anclote Muck	Mollisol	Lake shore			X	
Astatula Sand	Entisol	Sandhills & scrub land		X		X
Basinger Fine Sand (Depressional)	Entisol	Depression marsh	X			X
Basinger, St Johns Placid Soils	Entisol & Spodosols	Bayheads, flatwoods	X			
Brighton Muck	Histosol	Bayheads	X			
Duette Fine Sand	Spodosol	Scrub land				X
Immokalee Sand	Spodosol	Flatwoods	X		X	X
Placid Fine Sand (Depressional)	Inceptisol	Flatwoods	X			X
Pomello Sand	Spodosol	Flatwoods & scrubby flatwoods	X			X
Samsula Muck	Histosol	Bayheads	X	X		X
St. Lucie Fine Sand	Entisol	Scrub land			X	
Tavares Fine Sand	Entisol	Sandhills	X			X
Tavares, Basinger, Sanibel Complex	Entisol	Sandhills		X		

(United States Department of Agriculture (USDA) Web Soil Survey 2009)

HYDROLOGY, WATER QUALITY, AND WATER QUANTITY

Surface Water Hydrology

All of the four units that make up Lake Wales Ridge NWR are within the Kissimmee River basin. While there are several streams and creeks that are near refuge lands, no significant water courses traverse refuge property. However, during wet periods, water from bayheads and seasonally flooded areas can flow into to these nearby waterways. Runoff from the Snell Creek Unit courses to Snell Creek itself. Water from the Lake McLeod Unit flows through the bayhead at the west end and then into Lake McLeod. Arbuckle Creek accepts outflow from the Carter Creek Unit which empties into Lake Istokpoga. Urbanization has altered the sheet flow from the northern part of the Flamingo Villas Unit, but it is likely that it still goes into Arbuckle Creek. The part of the Flamingo Villas Unit south of the railroad easement flows into Red Beach Lake and Yellow Bluff Creek to Lake Istokpoga. As is the case with the entire Kissimmee River Basin, water coming off the refuge ends up in Lake Okeechobee.

The Lake Wales Ridge has numerous lakes, many of which are the result of sinkhole formation (Carter et. al. 1989). Only two of these are associated with refuge property. The Lake McLeod Unit is located on the eastern side of Lake McLeod, and Red Beach Lake is adjacent to the Flamingo Villas Unit.

An important surface water feature in the Carter Creek and Flamingo Villas Units is depression marshes. Both of these units have numerous low areas which are seasonally flooded. While overland flow can occur between these ponds during very wet times, these areas are usually isolated from one another. In the past few years, extended drought conditions have caused many of these to dry up.

Surface Water Quality

Much of the area surrounding refuge lands is either urbanized or in agriculture. This would raise the possibility of contamination of the water from both point and non-point sources. While there has been no sampling of water quality on the refuge itself, there has been monitoring done in some of the nearby water bodies. The U.S. Geological Survey (USGS) report on water quality in Florida (Kane and Dickman 2005) shows data from three sites near the Carter Creek and Flamingo Villas Units of the refuge (Table 4).

Table 4. Selected USGS water quality data from three sites near the Carter Creek and Flamingo Villas Units

Site Location	Ammonia mg/L	Nitrite & Nitrate mg/L	Total N mg/L	Ortho Phosphate mg/L	Total P mg/l
Carter Creek	.02-.04	.20-.77	.87-.95	<.02	.02-.05
Josephine Creek near De Soto City	.03-.18	.07-.47	.81-1.30	.01-.03	.04-.06
Livingston Creek near Lake Arbuckle	.10-.06	.13-.41	1.33-1.66	.01-.04	.11-.14

In addition, the FDEP monitors water quality including Total Maximum Daily Loads (TMDL) throughout Florida as part of the Integrated Water Resource Monitoring network (IWRM) Program – a multi-level or "tiered" approach to answer questions about Florida's water quality at differing scales. The program is supported by several FDEP water quality monitoring groups in Tallahassee and in regional (district) offices (FDEP 2010). In general, Tier I addresses statewide and regional questions, Tier II focuses on basin-specific to stream-segment-specific questions, while Tier III answers site-specific questions. The refuge is a part of FDEP's Kissimmee River watershed monitoring basin network where basin wide water quality is sampled at least once every 5 years. Within the Kissimmee River basin, FDEP random samples are collected from water resources including aquifers, streams, rivers, and lakes in order to assess water quality trends and status. Water quality information is also available for Red Beach Lake near the Flamingo Villas Unit. Lakewatch data from the Highlands County Soil and Water Conservation District (1999) report that phosphorus levels are low averaging 15 parts per billion (ppb). Nitrogen is also low averaging 754 ppb. Water clarity is good due to the low levels of nutrients. Secchi depths in the lake average 3.8 feet (1.2 m).

Ground Water Resources

The ground water resources for the refuge include a sequence of aquifers and confining units. The uppermost of these is the surficial aquifer system. This system is unconfined. Most of the water contained in this aquifer comes from precipitation although there is some leakage from underlying aquifer in places (Bishop 1956). Most of the water in the surficial aquifer flows downward to recharge the Upper Floridan aquifer. However some flows laterally and is directed by the topography.

The thickness of this aquifer varies with the base of the system being defined by the first persistent beds of Miocene or Pliocene age sediments that contain a substantial amount of clay and silt (Spechler and Kroening 2007). The upper limit of the surficial aquifer varies from one physiographic region to another. In low poorly drained areas, such as the bayheads on the refuge, the top of the water table is at or near the surface for much of the year. On the other hand, in some of the higher sand hills and scrub areas of the refuge the water table may be as much as 100 feet (30.5 m) below the surface, although the refuge lacks baseline information to confirm.

An intermediate aquifer can occasionally be found between the surficial aquifer and the upper Floridan aquifer. This aquifer is present in much of the northern and eastern parts of Polk County (Spechler and Kroening 2007). This would include the Snell Creek Unit and possibly the Lake McLeod Unit. This system may not be present in the vicinity of the Carter Creek and Flamingo Villas Units.

The Floridan aquifer is the principle ground water source for both Polk and Highlands Counties. It can be divided into two sub systems—the upper Floridan and lower Floridan aquifers. In between these two is a less permeable area. The upper Floridan aquifer is the primary source of drinking water in many places including Polk and Highlands Counties. The lower Floridan aquifer is more mineralized and is rarely used as a water source.

Ground Water Quality

The surficial aquifer system is primarily insoluble quartz sand the water generally has low mineral content and hardness. However, when considering other water quality factors, one must remember that the surfical aquifer is open to the surface and contaminants can easily enter the system. Even if no contaminants entered through the refuge's soils, the lateral movement of the aquifer could bring material in. Iron is one element that is most assuredly present. Other chemicals that could be present include chlorides, sulfur, and nitrates. These all occur in some amount even if there were no urbanization or agriculture in the area. The presence of human activity would increase the chances of these appearing in higher concentrations. Human activity also increases the risk of pesticide

contamination. Since there has been little sampling activity on refuge lands, a definite answer to what is really there cannot be answered.

The upper Floridan aquifer is primarily freshwater (Spechler and Kroening 2007). The water here is hard due to the presence of calcium and magnesium. There are some nitrates in the upper Floridan aquifer. These enter the system through breaches in the intermediate confining layer caused by sinkholes and other gaps in the confining unit. Sampling from wells has also detected small amounts of chlorides and sulfur. There are few wells that reach into the lower Floridan aquifer. Since wells are the primary source of sampling data, there is little known of the actual chemical makeup other than that it is heavily mineralized.

AIR QUALITY

The Clean Air Act of 1970 (as amended in 1990 and 1997), required the U.S. Environmental Protection Agency (EPA) to implement air quality standards to protect public health and welfare. National Ambient Air Quality Standards (NAAQS) were established based on protecting health (primary standards) and preventing environmental and property damage (secondary) for six pollutants commonly found throughout the United States: lead, ozone, nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matter less than 10 and 2.5 microns in diameter (PM_{10} and $PM_{2.5}$).

Criteria air pollutants in Florida include carbon monoxide, lead, nitrogen dioxide (NO_2), ozone O_3, particulate pollution (2.5 and 10 ug/m^3), and sulfur dioxide (SO_2) (FDEP 2006). These pollutants are monitored by a network of monitoring stations throughout Florida and analyzed in order to better understand general air quality trends and to locate exceedances. Primary sources of pollutants in Florida are vehicle emissions, power plants, and industrial activities. In 2006, there were 216 ambient monitors in the statewide air monitoring network and the EPA designated Florida an attainment area for all criteria pollutants, based on data collected in the previous 3 years (FDEP 2006).

The Florida Division of Air Resource Management operates National Ambient Monitoring Stations (NAMS) and State and Local Ambient Monitoring Stations (SLAMS) to measure ambient concentrations of these pollutants. In 2005, ambient air quality data were collected by 220 monitors (in 34 counties) strategically placed throughout the state (FDEP 2006). Areas that meet the NAAQS standards are designated “attainment areas,” while areas not meeting the standards are termed “non-attainment” areas. While no pollutant monitoring data are being collected on the Lake Wales Ridge NWR per se, air quality is monitored on a regular basis by six monitors in Polk (5) and Highlands (1) Counties. The Highlands County monitoring station is located at ABS. Table 5 provides air quality data collected for Polk, Highlands, nearby counties, and national level standards. Florida's 2006 monitoring results indicate that both Polk and Highlands Counties qualify as an attainment area for all monitored pollutants (FDEP 2006).

Table 5. Air quality statistics by county, 2007

County	2000 Population	CO 8-hr (ppm)	Pb Qmax (µg/m3)	NO_2 AM (ppm)	O_3 1-hr (ppm)	O_3 8-hr (ppm)	PM_{10} Wtd AM (µg/m3)	PM_{10} 24-hr (µg/m3)	$PM_{2.5}$ Wtd AM (µg/m3)	$PM_{2.5}$ 24-hr (µg/m3)	SO_2 AM (ppm)	SO_2 24-hr (ppm)
Home Counties of the Refuge												
Polk County	483,924	ND	ND	ND	ND	0.077	66	9.3	19	ND	ND	ND
Highlands County	87,366	ND	ND	ND	0.079	0.071	ND	ND	ND	ND	ND	ND
Nearby Counties												
Osceola County	172,493	ND	ND	ND	ND	0.073	ND	ND	ND	ND	ND	ND
Hillsborough County	998,948	2	1.65	0.007	ND	0.083	ND	86	10.1	27	0.004	0.031
Lake County	210,528	ND	ND	ND	ND	O.O78	ND	ND	ND	ND	ND	ND
United States												
National Ambient Air Quality Standards		9	1.5	0.053	0.125	0.085	50	150	15	65	0.03	0.14

CO - Highest second maximum non-overlapping 8-hour concentration (applicable NAAQS is 9 ppm)
Pb - Highest quarterly maximum concentration (applicable NAAQS is 1.5 µg/m^3)
NO_2 - Highest arithmetic mean concentration (applicable NAAQS is 0.053 ppm)
O_3 (1-hour) - Highest second daily maximum 1-hour concentration (applicable NAAQS is 0.125 ppm)
O_3 (8-hour) - Highest fourth daily maximum 8-hour concentration (applicable NAAQS is 0.085 ppm)
PM_{10} - Highest weighted annual mean concentration (applicable NAAQS is 50 µg/m^3)
- Highest second maximum 24-hour concentration (applicable NAAQS is 150 µg/m^3)
$PM_{2.5}$ - Highest weighted annual mean concentration (applicable NAAQS is 15 µg/m^3)
- Highest 98th percentile 24-hour concentration (applicable NAAQS is 65 µg/m^3)
SO_2 - Highest annual mean concentration (applicable NAAQS is 0.03 ppm)
- Highest second maximum 24-hour concentration (applicable NAAQS is 0.14 ppm)
ND - Indicates data not available IN – indicates insufficient data to calculate summary statistic
AM - Annual mean
µg/m^3 - units are micrograms per cubic meter
Qmax - Quarterly maximum
Ppm - units are parts per million
Notes: Data from exceptional events are not included. The monitoring data represent the quality of air in the vicinity of the monitoring site and, for some pollutants, may not necessarily represent urban-wide or parish/county-wide air quality.
Source: U.S. EPA 2009

The Air Quality Index (AQI) is a summary index developed by EPA for reporting daily air quality. It indicates how clean or polluted the air is, and what associated health effects might be concerns. The AQI focuses on health effects that may be experienced within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. Lead is also considered a major air pollutant under the Clean Air Act. However, because all areas of the United States are currently attaining the NAAQS for lead, the AQI does not specifically address lead. For each of these pollutants, EPA has established national air quality standards to protect public health (AIRNow 2009).

Highlands County AQI is derived from ozone concentrations recorded at one station. From 2002 through 2006, ozone AQI was in the "good" range (0-50 AQI) from 326 (2004) to 355 (2002) days. The county experienced a low of 3 days in the moderate (51-100 AQI) range in 2002 to a high of 19 days in 2006. Data suggest increasing trends of moderate days in Highlands County with no days in the reporting period reported as "unhealthy." Polk County AQI over the same reporting period is based on Ozone, PM_{10} and $PM_{2.5}$ inputs over five reporting stations. Polk County AQI is in the "good" range a minimum of 326 days (2006 levels) from which 38 days are reported in the moderate range during the same year (2006). Polk County AQI trends indicate an apparent decreasing air quality based on increasing moderate days and decreasing good days over the reporting period (FDEP 2006).

BIOLOGICAL RESOURCES

The Lake Wales Ridge NWR is located along prehistoric ridges between Orlando and Lake Okeechobee. Ancient scrubs are largely restricted to three interior ridges: Lake Wales, Winter Haven, and Lake Henry. The LWR is by far the largest and longest of the three. The ridges were formed as the slender southern tip of a much smaller Florida peninsula. McCartan (1992) dates the beach and dune complex of the LWR at 2.5 million years old. Over this period there have been several warm wet periods and cool dry periods where the vegetation communities underwent some change. Nonetheless, Florida scrub has been present for tens of thousands of years with flora and fauna possibly going back millions of years. Scrub habitats on the Lake Wales and other central Florida ridges are ancient compared with vegetation elsewhere in eastern North America. The ebb and flow of scrub, resulting from the changing climate, may have created the opportunity for speciation in isolated patches of scrub, resulting in the patterns of endemism seen today, particularly among short-lived plants and those related to disturbance (Menges et. al 2006).

LAKE WALES RIDGE OVERVIEW

The Lake Wales Ridge supports a wide diversity of species including at least 30 federally listed species and one candidate species, some of which are found nowhere else on earth. Table 6 lists threatened, endangered, and rare species of the upland habitats of the Lake Wales Ridge (Swain et al. 2000, Turner et al. 2006, supplemented with species occurrence information specific to the Lake Wales Ridge NWR from staff, researchers, and volunteers).

Table 6. Rare, threatened, and endangered species of the upland habitats of the LWR

Scientific Name	Common Name	Legal Status		FNAI Designation
		Federal	State	
Plants				
Asclepias curtissii	Curtiss' milkweed	N	E	G3/S3
Bonamia grandiflora	Florida bonamia	T	E	G3/S3
Calamintha ashei	Ashe's savory	N	T	G3/S3
Chionanthus pygmaeus	pygmy fringe-tree	E	E	G3/S3
Cladonia perforata	Florida perforate cladonia	E	E	G1/G1
Clitoria fragrans	scrub pigeon-wing	T	E	G3/G3
Conrandina brevifolia	short-leaved rosemary	E	E	G1/S1
Crotalaria avonensis	Avon Park harebells	E	E	G1/S1
Dicerandra christmanii	Garrett's mint	E	E	G1/S1
Dicerandra frutescens	scrub mint	E	E	G4T/S3
Eriogonum longifolium var. gnaphalifolium	scrub buckwheat	T	E	G1/S1
Eryngium cuneifolium	wedge-leaved button snakeroot	E	E	G1/S1
Gymnopogon chapman ianus	Chapman's skeletongrass	N	N	G3/S3
Hypericum cumulicola	Highlands scrub hypericum	E	E	G2/S2
Hypericum edsonianum	Edison's St. John's-wort	N	E	G2/S2
Ilex opaca var. arenicola	scrub holly	N	N	G5T3/S3
Illicium parviflorum	yellow star anise	N	E	G2/S2
Lechea cernua	nodding pinweed	N	T	G3/S3
Lechea divaricata	pine pinweed	N	E	G2/S2
Liatris ohlingerae	scrub blazing star	E	E	G2T1/S1
Lupinus aridorum	scrub lupine	E	E	G2/S2
Nolina brittoniana	Britton's beargrass	E	E	G2/S2
Panicum abscissum	cutthroat grass	N	E	G3/S3
Paronychia chartacea ssp. chartacea	papery whitlow-wort	T	E	G3/S3
Persea humilis	scrub bay	N	N	G3/S3
Polygala lewtonii	Lewton's polygala	E	E	G3/S3

Scientific Name	Common Name	Legal Status		FNAI Designation
		Federal	State	
Polygonella basiramia	wireweed	E	E	G3/S3
Polygonella myriophylla	sandlace	E	E	G3/S3
Prunus geniculata	scrub plum	E	E	S2/S3
Salix floridana	scrub willow	N	E	G2/S2
Schizachyrium niveum	scrub bluestem	N	E	G1/S1
Stylisma abdita	scrub stylisma	N	E	S2/S3
Warea amplexifolia	clasping warea	E	E	G1/S1
Warea carteri	Carter's warea	E	E	G1/S1/S2
Ziziphus celata	Florida ziziphus	E	E	G1/S1
Amphibians and Reptiles				
Rana capito	gopher frog	N	SSC	G3/S3
Eumeces egregious lividus	bluetail mole skink	T	T	G4T2/S2
Gopherus polyphemus	gopher tortoise	N	SSC	G3/S3
Neoseps reynoldsi	sand skink	T	T	G2/S2
Pituophis melanoleucas mugitus	Florida pine snake	N	SSC	G5T3/S3
Sceloporus woodi	scrub lizard	N	N	G3/S3
Stilosoma extenuatum	short-tailed snake	N	T	G3/S3
Invertebrates				
Cicindela highlandensis	Highlands tiger beetle	C	N	G2/S2
Birds				
Aphelocoma coerulescens	Florida scrub-jay	T	T	S3
Falco spaverius paulus	Southeastern American kestrel	N	T	G5T3T4/S3
Grus Canadensis pratensis	Florida sandhill crane	N	T	G5T2T3/S2S3
Haliaeetus leucocephalus	bald eagle	N	T	G4/S3
Mycteria americana	wood stork	E	E	G4/S2
Polyborus plancus audubonii	crested caracara	T	T	G5/S2
Ammodramus savannarum floridanus	grasshopper sparrow	E	E	G5T1/S1
Grus canadensis pratensis	sandhill crane	N	T	G5T2T3/S2S3

Scientific Name	Common Name	Legal Status		FNAI Designation
		Federal	State	
Falco peregrinus	peregrine falcon	N	E	N
Picoides borealis	red-cockaded woodpecker	E	T	G3/S2
Mammals				
Podomys floridanus	Florida mouse	N	SSC	G3/S3
Sciurus niger shermani	Sherman's fox squirrel	N	SSC	G5T2/S2
Ursus americanus floridanus	Florida black bear	N	SSC	G5T2/S2
Puma concolor coryi	Florida panther	E	E	G5T1/S1
Eumops floridanus	Florida bonneted bat	C	E	G1/S1

Key:
Federal and State Listings: E = Endangered, T = Threatened, C = Candidate for Listing, N = Not Listed, SSC = Species of Special Concern
FNAI -Status Rank: The Global (G) element rank is based on a species' worldwide status; the State (S) rank is based on the species' status in Florida; N = not ranked.
1: Critically imperiled. Extremely rare (5 or fewer occurrences or less than 1000 individuals) or extremely vulnerable to extinction.
2: Imperiled. Very rare (6 to 20 occurrences or less than 3000 individuals) or vulnerable to extinction.
3: Either very rare or local throughout its range (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction.
4: Apparently secure globally (may be rare in part of its range).
5: Demonstrable secure globally.
T: Rank of a taxonomic subgroup; the G portion of the rank refers to the entire species and the T portion refers to the specific subgroup.

According to Weekley et al. (2008), the Lake Wales Ridge includes 209,345 ha (808.1 square miles) of xeric uplands, flatwoods, wetlands, and lakes stretching 186.3 km (115.7 miles) from just south of Lake Harris in Lake County, Florida, to near the Highlands/Glades County line and averages 11.7 km (7.3 miles) in width. The Lake Wales Ridge was never blanketed by scrub vegetation, but rather has "over 200 isolated, recognizable scrub islands imbedded in high pine, turkey oak, flatwood, and bayhead habitats" (Christman 1988). Few existing scrubs are larger than a few hundred acres (the largest is 2,866 acres measured by Christman 1988) and no site contains all of the ridge's endemic species. Conserving plant species requires protection of numerous sites in Polk and Highlands Counties and conservation of a number of small or medium-sized tracts, rather than of just a few large tracts.

Christman (1988) attempted to rank scrub by size to see whether larger scrub areas have more species than small ones. Neither this study nor one by Connery (1984) showed a correlation between the size of a scrub and the number of species present, nor between size and number of endemic species. Small sites, such as Lake McLeod (38 ac/15.4ha), where 10 federally listed species are known to occur helps demonstrate this point. Maintaining a patchwork of small, medium, and large tracts of scrub habitat seems to be an effective strategy in protecting the Lake Wales Ridge's endemic species. Nevertheless, the restricted nature of scrub endemics, spotty distribution, and poor dispersal across non-scrub habitats emphasizes the importance of maintaining connections between sites.

Accenting the importance of the ecosystem to the narrowly endemic species occurring here can perhaps be best expressed by determining how much of these ancient habitats have been lost since post-Columbian settlement. Weekley et al. (2008) defined the Lake Wales Ridge extent and assessed post-Columbian habitat loss based on soils, topography, vegetation, land use, and species distribution. In addition, Weekley et al. (2008) determined the aerial extent of pre-Columbian xeric habitat loss on the Lake Wales Ridge based on soils maps overlain on aerial photographs (1979-2000). Weekley et al. (2008) determined that, overall, 78 percent of xeric upland communities were lost by 1990 with more recent estimates suggesting losses of greater than 85 percent (Weekley et al. 2008). Losses were greatest on yellow sands at the northern end of the ridge, and least on white sands near the southern end (Weekley et al. 2008).

WINTER HAVEN RIDGE OVERVIEW

The Winter Haven Ridge is located in central Polk County and rises from the Polk uplands with a base elevation of 100 (30.5 m) to 130 feet (39.6 m) (White 1970). The refuge's Lake McLeod Unit is located on the Winter Haven Ridge, which is believed to be a remnant of previous widespread uplands (White 1970). Soils are composed of clayey, micaceous, quartz pebbly sands in the past described as "Miocene coarse clastics," but presently thought to be Pliocene in age (Campbell 1986). These unconsolidated deposits (sand and sandy clay) are as much as 150 feet (45.7 m) thick and overlie a mantle of limestone (Sinclair and Reichenbaugh 1981).

The area of the Winter Haven Ridge is about 80.7 square miles (20,900 ha). The highest elevation is about 190 feet (60 m). The primary soils types are sands including Candler, Tavares, Sparr, Adamsville, Smyrna, Myakka, and Apopka (Soil Conservation Service 1990). Based on these soils types, up to 72 percent (37,057 ac/14,996 ha) of the Winter Haven Ridge area could be scrub (U.S. Soil Conservation Service 1980) (Table 7). As of 2004, only 6 percent remains as natural communities (SWFWMD 2006) (Table 8).

Based on species distribution, the Winter Haven and Lake Wales ridges are biogeographically related (Christman 1988). Two federally listed skinks, the bluetail mole skink (*Eumeces egregius lividus*) and sand skink (*Neoseps reynoldsi*), are found on the Winter Haven Ridge (Christman 1988, Service 1999), both of which have been identified on the Lake McLeod Unit.

Listed plant species found include *Hypericum cumulicola, Lupinus aridorum*, *Polygonella basiramia*, and *Chionanthus pygmaeus* (Service 1999) and *Liatris ohlingerae, Paronychia chartacea, Polygonella myriophylla,* and *Prunus geniculata* (Christman 1988). Christman (1988) could not find a potential preserve for *Lupinus aridorum* (scrub lupine) and predicted that it would go extinct in 5 to 10 years. This species occurs on the refuge's Lake McLeod Unit, one of only two protected areas where a population of scrub lupine exists.

Table 7. Area of typical scrub vegetation communities based on soil types

NCRS Vegetation Type	Scrub	Acres	Common Soil Types (in order of abundance)
Longleaf pine - turkey oak hills (Sandhill)	Primary	22,641	Candler, Taveres, Apopka
Sand Pine Scrub	Primary	1,469	Pomello, St. Lucie, Archbold, Duette, Satellite
Upland Hardwood Hammocks	Secondary	4,968	Sparr, Millhopper, Zolfo, Kendrick, Lochoosa, Ft. Meade
South Florida flatwoods	Secondary	7,978	Adamsville, Smyrna and Myakka, Pomona, Myakka, Immokalee
TOTAL Scrub		**37,057**	**72% of WHR**
TOTAL WHR		**51,600**	

Source: U.S. Soil and Conservation Service (1980)

Table 8. Summary of land use on the WHR based on 2004 FLUCCS

Land Category	Acres	Percent
Developed	23,227	45
Agriculture	15,443	30
Water	9,827	19
Natural	3,136	6
TOTAL	**51,633**	**100**

Source: SWFWMD (2006)

FIRE HISTORY OF FLORIDA

Fire has played an important ecological role on the Lake Wales Ridge for thousands of years. The use of fire will be essential in efforts to restore and maintain the vegetative communities found on the Lake Wales Ridge NWR. In order to understand the role fire plays in Lake Wales Ridge ecosystems, some knowledge of the long history of fire is needed.

Pre-human Fire
Fire has been a component of Florida ecosystems since before humans occupied the area. The central Florida area has an extremely high incidence of lightning strikes and, therefore, a high incidence of lightning-caused fires. Charcoal deposits in lake sediments show that fires have occurred in south central Florida for 50,000 years (Watts and Hansen 1988). Those authors also report that 18,000 years ago, the climate was similar to what we have today. This climate should have produced thunderstorms during the late spring through the early fall. We can speculate that, without roads and other human-made barriers, fires burned large areas, and most of them occurred during the summer months. This would lead us to the conclusion that lightning fires have been instrumental in favoring the selection of fire-adapted traits in the plants and animals in Florida. One can also assume that the pre-human fire season would be from late spring through the end of summer.

Aboriginal Fire Use
There is evidence that Indians used fire extensively prior to the arrival of the first European explorers (Robbins and Myers 1992). The journals of many of the early explorers indicate that the southeastern Indians used fire to clear fields, drive game, and for communication. Many of the fires set by the Indians were outside of the natural fire season.

European Settler Fire Use
The early European settlers used fire extensively to improve forage, drive game, and for other reasons. Turpentine operations used fire in the winter, cattlemen used fire in the spring, and hunters used fire in the fall. These activities, combined with the natural summer fires, resulted in fire throughout the year.

Recent Fire Use
In the past 50 years, there has been conflict over the use of fire. Ranchers, timber companies, and others have continued to use fire, much of the time outside of the natural fire season. During the 1950s and 1960s, there was a strong effort in the southeast to stop burning and to suppress all unwanted wildland fires. This led to changes in the ecosystem and an increase in fuel loading. Ecological changes and severe wildfires brought many to realize the necessity of fire and, therefore, prescribed burning programs were developed.

FIRE HISTORY OF THE LAKE WALES RIDGE NWR

There have been nine documented unwanted wildland fires on the refuge (Table 9). The largest was the Red Beach Fire that occurred in February and March 2001, which burned over 600 acres (242.8 ha) of the Flamingo Villas Unit. Initial attack was handled by the FDOF, but the fire was eventually managed under a Unified Command consisting of the FDOF and Service personnel. The Service and FDOF have a long history of shared responsibility for wildfire throughout Florida. Due to the distance between Lake Wales Ridge NWR and Merritt Island NWR, where the fire crew is stationed, some of unwanted wildland fires occurring on the refuge were suppressed by FDOF personnel. Similarly, several additional fire actions have occurred throughout the Lake Wales Ridge region off refuge lands where Service fire personnel has assisted FDOF with fire suppression.

Table 9. Fire activity on Lake Wales Ridge NWR

Fire Name	Fire Type	Date	Unit	Acres/Hectares
Carter Creek 1	Wildfire	Unknown	Carter Creek	0.2/0.08
Lake McLeod 1	Wildfire	Unknown	Lake McLeod	0.1/0.04
Red Beach	Wildfire	02/18/2001	Flamingo Villas	640.0/259
Ziziphus	Rx Burn	08/16/2001	Carter Creek	63.0/25.5
Love Seat	Wildfire	04/22/2004	Threat to Carter Creek FDOF Assist	250.0/101.2
Natal	Wildfire	02/19/2005	Lake McLeod	3.0/1.2
SFWMD1	Rx Burn	04/2005	Snell Creek	102.5/41.5
Silver Bullet	Wildfire	04/08/2006	Carter Creek	1.0/0.4
Flamingo	Wildfire	05/29/2006	Flamingo Villas	27.0/10.9
Tubbs	Wildfire	05/30/2006	Assist to FDOF	0.2/0.08
Grasshopper	Wildfire	06/08/2006	Threat to Flamingo Villas FDOF assist	1.0/0.4
Green Dragon	Wildfire	06/09/2006	Flamingo Villas	1.0/0.4
Cactus	Wildfire	06/14/2006	Assist to FDOF	472.0/191
Warehouse	Wildfire	02/18/2007	Flamingo Villas	1.0/0.04
Flamingo	Wildfire	06/11/2007	Flamingo Villas	5.0/2.0
CC 1 & 2	Rx Burn	12/03/2007	Carter Creek	145.0/58.7
FV 1	Rx Burn	12/05/2007	Flamingo Villas	125.0/50.6
CC 1,2,3, & 4	Rx Burn	06/08/2009	Carter Creek	600.0/242.8
Flamingo Units 3,9,10,12,13	Rx Burn	06/08/2009	Flamingo Villas	327.0/132.3

Other than the fires mentioned above, information on wildfires on the lands now owned by the Service or designated for future purchase is incomplete. There are anecdotal records of several fires in the late 1990s, and surveys of the Carter Creek and Flamingo Villas Units indicated that portions of these areas have had wildfires within that time span. Most of the lands in question have been subjected to total fire suppression, and there are numerous plow lines on the refuge.

Prescribed burning on Lake Wales Ridge NWR has been limited. The remoteness of the area from Merritt Island NWR has a large impact on the ability to plan, prepare, and execute burning activities. In spite of these difficulties, a burning program has been initiated. It began in 2001 with the Ziziphus fire at the Carter Creek Unit (Table 9). The objective of this prescribed burn was to prepare a site for the re-establishment of *Ziziphus celata* on the refuge. Three other burns for fuels reduction and habitat improvement have since been completed (Table 9).

LAKE WALES RIDGE NWR MANAGEMENT UNITS

As mentioned, the refuge includes four management units – Flamingo Villas, Carter Creek, Lake McLeod, and Snell Creek – separated by 60 miles (96.5 km) of urban, rural, and natural areas along the Lake Wales Ridge and Winter Haven Ridge within Polk and Highlands Counties (Figure 2). The following review summarizes the land status, land cover, and priority management projects of each unit.

Flamingo Villas Unit

Flamingo Villas - Existing Conditions and Management
The Flamingo Villas Unit is the southernmost of the four refuge units (Figure 2). The name Flamingo Villas is derived from a platted, approved, and to date unbuilt subdivision, which bears the name. Schultz et al. (1999) provided a comprehensive survey of the Flamingo Villas Unit as part of an FNAI analysis of rare plant species and natural communities of 26 CARL sites in the Lale Wales Ridge ecosystem. Schultz et al. (1999) describes the Flamingo Villas as a diverse mosaic of sand pine scrub, oak scrub, scrubby flatwoods, depression marshes, baygall, and lakes. The Flamingo Villas Unit has a small grid of sand roads which are currently used for site access by refuge staff, researchers, volunteers, and as access for private inholders in addition to functioning as fire lines and fire unit breaks. The site is partially owned by the Service. As of January 2010, approximately 28 percent of the land within the Flamingo Villas Unit acquisition boundary is unprotected including over 86 acres of inholdings (34.8 ha) in the Flamingo Villas subdivision, where 316 unprotected lots (includes five subdivision common areas) are scattered throughout the unit. Refuge land acquisition efforts began at the Flamingo Villas Unit with the purchase of a quarter-acre lot in April 1994. Today, over $1.6 million in funding has been used to purchase 1,039.1 acres (420.5 ha) within the Flamingo Villas Unit.

The unit contains both a powerline and railroad easement within the acquisition boundary. The powerline easement traverses the middle of the unit running east/west with a north/south jog in the unit's center. The railroad easement runs southeast/northwest and separates the northern and southern portions of the unit. The railroad track bed was constructed by a dredge and fill process and the resulting borrow canal exists adjacent (south) to the track bed. *Dicerandra christmanii* and other endangered plants are found along sections of both easement corridors.

The Flamingo Villas unit contains a diversity of habitats including sandhill, yellow sand scrub, and scrubby flatwoods; however, much of the scrub is currently in an overgrown condition due to long-term fire suppression. Schultz et al. (1999) reports the site's most outstanding natural features are the large high-quality scrub and the high number of listed species, including *Dicerandra christmanii*. This species is not known to exist on any other protected lands but the Flamingo Villas Unit. Land cover types are detailed in Figures 5.1.1-5.1.3.

Figure 5.1.1 Land cover - Flamingo Villas Unit (East)

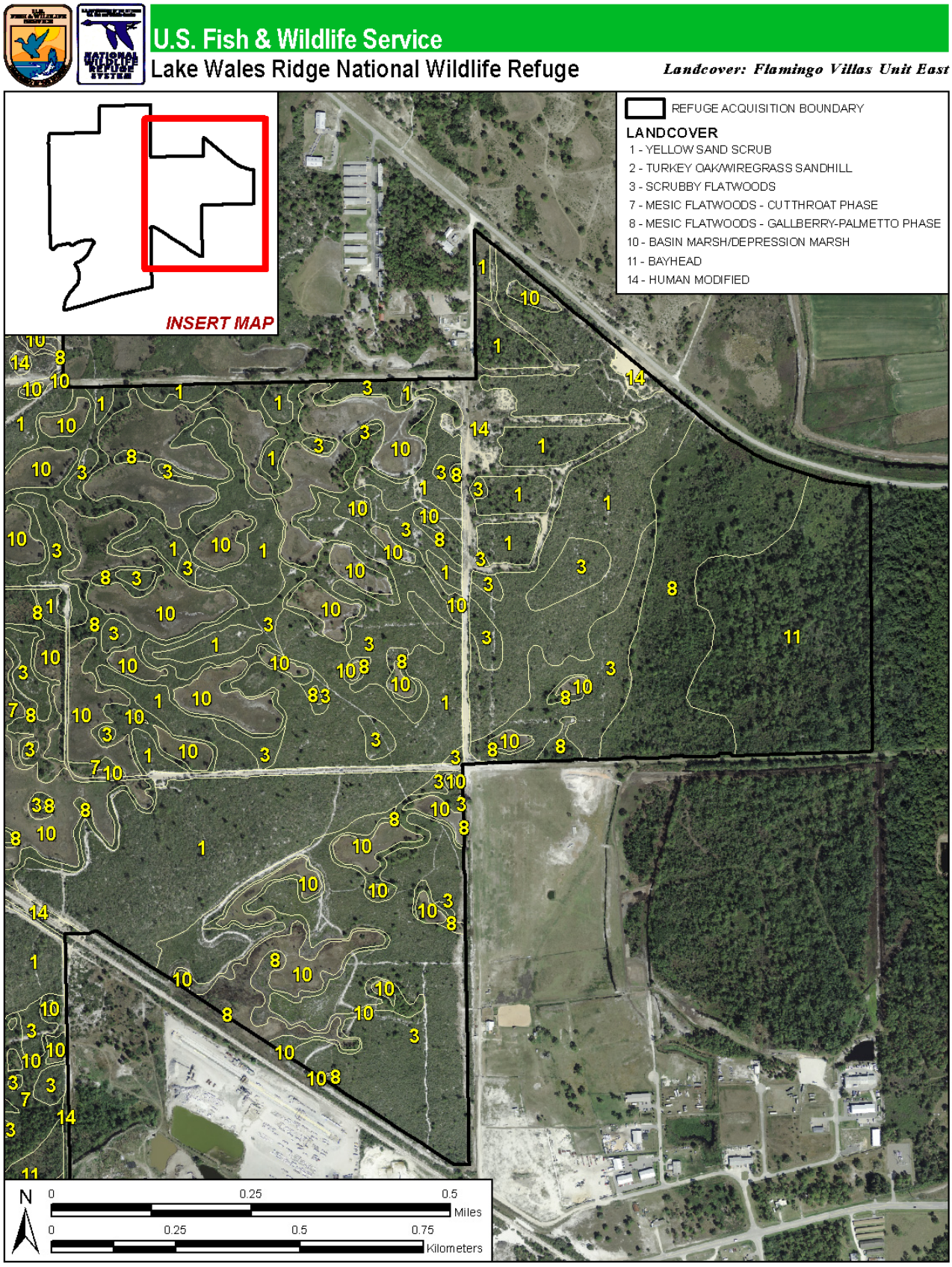


Figure 5.1.2. Land cover - Flamingo Villas Unit (Northwest)

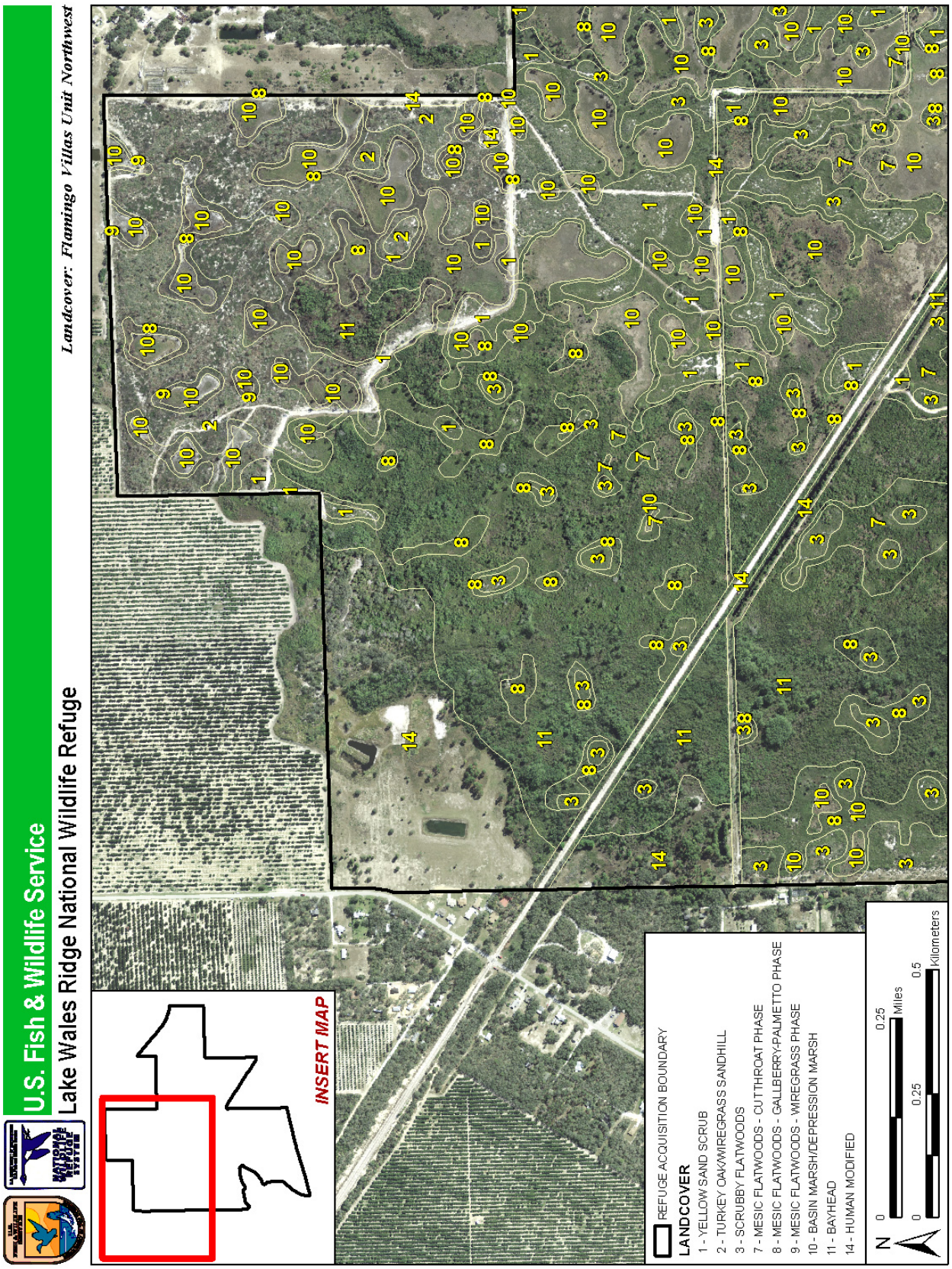
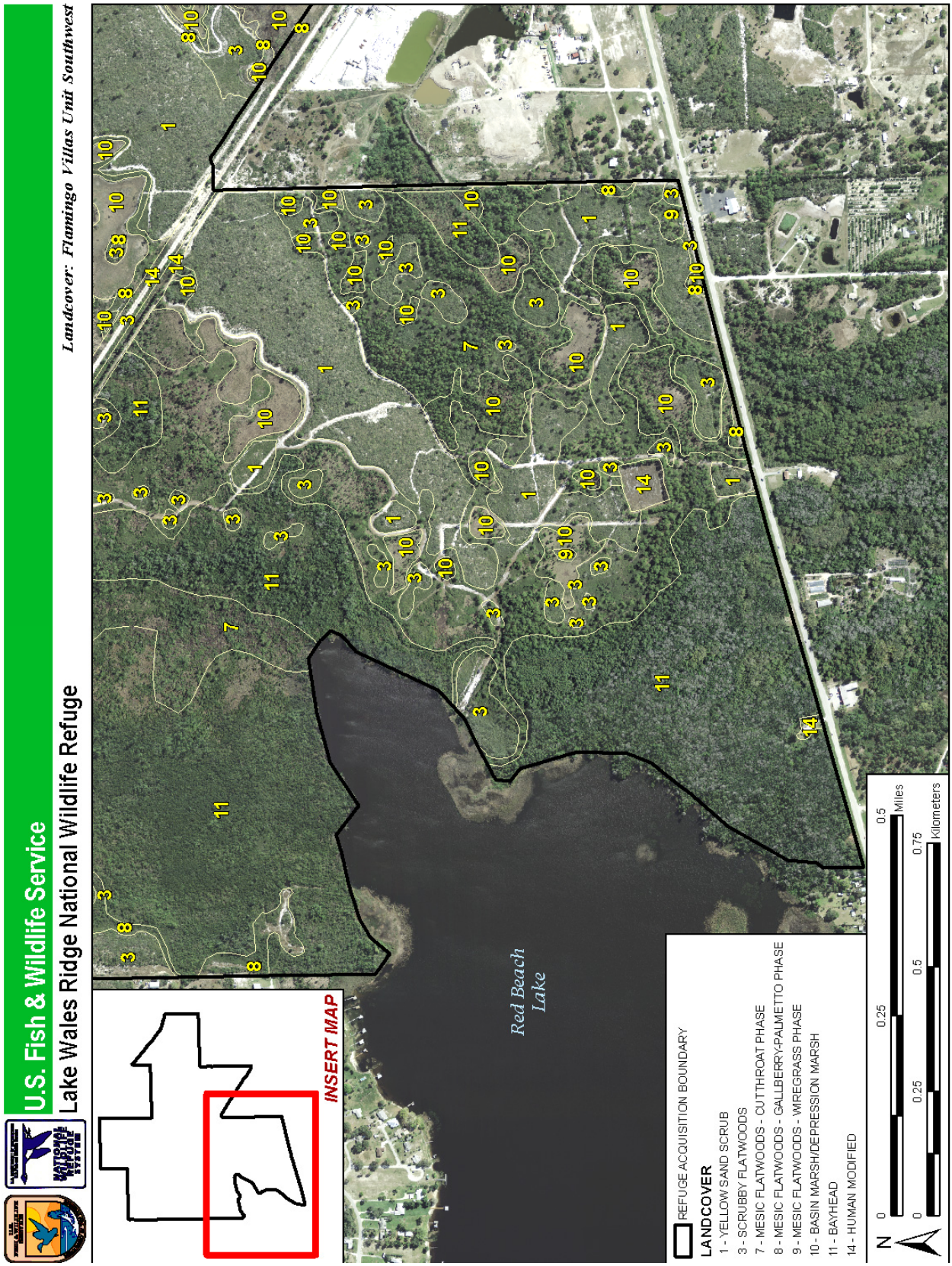


Figure 5.1.3. Land cover - Flamingo Villas Unit (Southwest)



The northeast portion of the property contains a combination of habitats including a yellow sand scrub ridge which transitions downslope to scrubby and mesic flatwoods to the east and through scrubby flatwoods to mesic flatwoods and basin marsh/depression marshes to the west. The overstory is a mix of longleaf, slash, and sand pine. About 59 acres (23.9 ha) of turkey oak/wiregrass sandhill occur in the north central part of the unit, transitioning south into scrubby flatwoods, basin/depression marshes then to bayhead. The south side of the property (south of the railroad tracks) is dominated by xeric scrub and scrubby flatwoods. In total, 140 acres (56.6 ha) of scrubby flatwoods exists throughout the unit, interspersed with close to 200 acres (81 ha) of basin marsh/depression marsh. A large portion of the southern section also contains bayhead habitat and ephemeral wetlands where elevations are at times 30 feet (9.1 m) less than the top of the yellow sand ridge located only 500 feet (152.4 m) away in places. The xeric habitat exhibits a longleaf pine overstory. Shrubs including *Quercus geminata*, *Quercus myrtifolia*, *Quercus chapmanii*, *Carya floridana*, *Lyonia ferruginea*, *Serenoa repens*, and *Sabal etonia* cover the entire area, except for the sand roads. Smaller shrubs and herbaceous plants, including rare, threatened, and endangered species, occupy roadsides, fire lanes, and the few remaining gaps in the overgrown shrub. Ground lichens are abundant in white sand gaps.

Over 387 acres (157 ha) of bayhead habitat occurs within the western portions of the unit from the northeast end of Red Beach Lake and east of the yellow sand scrub ridge north to the sandhill setting. The east area has a mature canopy of large southern magnolia (*Magnolia virginiana*) and slash pine.

Perhaps the most interesting habitat feature of Flamingo Villas Unit is the existence of 239 acres (96.7 ha) of yellow sand scrub that quickly rises 20 feet (6 m) above contiguous scrubby flatwoods and cutthroat seeps. The yellow sand scrub ridge is part of a much larger ridge of yellow sand scrub extending from the southwest to the northeast through the unit then northward to the southern portion of the Carter Creek Unit acquisition boundary. Schultz et al. (1999) described this ridge as one with numerous undulations and abrupt edges with sands varying from white to yellow, depending on location within the scrub. Shultz et al. (1999) characterized the ridge as being covered by dense oak scrub with a thin canopy of mature slash pine where dense shrubs cover the entire area, except for the few sand roads and historic off-road vehicle trails. Dominant shrub species are *Quercus germinata*, *Q. myrtifolia*, *Q. inopina*, *Q. chapmanii*, *Carya floridana*, *Serenoa repens*, *Sabal etonia*, and *Lyonia ferruginea*. Low shrubs and herbs are mainly restricted to the small gaps and roadsides with *Vaccinium mysinites*, *Licania michauxii*, and *Polygonella myriophylla* being most prominent (Schultz et al. 1999). *Dicerandra christmanii* (Garrett's mint) currently occupies gaps in the yellow sand scrub habitat on the refuge where individual plants are monitored by ABS. Since 2003, however, Garrett's mint populations at the Flamingo Villas Unit have been declining due in part to historic fire suppression on the refuge. Droughty conditions over the last few years (2007/2008) have also increased mortality and reduced seedling recruitment (Menges, E.S. pers. com. *in* email to Service 2008a).

Utilizing both Schultz et al. (1999) and Turner et al. (2006), coupled with species accounts by staff, researchers, and volunteers, 15 federally listed species (10 plants, 5 wildlife species) and 1 candidate species are known to occur on the Flamingo Villas Unit. Most of these species have been documented over the eastern (subdivision) portion of the refuge. In addition to the federally listed species, many state listed and rare species have been documented. Refer to Tables 14 and 15 for rare, threatened, and endangered species of the Flamingo Villas Unit.

ABS has established permanent sample plots to monitor rare, threatened, and endangered plants, as part of their Population Dynamics of Endemic Plants project. This project collects standardized monitoring data from managed sites across the Lake Wales Ridge. The plots are visited annually and counts of each species are recorded for each plot. In addition, ABS carries out detailed demographic monitoring of Garrett's mint at the Flamingo Villas Unit. Individual plants are marked and tracked from seedling to mortality. Seedling recruitment, growth rate, fecundity, and mortality of

individuals are recorded annually. Demographic data collected over a period of several years can be used to construct a population viability analysis.

Trash and debris cleanups have also been conducted through the assistance of volunteers. Periodic inventorying and monitoring of rare species have been conducted through a Service contract with ABS, and through volunteer efforts. The Flamingo Villas Unit is part of Jay Watch, a Florida scrub-jay monitoring project administered through TNC. Scrub-jay monitoring through the Jay Watch program has been conducted annually since 2002. Feral hog (*Sus scrofa*) trapping and removal has been conducted through the help of the refuge's volunteers. Treatment of non-native plants has been conducted through Service contract, volunteer efforts, and with the assistance of the Service's Southeast Region Invasive Species Strike Team. Most of the Flamingo Villas Unit has been fenced and administrative signage is present along State Highway 98.

A detailed inventory of exotic vegetation was conducted in 2006 through a contract with North Wind, Inc. According to this inventory, disturbance areas including the multiple roads, trails, and a railway line that transect the unit, are sparsely, but uniformly infested with a variety of invasive exotic species. These include Natal grass (*Melinis repens*), Caesar's weed (*Urena lobata*), Brazilian pepper (*Schinus terebinthifolius*), cogongrass (*Imperata cylindrica*), Old World climbing fern (*Lygodium microphylluym*), and rosary pea (*Abrus precatorius*). Much of the unit is covered by bayhead, marshland, and dense intact scrubland dominated by scrub oak and gallberry, with invasive exotics almost exclusively limited to areas immediately adjacent to roads and the railway. Within the Flamingo Villas Unit, the highest densities of invasives appear to be along the railway line and near the western entrance to the parcel (North Wind Inc., 2006). Table 10 identifies exotic species present on the Flamingo Villas Unit in 2006 (North Wind Inc., 2006).

Table 10. Exotic plant species present on the Flamingo Villas Unit in 2006

Scientific Name	Common Name	Density*			Total
		1	2	3	
Flamingo Villas					
Casuarina equisetifolia	Australian pine	0	0	3	**3**
Sansevieria hyacinthoides	bowstring hemp	0	1	0	**1**
Schinus terebinthifolius	Brazilian pepper	7	21	4	**32**
Urena lobata	Caesar's weed	4	48	13	**65**
Cinnamomum camphora	camphor tree	2	1	0	**3**
Ricinus communis	castor bean	1	1	0	**2**
Imperata cylindrica	cogongrass	0	8	14	**22**
Albizia julibrissin	mimosa	3	1	1	**5**
Melinis repens	natal grass	4	80	12	**96**
Lygodium microphyllum	Old World climb fern	2	12	2	**16**
Abrus precatorius	rosary pea	3	27	7	**37**
Panicum repens	torpedo grass	0	2	3	**5**
Solanum viarum	tropical soda apple	0	3	0	**3**
Total		**26**	**205**	**59**	**290**

Source: North Wind Inc. 2006
**Density Key: 1=single occurrence, 2=scattered, 3=abundant*

In 2007 the refuge conducted one prescribed burn on Flamingo Villas Unit totaling 250 acres (101 ha). Five Flamingo Villas Units totaling 327 acres (132 ha) were burned under prescription in June 2009 (Table 9). The Flamingo Villas Unit has the highest known occurrence of wildfire compared to the other refuge units. Since records have been kept (2001), five wildfires (Table 9) have occurred on the unit, the biggest of which was the Red Beach fire in 2001 that burned 640 acres of the unit's interior. Due to logistical constraints including distance to Merritt Island NWR fire program and lack of on-site staff, wildfire reporting is sketchy. The refuge maintains a statewide memorandum of understanding (MOU) with the FDOF for wildfire initial attack but these resources are stretched throughout the region which further limits reporting. Two prescribed fire events have occurred on the unit since 2007, targeting the sandhill habitat to the north (FV 1) and yellow sand scrub and mesic flatwoods/cutthroat phase (FV 3, 9, 10, 12, 13, see Figure 5.2 for location of the Flamingo Villas Unit Fire Management Units). Through the application of prescribed fire, the refuge is targeting restoration of lands to pre-fire exclusion conditions to benefit rare, threatened, and endangered species and the habitats they occupy. In addition, fire lines are maintained by Service staff and through contract by FDOF.

Flamingo Villas - Land Status

The Flamingo Villas Unit acquisition boundary includes a varied and wide array of ownership and land use/zoning designations. The Flamingo Villas Unit acquisition boundary is 1,436.2 acres (581.2 ha) of which the Service and State of Florida have combined to acquire 1040.1 acres (420.9 ha) [Service - 1,039.1 acres (420.5 ha), State of Florida 1.0 acre (0.4 ha)], together comprising approximately 72 percent of the total lands within the unit's acquisition boundary (Figure 5.3.1). Of the remaining lands within the unit's acquisition boundary, easements, rights-of-way, and common areas account for 11 percent of the existing or planned land use, while 245.8 acres (99.5 ha) or 17 percent of the Flamingo Villas Unit remain as parcels under private ownership, the majority of which (316 parcels) are located in the Flamingo Villas subdivision (Figure 5.3.2). For fire management purposes and to meet operational, logistical, and safety requirements, the functional fire management boundary of the unit is slightly larger at 1,253.4 acres (507.2 ha) due to the inclusion of private inholdings. Detailed analysis of the originally approximated 1,600-acre acquisition boundary (Service 1993) was performed for the development of this Plan utilizing ArcGIS 9.3.1 software, current digital aerial imagery, Highlands County parcel data, rectified images of the original LPP map, and the Service's Division of Realty refuge boundary files to determine boundary, ownership, and land cover acreages.

<u>West Flamingo Villas Subunit</u>

The 1020.6 acre (413 ha) western portion of the Flamingo Villas Unit (Figure 5.3.1) has future land use designations of Conservation and Agriculture, the latter designated on inholdings within the acquisition boundary (Highlands County 2008). The western portion of the Flamingo Villas Unit has inholdings totaling 158 acres (63.9 ha), two of which are nested within the east-central part of the subunit and are land-locked from improved roads with access attained only through refuge-owned property. Two inholdings are located adjacent to Red Beach Lake where a home is currently under construction on the southernmost parcel. An additional area comprised of three inholdings is located to the northwest of the refuge's management boundary (Figure 5.3.1). Two of the inholdings have recently been approved for development of residential homes, while the third (an inholding adjacent to the refuge's management boundary) is lightly developed and zoned by Highlands County for agricultural use. Agricultural use designations may entitle residential zoning for single family use in cases where lots were vested, a process provided for through Highlands County in the early 1990s. A right-of-way exists adjacent to the refuge's west management boundary running west to east and is associated with the now vacated Ben Bruno subdivision (Hanna, D. Highlands County Planning Department pers. com. 2009, Highlands County Plat Book 3, p. 22) that once comprised 36 lots in three strips of 13 lots.

Figure 5.2. Fire management units - Flamingo Villas Unit

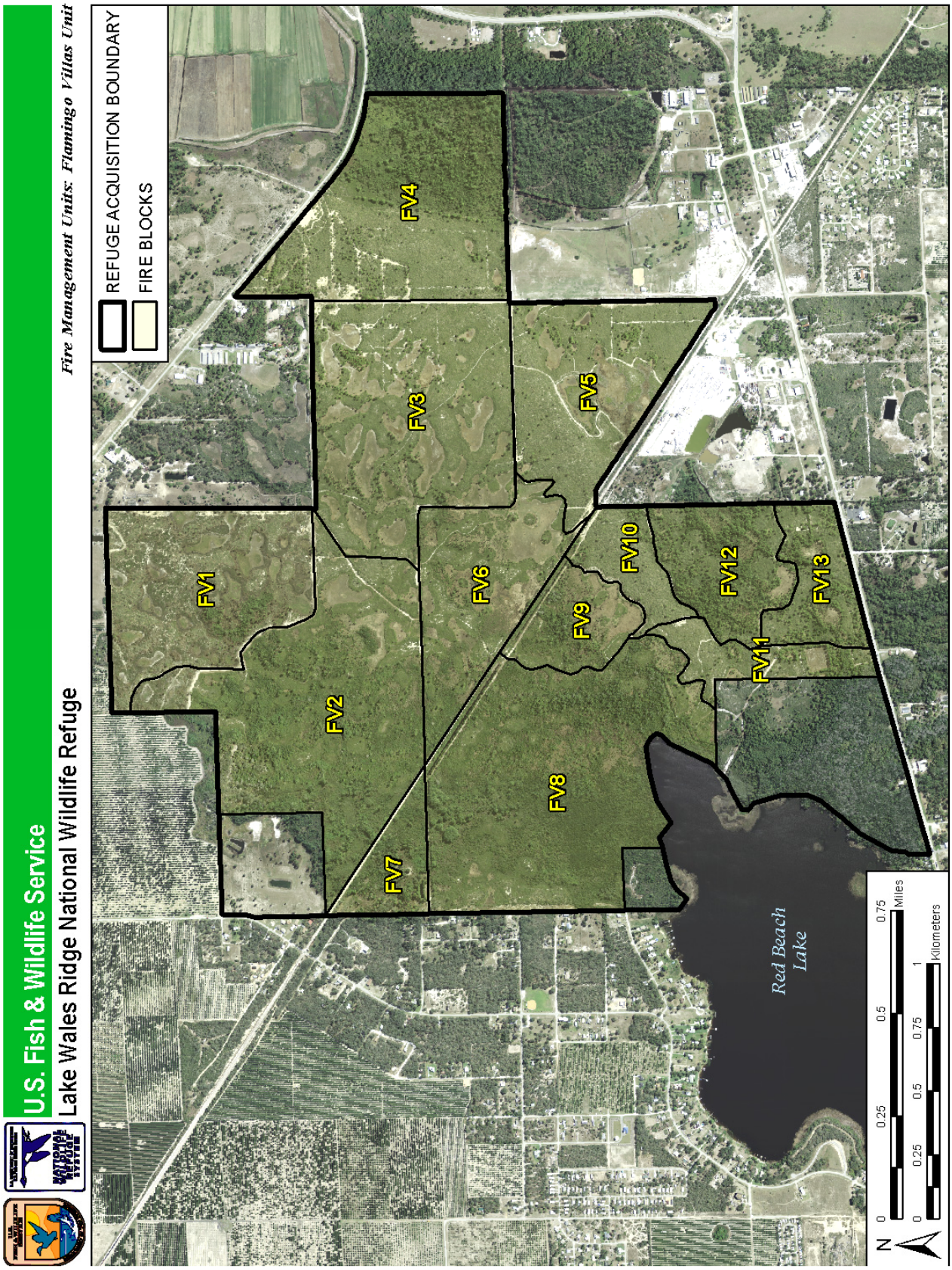
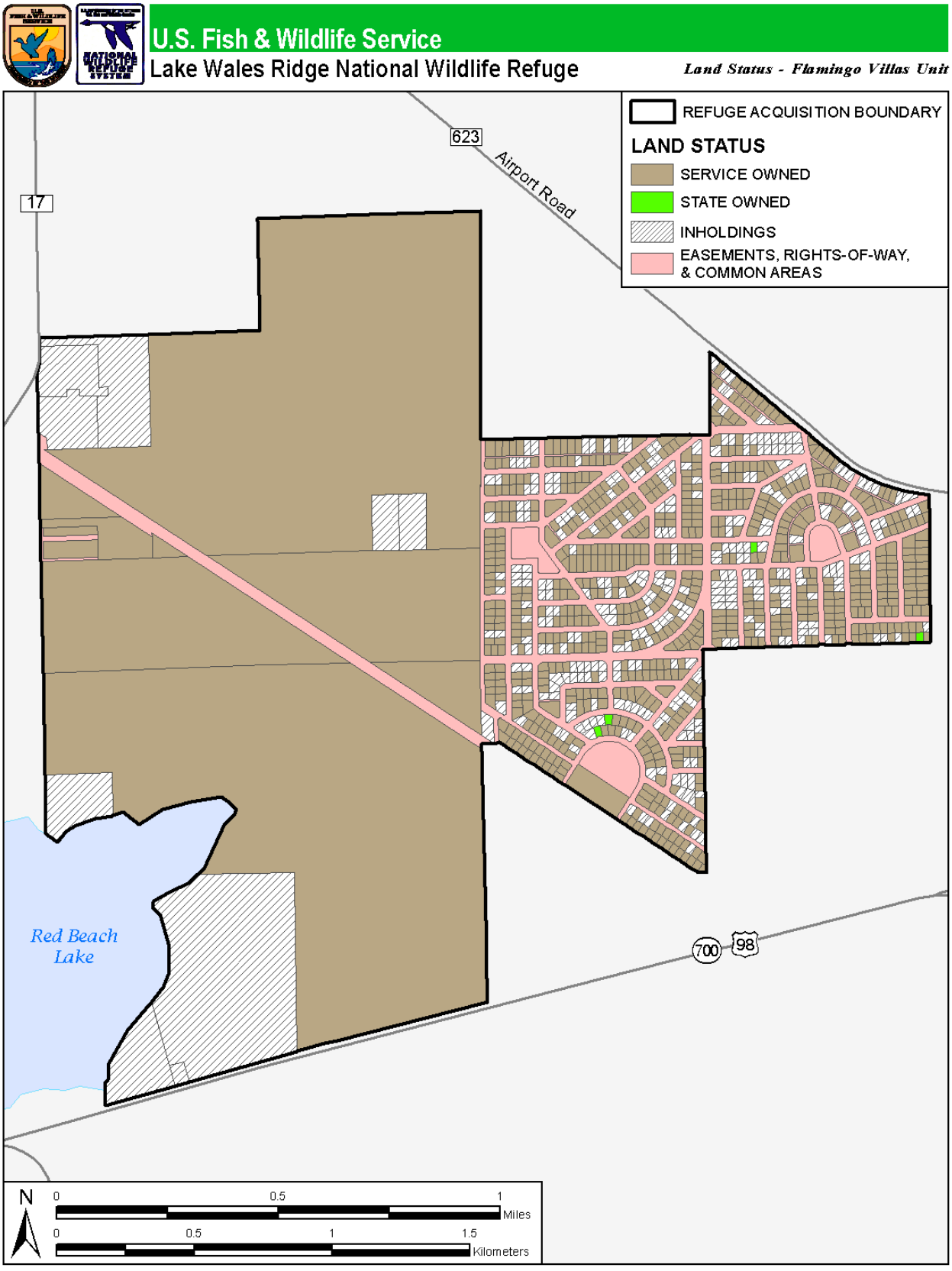


Figure 5.3.1. Land status - Flamingo Villas Unit (Overview)



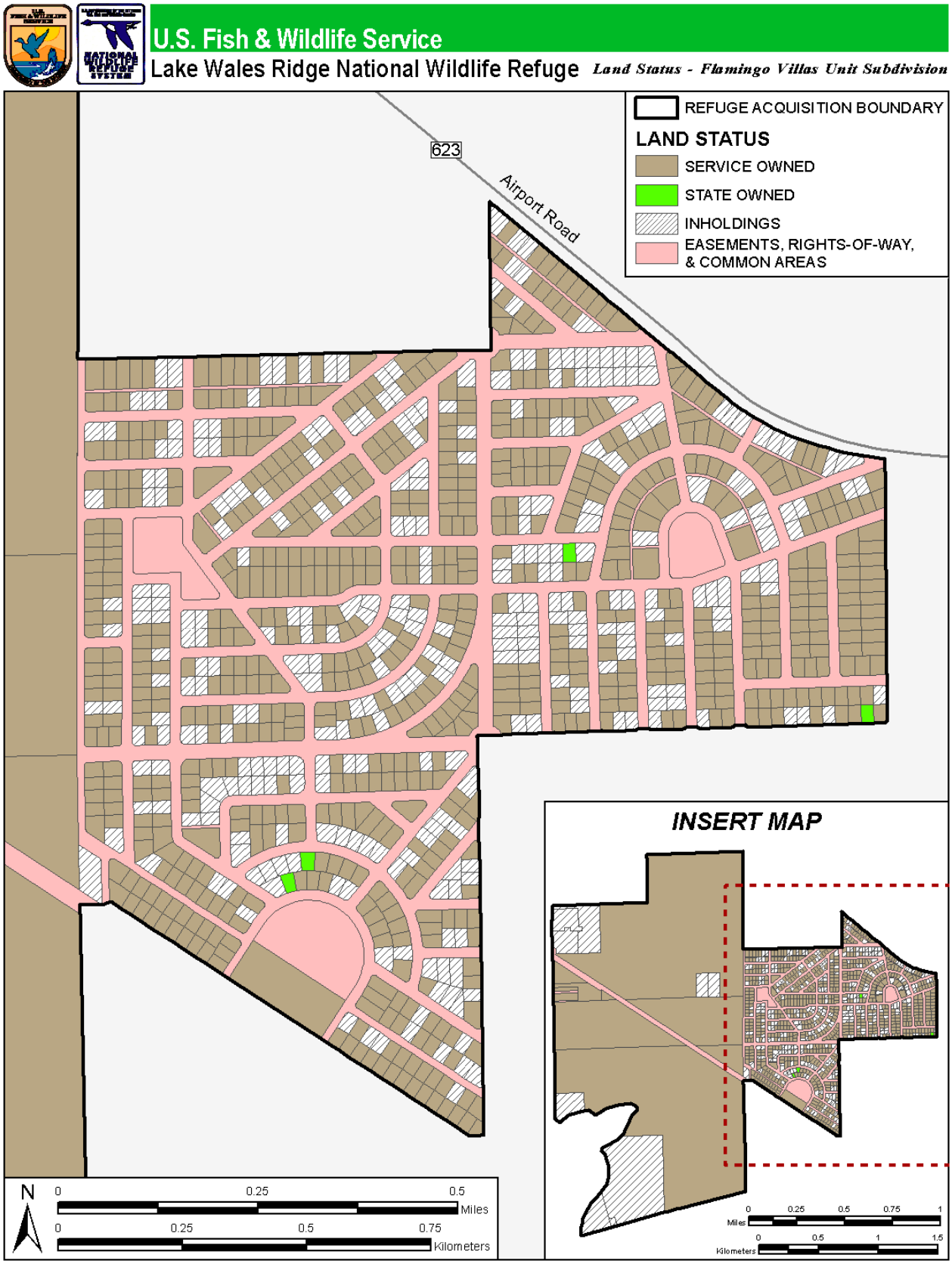
Flamingo Villas Subdivision (east subunit)

The 415.6-acre (168.2-ha) Flamingo Villas Subdivision is a checkerboard mix of ownership where the Service has acquired 203.6 acres (82.4 ha) and the State of Florida has acquired 1.0 acre (0.4 ha) (Figure 5.3.2). The remaining area is a combination of single family home lots totaling 86.8 acres (35.1 ha) and 124.2 acres (50.3 ha) of platted easements, common areas, and rights-of-way. The subunit is currently zoned for agriculture based on Highlands County's 2003 Future Land Use Map (FLUM) and is also zoned for residential housing (R1 zoning). FLUM agriculture use designation permits residential development as-of-right, depending on a vesting determination, as is the case with the Flamingo Villas Subdivision. However, development requests for Flamingo Villas currently require special approval of the Highlands County Board of County Commissioners. In the case of Flamingo Villas, inholdings maintain vested rights for residential development in addition to approved agricultural uses. The State of Florida owns four parcels scattered throughout the unit (Figure 5.3.2) for which no official management agreement exists. The remaining lots are platted and unimproved, and typically exist as quarter-acre lots. A series of platted roads and common areas are identified throughout the subunit (Figure 5.3.2). To date, no development has occurred in the subdivision. Common areas and roads are not available for purchase, however, if the plat is ever vacated, these areas may then be transferred to the Service under approval and agreement by the Highlands County Board of County Commissioners.

In 1999, the Florida Ziziphus Ad Hoc Recovery Team proposed an experimental reintroduction of Florida ziziphus at the then newly acquired Carter Creek Unit (acquired in 1998). In keeping with the Service's recovery plan for Florida ziziphus (Service 1999), the reintroduction necessitated the application of prescribed fire to the long-unburned Carter Creek sandhill community. ABS provided an experimental design for the prescribed fire that included a plan for the experimental reintroduction of Florida ziziphus plants and seeds. In July 1999, the Florida ziziphus recovery team carried out a peer review of an experimental reintroduction at the Carter Creek Unit, which received the endorsement of the team. The proposal called for transplanting potted plants and planting seeds to create a new viable population and to learn more about the micro habitat preference and management needs.

In June 2002, after a prescribed fire in August 2001 to prepare the site, 144 two- to three-year-old potted plants and 1,728 seeds were introduced to 36, 16.4 feet (5 m) radius plots at the Carter Creek Unit representing three experimental treatments: burn-only, chainsaw felling subcanopy followed by burning, and an untreated control (Weekley and Menges *in* Soorae, P.S. 2008a). Introduced transplants were monitored at least quarterly for the first year and at least annually thereafter; seed arrays, each containing 24 seeds, were monitored at least monthly for 4 to 6 months for seedling emergence (Weekley and Menges *in* Soorae, P.S. 2008a). Research results indicate that transplants outperformed seeds as effective propagules. Weekley and Menges *in* Soorae, P.S. (2008a) reports that cumulative transplant survival 4.5 years post-reintroduction stood at 76.4 percent, while the 1,728 introduced seeds resulted in only three surviving seedlings, an establishment rate of 0.17 percent, however, growth rates of transplants was negligible at only a 1.6 percent increase after 4.5 years (Weekley and Menges *in* Soorae, P.S. 2008a).

Figure 5.3.2. Land status - Flamingo Villas Unit (Subdivision)



Carter Creek Unit

Carter Creek - Existing Conditions and Management
The Carter Creek Unit is located in Highlands County, near Sebring (Figure 2), roughly 3.5 miles (5.6 km) north of the Flamingo Villas Unit.

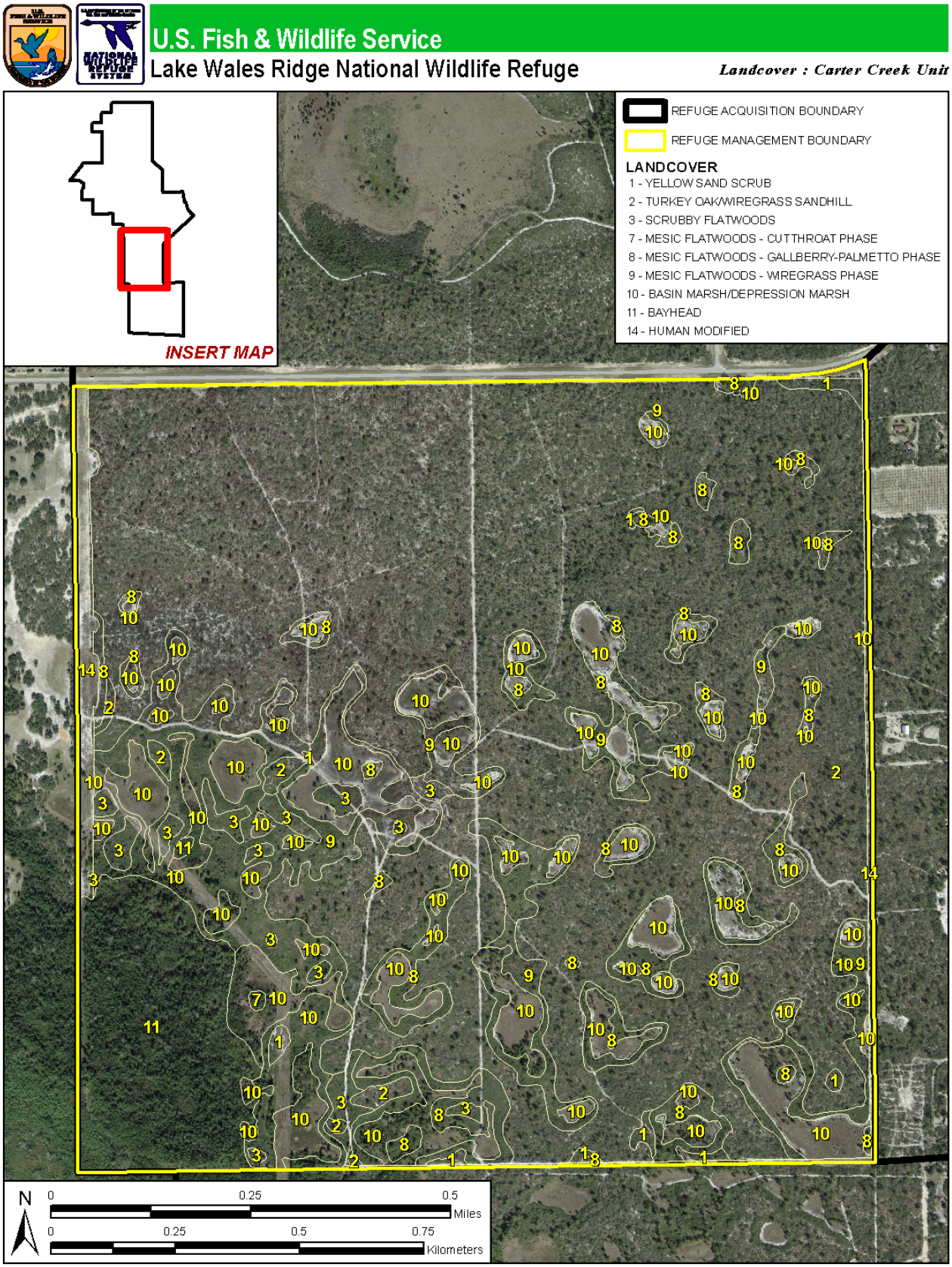
The Carter Creek Unit exhibits over 378 acres (153 ha) of turkey oak/wiregrass sandhill habitat, by far the largest contiguous area of xeric sandhill of the refuge's four management units (Figure 6.1). Schultz et al. (1999) described the unit as divided between open sand pine scrub to the northeast and dense yellow sand oak scrub to the southwest, with the sand pine scrub including areas of both rosemary and oak scrub. Schultz et al. (1999) characterized sand pine cover as varying in density from dense patches of young trees to widely spaced mature trees. In some areas, abundant *Ceratiola ericoides* and *Quercus inopina* occur with abundant white sands gaps, in others, dense patches of *Q. inopina*, *Q. germinata*, *Serenoa repens*, and *Sabal etonia* dominate (Schultz et al. 1999). Recent observations by Service staff indicate that the Carter Creek Unit is dominated by sandhill on the north half of the property with dominate cover of longleaf pine, live oak, turkey oak, and scrub oak. The property gradually drops in elevation to the south, exhibiting a 20-foot (0.5 m) to 25-foot (0.6 m) drop in elevation from north to south. Bayhead and ephemeral marsh habitats occur throughout the south end of the Carter Creek Unit. Sand pines are very sparsely scattered across the northern half of the property while slash pine cover and density increases from north to south.

According to Schultz et al. (1999), rare, threatened, and endangered species occurring on the Carter Creek Unit include *Asclepias curtissii*, *Chionanthus pygmaeus*, *Hypericum cumulicola*, *Liatris ohlingerae*, *Paronychia chartacea* ssp. *chartacea*, *Persea humilis*, *Polygonella basiramia*, *P. myrophylla*, *Prunus geniculata*, *Stylisma abdita*, *Gopherus polyphemus*, *Neoseps reynoldsi*, and *Sceloporus woodi*, *Eriogonum longifolium* var. *gnaphalifolium*, and *Prunus geniculata*. Since the time of Schultz' inventory, *Ziziphus celata* has been introduced to the unit. Turner et al. (2006) synthesized and collated existing data on 36 of the LWR ecosystem's rare and endemic species. Of the 36 study species, Turner et al. (2006) identified 12 species found on the Carter Creek Unit, including *Z. celata*, *C. highlandensis*, *P. lewtonii*, *W. carteri*, *S. abdita*, *P. geniculata*, *N. brittoniana*, *E. longifolium*, *C. fragrans*, *C. pygmaeus*, *A. coerulescens*, and *S. woodi*. Utilizing both Schultz et al. (1999) and Turner et al. (2006), coupled with species accounts by staff, researchers, and volunteers, 15 federally listed species (13 plants, 2 wildlife species) are known to occur on the Carter Creek Unit in addition to one candidate species. In addition to the federally listed species, many state listed and rare species have been documented (Tables 14 and 15).

The Carter Creek Unit is fenced and signage identifying the refuge is located along the Arbuckle Creek Road boundary.

In the 2008 census, conducted by ABS a few weeks following the December 2007 experimental burn, none of the 16 top-killed Florida ziziphus in the burn area had resprouted and only 1 of the 15 scorched plants had green leaves. These plants were provisionally recorded as dead. In the 2009 census, 100 percent of scorched plants and 93.8 percent of top-killed plants had refoliated or resprouted. For plants in the control blocks and unburned plants in the burn blocks, percent annual survival was 90.7 percent and 95.8 percent, respectively. Thus, both scorched and top-killed plants have survival rates equal to or greater than unburned plants (Weekley and Menges 2009).

Figure 6.1. Land cover - Carter Creek Unit



A detailed inventory of nonnative, exotic vegetation was conducted in 2006 through a contract with North Wind, Inc. (Table 11). According to this report, occasional trails and feral hog pathways transecting the dense, intact oak scrublands were found to be free from infestations. However, the northern portions of the perimeter firebreak roads are uniformly covered with moderately dense natal grass. Some cogon grass is present along the northern road boundary, and rosary pea is present along the northwestern fence. Threatened and endangered species in close proximity to invasive exotics are predominantly scrub plum and Lewton's polygala, although the interior scrubland contains many more threatened and endangered species occurrences, including transplanted Florida ziziphus. The survey concluded that the unit does not appear to be a high priority for treatment, as natal grass is unlikely to spread beyond the disturbed firebreak roads.

Table 11. Exotic plant species present on the Carter Creek Unit in 2006

Scientific Name	Common Name	Density*			Total
		1	2	3	
Carter Creek					
Imperata cylindrica	Cogon grass	0	3	3	**6**
Melinis repens	Natal grass	0	54	10	**64**
Abrus precatorius	Rosary pea	0	3	0	**3**
Total		**0**	**60**	**13**	**73**

Source: North Wind Inc. 2006
**Density Key: 1=single occurrence, 2=scattered, 3=abundant*

Three prescribed burns have been conducted by the Service on the Carter Creek Unit since the unit was acquired in March 1998. As mentioned, a prescribed burn was conducted in the northwest unit in August 2001, in preparation for the Florida ziziphus reintroduction project totaling 63 acres (25.5 ha). Species response was considered good with orders of magnitude increases in *polygala lewtonii* experienced. This unit along with a second unit to the east was burned in December 2007, totaling 145 acres (58.7 ha). This prescribed fire was patchy compared to the 2001 prescribed burn with fewer than half of the data loggers put in place to monitor fire condition including temperature experiencing fire. In June 2009, the entire Carter Creek Unit was targeted with prescribed fire and 600 acres (242.8 ha) were burned. Results from the June 2009 prescribed burn are not yet available, however, response of introduced Florida ziziphus are of particular interest to recovery efforts. Very few wildfires (n=2) have been documented at the Carter Creek Unit and those that have were small in area. None have been documented since 2006. Additional fire management includes fire line maintenance and construction. Between 2004 and 2006, FDOF was contracted to conduct fire line maintenance and installation. Firelines were improved using a bulldozer and roller chopper and a Gyrotrac at the Carter Creek Unit before funds were exhausted. In 2007, a new firebreak was installed through Service contract, providing an east to west break to secure quarter section burn units. Refer to Table 9 for documented fire history on the Carter Creek Unit and to Figure 6.2 for mapped representation of fire units.

Figure 6.2. Fire management units - Carter Creek Unit

Carter Creek - Land Status
The Carter Creek Unit acquisition boundary encompasses 5,506 acres (2,228.2 ha) (Figure 6.3). The Service owns and manages 627.5 acres (253.9 ha) south of Arbuckle Creek Road, while the State of Florida, TNC, and Highlands County own/manage 2,376.4 acres (961.7 ha). These lands are managed by FWC as part of the LWRWEA. Together, Service and partner lands protect 3,003.9 acres (1,215.7 ha) or 54 percent of the Carter Creek acquisition boundary. Unprotected or already developed inholdings total 2,164 acres (875.7 ha), with the remaining 338.1 acres (136.8 ha) as easements, rights-of-way, and common lands. Area values for the refuge boundary were determined using the most up-to-date ESRI GIS software (ArcGIS 9.3.1), utilizing 2008 aerials images, property maps from Highlands County, Florida, and the Service's Division of Realty Lake Wales Ridge NWR boundary files. According to the 1993 LPP, the Carter Creek acquisition boundary was reported as one of three top priority acquisitions for the proposed refuge.

The lands within the Carter Creek acquisition boundary contain 22 rare, threatened, and endangered species and are considered one of the most biologically rich sites on the LWR (Service 2005). In 1993, when the Congress authorized funding for the refuge, portions of Carter Creek (the area north of Arbuckle Creek Road) were being acquired by FWC, and due to the state's interest and acquisition efforts, the Service did not initially target acquisition of these portions. However, in 1998, TNC crafted an acquisition agreement with the principal landowner to acquire his property at Carter Creek. The Service, working with FWC and TNC, provided funding support and TNC was able to acquire the property with FWC purchasing 872 acres (352.9 ha) north of Arbuckle Creek Road and the Service utilizing $1.33 million dollars to purchase 627.5 acres (253.9 ha) south of the road. TNC acquired a small tract separating the north and south units.

The largest out-parcel remains a 1,124-acre (454.9-ha) tract located just south and continuous to the Carter Creek Unit. The eastern half of the unit is high-quality scrub and is reported to be rich in species. If acquired, this addition would provide better connection to the Flamingo Villas Unit to the south.

Lake McLeod Unit

Lake McLeod - Existing Conditions and Management
The Lake McLeod Unit is the westernmost refuge unit and is located in Polk County, between Winter Haven and Bartow (Figure 2). Field surveys of the Lake McLeod Unit were conducted by Schultz et al. (1999) in August 1998, reporting that the most outstanding natural feature was the robust population of scrub lupine (*Lupinus aridorum*).

Schultz et al. (1999) characterizes the Lake McLeod Unit as an open, white sand scrub with a small area of xeric hammock, and a dense scrub west of the Gerber Dairy Road. About 30 acres (12.1 ha) of extremely open scrub occur east of Gerber Dairy Road. Widely spaced oak clumps and sand pine form small islands in the sea of white sand, which has been kept open by a history of illegal off-road vehicle use. The shrub stratum is dominated by *Quercus geminata*, *Q. inopina*, *Q. chapmanii*, *Serenoa repens*, and *Polygonella myriophylla*, while the ground cover consists mainly of lichens with abundant *Cladonia leporina* and occasional *Cladina evansii*, *C. subtenuis*, and *Cladonia prostrata* (Schultz et al. 1999). Recently, *Cladonia perforata* has been discovered (Stout pers. comm. to Service 2009). About 2 acres of the north edge of the west side has a closed canopy of *Quercus geminata* up to 30-foot tall, growing over abundant *Serenoa repens*. An area of transitional sand pine scrub occurs from the Lake McLeod shoreline to the east about 750 feet. This area includes an historic citrus grove site. Sand pine disturbed by the historic use of off-road vehicles is the primary habitat cover of the eastern portion of the unit apart from the disturbed inholdings. While this habitat is not in prime condition due to many years of disturbance, it sustains the highest known concentration of scrub lupine currently found on public lands (Figure 7.1).

Figure 6.3. Land status - Carter Creek Unit

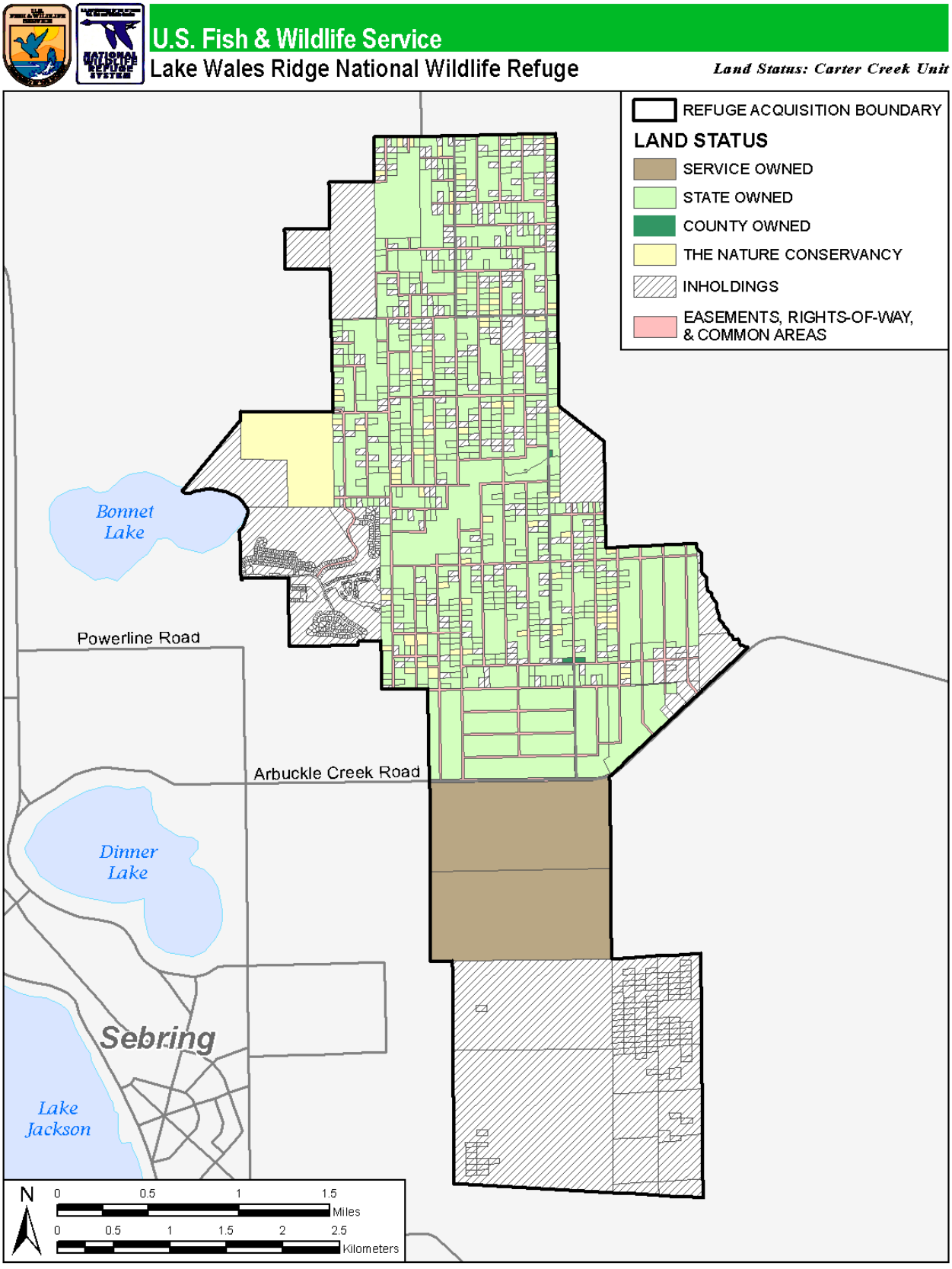
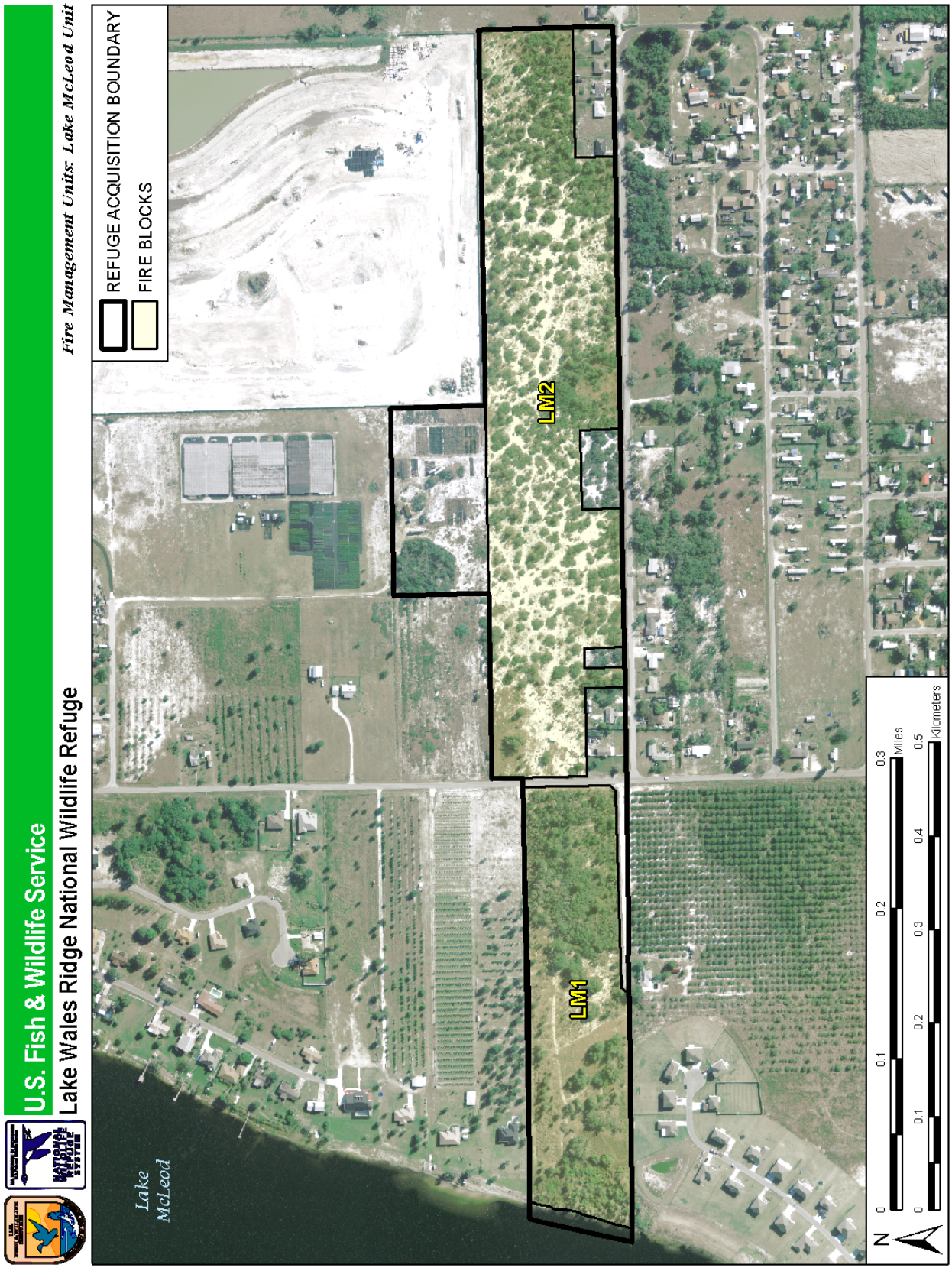


Figure 7.1. Land cover – Lake McLeod Unit



Schultz et al. (1999) reported that swaths of exposed white sand have allowed vigorous populations of rare, threatened, and endangered species to become established at the Lake McLeod Unit. Over 400 plants of all sizes of *Lupinus aridorum* occur on site; *Bonamia grandiflora* is widespread; and *Polygonella myriophylla* is an abundant ground cover. A pair of *Eumeces egregius lividus* was observed on February 12, 1998. Occurrences of *Bonamia grandiflora*, *Lupinus aridorum*, and *Polygonella myriophylla*, *Asclepias curtissii*, *Lechea cernua*, *Nolina brittoniana*, *Paronychia chartacea*, *Persea humilis*, *Polygonella basiramia*, *Prunus geniculata*, *Stylisma abdita*, *Eumeces egregius lividus*, and *Sceloporus woodi* were recorded (Schultz et al. 1999). Schultz et al. (1999) found no occurrence of *Lupinus aridorum* west of Gerber Dairy Road. Utilizing occurrence information conducted by Schultz et al. (1999), coupled with species accounts by staff, researchers, and volunteers, 10 federally listed species (8 plants, 2 wildlife species) are known to occur on the Lake McLeod Unit. In addition to the federally listed species, many state listed and rare species have been documented (Tables 14 and 15). Fringe trees (*Chionanthus pygmaeus*) no longer occur on the east side of the refuge at Lake McLeod but six individuals do occur on the west side of Gerber-Dairy Road (Stout pers comm. 2010).

Prior to Service fiscal commitments to the unit and up to 1997, the site was severely impacted and heavily used by off-road vehicles. In addition, the site was covered with mounds of trash and debris. To this day, it is the only publically owned site that offers protection for the endangered scrub lupine (*Lupinus aridorum*). Management actions on the Lake McLeod Unit include erecting signage and fencing in 2005. The refuge has conducted non-native plant control periodically on the unit. Periodic prescribed burns to reduce vegetation and debris associated with exotic and vegetation control activities also occur. Debris and trash removal provided though the help of dedicated volunteers is the most consistent management action on the unit, while these volunteers also help with inventorying and monitoring of rare species. Two homes were demolished after acquisition of the larger tract of the eastern subunit. A secure, tin-roofed outbuilding is in place and being used by the refuge for equipment storage. Since March 1997, Scrub lupine research has been conducted by the University of Central Florida through a Service contract to document survival, size germination, and flowering of scrub lupines (Stout, pers comm. 2010).

A detailed inventory of exotic vegetation was conducted in 2006 through a contract with North Wind, Inc. According to that report, the Lake McLeod Unit contains substantial areas infested by rosary pea, lantana, Caesar's weed, and Brazilian pepper, intermingled with rare, threatened, and endangered species, predominantly scrub bay and scrub holly. The eastern part is sparsely vegetated, where much of it consists of open white sand supporting multiple individuals of a variety of rare, threatened, and endangered species, principally scrub lupine, nodding pinweed, wireweed, and sandlace. The eastern area is uniformly infested by scattered clumps of natal grass, with Caesar's weed and a few Brazilian peppers confined to the perimeter of the parcel. Table 12 identifies exotic species present on the Lake McLeod Unit.

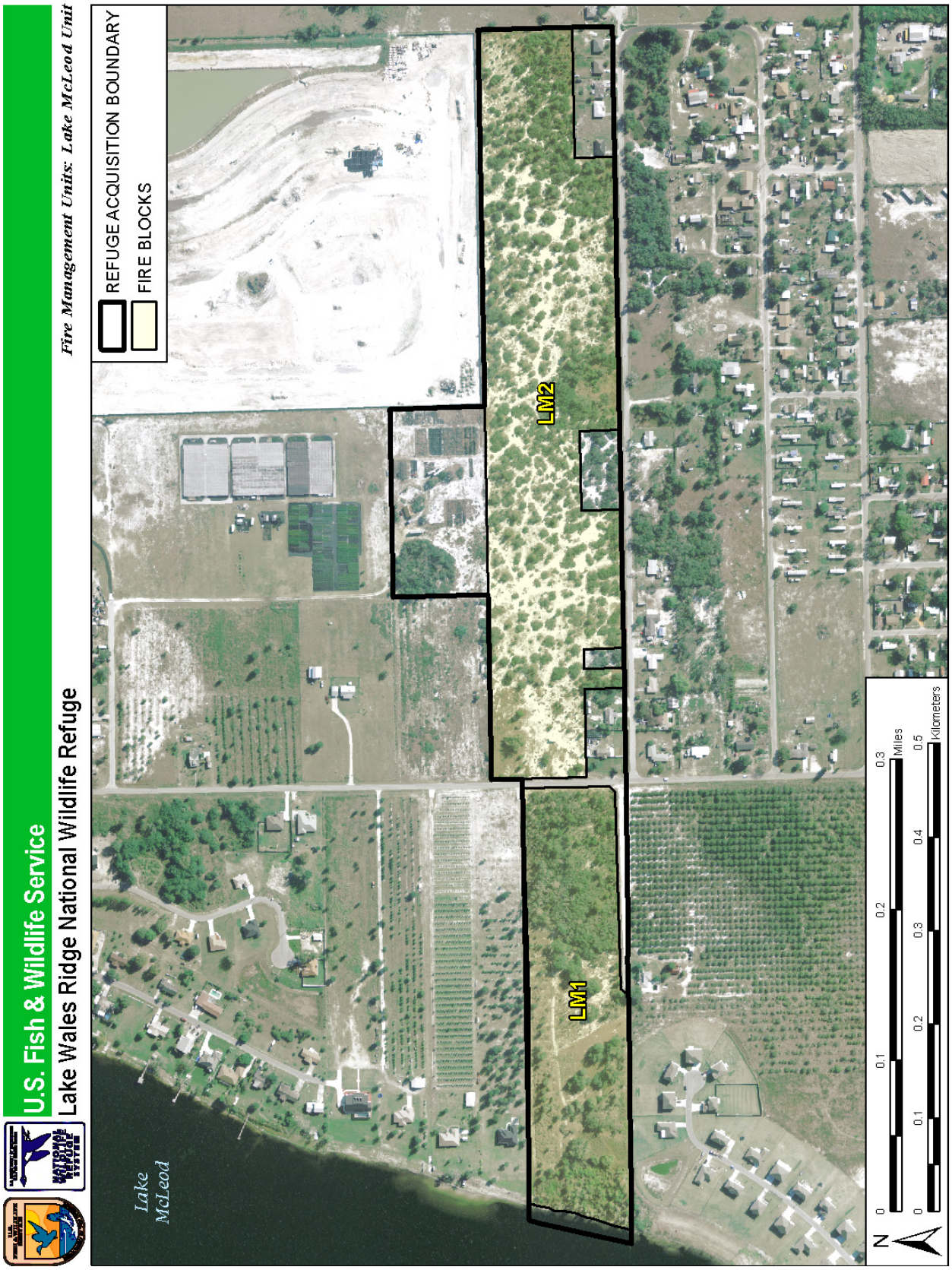
Table 12. Exotic plant species present on the Lake McLeod Unit 2006

Scientific Name	Common Name	Density*			Total
		1	2	3	
Lake McLeod					
Sansevieria hyacinthoides	bowstring hemp	0	1	0	**1**
Schinus terebinthifolius	Brazilian pepper	3	16	1	**20**
Urena lobata	Caesar's weed	3	16	5	**24**
Imperata cylindrica	cogon grass	1	2	0	**3**
Lantana camara	lantana	7	18	1	**26**
Catharanthus roseus	Madagascar periwinkle	1	3	0	**4**
Melinis repens	natal grass	6	94	7	**107**
Tradescantia spathacea	oyster plant	1	0	0	**1**
Abrus precatorius	rosary pea	6	21	10	**37**
Total		**28**	**171**	**24**	**223**

Source: North Wind Inc. 2006
*Density Key: 1=single occurrence, 2=scattered, 3=abundant

At least two wildfires have occurred on the Lake McLeod Unit since the Service has been acquiring lands within the unit's acquisition boundary. Both fires occurred on the west side of Gerber Dairy Road (on the lake side of the property) and totaled little over 3 acres (1.2 ha). No landscape level prescribed burn has been conducted at the Lake McLeod Unit by the Service. There have been approximately 30 brush piles burned along the boundaries of the Lake McLeod Unit. These burns were primarily conducted to reduce fuels and to increase openings for native vegetation. Refer to Figure 7.2 for location of fire management units on the Lake McLeod Unit.

Figure 7.2. Fire management units – Lake McLeod Unit



Lake McLeod - Land Status
The Lake McLeod Unit acquisition boundary totals 46.8-acres (18.9 ha) (Figure 7.3) of mostly sand pine scrub of varying quality due in large part to historic impacts of off-road vehicles and fire suppression. The unit is surrounded by agriculture and residential development to the north, south, and east, and boarders Lake McLeod to the west. The 1993 LPP approximated the acquisition boundary at 50 acres (20.2 ha), while the Service's Realty Office boundary files calculate the boundary at 62 acres (25.1 ha). As part of the preparation for this CCP, Service staff sought to update the Lake McLeod Unit acquisition boundary due in part to these discrepancies. Staff utilized the latest ArcGIS (9.3.1) technology and the most current digital parcel and image data available (2009 Polk County parcel data and 2007 Polk County aerial imagery), comparing these references to the Service's Realty Office spatial data and digitally rectified images of the original LPP maps. Based on this methodology, results suggest an acquisition boundary of 46.8 acres (18.9 ha) represented in Figure 7.3. The Service owns and manages 38 acres (15.4 ha) within the boundary while the remaining 8.8 acres (3.5 ha) includes 10 unprotected developed inholdings (8 single family dwellings and 2 scarified lots), 2 undeveloped inholdings, and 1 easement surrounded by Service-owned property.

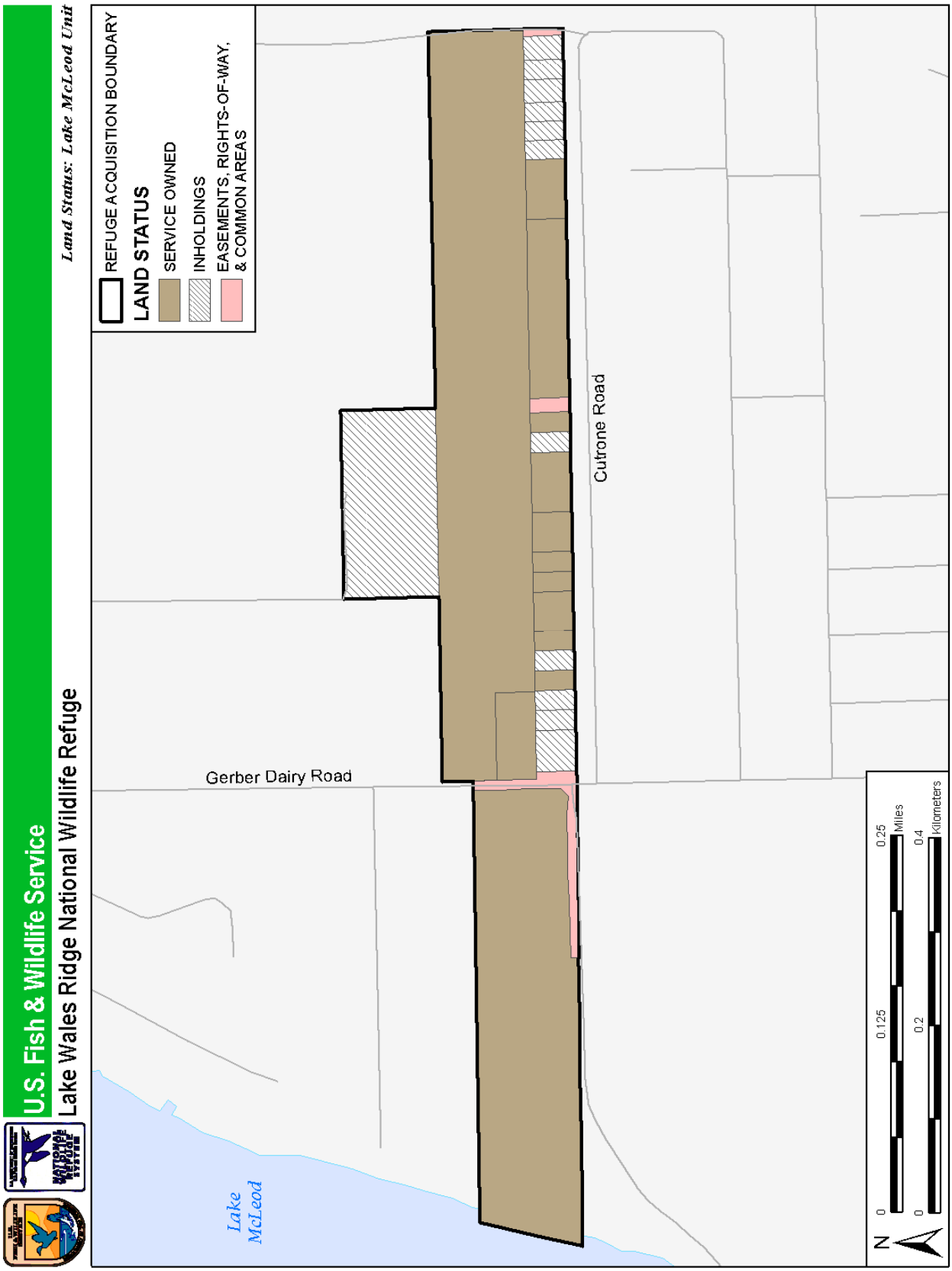
Of specific notation is an area encompassing a 5-acre (2-ha) inholding not characterized on the current Service boundary file but provided for in the original LPP. A range of historic aerial photos provided for by refuge volunteers was used to compare historic conditions to present. According to historic aerial photos (University of Florida Map and Digital Imagery Library Center) from 1941, 1958, 1971, 1984, and 1995 of the Lake McLeod Unit area, significant habitat loss to agricultural conversion on the lands surrounding the current Lake McLeod Unit are evident. By 1984, most of the natural area to the north of the current management boundary was converted to agricultural use, but for one distinct 5-acre (2-ha) area, which can be identified in the 1984 and 1995 aerials – the time period during which the refuge was planned and established. We believe this area was intended within the original acquisition boundary as its estimated extent is represented in the original 1993 LPP paper maps.

Snell Creek Unit

Snell Creek - Existing Conditions and Management
The Snell Creek Unit is the northernmost refuge management unit and is located in Polk County, near Haines City (Figure 2). Very little is currently known about the unit's trust resources as baseline species occurrence and habitat condition are lacking. The Snell Creek Unit was identified by Turner et al. (2006); however, no species were documented. Schultz et al. (1999) did not include the Snell Creek Unit in the inventory. Five federally listed (4 plants, 1 wildlife species) and one candidate species have been documented on the Snell Creek Unit through staff observation, however, status and trends of these species are unknown (Tables 14 and 15).

The Snell Creek Unit is dominated by flatwoods habitat of varying elevations and soil moistures. The scrubby flatwoods habitat, which is found on small ridges, makes up the majority of the property. For the most part, this habitat is open, well-maintained by fire, and has a rich diversity of herbaceous plants. At the southern end of the property, there is an open ephemeral pond, which is surrounded by well-managed scrubby flatwoods containing several gopher tortoise burrows. Scrubby flatwood habitat occurs on the units xeric soils and is interspersed by wet soils where both ephemeral wetlands and mesic flatwoods occur. There are healthy stands of trees on this property, dominated by *Pinus elliottii* in the wet areas, *Pinus palustris* on the ridges, and some scattered *Pinus clausa*. On the north and eastern edges of the property, the elevation drops further and bayhead habitat is found. These areas are not large in size but are densely vegetated and dominated by sweetbay (*Laurus nobilis*) and southern magnolia (*Magnolia grandiflora*). Refer to Figure 8.1 for land cover occurring on the Snell Creek Unit.

Figure 7.3. Land status – Lake McLeod Unit



According to North Wind Inc., (2006) invasive exotics plant species mapping efforts, scattered natal grass (*Melinis repens*) occurs on the Snell Creek Unit and these occurrences were not found in close proximity to threatened or endangered species.

The SFWMD has conducted prescribed burns on portions of the Snell Creek Unit, including a 102.4-acre (41.3 ha) burn in April 2005. This informal arrangement between the refuge and the SFWMD is in place due to logistic and safety concerns. SFWMD conducts many controlled burns in the area and there are currently no firebreak boundaries on the Snell Creek Unit. In the case of Snell Creek where SFWMD burns are allowed to partially burn onto adjacent refuge lands, prescribed fire management is safely facilitated. This fire management direction reduces burn complexity by limiting the need for ground support to unnecessarily hold fire at common boundaries. This approach has the added benefit of limiting development of unnecessary perimeter fire lines and reduces costs. Refer to Figure 8.2 for fire management units of the Snell Creek Unit.

Snell Creek - Land Status

The current Snell Creek management boundary is 139.3 (56.4 ha) acres, comprising 29 percent of the original 483.4-acre (195.6-ha) unit acquisition boundary (Figure 8.3.). The State of Florida owns and manages 208.6 acres (84.4 ha) within the approved unit acquisition boundary, while 135.5 acres (54.8 ha) of unprotected inholdings and road rights-of-way make up the remaining lands. Detailed analysis of the originally approximated 320-acre (129.5-ha) acquisition boundary (Service 1993) were performed for the development of this Plan, utilizing ArcGIS 9.3.1 software, current digital 2007 Polk County aerial imagery, 2009 Polk County parcel data, and rectified images of the original LPP maps. According to this analysis, the refuge's acquisition boundary calculates to 483.4 acres (195.6 ha) for which the refuge owns and manages 139.3 acres (56.4 ha).

The Service purchased interest in the unit's acquisition boundary in September 1996. The owner, Hall Communications, retained its transmission tower and roadway right-of-way currently located to the south of the refuge unit (Figure 8.3). The SWFWMD currently owns the remaining 208.6 acres (84.4 ha) of the original acquisition boundary and through agreement, the tract is managed by the SFWMD as part of the Lake Marion and Reedy Creek management areas. The SFWMD developed a management plan for these lands (Lake Marion Creek and Reedy Creek Management Areas Five-Year General Management Plan 2005-2010) and as mentioned, has implemented frequent prescribed burns to reduce fuels and restore and maintain habitats. No formal agreements exist that provide for SFWMD management of the Snell Creek Unit and the refuge is fortunate to receive law enforcement assistance by FWC. There are no inholdings within the current management boundary at the Snell Creek Unit.

Habitat

Habitat descriptions for Lake Wales Ridge NWR were adapted from FNAI's Guide to the Natural Communities of Florida (FNAI 1990) and the Florida Land Use/Land Cover Classification System (FLUCCS) (FDOT 1999) and include basin wetland, bayhead, depression marsh, grove, hardwood hammock, human modified, mesic flatwoods, roads, ruderal, ruderal sandpine scrub, sandhill, scrub, scrubby flatwoods, and xeric hammock (Table 13). In addition, landcover data for Carter Creek and Flamingo Villas Units were defined and mapped (Figures 5.1.1-5.1.3, 6.1) by ABS under a contract awarded by the Service (Main 1999), while land cover data for the Lake McLeod and Snell Creek Units (Figures 7.1 an 8.1) were derived from 1999 State of Florida's Florida Land Use Land Cover Classification System (FLUCCS) (FDOT 1999).

Figure 8.1. Land cover – Snell Creek Unit

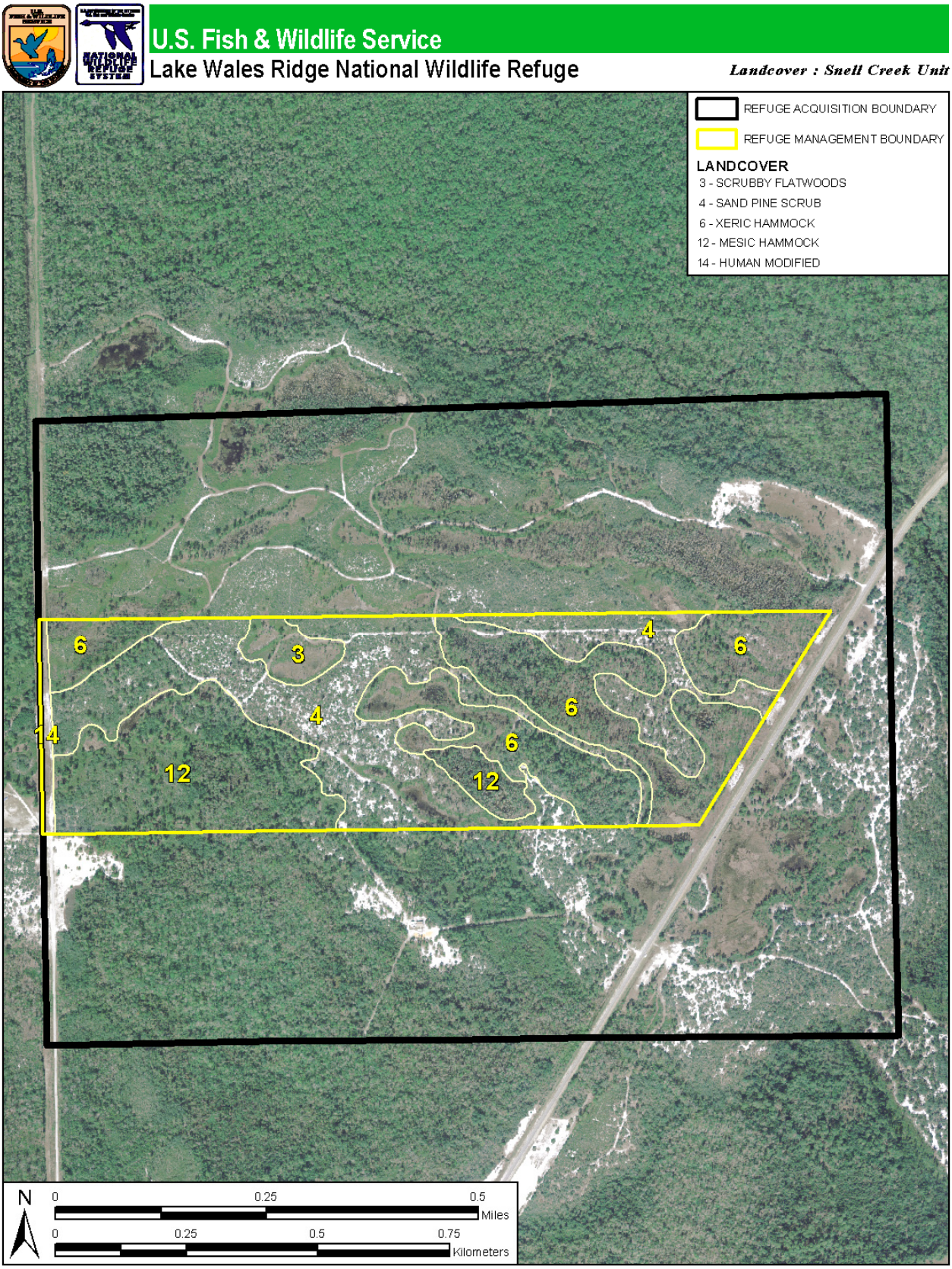


Figure 8.2. Fire management units – Snell Creek Unit

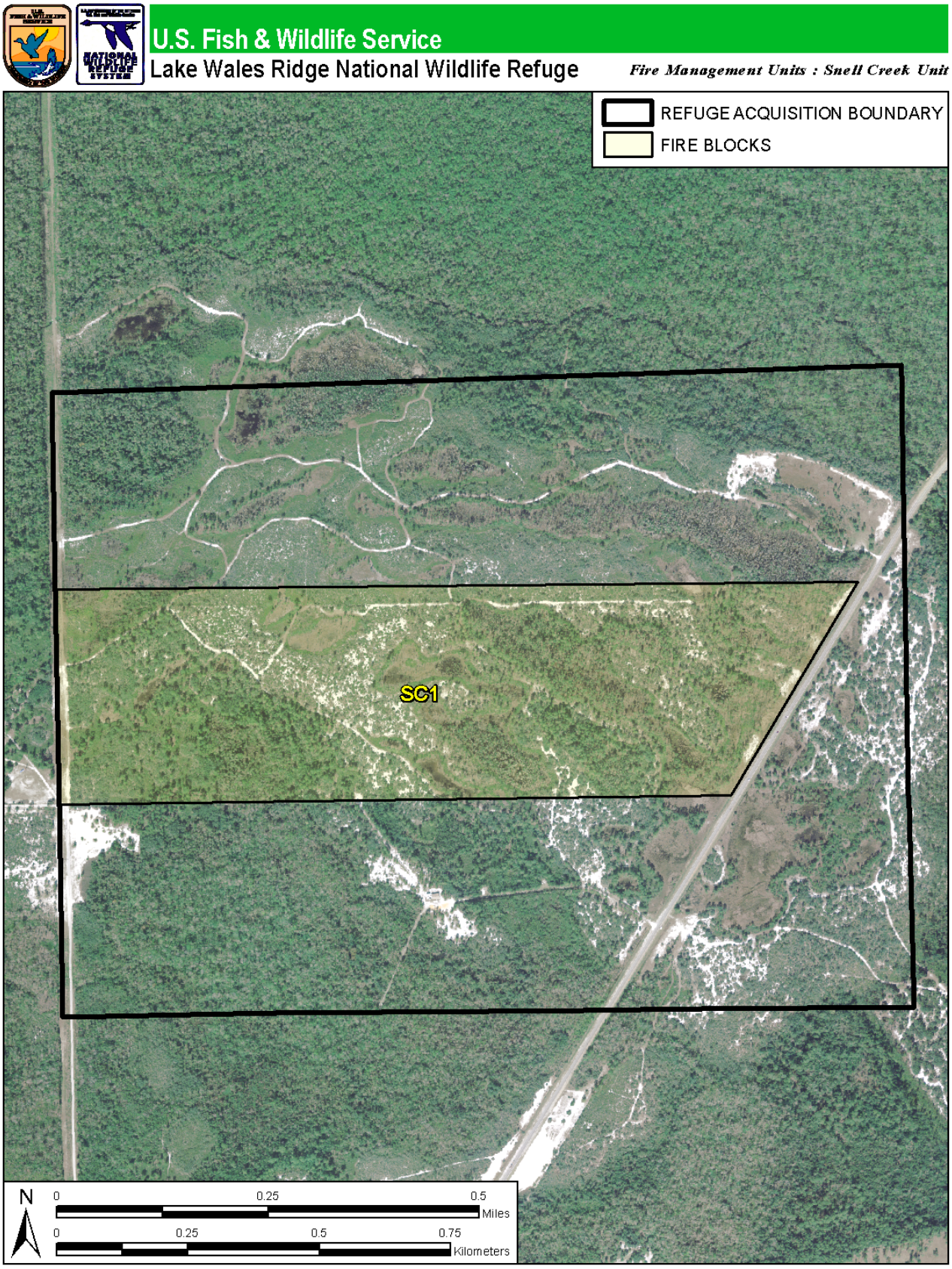


Figure 8.3. Land status – Snell Creek Unit

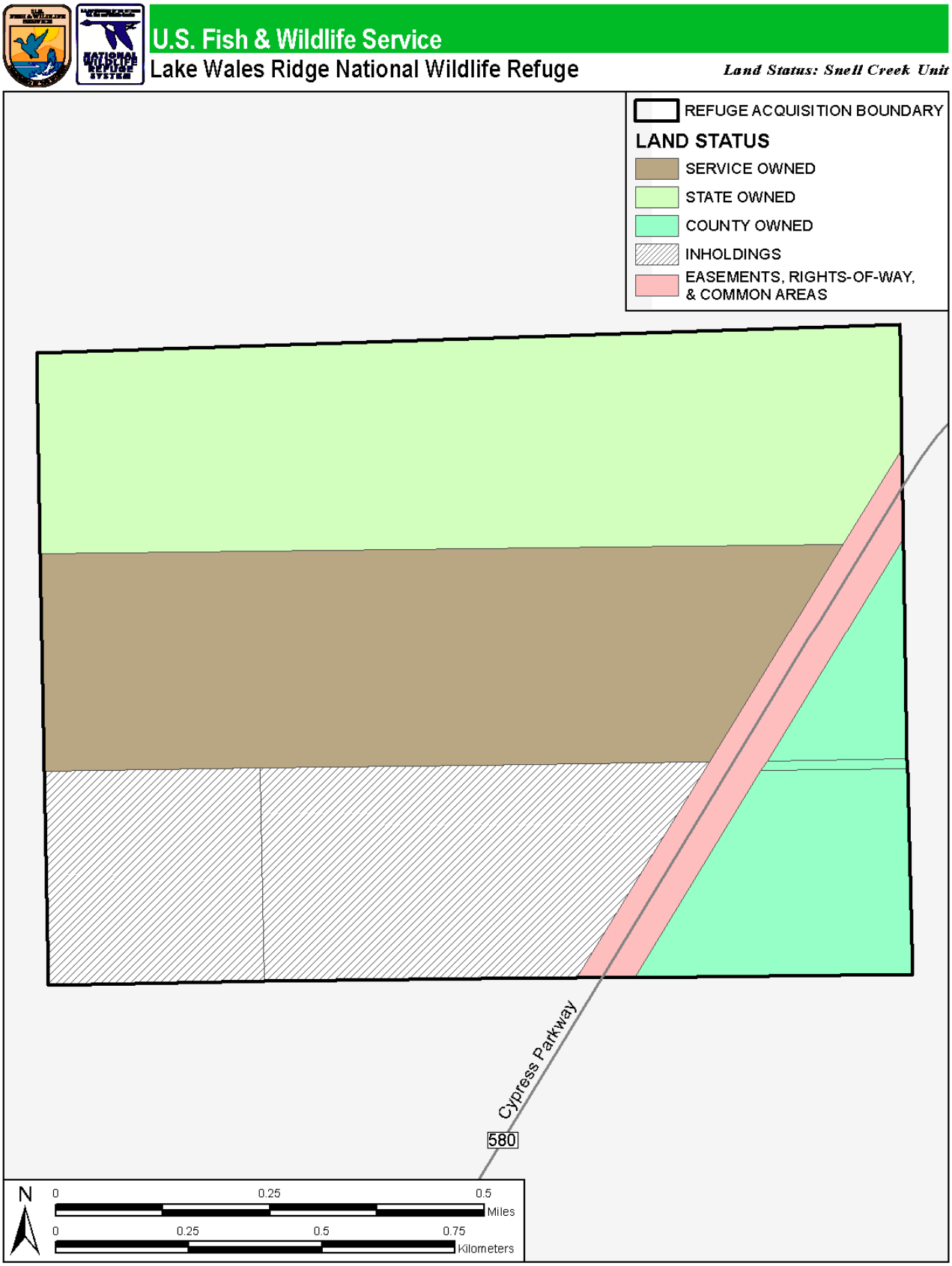


Table 13. Major habitat types of the Lake Wales Ridge NWR

Habitat Type	Flamingo Villas	Carter Creek	Lake McLeod	Snell Creek	Total Area Ac/Ha
Basin Marsh/Depression Marsh	X	X			234.2a 94.8h
Bayhead	X	X			335.4a 135.7h
Flatwoods - Mesic Flatwoods Cutthroat Phase	X	X			108.9a 44.1h
Flatwoods - Mesic Flatwoods Gallberry-Palmetto Phase	X	X			159.2a 64.4h
Flatwoods - Mesic Flatwoods Wiregrass Phase	X	X			65.6a 26.6h
Flatwoods - Scrubby Flatwoods	X	X		X	103.1a 41.7h
Human Modified	X	X	X	X	58.2a 23.5h
Lake			X		0.5a 0.2h
Mesic Hammock				X	31.5a 12.7h
Scrub - Sand Pine Scrub			X	X	83.3a 33.7h
Scrub – Sand Pine Scrub Transitional			X		7.7a 3.1h
Scrub - Yellow Sand Scrub	X	X			171.0a 69.2h
Turkey Oak/Wiregrass Sandhill	X	X			437.3a 177.0h
Xeric Hammock				X	48.0a 19.4h

Basin Marsh/Depression Marsh
Florida Natural Areas Inventory (FNAI 1990) identifies basin marsh as freshwater marsh areas that are shallow, closed basin with outlet usually only in time of high water; peat or sand substrate, usually inundated; and wetland woody and/or herbaceous vegetation. Depression marshes are similar in vegetation and physical features to, but are generally smaller than, basin marshes. These habitat types are mapped together due to the similar nature of habitat conditions and the role played in the refuge landscape, however, they are described separately below.

Basin Marsh. Basin marsh is characterized as an herbaceous or shrubby wetland situated in a relatively large and irregularly shaped basin that usually develops in large solution depressions that were formerly shallow lakes. The lake bottom has slowly filled with sediments from the surrounding uplands and with peat derived from plants. Thus, the soils are usually acidic peats. The hydroperiod is generally around 200 days per year. Fire maintains the open herbaceous community by restricting shrub invasion. The normal interval between fires is 1 to 10 years, with strictly herbaceous marshes burning about every 1 to 3 years, and those with substantial willow and buttonbush having gone 3 to 10 years without fire. Fires during drought periods will often burn the mucky peat and will convert the marsh into a marsh lake (FNAI 1990).

Basin marshes are associated with and often grade into wet prairie or lake communities. They may eventually succeed to bog, if succession is not reversed by a muck fire. Many of the plants and animals occurring in basin marshes also occur in floodplain marsh, slough, swale, and depression marsh. Large examples of the depression marsh, in fact, may be very difficult to distinguish from small examples of basin marsh. Normal hydroperiods must be maintained, or basin marsh vegetation will change. Shortened hydroperiods will permit the invasion of mesophytic species, while longer hydroperiods will convert marsh into lake. Fire is also necessary to control hardwood encroachment. However, fires during droughts should be avoided to reduce the possibility of a muck fire (FNAI 1990).

Depression Marsh. FNAI (1990) characterizes depression marsh as a shallow, usually rounded depression in sand substrate with herbaceous vegetation often in concentric bands. The ground cover in the depression marshes is primarily cutthroat and other grasses. There are clumps of palmetto, and in many cases, other woody brush species have begun to grow. Some of the ponds have slash pine in them.

Larger and more permanent depression marshes may have many of the same plants and animals listed as typical of basin marshes. However, because of their isolation and small size, many depression marshes support a very different assemblage of species than that found in larger, more permanent wetlands. Depression marshes are considered extremely important in providing breeding or foraging habitat for such species as the flatwoods salamander (*Ambystoma cingulatum*), mole salamander (*Ambystoma talpoideum*), tiger salamander (*Ambystoma tigrinum*), dwarf salamander (*Euycea quadridigitata*), striped newt (*Notophthalmus perstriatus*), oak toad (*Bufo quercicus*), southern cricket frog (*Acris gryllus*), pinewoods tree frog (*Hyla femoralis*), barking treefrog (*Hyla gratiosa*), squirrel treefrog (*Hyla squirella*), little grass frog (*Pseudacris ocularis*), southern chorus frog (*Pseudacris nigrita*), ornate chorus frog (*Pseudacris ornata*), narrowmouth toad (*Gastrophryne carolinensis*), eastern spadefoot toad (*Scaphilopus holbrooki*), gopher frog (*Rana capito*), white ibis (*Eudocimus albus*) wood stork (*Mycteria americana*), and sandhill crane (*Grus canadensis*). Depression marshes occurring as isolated wetlands within larger upland ecosystems are of critical importance to many additional wetland and upland animals (FNAI 1990).

Depression marshes are typical of karst regions where sand has slumped around or over a sinkhole and thereby created a conical depression subsequently filled by direct rainfall, runoff, or seepage from surrounding uplands. The substrate is usually acid sand with deepening peat toward the center. Some depressions may have developed or be maintained by a subsurface hardpan. Hydrological conditions vary, with most depression marshes being dry in most years. Hydroperiods range widely from less than 50 days to more than 200 days per year (FNAI 1990).

Fire is important to maintaining this community type by restricting invasion of shrubs and trees and the formation of peat. Fire frequency is often greatest around the periphery of the marsh and least toward the center. A severe peat fire can lower the ground surface and create a pond at the center of the marsh (FNAI 1990).

Depression marshes are often associated with and grade into wet prairie, seepage slope, wet flatwoods, mesic flatwoods, dome swamp, or bog. They also may occur in association with various types of lakes, such as those found in sandhill or flatwood communities (FNAI 1990).

Bayhead

Bayheads are characterized by dense stands of bay (*Persea* spp.) and other wetland shrubs and trees. These areas also have some slash pines present. Palmetto (*Serenoa repens*) occurs in the midstory, and cutthroat grass (*Panicum abscissum*) is found from time-to-time. There are almost no bare areas.

FNAI (1990) characterizes bayheads as densely forested, peat-filled seepage depressions often at the base of sandy slopes. The canopy is composed of tall, densely packed, generally straight-boled evergreen hardwoods dominated by sweetbay, swamp red bay (*Persea palustris*), and loblolly bay (*Gordonia lasianthus*). A more or less open understory of shrubs and ferns commonly occurs, while sphagnum mats are often interlaced with the convoluted tree roots. Other typical plants include dahoon holly (*Ilex cassine*), fetterbush (*Leucothoe racemosa*), male-berry (*Lyonia ligustrina*), myrtle-leaved holly (*Ilex myrtifolia*), large gallberry (*Ilex coriacea*), wax myrtle (*Myrica cerifera*), odorless wax myrtle (*Myrica inodora*), hurrah-bush (*Arctium lappa*), dog-hobble (*Leucothoe fontanesiana*), white alder (*Alnus rhombifolia*), possumhaw (*Ilex decidua*), red chokeberry (*Aronia arbutifolia*), Virginia willow (*Itea virginica*), laurel greenbrier (*Smilax laurifolia*), poison ivy (*Rhus toxicodendron*), cinnamon fern (*Osmunda cinnamomea*), chain fern (*Woodwardia virginica*), wild grape (*Vitus rotundifolia*), netted chain fern (*Woodwardia aerolata*), sweetgum (*Liquidambar styraciflua*), bald cypress (*Taxodium distichum*), lizard's tail (*Saururus cernuus*), and needle palm (*Rhapidophyllum hystrix*). Typical animals include mole salamander, southern dusky salamander (*Desmognathus auriculatus*), southern mud salamander (*Pseudotriton montanus montanus*), opossum (*Didelphidae* spp.), southeastern shrew (*Sorex longirostris*), short-tailed shrew (*Blarina carolinensis*), marsh rabbit (*Sylvilagus palustris*), black bear (*Ursus americanus*), raccoon (*Procyon lotor*), southern mink (*Mustela vison*), and bobcat (*Felix rufus*) (FNAI 1990).

Bayheads typically develop at the base of a slope where seepage usually maintains a saturated peat substrate. They may also be located at the edges of floodplains or in other flat areas where high water tables help maintain soil moisture. Bayhead soils are generally composed of peat with an acidic pH (3.5 - 4.5). Since bayheads rarely dry out enough to burn, the normal fire interval in these communities is probably 50-100 years or more. After a fire, bay trees usually resprout from the roots and replace themselves, but severe fires may change a bayhead into a different plant community. If only a small amount of surface peat is removed, a bayhead may be replaced by a wet flatwoods community. If the ground surface is lowered considerably, willows may invade, followed by a cypress-gum community. With recurrent fire, the site will become a shrub bog (FNAI 1990).

Bayheads are often associated with and may grade into seepage slope, floodplain forest or floodplain swamp. The species composition of bayheads frequently overlaps with bog, dome swamp, basin swamp, strand swamp, bottomland forest, wet flatwoods, and hydric hammock. Bayheads are dependent upon seepage flow and a high water table. Alterations in the local or regional hydrology could impact bayhead communities. They may also need fire protection during droughts, especially if water tables are lowered (FNAI 1990).

Flatwoods

There are four classifications of the flatwoods found on the refuge, mesic flatwoods including cutthroat phase, gallberry/palmetto phase, and wiregrass phase, and scrubby flatwoods. They vary in soil type and understory vegetation. All of them have some pine overstory. FNAI (1990) synonyms for mesic flatwoods including a cutthroat phase, gallberry-palmetto phase, and wiregrass phase are pine flatwoods, pine savannahs, and pine barrens.

According to FNAI designations (FNAI 1990), mesic flatwoods are characterized as an open canopy forest of widely spaced pine trees with little or no understory, but with a dense ground cover of herbs and shrubs. Several variations of mesic flatwoods are recognized, the most common associations being longleaf pine, wiregrass - runner oak, and slash pine - gallberry - saw palmetto. Other typical plants include: St. John's-wort (*Hypericum perforatum*), dwarf huckleberry (*Gaylussacia dumosa*), fetterbush, dwarf wax myrtle (*Myrica pusilla*), stagger bush (*Lyonia mariana*), blueberry (*Vaccinium* spp.), gopher apple (*Licania michauxii*), tar flower (*Befaria racemosa*), bog buttons (*Lachnocaulon beyrichianum*), blackroot (*Pterocaulon virgatum*), false foxglove (*Agalinis* spp.), white-topped aster (*Sericocarpus linifolius*), yellow-eyed grass (*Sisyrinchium striatum*), and cutthroat grass. Typical animals of mesic flatwoods include: oak toad, little grass frog, narrowmouth toad, black racer (*Coluber constrictor priapus*), red rat snake (*Elaphe guttata*), southeastern kestrel (*Falco sparverius paulus*), brown-headed nuthatch (*Sitta pusilla*), pine warbler (*Dendroica pinus*), Bachman's sparrow (*Aimophila aestivalis*), cotton rat (*Sigmodon hispidus*), cotton mouse (*Peromyscus gossypinus*), black bear, raccoon, gray fox (*Urocyon cinereoargenteus*), bobcat, and white-tailed deer (*Odocoileus virginianus*) (FNAI 1990).

Mesic flatwoods occur on relatively flat, moderately to poorly drained terrain. The soils typically consist of 1 to 3 feet of acidic sands generally overlying an organic hardpan or clayey subsoil. The hardpan substantially reduces the percolation of water below and above its surface. During the rainy seasons, water frequently stands on the hardpan's surface and briefly inundates much of the flatwoods; while during the drier seasons, ground water is unobtainable for many plants whose roots fail to penetrate the hardpan. Thus, many plants are under the stress of water saturation during the wet seasons and under the stress of dehydration during the dry seasons.

Mesic Flatwoods - Wiregrass. This version of the flatwoods occurs on more moist sites than the scrubby flatwoods. The shrub layer is palmetto with some other flatwoods species mixed in. Overstory is primarily slash and longleaf pine with a few sand pines. The ground cover is largely wiregrass, but there are recurrent areas of cutthroat grass. Patches of bare sand are infrequent.

Mesic Flatwoods - Cutthroat Grass. This category of flatwoods also occurs on moist soils. It has a palmetto midstory with an average height of less than 3 feet. However, in this type, cutthroat grass is the dominant ground cover and wiregrass is not present. Areas of bare ground are seldom found. The overstory of pines is denser than that of the wiregrass flatwoods, covering over 40 percent of the area.

Mesic Flatwoods - Palmetto/Gallberry. The final version of the flatwoods has a palmetto/gallberry midstory. Wax myrtle (*Myrica cerifera*) and *Lyonia* sp. are also present. The average shrub height is typically between 3 and 6 feet. The overstory is chiefly slash pine covering between 16 percent and 40 percent of the area. Scattered sand pine is present on the drier sites. Wiregrass and cutthroat grass are present.

Another important physical factor in mesic flatwoods is fire, which probably occurred every 1 to 8 years during pre-Columbian times. Nearly all plants and animals inhabiting this community are adapted to periodic fires, while several species depend on fire for their continued existence. Without relatively frequent fires, mesic flatwoods succeed into hardwood-dominated forests whose closed canopy can essentially eliminate the ground cover herbs and shrubs. Additionally, the dense layer of

litter that accumulates on unburned sites can eliminate the reproduction of pines, which require a mineral soil substrate for proper germination. Thus, the integrity of the mesic flatwoods community is dependent on periodic fires. However, fires that are too frequent or too hot would eliminate pine recruitment and eventually transform mesic flatwoods into dry prairie (FNAI 1990).

Mesic flatwoods are closely associated with and often grade into wet flatwoods, dry prairie, or scrubby flatwoods. The differences between these communities are generally related to minor topographic changes. Wet flatwoods occupy the lower wetter areas, while scrubby flatwoods occupy the higher drier areas. Mesic flatwoods are the most widespread biological community in Florida, occupying an estimated 30 to 50 percent of the state's uplands. However, very few undisturbed areas of mesic flatwoods exist because of habitat mismanagement and silvicultural, agricultural, and residential development. Mesic flatwoods are often fairly resilient, and with proper management they can generally be restored (FNAI 1990)

Scrubby Flatwoods. Scrubby flatwoods occur on drier soils. The shrub layer is a mixture of palmetto and scrub oaks, with an average height of 3 to 6 feet. The overstory is scattered slash pine with some sand pine. Less than 15 percent of the area is covered by pines. Cutthroat grass (*Panicum abscissum*) and wiregrass (*Aristida* spp.) are found as groundcover. Areas of bare ground are infrequent.

FNAI (1990) characterizes scrubby flatwoods by an open canopy forest of widely scattered pine trees with a sparse shrubby understory and numerous areas of barren white sand. The vegetation is a combination of scrub and mesic flatwoods species and scrubby flatwoods often occupy broad transitions or ecotones between these communities. Typical plants include longleaf pine, slash pine, sand live oak (*Quercus geminata*), Chapman's oak (*Quercus chapmanii*), myrtle oak (*Quercus myrtifolia*), scrub oak (*Quercus ilicifolia*), saw palmetto, staggerbush, wiregrass, dwarf blueberry (*Vaccinium coymbosum*), gopher apple, rusty lyonia (*Lyonia ferruginea*), tarflower, golden-aster (*Chrysopsis villosa*), lichens, silkbay (*Persea humilis*), garberia (*Garberia heterophylla*), goldenrod (*Solidago* spp.), runner oak (*Quercus margarettae*), pinweeds (*Lechea* spp.), and frostweed (*Verbesina virginica*) (FNAI 1990).

Scrubby flatwoods generally occur intermingled with mesic flatwoods along slightly elevated relictual sandbars and dunes. The white sandy soil is several feet deep and drains rapidly. However, the water table is unlikely to be very deep. Scrubby flatwoods normally do not flood, even under extremely wet conditions. Temperature and humidity of air and soil in scrubby flatwoods fluctuate substantially more than in most other communities because the scattered overstory, sparse understory, and barren sands of scrubby flatwoods do not ameliorate daily (FNAI 1990).

Although the elevated, deeper sandy soils of scrubby flatwoods engender a drier environment than the surrounding mesic flatwoods, the general scarcity of ground vegetation and the greater proportion of relatively incombustible scrub-oak leaf litter reduce the frequency of naturally occurring fires. Only after a long absence of fire and during periods of drought does the leaf litter become sufficiently combustible and concentrated enough to support an ecological burn. Several species of plants in scrubby flatwoods are typical scrub plants, which endure only when long intervals between fires occur. Thus, a periodicity of approximately 8 to 25 years between fires appears to be natural for this community. Scrubby flatwoods are associated with and often grade into mesic flatwoods, scrub, dry prairie, or sandhills. This community is essentially a mesic flatwoods with a scrub understory (FNAI 1990).

Human Modified (Includes ruderal lands, human modified lands, and roads).
In addition to the more or less natural vegetation types described in this section, there are several areas where human influence has significantly altered the landscape. On the Lake McLeod Unit, for instance, most of the eastern portion of the site has had extensive off-road vehicle use. Although the

area is still populated with scrub species, including numerous threatened and endangered plants, the continuity of the vegetation has been broken up to such an extent that management with fire would be difficult. Other areas of disturbed land occur in the Flamingo Villas Unit, including railroad and powerline rights-of-way, and cleared lands. According to FNAI designations (FNAI 1990), the ruderal land use description applies to areas that have been cleared for development, agriculture, demolition, or habitat restoration. Some have no positive indicators of the intended land use. The grounds appear scraped and worked, usually with angular or geometric boundaries. Little to no vegetation exists in these settings, or the vegetation is in a state of transition without stable community structure.

Lake
Lakes (clastic upland lakes) are generally characterized as shallow to relatively deep, irregular depressions or basins in uplands on clay substrates. They are lentic water bodies with surface inflows but often without significant outflows. Water is generally dissipated through evaporation and transpiration, but it may also disappear, especially during periods of prolonged drought, through sinks that connect with the aquifer. Lakes are generally densely vegetated by concentric bands of emergents, floating, and submersed aquatics. Clastic upland lakes are important areas for many terrestrial and semi-aquatic amphibians and are frequently important feeding and nesting areas for many wading birds, ducks, reptiles, and fish (FNAI 1990).

Mesic Hammock
Mesic hammock is defined by FNAI (1990) as a hardwood forest community of open or closed canopy dominated by live oak (*Quercus virginiana*), with cabbage palm (*Sabal palmetto*) often present in the canopy and subcanopy. Epiphytes (ferns orchids and bromeliads) are often found and may become abundant in undisturbed stands. Shrubby understory may be dense or open, tall or short, and is composed of saw palmetto (*Serenoa repens*), beautyberry (*Callicarpa americana*), and wax myrtle (*Myrica cerifera*), with the addition of tropical shrubs, such as nakedwood (*Myrcianthes fragrans*) and wild coffee (*Psychotria nervosa*), in the south. The herb layer is often sparse or patchy and consists of various grasses, including low panic grasses (*Dichanthelium* spp.) and basket grass (*Oplismenus hirtellus*), and sedges. Mesic hammock usually occurs as fringes or small patches on the borders of, or in higher parts of, rivers, swamps, marshes, and large lakes, and ranges from central and south Florida (Polk to Dade and Collier Counties) northward along the Atlantic and Gulf coasts to North Carolina and Texas. Soils are sand mixed with organic matter and are normally dry underfoot. It is distinguished from prairie hammock by its situation bordering wetlands in an upland landscape, rather than on rises in a marshy, wetland landscape; it differs from hydric hammock in the absence of wetland trees such as sweetbay (*Magnolia virginiana*) and black gum (*Nyssa biflora*), and from xeric hammock in the absence of sand live oak (*Quercus geminata*), myrtle oak (*Quercus myrtifolia*) and other scrub species. It is distinguished from maritime hammock by its inland occurrence on non-dune substrates and from upland hardwood and upland mixed forests to the north by its low species diversity and lack of many characteristic deciduous broad-leaved trees in the canopy and subcanopy, such as *Quercus michauxii, Carpinus caroliniana*, and *Cornus florida,* as well as by its occurrence on sandy soils in contrast to the loamy or clay-based soils on which upland forests occur. It is found primarily in Florida where its area may be between 100,000 and 500,000 acres, although this is difficult to estimate since it occurs as scattered small stands or fringing borders in a matrix of dry prairie, mesic flatwoods, floodplain marshes, or hydric hammock. Examples may be found around large lakes in Osceola and Polk Counties, and along the St. Johns River marshes (FNAI 1990).

Scrub
FNAI (1990) describes sand pine scrub as a scrub community type, together with yellow sand scrub, Florida scrub, sand scrub, rosemary scrub, and oak scrub. For discussion purposes scrub habitat is generally discussed with yellow sand scrub and sand pine scrub specifically addressed.

Scrub occurs in many forms, but is often characterized as a closed to open canopy forest of sand pines with dense clumps or vast thickets of scrub oaks and other shrubs dominating the understory. The ground cover is generally very sparse, being dominated by ground lichens or, rarely, herbs. Open patches of barren sand are common in scrub that does not have a history of fire suppression or is being managed with prescribed fire. Where the overstory of sand pines is widely scattered or absent altogether, the understory and barren sands are exposed to more intense sunlight. It is within these gaps that most of the herbaceous endangered plant species thrive, reproducing in most cases from the soil seed bank after fire. Typical plants include sand pine, sand live oak, myrtle oak, Chapman's oak, scrub oak, saw palmetto, rosemary (*Rosmarinus officinalis*), rusty lyonia, ground lichens, scrub hickory (*Carya floridana*), saw palmetto, hog plum (*Prunus umbellata*), silk bay, beak rush (*Rhynchospera cephalantha*), milk peas (*Galactia* spp.), and stagger bush. Typical animals include red widow spider (*Latrodectus bishopi*), scrub wolf spider (*Geolycosa* spp.), oak toad, Florida scrub lizard (*Sceloporus woodi*), bluetail mole skink (*Eumeces egregius lividus*), sand skink (*Neoseps reynoldsi*), sixlined racerunner (*Cnemidophorus sexlineatus*), coachwhip (*Masticophis flagellum flagellum*), ground dove (*Columbiana passerina*), scrub-jay (*Aphelocoma coerulescens*), loggerhead shrike (*Lanius ludovicianus*), yellow-rumped warbler (*Dendroica coronata*), eastern towhee (*Pipilo erythrophthalmus*), Florida mouse (*Podomys floridanus*), and spotted skunk (*Spilogale putorius*). Scrubs of the LWR are notable for the large number of narrowly endemic plants and animals that occur in them (FNAI 1990).

Scrub occurs on sand ridges along former shorelines. Some of the sand ridges originated as wind-deposited dunes, others as wave-washed sand bars. Some scrub soils are composed of well-washed, deep sands that are brilliant white at the surface, while some scrubs occur on yellow sands. The loose sands drain rapidly, creating very xeric conditions for which the plants appear to have evolved several water conservation strategies (FNAI 1990).

Scrub is essentially a fire-maintained community. The characteristic dense canopy of oaks, pine, and hickory is periodically top-killed by fire. Ground vegetation is extremely sparse and leaf fall is minimal, thus reducing the chance of frequent ground fires. As the sand pines mature, however, they retain most of their branches and build up large fuel supplies in their crowns. When a fire does occur, this fuel supply, in combination with the resinous needles and high stand density, ensures a hot, fast fire. Such fires allow for the regeneration of the scrub community, which might otherwise succeed to xeric hammock. Fire opens shrub canopies and consumes litter. Most perennials in the community resprout vigorously after fire, re-establishing the canopy. Others, including *Dicerandra christmanii* and other listed plant species, are killed by fire and must regenerate from a persistent seed bank (Menges et al. 2006). The gaps maintained by fire are the key habitat element required for most of the listed plant species. The minerals in the vegetation are deposited on the bare sand as ashes, and the heat of the fire generally facilitates the release of pine seeds. The natural fire return interval varies by the type of Florida scrub. Scrub vegetation tends to burn infrequently (every 10 to 60 years) and intensely (Myers 1985). Yellow sand scrub becomes extremely dense after 30 years, crowding out herbaceous gap specialists (Menges 1992). Based on PVA modeling Menges et al. (2006) recommended a fire return interval of 6 to 21 years in xeric oak scrub to maximize persistence of herbaceous gap specialist.

Scrub is associated with and often grades into sandhill, scrubby flatwoods, and xeric hammock. Some xeric hammocks are advanced successional stages of scrub, making intermediate stages difficult to classify. Because scrub occurs on high dry ground, this ecosystem and its many threatened and endangered species are rapidly being lost to development. Scrub is also readily damaged by off-road vehicle traffic or even foot traffic, which destroys the delicate ground cover and allows the loose sand to erode. Ground lichens may require 50 years or more to recover from such disturbances (FNAI 1990).

Sand Pine Scrub. (Includes Sand Pine Scrub Transitional) Approximately 38 acres (15.4 ha) of Lake McLeod are designated as ruderal sand pine according to (FNAI 1990) designations. The refuge considers this area sand pine scrub as human influence in the form of illicit off-road vehicle use has impacted habitat, but not to the extent that habitat is not functional or unrestorable. Dominant canopy cover in sand pine scrub is sand pine with thickets of scrub oaks as understory with sparse ground cover typically dominated by ground lichens. Fire is necessary for the regeneration of sand pine (Brendemuehi 1990). The serotinous cones of this species require heating before the cones will open and seeds are released. Since sand pine is a short-lived species, long periods of time without fire could eliminate this component of the ecosystem.

Yellow Sand Scrub. Yellow sand scrub occurs on deeper sandy soils. The principle vegetation is scrub oaks, and there are some patches of rosemary scrub. Palmetto is also present in significant numbers. The average shrub height is between 9 and 12 feet. Scattered longleaf pine and sand pine can be found. Wiregrass occurs in many places, while areas of bare sand are frequent.

Yellow sand scrub vegetation sprouts vigorously after fire. There is little change in species composition or richness, but dominance changes for a short period of time since palmetto recovers quicker than oaks (Schmalzer and Hinkle 1991). Scrub communities soon recover to their preburn structure and species composition (Menges and Hawkes 1998). Most of the larger plants sprout vegetatively, while many herbaceous species are obligate seeders (Menges and Kohfeldt 1995). The fire return interval in the yellow sand scrub is quite long, between 20 and 50 years. Fire intensity is high, burning most of the stand. Recovery comes from both sprouting and seeds stored in the soil.

Turkey Oak/Wiregrass Sandhill

According to FNAI (1990), sandhill includes turkey oak/wiregrass sandhill among other habitat variants including longleaf pine - turkey oak, longleaf pine - xerophytic oak, longleaf pine - deciduous oak, and high pine. Sandhills are characterized as a forest of widely spaced pine trees with a sparse understory of deciduous oaks and a fairly dense ground cover of grasses and herbs on rolling hills of sand (FNAI 1990).

Turkey oak/wiregrass sandhill occurs on the higher ridges on the refuge. Overstory vegetation is scattered longleaf (*Pinus palustris)* and slash pine (*P. elliottii)*. Some sand pine (*Pinus clausa*) can also be found. Turkey oak (*Quercus laevis)* makes up most of the midstory and stems can be quite numerous. The shrub layer consists primarily of a mixture of saw palmetto (*Senora repens*) and scrub palmetto (*Sabal etonia*). Shrub height varies from 3 to 6 feet. Wiregrass (*Aristida stricta*) is present over much of the area. Areas of bare sand are frequently encountered.

In general, sandhills occur on hilltops and slopes of gently rolling hills. Their soils are composed of deep, marine-deposited, yellowish sands that are well-drained and relatively sterile. The easily leached soil nutrients are brought back to the surface by the burrowing habits of some sandhill animals. Sandhills are important aquifer recharge areas because the porous sands allow water to move rapidly through to the aquifer with little runoff and minimal evaporation. The deep sandy soils help create a xeric environment that is accentuated by the scattered overstory, which allows more sunlight to penetrate and warm the ground. The absence of a closed canopy also allows sandhills to cool more rapidly at night and to retain less air moisture. Thus, temperature and humidity fluctuations are generally greater in sandhills than in nearby closed canopy forests (FNAI 1990).

Fire is a dominant factor in the ecology of this community. Sandhills are a fire climax community, being dependent on frequent ground fires to reduce hardwood competition and to perpetuate pines and grasses. The natural fire frequency appears to be every 2 to 5 years. Without frequent fires, sandhills may eventually succeed to xeric hammock. Unburned or cutover sandhills may be

dominated by turkey oak (FNAI 1990). The wire grass ground cover in turkey oak/wiregrass sandhill responds well to fire. Sufficient fuel is available to carry fire within 18 months of a burn. Fire return interval is believed to be between 2 to 5 years. Fires are low in intensity and move across the landscape rapidly. Burn out of the grasses is quick and residence time of the flaming front is short.

Sandhills are often associated with and grade into scrub, scrubby flatwoods, mesic flatwoods, upland pine forest, or xeric hammock. Sandhills were widespread throughout the Coastal Plain, but most have been degraded by timbering, overgrazing, plowing, and excluding fire, as well as other disturbances. Much of Florida's sandhill communities have been converted to citrus groves, pastures, pine plantations, or residential and commercial developments. Thus, the importance of properly managing the remaining tracts is accentuated (FNAI 1990).

Xeric Hammock
FNAI synonyms for xeric hammock include: xeric forest, sand hammock, live oak forest, oak woodland, and oak hammock. Xeric hammock is characterized as either a scrubby, dense, low canopy forest with little understory, other than palmetto, or a multi-storied forest of tall trees with an open or closed canopy. Several gradations between these extremes exist. Typical plants include live oak (*Quercus virginiana*), sand live oak, laurel oak (*Quercus laurifolia*), turkey oak (*Quercus laevis*), blackjack oak (*Quercus marilandica*), red oak (*Quercus rubra*), sand post oak, staggerbush, saw palmetto, sparkleberry (*Vaccinium arboreum*), pignut hickory (*Carya glabra*), southern magnolia, redbay (*Persea borbonia*), American holly (*Ilex americana*), wild olive (*Cordia boissieri*), black cherry (*Prunus serotina*), fox grape (*Vitus labrusca*), beautyberry (*Callicarpa americana*), bluejack oak (*Quercus incana*), Chapman's oak, persimmon (*Diospyrus virginiana*), and yaupon (*Ilex vomitoria*). Typical animals include barking treefrog, spadefoot toad, gopher tortoise (*Gopherus polyphemus*), worm lizard (*Amphisbaena alba*), fence lizard (*Sceloporus occidentalis*), black racer, red rat snake, hognose snake (*Heterodon platirhinos*), crowned snake (*Tantilla coronata*), screech-owl (*Megascops asio*), turkey (*Meleagris gallopavo),* blue jay (*Cyanocitta cristata*), eastern mole (*Scalopus aquaticus*), and gray squirrel (*Sciurus carolinensis*).

Xeric hammock is an advanced successional stage of scrub or sandhill. The variation in vegetation structure is predominantly due to the original community from which it developed. In all cases, however, the soils consist primarily of deep, excessively drained sands that were derived from old dune systems. The sparsity of herbs and the relatively incombustible oak litter preclude most fires from invading xeric hammock. When fire does occur, it is nearly always catastrophic and may revert xeric hammock into another community type. Xeric hammock only develops on sites that have been protected from fire for 30 or more years.

Xeric hammocks are often associated with and grade into scrub, sandhill, upland mixed forest, or slope forest. The species composition of xeric hammock is also often similar to prairie hammock and maritime hammock. Xeric hammock is often considered the climax community on sandy uplands.

Xeric hammock occurs generally as isolated patches that rarely cover extensive areas. Mature examples are rare, and scrub-derived types have always been scarce. Because of its general location on high ground with big trees, xeric hammock is prime residential property, especially when near the coast. Remaining tracts of xeric hammock require protection from fire and development.

PLANTS

Seventeen federally listed plants are known to occur on the Lake Wales Ridge NWR (Table 14). Of particular priority to refuge management interests are scrub lupine (*Lupinus aridorum*), Florida ziziphus (*Ziziphus celata*), and Garrett's mint (*Dicerandra christmanii*), due to the limited occurrence

of these species on public lands of the Lake Wales and Winter Haven Ridges. These species are specifically monitored and managed for on refuge units. Agreements to monitor the status of re-establishing Florida ziziphus at the Carter Creek Unit and to identify trends and status of Garrett's mint have been and currently are being conducted by ABS. Scrub lupine status and trend monitoring have been provided by the University of Central Florida and monitoring is currently ongoing at the Lake McLeod Unit through the assistance of volunteers.

Recovery plans, species status, trend information and recovery objectives for federally listed species found in Table 14 can be found in the Service's 1999 South Florida Multi-Species Recovery plans and available 5-year reviews.

Table 14. Status of rare plants known to occur or potentially occurring on the Lake Wales Ridge NWR

Scientific Name	Common Name	Agency Status in Florida		Occurance			
		Federal	State	FV	CC	LM	SC
Asclepias curtissii	Curtiss' milkweed	N	E	X	X	X	X
Bonamia grandiflora	Florida bonamia	T	E	X		X	X
Calamintha ashei	Ashe's Calamint	N	T				
Chionanthus pygmaeus	Pygmy fringe-tree	E	E	X	X	X	X
Cladonia perforate	Florida perforate cladonia	E	E			X	
Clitoria fragrans	Pigeon-wing	T	E	X	X		
Conradina brevifolia	Short-Leaved Rosemary	E	E				
Crotalaria avonensis	Avon Park Harebells	E	E				
Dicerandra frutescens	Scrub Mint	E	E				
Dicerandra christmanii	Garrett's mint	E	E	X			
Drosera intermedia	Spoon-Leaved Sundew	N	T				
Eltroplectris calcarata	Spurred Neottia	N	E				
Eriogonum longifolium var. *gnaphalifolium*	Scrub buckwheat	T	E	X	X		
Eryngium cuneifolium	Snakeroot	E	E				

Scientific Name	Common Name	Agency Status in Florida		Occurance			
		Federal	State	FV	CC	LM	SC
Hypericum cumulicola	Highlands scrub hypericum	E	E		X		
Lechea cernua	Nodding pinweed	N	T			X	
Liatris ohlingerae	Florida blazing star	E	E	X	X		
Lupinus aridorum	Scrub lupine	E	E			X	
Nolina brittoniana	Britton's beargrass	E	E		X	X	
Panicum abscissum	Cutthroat grass	N	E	X	X		
Paronychia chartacea spp. *chartacea*	Paper-like nailwort (Papery Whitlow-wort	T	E	X	X	X	
Persea humilis	Scrub bay	N	N	X	X	X	X
Polygala lewtonii	Lewton's polygala	E	E		X		
Polygonella basiramia	Wireweed	E	E	X	X	X	
Polygonella myrophylla	Sandlace	E	E	X	X	X	
Prunus geniculata	Scrub plum	E	E	X	X	X	X
Pteroglossaspis ecristata	Giant Orchid	N	T				
Schizachyrium niveum	Scrub Bluestem	N	E				
Stylisma abdita	Scrub stylisma	N	E		X	X	
Warea amplexifolia	Wide-Leaf Warea	E	E				
Warea carteri	Carter's warea (Carter's mustard)	E	E	X	X		X
Ziziphus celata	Florida ziziphus	E	E		±		

Key: E = endangered; T = threatened; N = Not listed or not being considered; ± = Re-introduced, LM = Lake McLeod, CC = Carter Creek, FV = Flamingo Villas, SC = Snell Creek

The following plant discussions summarize the biologic condition of the federally listed plants present on the refuge as described by Service staff, partners, research, and synthesis reporting. Much of the information used to prepare this section was compiled from the U.S. Fish and Wildlife Service's South Florida Multi-Species Recovery Plan (MSRP) of 1999 and current 5-year reviews, when available. Where these two series of documents were used to populate the wildlife and habitat management review conducted for the refuge, a citation is provided either throughout the body of the discussion or at the end of main paragraphs. Literature cited in the MSRP or 5-year plans is provided in the body of the biological summaries and referenced in Appendix B.

***Bonamia grandiflora* (Florida bonamia)**

Bonamia grandiflora is a member of the morning glory family (Convolvulaceae), and is the only species of its genus in the continental United States. This endemic scrub is found only on scrub areas of central and south Florida. Destruction of Florida's scrub habitat for residential housing and agricultural expansion has dramatically reduced the size and number of *B. grandiflora's* population, resulting in its federal listing as a threatened species in November 1987 (Service 1999). *Bonamia grandiflora* is currently found in the Flamingo Villas, Lake McLeod, and Snell Creek Units (Turner et al. 2006, Schultz et al. 1999).

Bonamia grandiflora formerly occurred in central Florida from Volusia and Marion Counties south to Highlands and Charlotte Counties (Wunderlin et al. 1980). It is a scrub endemic of central Florida where all of its known populations occur within or near scrub or on the edge of scrub habitat in the white sands associated with the ancient Pleistocene dune systems of the central ridge system (Ward 1979). The substrate is associated with a sand pine scrub vegetation consisting of evergreen scrub oak (*Quercus myrtifolia* and *Q. germinata*) and sand pine (*Pinus clausa*) with openings between trees and shrubs occupied by lichens and herbs. The openings are cleared by infrequent fires or by mechanical disturbance. *Bonamia grandiflora* is also known to live in disturbed areas near roadways and clearings caused by logging operations (50 FR 42068). This species is not found on altered soils such as the clay applied to logging roads (Miller 1989, Service 1999).

As the scrub community reaches maturity, encroachment and shading from overstory pines and oaks cause the decline of this species as well as other associated endemics (Wunderlin et al. 1980). It seems that this species prefers an open canopy in full sunlight in order to avoid competition from the surrounding shrubs. For example, in Ocala National Forest, bonamia grows in a variety of growth stages of sand pine, but flowers profusely only in open, sunny conditions of regeneration stands, and sparsely if at all in older stands (Service 1999).

Bonamia grandiflora was federally listed as threatened on November 1987, due to habitat destruction, excessive collection, and habitat degradation due to invasive exotics, off-road vehicles, and lack of proper management (52 FR 42068). Because *Bonamia grandiflora* is limited to small areas of scrub surrounded by residential housing and cultivated lands, habitat destruction or degradation often occurs because of trash dumping, invasion by exotics and weeds (e.g., cogon grass, *Imperata* sp.), and off-road vehicle use (Service 1999).

No systematic surveys have been conducted for this species throughout its range. Rare plant surveys have been conducted periodically on the Lake Wales Ridge State Forest since the late 1980s and the extent of surveys has increased as management activities and public property ownership have expanded (Weekley 1996, 1998; Cox 2003; Hardin and Schrift 2006; Clanton 2007a).

The demography of Florida bonamia has not been extensively studied. Romano (1999) described the reproductive system as mixed and occasionally apomictic (production of seeds without pollination), but noted that pollinators were essential to ensure substantial seed production by self

and cross-fertilization. Hartnett and Richardson (1989) described basic demographics of this species when comparing effects of fire on plant and seed bank dynamics, stem densities, seedling recruitment, flowering, and seed production than in habitat that had not been disturbed recently and that was considered successionally mature (Hartnett and Richardson 1989). In another study evaluating pre- and post-burn responses of bonamia, Weekley and Menges (2003) did not find a significant difference in the mean number of stems for pre- and post-burn individuals and found no evidence of increased recruitment. They did, however, confirm previous conclusions (Hartnett and Richardson 1989, Menges and Hawkes 1998) that Florida bonamia is a strong resprouter following fire. Additionally, they did note that unpublished data were available indicating a substantial increase in the number of seedlings within one year following a prescribed fire in a long unburned yellow sand scrub community and suggested that a more fine-scaled survey design may be needed to evaluate this finding more thoroughly (Service 2008a).

Florida bonamia is currently represented in the Center for Plant Conservation's national collection of endangered plants at Historic Bok Sanctuary (HBS). Two hundred and six individuals representing five populations are included in this collection, which includes both seed and individual plants rescued from areas previously destroyed by development (C. Peterson, HBS, pers. comm. 2008). HBS has evaluated seed germination of Florida bonamia under controlled conditions and found best results when seeds are scarified first and then soaked in water for 12 hours. Germination rates in these studies were 30-35 percent, but seed viability declined with age – 8-year-old seeds had a 6 percent germination rate (C. Peterson, HBS, pers. comm. 2008). Furthermore, propagation by cuttings was not found to be reliable. Success in transplantation efforts have been mixed with small plants having lower mortality rates than larger specimens (Service 2008a).

According to Hartnett and Richardson (1989), fire stimulates seed production and germination as well as regrowth from clonal stems. The first season after fire, clonal stem production is the greatest and then declines. However, seed production is greatest during the second season after a fire. The lag is probably due to the increased energy needed for regrowth following fire; seed production is postponed to conserve energy. New seed production replaces the seed banks that are often destroyed by fire (Service 1999, Service 2008a).

Bonamia grandiflora is dependent on the sunny cleared areas left by periodic fires or physical disturbance (Service 1999). Historically, lighting fires swept through the scrub and surrounding communities, burning large tracts of land. Today, fragmentation of habitat and fire suppression has interrupted the natural burn regime. Reduced fire frequency has left many of the scrub sites overgrown and unsuitable for highly specialized scrub endemics that require open, sunny patches (Service 1999).

Florida bonamia evolved in fire-maintained white and yellow sand xeric vegetative communities, including rosemary scrub, oak dominated scrub, and sandhills (Service 1999, Weekley and Menges 2003, Menges et al. 2007). Because systematic range-wide surveys have not been conducted, we have little information about habitat conditions for many of the known localities where bonamia occurs. This is especially true for locations that are in private ownership where conditions are not optimal for the long-term persistence of bonamia because most landowners suppress naturally ignited fires and/or do not use prescribed fire. Fire suppression leads to changes in composition and structure within vegetative communities (Weekley and Menges 2003), which typically results in taller and denser vegetation that may shade-out Florida bonamia. However, there is anecdotal information indicating Florida bonamia may be more shade tolerant than previously thought (Weekley, ABS pers. comm. 2008a *in* Service 2008a) and this may extend the time that bonamia will persist in fire-excluded communities (Service 2008a).

The sand pine scrub community historically burned every 20 to 70 years, and like many other scrub plants, *Bonamia grandiflora* needs fire or mechanical disturbance to reduce competition and maintain a healthy population. Periodic fire also stimulates flowering and seed production of mature plants, stimulates germination of seed, and causes turnover of stored seed bank. This species resprouts after fire and can withstand mechanical site preparation or low-intensity mowing, but the timing of the mowing is very important. If mowed repeatedly while growing or blooming, energy stores would be used for regrowth and not reproduction. Postponing reproduction for a full growing season could have long-term detrimental effects. However, mowing may be a useful management tool if used after seed set or before leaf out (Romano, University of Florida, pers. comm. 1997 in Service 2008a, Service 1999).

***Chionanthus pygmaeus* (Pygmy fringe-tree)**
Chionanthus pygmaeus is a large shrub that occurs primarily in scrub, as well as in high pineland, dry hammocks, and transitional habitats in central Florida. Much of this species' habitat has been lost because of land clearing for citrus production and residential development. As a result, it was listed as a threatened species In January 1987 (52 FR 2234). This ruling was based on loss of habitat primarily by conversion of sand scrub habitat to citrus groves or residential subdivisions (Service 1999). *Chionanthus pygmaeus* has been identified on the refuge's Flamingo Villas and Carter Creek Units (Schultz et al. 1999, Turner et al. 2006) and is known to occur on the refuge's Lake McLeod Unit in open patches west of Gerber Dairy road.

Chionanthus pygmaeus is known from west of Lake Apopka in Lake County, northwestern Osceola County, and the LWR in Polk and Highlands Counties. One of the largest populations is in the Carter Creek scrubs in Highlands County, where is occurs with turkey oak (*Quercus laevis*), a species more typical of high pine community (Service 1996a). *Chionanthus pygmaeus* inhabits excessively drained sandy soils on the LWR (and historically on the Mount Dora Ridge which is part of its historic range, but where it is no longer found). This species is found on the low-nutrient St. Lucie fine sand which is subject to rapid drying (Wunderlin et al. 1981, Service 1999).

Chionanthus pygmaeus colonizes and thrives in areas of bare sand that are exposed to full sun, although it also occurs and flowers in areas of deep shade and pine canopy. Fire prevention, habitat fragmentation, or other factors that may preclude the creation or maintenance of a mosaic of open, sandy patches could threaten this species (Service 1999).

Chionanthus pygmaeus is long-lived and persists in areas that are burned on a frequency of 20 to 70 years. Very little is known about the fire ecology of *Chionanthus pygmaeus*, however, we know that it is a fire-dependent species that resprouts after fire events. This species has above-ground stems growing from rootstocks or buried stems that have survived the infrequent fires that are characteristic of the habitat (Kral 1983, Ward and Godfrey 1979). Fire may have an important indirect effect on *Chionanthus pygmaeus* by regulating the numbers and sizes of plants that might shade or otherwise compete with it (Kral 1983, Service 1999).

***Cladonia perforata* (Florida perforate cladonia)**
Cladonia perforata is a member of the family Cladoniaceae, commonly called the reindeer lichens. *Cladonia perforata* is restricted to the high, well-drained sands of Florida scrub. The species was listed as endangered in April 1997 (58 FR 25746) because of the significant loss of scrub habitat in Florida (Service 1999). *Cladonia perforata* has been identified on the refuge's Lake McLeod Unit (Stout, University of Central Florida, pers. com. 2009, Schultz et al. 1999).

Florida scrub, which is characterized in part by persistent, open patches of sand, supports a relatively rich assemblage of these terrestrial lichens. Up to eight species of reindeer lichens commonly occur in Florida scrub. *Cladonia perforata* is a habitat-specialist, usually restricted to openings in very xeric sites. It can occur in monospecific mats or in mixed-species mats with *Cladonia leporine*, *Cladonia prostrate*, *Cladonia pachycladodes*, *Cladina evansii*, *Cladonia subsetacea*, and/or *Cladina subtenuis* (Service 1999). *Cladonia perforata* is the most unique member of the scrub-lichen community by virtue of its restricted and unusual disjunct distribution and overall global rarity (Service 1999). The loss of habitat is the primary reason *Cladonia perforata* is listed as endangered (58 FR 25754). Land conversion to citrus and residential development continues to diminish scrub habitat (Service 1999).

Typical habitat for *Cladonia perforata* is found on the high sand dune ridges of Florida's peninsula, including the Atlantic Coastal and Lake Wales ridges. In these areas *Cladonia perforata* is restricted to the highest, xeric white sands in sand pine scrub, typically in the rosemary phase (Abrahamson et al. 1984). Such rosemary scrubs are particularly well-drained and structurally open and include the following associated plant species: scrub oaks (*Quercus inopina*, *Q. geminate*, *Q. myrtifolia*), sand pine (*Pinus clausa*), and Florida rosemary (*Ceratiola ericoides*), which dominate the shrub layer. *Cladonia perforata* typically occurs in open patches of sand between shrubs in areas with sparse or no herbaceous cover (Service 1999). In Highlands and Polk Counties on the LWR, *Cladonia perforata* occurs at relatively higher elevations than surrounding areas, on excessively well-drained, nutrient-poor, white sands of the St. Lucie series (Buckley and Hendrickson 1988, R. Yahr, personal communication 1995 *in* Service 1999).

Little is known about the life history and ecology of *Cladonia perforata*, and demographic features and trends remain poorly understood. This species' growth rate and seasonality are unknown (Yahr 1997), but it appears to grow slowly and branches once a year (Yahr 2003, Yahr and DePriest 2005). The main form of reproduction is presumably through vegetative reproduction (fragmentation), which can happen via trampling or natural breakage after decades of growth *in situ* (Yahr 2003). No primary thallus (body), apothecia (reproductive structure), and spermagonia (cavity or receptacle in which spermatia are produced) of this species are known (Evans 1952, Moore 1968, Hammer 2000, Yahr 2000, Cox 2003). Yahr (2003) indicated that this lichen consists of strictly asexual, branching structures, which reproduce via vegetative fragmentation and that genetic studies have so far supported an asexual life history.

Basic status surveys and demography of lichens is challenging due to lack of determinate life stages and slow observable responses to environmental changes (Yahr and DePriest 2005). Counts of individual fragments are generally not feasible and probably not informative, since individuals cannot be readily defined (Service 1999). In addition, the vagrant habit of *Cladonia perforata* is such that fragments are unattached to any substrate and are free to drift; fragments can be carried by wind, water, or animals (Yahr and DePriest 2005). Yahr (2003) suggested that density and area occupied are probably better measures of abundance for this species than count data.

Although some lichens can colonize disjunct habitat patches via spores or specialized long-distance dispersal units, *Cladonia perforata* has only large, bulky, vegetative fragments, which are poor dispersers (Yahr and DePriest 2005). Limited dispersal may be the most important demographic feature of this species (Yahr 2000a, Yahr and DePriest 2005). Unoccupied but otherwise suitable sites can support lichen, since survival of transplants into recently burned or unoccupied suitable sites is nearly 100 percent (Yahr 2000, Yahr and DePriest 2005) (Service 2008b). Population recovery via dispersal may be slow and decrease with distance from source due to relatively large and heavy vegetative fragments (Yahr 1997). Yahr (2000) suggested that dispersal of this species beyond occupied rosemary scrub patches may be physically impeded by dense accumulations of leaf litter or plant stems in adjacent habitat types.

Menges and Kohfeldt (1995) found that *Cladonia perforata* decreases in dominance in sites that have gone unburned for more than 20 years. This decrease in dominance on unburned sites may be a result of a combination of factors that influence microhabitat, such as decreased insulation or increased litter accumulation (Service 1999).

Florida scrub has historically experienced variable fire frequencies and patchy high-intensity fires. Scrub plant communities are therefore fire-adapted, and recover relatively quickly. In sand pine and rosemary scrub, however, recovery of dominant species is slower than in oak-dominated scrubs and open spaces between shrubs persist longer. In fire-maintained systems, low-fuel, bare sand patches may serve as refugia from fire for *Cladonia perforata* and other lichen species which cannot survive fire. These refugia provide a local source for recolonization and population recovery (Service 1999).

At other sites, management practices have generally favored maintenance of the rosemary phase of xeric oak scrub communities inhabited by *Cladonia perforata*. In some cases, management for other scrub endemics may conflict with management for the lichen. For example, lichens and some rare forbs prefer open sandy areas between shrubs, but as lichen cover becomes more complete, open sandy habitat needed by rare forbs may decrease (A. Johnson, FNAI, pers. comm. 2007 *in* Service 2008b). Populations of rare forbs may be maximized by more frequent burning, but this may pose a conflict in managing for lichens (A. Johnson, pers. comm. 2007 *in* Service 2008b). Preliminary results from a study to examine the effects of mechanical treatments and fire on Florida scrub vegetation suggests that lichens are killed by fire, but not by mowing (Rickey et al. 2006).

Population trends need further study, but based on inferences from observations of occupied sites, it is probably important to provide a mosaic of times-since-fire in the landscape and to encourage patchy burns if fuels have become continuous due to long-unburned conditions. Because *Cladonia perforata*, like other lichens, cannot survive fire and likely can recolonize sites slowly and from local sources, such as unburned patches within sites, it is important to avoid complete burns in sites which support this species (Service 1999)

Human activities, including off-road vehicle use, trash dumping, and inadvertent trampling during outdoor recreation activities, as identified at the time of listing (58 FR 25746), continue to threaten this species. Physical destruction of the lichen itself and destabilization of its habitat is a concern at some sites. Crushing or trampling by vehicles, animals, and humans may break up thalli into small fragments that are easily carried away by the wind into unsuitable habitats (swales, areas of heavy leaf litter, or other vegetation), easily covered by wind-swept sand, or too small to recolonize suitable habitats (Service 2008b). It has a limited aerial extent and its management is further complicated by its limited reproduction and dispersal capability (Service 1999).

***Clitoria fragrans* (Pigeon-wing)**

Clitoria fragrans is an erect perennial herb belonging to the pea family (Fabaceae). The distribution of the species is limited mainly to the rapidly disappearing scrub habitats of the LWR in Highlands and Polk Counties (Fantz 1977, Wunderlin et al. 1980, Christman 1988). The total number of *Clitoria fragrans* has been estimated to be less than 3,000 in Orange, Polk, and Highlands Counties (Muller et al. 1989). Loss of habitat to agriculture and residential development resulted in the listing of this species in April 1993 (Service 1999). *Clitoria fragrans* has been identified on both the refuge's Carter Creek and Flamingo Villas Units (Schultz et al. 1999, Turner et al. 2006).

Some confusion exists with respect to the vegetative community inhabited by *Clitoria fragrans*. Christman (1988) indicates that the species is found primarily within habitats intermediate with high pine and scrub. Christman and Judd (1990) reported the species from scrub, turkey oak barrens, and the edges of high pines. Others report *Clitoria fragrans* from scrubby high pine, more typical of

hickory-dominated scrub (hickory phase of high pineland) (E. Menges, ABS, pers. comm. 1997 *in* Service 1999). There is also disagreement about the plant's preference for white sand soils versus yellow sand soils. As mentioned above, the species has been found in turkey oak barrens and scrub hickory, both of which occur on yellow sand soils. However, Fantz (1979) regards the pigeon-wing as a species of white sand soils. The species has also been in white sand scrub at Carter Creek and has been noted in the LWRSF on both white (Archbold) and yellow (Tavares) sands (Service 1996a, C. Weekly, FDOF, pers. comm. 1998 *in* Service 1999; Service 1999).

Though the species may exist in a continuum of scrub to high pine habitat, it appears that it is most prevalent in an intermediate vegetative complex referred to as the turkey oak barrens. In this habitat, wiregrass (*Aristida beyrichia*) may be locally patchy or scattered with longleaf pine (*Pinus palustris*) scattered, while bluejack (*Quercus cinerea*) and turkey oak (*Q. laevis*) are usually permanent. Scrub buckwheat (*Eriogonum longifolium* var. *gnaphalifolium*) and Lewton's polygala (*Polygala lewtonii*) also appear to be more common in the turkey oak barrens than in other habitats (Christman 1988, Service 1999).

As more recent studies of *Clitoria fragrans* have shown, the species occupies several xeric upland habitats on white, yellow, and gray sands (Menges et al. 2007, Stout and Lewis 2006), however, the species appears to require the appropriate use of fire to manage and maintain its habitat. The occurrence of pigeon-wing in both frequent and infrequent fire return interval habitats (i.e., both sandhill and scrub) suggests that it is tolerant of a range of fire return intervals. However, determining the optimal fire return interval (Menges 2007) for pigeon-wing populations requires data that are not currently available (Service 2008c).

ABS's Population Dynamics of Endemic Plants (PDEP) project is currently surveying sites managed by the FWC (e.g., Carter Creek North, Lake Blue, and Silver Lake) and the refuge's Carter Creek and Flamingo Villas Units to map new locations and to collect abundance data for federally listed and selected state listed plants. As of May 2008, surveys had included 5 sites, 14 species, 402 species occurrences, and 4,541 counted individuals. PDEP surveys recorded 92 pigeon-wing plants at 3 sites (Service 2008c).

Clitoria fragrans has probably never been abundant since intermediate high pines/scrub habitat is not a major vegetative complex associated with central Florida ridges. At specific sites where *Clitoria fragrans* has been located, it had never been found in large numbers; typically 20 to 30 plants per site (D. Richardson, pers. comm. 1995 *in* Service 1999). On private lands, the species is threatened by habitat loss due to conversion for agriculture, residential, and commercial uses. Other threats to *Clitoria fragrans* include off-road vehicle use, trash dumping, and trampling (Service 1993). *Clitoria fragrans* is especially at risk because it is found in small, fragmented populations (Fantz 1979, Service 1999).

Pigeon-wing is a soil generalist, occurring on yellow, white, and gray sands (Menges et al. 2007; S. Orzell, APAFR, pers. comm. 2008; J. Stout, pers. comm. 2008a *in* Service 2008c). It occurs in a range of xeric habitats on the Lake Wales, Winter Haven, and Bombing Range ridges and on xeric upland sites west of Bombing Range Ridge within the APAFR. On the LWR in Polk and Highlands Counties, it is also known from yellow, white, and gray sands (Service 2008c). Within Highlands County, it occurs primarily on yellow sands (e.g., Astatula, Paola, and Tavares) in sandhill and oak-hickory scrub, but also on moderately well-drained white sands (Archbold) and on gray sands (Satellite) (Menges et al. 2007).

Studies at ABS have documented positive post fire responses in flowering and vegetative growth of *Clitoria fragrans* (Menges 1997 pers. comm. ABS *in* Service 1999). Decreased flowering within one year after burning suggests fire suppression and canopy closure adversely affect this plant, resulting in reduced vegetative vigor and reproduction. However, this plant has been observed flowering in a location that had not been burned in 30 years, indicating that *Clitoria fragrans* will persist for many years under suboptimal conditions. Even though plants may persist with infrequent fire, it is believed that fire management is essential to the long-term survival of this species. *Clitoria fragrans'* dependence on fire is particularly evident when considering the quick and profuse blooming in response to fire (Service 1999).

In a study of postfire responses of 12 Florida scrub endemics, Weekley and Menges (2003) characterized pigeon-wing as a moderate resprouter based on the percentage of tagged aboveground individuals present two years postburn (48.4 percent). However, aboveground pigeon-wing populations may fluctuate annually due to belowground dormancy (C. Weekley, pers. comm. 2008b *in* Service 2008c). Anecdotal evidence also indicates that dramatic increases in postburn aboveground population sizes may be short-lived (Weekley, pers. obs. 2008c *in* Service 2008c). Thus, population densities may increase by postfire and decline with time-since fire. High percent flowering by postburn plants also suggests that they are more likely resprouts than seedling recruits (Weekley, pers. obs. 2008c *in* Service 2008c).

Christman (1988) recorded the presence of pigeon-wing in 21.8 percent (42 of 193) of the scrub sites he surveyed in the late 1980s and these records have been incorporated into the FNAI database. Element occurrence records (EORs) compiled by FNAI represent a species occurrence that is a minimum of 1 km from another occurrence of the same species. FNAI lists 77 EORs for pigeon-wing, 70.1 percent on protected sites on the LWR or WHR or on the APAFR (Service 2008c).

Heavy vertebrate and invertebrate predation, including the destruction of entire seed crops of the complete removal of aboveground individuals, have been documented for pigeon-wing (e.g., Stout and Lewis 2004; Lewis 2007; A. Faivre, pers. comm. 2008 *in* Service 2008c). *Clitoria spp*. are host species of the hoary edge (*Achalarus lyciades*) and long-tailed (*Urbanus proteus*) skippers and the southern cloudywing (*Thorybes bathyllus*) butterfly (Minno et al. 2005). Long-tailed skippers and southern cloudywings are both known to use pigeon-wing as a host plant (Stout and Lewis 2004; Weekley, pers. obs. 2008c *in* Service 2008c). The impact on pigeon-wing plants of partial or complete defoliation is unknown. Other likely invertebrate predators on pigeon-wing include orthopterans and possible seed predating coleopterans. Vertebrate herbivores probably include white-tailed deer (*Odocoileus virginianus*) and eastern cottontail rabbits (*Sylvilagus floridanus*). Herbivory may threaten the persistence of local populations. Pigeon-wing plants overgrown by *Cuscuta sp*., a parasitic plant, at one study site at APAFR failed to flower (Stout, pers. comm. 2008b *in* Service 2008c), suggesting that competition for light or resources may limit flowering (Service 2008c).

***Dicerandra christmanii* (Garrett's Mint)**

Dicerandra christmanii, a member of the mint family (Lamiacaeae), is a partially woody, short-lived (less than 10 years) perennial shrub growing to 50 centimeters (cm) (Huck et al. 1989). Small white flowers with purple splotches are produced July through October. The leaves of this species produce a strong odor of eucalyptus oil when crushed (Huck et al. 1989).

Dicerandra christmanii is endemic to the LWR and occurs only in Highlands County, Florida, approximately 5 to 8 kilometers (km) southeast of the town of Sebring. The species was first collected by Ray Garrett in 1948 and was originally identified as scrub mint (*D. frutescens*). Huck et al. (1989) subsequently reclassified it as new species and assigned the name *Dicerandra christmanii.* Ranges of the two species do not overlap. The range of *Dicerandra christmanii* begins just 10.5 km

north of the nearest population of *D. frutescens*. It is distinguished from scrub mint by anther color, odor, leaf length, and chemistry of the compounds found in leaves (Huck et al. 1989).

Dicerandra christmanii was listed as endangered on September 21, 1989 (54 FR 38947); however, it was protected as *D. frutescens* since 1985. Loss of habitat to residential and commercial development, compounded by an extremely small distribution, as well as fire suppression in tracts of remaining habitat, are the principal threats to this species (Service 1999). There are only four locations recorded for *Dicerandra christmanii*. Three of the four known occurrences are located on private land, and their present status is unknown. The habitat has been largely converted to citrus groves and scattered single family residences.

The refuge's Flamingo Villas Unit is the single protected area supporting *Dicerandra christmanii* (Turner et al. 2006, Schultz et al. 1999, Menges et al. 2007). At Flamingo Villas, estimates of the number of plants in the population began in 1994. From 1994 to 1998, the number of plants ranged from 2,266 to 3,507 (Menges and Weekly 1999). In the 2008 census of study plots at Flamingo Villas, ABS recorded 445 plants, up from 303 in 2007 (Weekley, ABS, pers. comm. 2008d). Overall, ABS annual surveys indicate that the population has been in decline since 2003, probably due to lack of fire (Menges, ABS, pers. comm. 2008a).

Acquisition of the Flamingo Villas Unit of the Lake Wales Ridge NWR is not complete and numerous small private inholdings still exist in the area where *Dicerandra christmanii* occurs. Notably, Schultz et al. (1999) reports *Dicerandra christmanii* occurring on a private tract southeast and outside of the Carter Creek acquisition boundary, found on the same yellow sand scrub ridge exhibited in the Flamingo Villas Unit to the south.

Habitat for *Dicerandra christmanii* is yellow sand xeric oak-hickory scrub. Oak-hickory scrubs are dominated by scrubby evergreen oaks (*Q. myrtifolia*, *Q. geminata*, and *Q. chapmanii*) and scrub hickory (*Carya floridana*) and may also have an overstory of pines (*P. clausa* and *P. elliottii* var. *densa*). All populations are found in areas with moderately well-drained Tavares yellow sands (Menges et al. 1999). These soils support scrub and sandhill vegetation, but have largely been converted to citrus cultivation (Menges 1992). Within the habitats where it occurs, *Dicerandra christmanii* is a gap specialist, growing almost exclusively in openings in between shrubs. Occupied microhabitats typically have shallow leaf litter (less than 2 cm) and partial to no canopy cover (Menges et al. 1999).

Regeneration occurs exclusively through episodic recruitment of seedlings, with germination occurring mainly in winter and early spring (Menges and Weekley 1999). Most mortality occurs in seedlings during the dry, hot spring typical of central Florida, suggesting that drought or temperature may affect survival. Annual seedling recruitment varies widely from year-to-year dependent on spring rainfall. A normal good year may have 50 times the number of seedlings as a drought year (Menges et al. 1999).

Lack of natural fire regime is currently the most important threat to the *Dicerandra christmanii* population at Flamingo Villas. Fire suppression started on a regional scale on the LWR about 70 years ago. In the absence of fire, yellow sand scrubs become extremely dense after 30 years, crowding out gap specialist species such as *Dicerandra christmanii* (Menges 1992). Based on population viability analysis modeling for its congener, scrub mint, Menges et al. (2006) recommended a fire return interval of 6 to 21 years in xeric oak scrub to maximize persistence of populations. Long-unburned oak scrub sites have dense shrub growth and litter accumulation. Within the long-unburned sites at Flamingo Villas, *Dicerandra christmanii* occurs primarily in areas

with regular small-scale soil disturbance (e.g., foot trails and abandoned fire lanes), in the limited remaining natural gaps, and rarely in overgrown scrub (Menges et al. 1999, Weekley et al. 2001).

Reintroducing fire to long-unburned sites presents complications for species recovery (Evans et al. 2004). Areas with excessive fuel loads may burn hot and completely through a site, killing all plants, and thus requiring populations to regenerate entirely from the seed bank. However, recent seed production may be low in overgrown sites. Fuel reduction treatment of shrubs around patches of scrub mint could allow for patchier burns and survival of some existing plants, and improve post-fire regeneration (Evans et al. 2004). Successfully mitigating the impacts of fire suppression may require mechanical control including hand removal of woody species in the general vicinity of individual plants. Removal of shrub material after cutting is important, as any medium or heavy fuels will increase fire residence time and potentially destroy the seed bank.

Drought exacerbates declines due to lack of fire and prevents strong post-fire recovery of populations of scrub mint, and the same is likely true for *Dicerandra christmanii*. Regeneration of populations from seed after fire appears to be lower due to reduced seedling survival when a "dry" year follows a fire (Menges, ABS, pers. comm. 2008a). To decrease the possibility of drought causing a catastrophic decline of an entire occurrence, prescribed fire should be implemented on a staggered schedule, with occurrences split into multiple burn units that are burned in different years.

Fruit and seed dispersal is limited to a few meters from the parent plant (Menges et al. 2001). It may be limited from dispersal beyond existing patches. It may be persistent in the soil seed bank for years, but numbers are expected to be reduced in long-unburned sites (Menges et al. 2006). Assisted dispersal of *Dicerandra christmanii* seed within suitable habitat may be necessary to recolonize long-unburned scrub after fire.

While fire is the predominant disturbance factor in Florida scrub, some degree of soil disturbance may also be a critical perquisite for the persistence of *Dicerandra christmanii* population (R. Huck, Florida Museum of Natural History, pers. comm. 2009). For this reason, limited and targeted manual soil scarification around existing *Dicerandra christmanii* plants after seeds have ripened and fallen also may be a useful technique to increase seedling establishment.

Turner et al. (2006) identified *Dicerandra christmanii* as "critically endangered" and identified it as one of at least eight LWR species in which translocation and/or captive propagation may be necessary to ensure its survival due to inadequate representation on conservation lands (Turner et al. 2006).

***Eriogonum longifolium var. gnaphalifolium* (Scrub buckwheat)**
Eriogonum longifolium var. *gnaphalifolium* was federally listed as threatened in 1993 due to rapid loss of suitable habitat. The species occurs in high pine and in turkey oak barrens in Marion, Pasco, Hillsborough, Lake, and Orange Counties in central Florida (Christman 1988). In Polk and Highlands Counties, it is found on the LWR as far south as ABS, south of Lake Placid (Service 1999). Scrub buckwheat has been identified on the refuge's Flamingo Villas and Carter Creek Units (Schultz et al. 1999, Turner et al. 2006). The northern range limits for *Eriogonum longifolium* var. *gnaphalifolium* are in Ocala National Forest and in areas of mixed scrub and high pine south of Ocala in Marion County. Suitable habitat and possibly the plant extend south into northern Sumter County. *Eriogonum longifolium* var. *gnaphalifolium* historically occurred near Eustis in Lake County (where it was collected around the turn of the century) and it still occurs near Clermont in remnants of high pine with *Polygala lewtonii* and several other endangered plant species (Service 1999).

Eriogonum longifolium var. *gnaphalifolium* occurs in several xeric plant communities that may be burned at intervals of 1 to 8 years for sandhill to 5 to 12 years for oak-hickory scrub. Lands managed under these general fire return intervals are presumed to have maintained suitable habitat for *Eriogonum longifolium* var. *gnaphalifolium* (Service 2008d).

The principle cause of decline of central Florida's plants is conversion of high pineland and scrub for agricultural purposes (principally citrus groves) and for commercial, residential, and recreational purposes. In addition to habitat loss, this species is threatened by invasive species such as cogon grass and centipede grass. Recreational motorized off-road vehicles (all-terrain vehicles and motorcycles) in publically owned pinelands also have the potential to severely impact *Eriogonum longifolium* var. *gnaphalifolium* (Service 1999).

Twenty-seven of the 48 known populations (56 percent) of *Eriogonum longifolium* var. *gnaphalifolium* occur on public conservation lands, but the species' status is still not known. Although the species' status was listed as decreasing in 2007, this determination was based on the fact that some populations occur on unprotected, private lands that are vulnerable to destruction or decline in the future if properties are developed and/or continue to be unmanaged. Available data for several monitored populations on public lands indicate populations there are stable, but data for scrub buckwheat on the Ocala National Forest suggest this species may be in decline. No data is currently available for the majority of populations on public lands (Service 2008d).

Demographic data have been collected at six sites since 1989 at ABS and these data have been used to evaluate the effects of fire on demographic performance (Menges 2007). Additional demographic monitoring has been conducted by ABS on the refuge's Carter Creek Unit since 2001 (Menges et al. 2008a) and populations at Ocala National Forest and LWRSF, representing 15 percent of the populations that occur on public lands (4 of 27) (Service 2008d). There are no data available to assess the abundance of *Eriogonum longifolium* var. *gnaphalifolium* throughout its range. However, based on the four areas for which *Eriogonum longifolium* var. *gnaphalifolium* has been monitored, including the Carter Creek Unit, inferences concerning relationships to differing fire regimes have been made. Of the six ABS monitored sites, the total number of plants (~5,000 individuals) had fluctuated by about 20 percent over the monitoring period (Menges 2007). Slight increases have occurred in areas where prescribed fire has been used recently (Menges, ABS, pers. comm. 2007 *in* Service 2008d). Overall, these populations seem to be stable given the fire return interval used at ABS (Service 2008d).

On the Carter Creek Unit, monitoring began in 2001 after use of prescribed fire. Initially, *Eriogonum longifolium* var. *gnaphalifolium* responded positively to the burn, however, over the next 6 years in which there were no additional prescribed fires, monitoring results indicated that *Eriogonum longifolium* var. *gnaphalifolium* populations declined slightly (Menges, ABS, pers. comm. 2007 *in* Service 2008d). Given the positive demographic response of *Eriogonum longifolium* var. *gnaphalifolium* to fire, the population appears stable even though it is now in post-fire decline (Service 2008d).

From 1988 to 2005, *Eriogonum longifolium* var. *gnaphalifolium* numbers increased and their range expanded on LWRSF (Clanton 2005), suggesting this population may be increasing due to implementation of an active fire management program. Prescribed fire has been introduced to long-unburned scrub habitat over this time period and is repeated regularly in some of the management units (Service 2008d).

The demographics of *Eriogonum longifolium* var. *gnaphalifolium* are largely influenced and dependent on fire frequency. *Eriogonum longifolium* var. *gnaphalifolium* resprouts, flowers, and recruits seedlings following fire and is able to do so where fire return intervals are relatively short

(McConnell and Menges 2002, Satterthwaite et al. 2002, Menges 2007). Flowering and seedling recruitment decline rapidly 2 to 3 years following fire and the remaining vegetative individuals tend to stabilize or decline in number. Demographic modeling suggests that *Eriogonum longifolium* var. *gnaphalifolium* population viability is highest when fire return intervals are 5 to 20 years (Satterthwaite et al. 2002). These fire frequencies are typical of fire regimes in sandhill and oak-hickory scrub, the main habitats of *Eriogonum longifolium* var. *gnaphalifolium* (Menges 2007). In modeled populations, the probability of a decline increased with increasing fire return intervals. Extinction risks also increased with longer fire return intervals. Satterthwaite et al. (2002) indicated that small *Eriogonum longifolium* var. *gnaphalifolium* populations may be more susceptible to the adverse effects of long fire return intervals. Nonetheless, *Eriogonum longifolium* var. *gnaphalifolium* is long-lived in its vegetative state and populations may persist long-term and remain viable for many years in fire suppressed habitats, if a sufficient number of individual plants survive the fire-suppressed time period (Menges 2007) (Service 2008d).

Even though *Eriogonum longifolium* var. *gnaphalifolium* can persist for long periods in fire suppressed conditions, a reduction in flowering and seedling recruitment can be expected in long-unburned habitats (McConnell and Menges 2002, Satterthwaite et al. 2002, Menges 2007). These adverse effects are expected to continue into the future on unprotected and unmanaged parcels (Service 2008d).

***Hypericum cumulicola* (Highlands scrub hypericum)**
Hypericum cumulicola is a rare species that is endemic to the LWR in central Florida and only known from Polk and Highlands Counties. The scrub hypericum is threatened by habitat loss, isolation of populations, and fire suppression threats, factors which led to its listing as an endangered species in January 1987 (Service 1999). Schultz et al. (1999) reports *Hypericum cumulicola* present on the Carter Creek Unit.

Hypericum cumulicola is a small, short-lived perennial herb reaching 20 to 70 centimeters in height. *Hypericum cumulicola* is limited to upland areas with well-drained, sterile, white sands (Judd 1980). It is almost exclusively found in the sunny openings in rosemary balds. Rosemary balds are unique vegetative communities that occur as patches within the more expansive scrub ecosystems. These habitat patches provide suitable habitat for a number of rare scrub endemics (Christman and Judd 1990). *Hypericum cumulicola* occurs occasionally in openings in well-drained scrubby flatwoods or among turkey/oak scrubs in yellow sands (Ascencio-Quintana, ABS pers. comm. 1995 *in* Service 1999). Where it is found, it is locally common and can occur even in large groups of several thousand individuals (Judd 1980). Population increase of this species is associated with the occurrence of fires that may release local populations from competitive exclusion (Abrahamson 1984, Johnson and Abrahamson 1990, Quintana-Ascencio and Morales Hernandez 1997, Quintana-Ascencio and Menges 1996) (Service 2008e).

Hypericum cumulicola is locally abundant at ABS, five properties of the Lake Wales Ridge Wildlife Environmental Areas (LWRWEA) – a series of 19 separate tracts scattered over 75 miles managed by FWC to sustain the widest possible range of native wildlife in their natural habitats (FWC 2009a), FDEP's Lake June in Winter Scrub State Park, TNC's Saddle Blanket Lakes Preserve, and FDOF's Arbuckle Tract of LWRSF. Despite the list of large populations, most other populations of *Hypericum cumulicola* are relatively small. The median size for 34 populations was 539 individuals and most populations are smaller than 1,000 plants, while the largest population was estimated to be greater than 300,000 plants (data summarized in Table 1 of Menges et al. 2001) (Service 2008e).

Population sizes of *Hypericum cumulicola* vary considerably over time, being highest in the first decade after fire (Dolan et al. in revision). In addition, higher fecundity, survival, establishment, and population growth rates occur after fire than in unburned populations (Quintana-Ascencio et al. 2003).

Fire return intervals less frequent than once every 50 years increase substantial extinction risk (Quintana-Ascencio et al. 2003). The population dynamics of *Hypericum cumulicola* at LWRSF have been characterized by volatile changes, especially roadside populations. Scrub populations subjected to fire generally show sharp initial decline, as plants directly affected by fire are killed. In most cases, there is a partial or full recovery of population size a few years after fire (Quintana-Ascencio et al. 2007) (Service 2008e).

A recent analysis of Florida scrub conservation progress (Turner et al. 2006) includes *Hypericum cumulicola* among 36 rare species of the LWR. This analysis confirmed that nearly all (98 percent) occurrences were on the LWR. Turner et al. (2006) calculated *Hypericum cumulicola Hypericum cumulicola* as a species of high conservation concern; in fact, it was included in a list of eight species thought to require intensive management (Service 2008e).

Hypericum cumulicola is found almost exclusively in upland areas with excessively drained white sand soil (Judd 1980, Menges et al. 2007). These areas have fire return intervals of 5 to 30 years (Menges 2007) or 10 to 100 years (Myers 1990). The species is not found in all areas of suitable habitat (Quintana-Ascencio et al. 1998), probably because of dispersal limitations. Because of this, patch occupancy is more likely in larger and less isolated patches (Quintana-Ascencio and Menges 1996) (Service 2008e).

Within these types of Florida scrub, *Hypericum cumulicola* is a gap specialist (Quintana-Ascencio and Morales Hernandez 1997) and a poor competitor with shrubs (Quintana-Ascencio and Menges 2000). In rosemary scrub, gap sizes are smallest in areas that have not burned in decades (Menges et al. 2008b). Shrinking gaps in long-unburned areas may be one explanation for the decline in population viability in *Hypericum cumulicola* in the absence of fire (Quintana-Ascencio et al. 2003) (Service 2008e).

In addition, *Hypericum cumulicola* grows in disturbed areas such as sandy roadsides that often occur adjacent to scrub populations. These roadside populations are demographically divergent from scrub populations: they are less stable with more variable life spans, earlier flowering, and higher fecundity (Quintana-Ascencio et al. 2007). These weedier tendencies could represent phenotypic plasticity or have a genetic basis. If the latter is true, these roadside genotypes might be able to invade scrub sites, perhaps to the detriment of adaptation to scrub conditions (Service 2008e).

Translocations of *Hypericum cumulicola* to degraded sites undergoing restoration may be a way to increase its distribution and local population sizes. Ongoing research includes introducing seeds and transplants into degraded scrub and pasture, respectively (Menges et al. 2008c). Field seed germination of *Hypericum cumulicola* is low (<2 percent) and restricted to open sites, consistent with its habitat preferences in more pristine scrub. Of eight species transplanted, *Hypericum cumulicola* suffered the greatest morality due to transplant shock (Menges et al. 2008c) (Service 2008e).

Hawkes (2004) concluded that *Hypericum cumulicola* germination is higher with soil crust present, suggesting that this species may be vulnerable to vehicle disturbance or trampling. In contrast, the presence of ground lichens appears to have a negative effect on recruitment of *Hypericum cumulicola* (Hawkes and Menges 2003), although these effects were slight given low rates of germination. Allelopathy from Florida rosemary may limit recruitment of *Hypericum cumulicola* as well (Hunter and Menges 2002, Hewitt and Menges in press, *in* Service 2008e). In scrub, *Hypericum cumulicola* occurs mainly in gaps (Quintana-Ascencio et al. 2003, Dolan et al. in revision). These results suggest that recently burned, untrampled sites with inter-shrub gaps provide the best conditions for recruitment of this species (Service 2008e).

Even on protected lands, *Hypericum cumulicola* may be threatened by habit modifications due to lack of fire. The effect of mechanical surrogates or pre-treatments for fire, which are widely used by land managers on the LWR, on *Hypericum cumulicola* is not fully known, although one study (Weekly et al. 2007) suggests that fire alone is most effective in maintaining this species (Service 2008e).

Inappropriate fire regime, mechanical treatments, damage from vehicles and pedestrian trampling, and invasive exotic species threaten the continued existence of *Hypericum cumulicola*. The main habitat for *Hypericum cumulicola*, Florida rosemary scrub, may be threatened by too frequent fire (more than once in 15 years may cause local extirpation of Florida rosemary) or infrequent fires (longer than every 50 years may lead to decline of Florida rosemary). Infrequent fires are probably the greatest threat on both managed and unmanaged sites, although specific data are lacking. Most scrub sites supporting *Hypericum cumulicola* are not burned frequently enough to support viable populations and mechanical pre-treatments or surrogates may not provide the same benefits as fire (Service 2008e).

***Liatris ohlingerae* [Florida (scrub) blazing star]**
Liatris ohlingerae belongs to the aster family (Asteracea) within the genus of perennial, long-lived herbs that live in open, usually fire-maintained, habitats. The *Liatris ohlingerae* was listed as an endangered species in 1989 due to habitat loss associated with land clearing for agricultural, residential, and commercial purposes (54 FR 31190). Most remaining scrub habitat continues to be degraded due to fire suppression (Service 1999). As with most of the plant species occurring on the refuge, it does not currently monitor and evaluate populations of *Liatris ohlingerae* on a regular basis. *Liatris ohlingerae* has been identified on the refuge's Flamingo Villas Unit (Schultz et al. 1999, Turner et al. 2006).

Liatris ohlingerae is endemic to the Lake Wales Ridge in Highlands and Polk Counties. During comprehensive surveys in the mid-1980s, the *Liatris ohlingerae* was found at 93 localities, 71 of them in Highlands County (Christman 1988). The species' range extends from Lake Blue in Polk County (Service 1996a), south along the Lake Wales Ridge to ABS at the south end of the ridge in Highlands County (Service 1999).

Liatris ohlingerae is one of the endemic plants found in rosemary balds. It is also found along the ecotone between these balds and surrounding scrub habitats on white or rarely on yellow sands (Christman and Judd 1990). It can also be found scattered in surrounding scrub. Rosemary balds are a unique community type within the scrub ecosystem. They are represented by small islands separated from each other, often by considerable distances. These islands provide suitable habitat for a number of scrub endemics (Christman and Judd 1990) that have evolved within well-drained, droughty, low-nutrient soils. These limiting habitat conditions have resulted in a vegetative complex whose above-ground biomass is sparse and does not support frequent fires. Rosemary balds typically burn every 40 to 100 years (Johnson 1982, Myers 1990), while the surrounding scrubs burn more frequently. Fire may either burn a section of rosemary scrub or it may sweep through the entire bald (Herndon 1996). The ecotone between rosemary balds and surrounding scrub is a dynamic vegetative complex dependent on the frequency and intensity of fire (Service 1999).

Herndon (1996) found that *Liatris ohlingerae* has important microhabitat requirements, particularly its preference for shade. Unlike most other scrub endemics, it appears to thrive in lightly shaded areas. Generally, it is found in highest densities on the lower slopes of rosemary balds especially where low, thin-canopied scrub oaks (*Q. chapmanii*, *Q. germinata*, and *Q. inopina*) or patches of palms (*Sabal etonia* and *Serenoa repens*) dominate the vegetation and where patches of open sand exist. These habitat conditions are also frequently found under individual sand pine (*Pinus clausa*) crowns, but never in dense groves of sand pines (Service 1999).

Over time, however, shady microhabitats are not fixed within rosemary balds. Large-scale disturbance, such as intense fire, may change the mosaic pattern of scrub vegetation and thus decrease the amount of shade in scrub habitat. Twenty-five percent of *Liatris ohlingerae* are found in open areas in direct sun while 25 percent are found along the edges of canopies in partial shade. Half of the plants are typically found under canopies of other rosemary bald vegetation (Service 1999).

Flowering and fruiting in this species are more abundant in shaded microhabitats. Individuals in open and edge habitats only produced one-quarter as many mature flower heads (Herndon 1996). The seed of this species are short-distance wind dispersers, with bristles and hairs that assist in planting the seeds correctly. Low germination on leaf litter-covered soils suggests that many seeds in shade (the favored microhabitat) may get trapped in the leaf litter and fail to sprout or die shortly after sprouting (Herndon 1996) (Service 1999).

Herndon (1996) found that the number of buds on *Liatris ohlingerae* plants is highly variable from year-to-year, from site-to-site, and from plant-to-plant. His study revealed an overall germination rate of 21 to 62 percent and hypothesized that the difference could be attributed to climatic factors such as rainfall and temperature. However, the factor most affecting germination rates was not the environmental conditions or where the plants were located, but the soil conditions in the vicinity of the plant. Seed on bare sand had a higher germination rate, 30 percent in contrast to 21 percent for all the plots. Though no germination rates were observed in relation to light intensity, survival of seedlings was greater in the shaded sites (Service 1999).

The seedling growth rate for *Liatris ohlingerae* is slow compared to most other scrub endemics. Many others grow to reproductive maturity in only one growing season, while juvenile stage for *Liatris ohlingerae* was found to be at least two years by Herndon (1996). Cultivated *Liatris ohlingerae* can flower in 8 months. Limited water and nutrients are believed to be responsible for the difference between wild populations and cultivated ones (Herndon 1996) (Service 1999).

In contrast to other rosemary bald endemics, *Liatris ohlingerae* prefers shade and is not as productive in sunny, open gaps. It occupies areas that would be too overgrown for other scrub endemics. Some rosemary bald endemics, such as *Ceratiola ericoides* (sand heath) produce chemicals that have allelopathic effects. *Liatris ohlingerae* probably is not affected by these chemicals, since it commonly grows under rosemary bushes (Herndon 1996). However, *Liatris ohlingerae* is missing from dense stands of *Ceratiola ericoides*. Herndon (1996) found the shade of dense stands of *Ceratiola ericoides* was more limiting than their allelopathic effects. However, single or widely spaces *Ceratiola ericoides* were not dense enough to preclude *Liatris ohlingerae* (Herndon 1996) (Service 1999).

Though mortality of *Liatris ohlingerae* appears to be low, recruitment and colonization rates are severely limited, as indicated by the number of seedlings in the vicinity of adult plants. *Liatris ohlingerae* occurs sparsely over the landscape and in highly clumped within rosemary balds. Connectivity between the islands of habitat is very important to this species due to its cross-pollination needs. Lack of connectivity or loss of pollinators may be responsible for loss of *Liatris ohlingerae* at some isolated sites (Service 1999).

Liatris ohlingerae is not abundant in rosemary balds because early seral stages do not provide sufficient shade. Following devastating fires, rosemary bald endemics generally recover via the seed bank (Menges and Kohfeldt 1995). Several years are then required to replace shade-bearing vegetation. For example, limited shade may be afforded to the scrub blazing star by *Ceratiola* or *Pinus clausa*. Mature individuals of these species may be killed by fire and must then recover from seedlings. The temporal lag of little to no shade is not suitable for the re-establishment of *Liatris ohlingerae* (Service 1999). Vegetation occurring on the ecotone of rosemary balds and surrounding

scrub reacts differently to fire events. These species typically respond to ground-clearing fires by re-sprouting (Menges and Kohfeldt 1995). Re-sprouting results in the re-establishment of shade-bearing vegetation within one to several years. *Liatris ohlingerae* may become re-established more rapidly under these conditions (Abrahamson 1984, Service 1999).

***Lupinus aridorum* (Scrub lupine)**

Lupinus aridorum is an herb endemic to Orange and Polk Counties, Florida, and is known to occur on the refuge's Lake McLeod Management Unit (Schultz et al. 1999, Kane 2003). *Lupinus aridorum* is known from two distinct areas. In western Orange County (Orlando area), it is found on the southern Mount Dora Ridge from the Apopka-Plymouth area south, past Lake Buena Vista. In south Florida, it is found in north-central Polk County on the Winter Haven Ridge near Audurndale and Winter Haven (Service 1999). The species is an unusual central Florida scrub plant because it is absent from the LWR. Like many other scrub species, however, it is threatened by loss of habitat due to land conversion for agriculture and residential construction. *Lupinus aridorum* was federally listed as endangered (52 FR 11172) in April 1987.

Current management of *Lupinus aridorum* includes habitat manipulation, exotic control, and periodic prescribed fire at the Lake McLeod Unit in addition to periodic monitoring conducted by volunteers and research conducted by the University of Central Florida focusing on inventorying plants, marking individual plants, determining cause of death, and monitoring disease dispersal.

Lupinus aridorum is found in open disturbed areas in sand pine and rosemary scrub communities of central Florida. Other federally listed species found in association with it are Florida bonamia (*Bonamia grandiflora*), papery whitlow-wort (*Paronychia chartacea*), sandlace (*Polygonella myriophylla*), and scrub plum (*Prunus geniculata*) (Service 1999). *Lupinus aridorum* grows primarily on well-drained sandy soils of the Lakewood or St. Lucie series (Wunderlin 1984). These soils are very dry and have very little organic accumulation (Lowe et al. 1990 *in* Service 2008f). The sands are white or occasionally yellow and generally support sand pine (Wunderlin 1984). They are also quite acidic with a pH from 4.0 to 4.5 (Stout, University of Central Florida, pers. comm. 1996 *in* Service 1999).

The natural habitat for *Lupinus aridorum* is believed to be sand pine and rosemary scrub (Stout, University of Central Florida, pers. comm. 1996 *in* Service 1999). *Lupinus aridorum* probably existed in sunny gaps until succession of the scrub resulted in excessive shading and closure of open, sunny patches. After long periods without disturbance, gap specialists usually become less common in scrub communities. Regrowth of *Lupinus aridorum* after fire or other disturbances occurs from seedbanks stored in the sand (Service 1999).

Most of the sites where *Lupinus aridorum* is now found are moderately to severely disturbed by soil scraping activities, road construction, land clearing activities, or off-road vehicles (Stout in press *in* Service 1999). With these disturbances and associated vegetative responses, it is difficult to determine what the natural vegetative cover may have been. However, Wunderlin (1984) found the predominant overstory for this species to be sand pine (*Pinus clausa*), longleaf pine (*Pinus palustris*), and occasionally turkey oak (*Quercus laevis*). The shrub layer tends to be sparse at *Lupinus aridorum* sites; however, this may be a result of human made disturbances to the soil. Shrub species most frequently found in association with *Lupinus aridorum* include rosemary (*Ceratiola ericoides*), scrub line oak (*Quercus geminata*), rusty lyonia (*Lyonia ferruginea*), *Palafoxia feayi*, tallowwood (*Ximenia americana*), and an occasional cabbage palm (*Sabal palmetto*). The herbaceous layer is mostly corkscrew threeawn (*Aristida gyrans*) (Stout, pers comm. 2010).

A 1998 census of 40 locations where *Lupinus aridorum* had previously been reported and five additional locations reported, but not recorded in the FNAI database, found individual plants at 19 sites (TNC 1999). Thirteen of the 40 historic sites had been developed for commercial or residential uses and contained no *Lupinus aridorum* by 2008 (Service 2008f).

At the time of the 1998 census, an estimated 1,054 non-seedling plants and 474 seedlings were unknown to exist, This is higher than the 936 non-seedling plants (which includes the maximum number of individuals reported at any specific location) and 30 seedlings previously reported in the FNAI database. However, comparison of these data is difficult because actual numbers were not recorded for some localities in the FNAI database (e.g., some locations contained "some", "many", ">100", or "unknown" as the reported number of individuals). Comparing only locations where FNAI records contained discrete numbers of individual plants resulted in 324 non-seedling plants and 30 seedlings (FNAI) versus 596 non-seedling plants and 154 seedlings found at these same locations in 1998 (TNC 1999). Much of the increase in numbers of non-seedling plants and seedlings is attributed to two locations, one of which is a managed conservation parcel. Combined, the two locations accounted for 566 (54 percent) of the 1,054 non-seedling plants and 142 (30 percent) of the seedlings known to have existed in 1998 (Service 2008f).

Kane (2003) subsequently conducted a rangewide census between 2002 and 2003 and, although she was unable to compare her findings with all historic locations, she did count 1,019 non-seedlings and 236 seedlings in 2002 and 980 non-seedlings and 4,919 seedlings in 2003 within 10 extant lupine populations (11 extant populations were cited, but one location was excluded because it was not visited in 2002). The refuge's Lake McLeod Unit had the largest number of non-seedlings and seedlings counted during 2002 and 2003 (Kane 2003) (Service 2008f).

Stout (University of Central Florida, pers. comm. 2005 *in* Service 2008f) indicated that long-term monitoring at seven sites on the Lake McLeod Unit showed an increase in the number of seedlings. However, comparison of the number of seedling plants between 2003 and 2007 on the unit showed a decline from 511 to 357 plants and the distribution on this unit declined as well (Service 2008f).

Long-term monitoring has also been conducted at one site in Orange County that is held in a conservation easement (J. Stout, pers. comm., University of Central Florida, 2007 *in* Service 2008f). Since 1990, around 45 non-seedling plants have persisted, but drought conditions since about 1998 have resulted in low or no recruitment in this population (Service 2008f).

The abundance and range-wide population trend of *Lupinus aridorum* is declining due principally to habitat loss. The number of known populations has declined from a historical record of 40, to 19 in 1998 and 11 in 2003. Seedling recruitment varies annually; therefore the number of seedlings present is not a good indicator of population size or status (Service 2008f).

There has been a documented decline in the spatial distribution and historic range of *Lupinus aridorum* (Kane 2003, C. Peterson, HBS, pers. comm. 2007 *in* Service 2008f). As of 2003, the historical records of 40 populations had declined to 11 extant populations occupying about 23 acres. Three of four of these populations have been extirpated since 2003, leaving only six to seven scrub lupine populations (Service 2008f).

Lupinus aridorum evolved in fire-maintained vegetative communities (scrub and sandhill). Many of the remaining locations where *Lupinus aridorum* is found are private properties that are not managed. As a result, vegetation density and canopy cover are high and bare sandy patches are small or non-existent (Service 2008f).

Several populations occur on public lands. Orange County Parks and Recreation Division maintains Shadow Bay Park (formerly Lake Cane-Marsha Park), but this site is not currently managed for *Lupinus aridorum* and is principally used for active and passive recreation. Orange County does not use prescribed fire in this park because of urban interface concerns (A. Eidam, Orange County Parks and Recreation Division pers. comm. 2007 *in* Service 2008f). Mechanical management is proposed at this site in the future. Orange County also holds a conservation easement on a parcel that contains about 45 mature plants. This site is not actively managed, but is currently in relatively good condition due to ongoing experiments evaluating the effects of grass and tree removal on *Lupinus aridorum* survival (J. Stout, University of Central Florida pers. comm. 2007 *in* Service 2008f) (Service 2008f).

In Polk County, the refuge's Lake McLeod Unit contains *Lupinus aridorum* in areas where historic off-road vehicle use created informal trails and other bare sandy patches that persist today. Vegetative density and canopy closure are not currently limiting *Lupinus aridorum* where it occurs. *Lupinus aridorum* seeds may be stored in soils in other areas of the refuge, but have not germinated because competing vegetation is too dense in these areas. Recent burning of brush piles may enhance habitat and result in additional recruitment of seedlings (S. Morrison, TNC, pers. comm. 2007 *in* Service 2008f) (Service 2008f).

Threats due to exotic or invasive plants are documented on the Lake McLeod Unit (North Wind, Inc. 2006), where a total of nine exotic plants infest the unit in varying densities and locations.

Lupinus aridorum plants suffer high mortality when transplanted. This fact has limited plantings of seedlings produced at HBS and is considered one of the primary obstacles to reintroduction of *Lupinus aridorum* to suitable, natural habitat. Recently, however, seeds have been germinated in native soil mixes in peat pots and transplant success of seedlings grown in these mixtures has been promising. Additional experimentation is underway to refine substrates and containers to maximize germination and early seedling survival (HBS 2006) (Service 2008f).

Wilt has been reported in *Lupinus aridorum* populations grown in green house conditions and only recently has been suspected in the extirpation of one wild population (A. Eidam, pers. comm. 2007 *in* Service 2008f). The bacterial pathogen *Xylella fastidiosa* is responsible for wilt affecting *Lupinus aridorum* (Stout et al. 2001). Disease is likely a threat, but more work is needed to determine risks. Predation is not thought to pose a risk at this time (Service 2008f).

Successful recruitment appears to decline during prolonged periods of drought. In one well-studied population, recruitment of seedlings has been low since 1988 and is attributed to drought conditions (J. Stout University of Central Florida pers. comm. 2007 *in* Service 2008f).

***Nolina brittoniana* (Britton's beargrass)**

Nolina brittoniana is a long-lived species of Agavaceae and is found from the south end of the LWR in Highlands County north to Orange County and northern Lake County, Florida. It is a relatively widespread species with highest concentrations in Polk and Highlands Counties. The species was federally listed as endangered in April 1993 and is threatened by habitat loss or modification due to land conversions for agriculture and development (Service 1999). *Nolina brittoniana* is known to occur on the refuge's Lake McLeod and Carter Creek units (Schultz et. al. 1999, Turner et al. 2006).

Nolina brittoniana occurs in a wide range of habitat types, from relatively open scrub to hammocks with closed canopies. It has been reported in scrub, high pine, and occasionally in hammocks (Christman 1988). The wide range of habitat types that *Nolina brittoniana* occupies are very different in appearance, physiognomy, species composition, fire dynamics, and land use history, but are closely linked ecologically and historically (Myers 1990). In all habitats where *Nolina brittoniana* occur, soil is

droughty and infertile, and all are considered upland sites (Myers 1990, C. Weekly, pers. comm. 1996 *in* Service 1999). These habitats are also fire-maintained and fire-dependent ecosystems that are presumably replaced by hardwoods in the absence of fire (Myers 1990, Service 1999).

Nolina brittoniana was listed as endangered because of habitat loss from agricultural and residential development. The Lake Wales Ridge continues to experience population growth and expansion of citrus groves, resulting in further destruction of scrub habitat. Fire exclusion is also degrading much of the remaining scrub habitats. Overgrown scrub can shade this species, which results in a reduction in sexual reproduction (Wunderlin et al. 1980). *Nolina brittoniana* can remain vigorous in fire-suppressed habitat, but trends of populations under these conditions are unknown (Reese and Orzell 1995). In 1989, the total number of *Nolina brittoniana* was estimated to be less than 1,000 plants (Muller et al. 1989, Service 1999).

Like many of Florida' ecosystems, scrub is pyrogenic and its flora and fauna have developed adaptations to fire (Myers 1990). The mosaic of scrub habitats is attributed to variable fire frequencies and patchiness of burn-intensities (Myers 1990). Studies have shown that *Nolina brittoniana* responds to fire with increased flowering at one year post fire (Menges et al. 1996). This is important in that it represents a pulse of reproduction and potential recruitment of new individuals to the population. Although *Nolina brittoniana* can persist in an area that has experienced fire suppression for many years, it may only exist in a vegetative state under these conditions. Adequate fire management is needed to maintain population diversity (Service 1999).

***Paronychia chartacea spp. chartacea* (Papery whitlow-wort)**
Paronychia chartacea is a short-lived dioecious herb, forming small mats. There are two geographically isolated subspecies of this small herb: *P. chartacea* ssp. *chartacea* in central Florida and *P. chartacea* ssp. *minima* in northwestern Florida. Both subspecies are federally listed as endangered due to habitat loss to agricultural, commercial, residential, and recreational purposes (52 FR 2227) (Service 1999). *Paronychia chartacea* is currently protected on 26 managed areas on the Lake Wales Ridge, including the refuge's Carter Creek and Flamingo Villas Units. *Paronychia chartacea* is also known to exist on preserved lands of the Winter Haven Ridge including the refuge's Lake McLeod Unit and of the Lake Wales Ridge at the refuge's Flamingo Villas Unit (Schultz et al. 1999, Turner et al. 2006).

Paronychia chartacea is endemic to the scrub community of the LWR (Kral 1983), in Highlands, Polk, Osceola, Orange, and Lake Counties (Anderson 1991). The natural habitat for the papery whitlow-wort is rosemary scrub, which is also known as the rosemary phase of sand pine scrub (Abrahamson et al. 1984, Christman 1988, Menges and Kohfeldt 1995). At ABS, rosemary scrubs are found only on the higher ridges and knolls in the intra-ridge valley at 40 to 50 meters in elevation, and are largely restricted to St. Lucie and Archbold soil types (Abrahamson et al. 1984), which are both well-drained white sands (Carter et al. 1989) (Service 1999). Surveys specific to rosemary bald elevations on refuge units are unavailable.

Within these scrub communities, *Paronychia chartacea* is more abundant in disturbed, sandy habitats, such as roadway rights-of-way and recently cleared high pine (Abrahamson et al. 1984, Christman 1988, Service 1996a). In rosemary scrub, *Paronychia chartacea* can become very abundant after a fire or on disturbed sites such as along fire lands or trails (Service 1996a, Johnson and Abrahamson 1990) (Service 1999).

Based on surveys on the Lake Wales Ridge in Highlands County, Menges et al. (2007) characterized *Paronychia chartacea* as a soil generalist. Forty percent of occurrences in Highlands County were recorded from xeric scrubby flatwoods soils (e.g., Satellite sand) and an almost equal percentage

from Florida rosemary scrub soils (e.g., Archbold and St. Lucie sands). *Paronychia chartacea* was rarely recorded on sandhill or flatwoods soils (<10 percent for each category). Although soil preferences for *Paronychia chartacea* elsewhere on the Lake Wales Ridge have not been qualified, it is well known from white, gray, and yellow sands throughout its range, but is most abundant on white sands (Service 2008g).

Because of its preference for open sand gaps within Florida rosemary scrub (Schafer et al. in revision *in* Service 2008g), *Paronychia chartacea* is characterized as a gap specialist (Menges et al. 2008b). As time-since-fire increases, gaps decrease in area (Menges et al. 2008b) and *Paronychia chartacea* decreases in abundance (Schafer et al. in revision). This dynamic may be reinforced by the adverse effects of the allelopathic litter of Florida rosemary on germination of *Paronychia chartacea* (Hunter and Menges 2002) and by increases in cover of terrestrial lichens (Hawkes and Menges 2003) and biotic soil crusts (Hawkes 2003) (Service 2008g).

Current range-wide status of *Paronychia chartacea* is unknown. The long-term species status was reported as unknown because while some populations are protected, detailed data for those populations are lacking, threats are continuing, and population trends are unknown (Service 2008g).

Abundance surveys typically either note the presence of *Paronychia chartacea* (Level 1 monitoring *sensu* Menges and Gordon 1996) or make broad estimates of population sizes (e.g., hundreds and thousands). However, two recent datasets contain data based on counts. Clanton (2007b *in* Service 2008g) reported 17,106 individuals of *Paronychia chartacea* from global positioning system (GPS) surveys at the LWRSF conducted in 2006. Schafer (University of Florida, pers. comm. 2008a *in* Service 2008g) recorded 1,425 plants from 16 rosemary scrub and four roadside plots censused at ABS from February to March 2003. Plant density was over three times higher in roadsides than in scrub populations (12.7 per m^2 vs. 4.29 per m^2) (Service 2008g).

Between May 2003 and June 2008, Schafer (pers. comm. 2008b *in* Service 2008g) followed over 3,400 *Paronychia chartacea* at ABS. These data confirm that it is a short-lived perennial, as described by Anderson (1991). For seven seedling cohorts tagged between 2003 and 2005, survival after one year varied from 7.5 percent to 34.2 percent. Thus, most plants survived less than one year. However, most cohorts produced individuals that survived for 2 or more years, and the maximum lifespan observed to date is 5 years (Service 2008g).

Schafer et al. (in revision *in* Service 2008g) investigated the distribution and density of *Paronychia chartacea* populations in Florida rosemary scrub adjacent to roadside populations in relation to fire history and microhabitat. These authors found that population sizes in rosemary scrub decreased with time-since-fire, a result consistent with the observations of Johnson and Abrahamson (1990) and Menges and Kohfeldt (1995). Within rosemary scrub, abundance was greatest in the centers of large gaps (as opposed to small gaps or the edges of large gaps). The density of roadside populations was similar to recently burned scrub populations (Service 2008g).

Sullivan (pers. comm. 2008 *in* Service 2008g) found surprisingly low levels of germination across microhabitats (despite supplemental watering and the application of gibberellic acid (GA_3), a plant growth hormone known to stimulate germination). However, other studies have shown higher rates of field germination (e.g., Hawkes and Menges 2003, Petru and Menges 2003). In particular, germination is promoted by the removal of terrestrial lichens (Hawkes and Menges 2003) and biotic soil crusts (Hawkes 2003), both of which increase with time-since-fire in Florida rosemary scrub (Service 2008g).

Maintenance of viable populations of imperiled plant species depends largely on the determination of the appropriate management regime of populations on managed areas. For *Paronychia chartacea*, inadequate use of fire or the use of mechanical treatments as a surrogate for fire may reduce population sizes or adversely impact demographic performance. Appropriate management means burning Florida rosemary scrub often enough to maintain large gaps within the rosemary scrub matrix. According to Menges (2007) habitat for *Paronychia chartacea* needs to be maintained through burning Florida rosemary scrub within the modal fire return interval defined by other gap specialists and by Florida rosemary (Service 2008g).

***Polygala lewtonii* (Lewton's polygala)**
Polygala lewtonii is a perennial herb that occurs in oak scrub and in high pine, but is more common in the transitional areas between these two community types (Service 1999). Both Schultz et al. (1999) and Turner et al. (2006) report the occurrence of *Polygala lewtonii* on the refuge's Carter Creek Unit. *Polygala lewtonii* was listed as an endangered species in April 1993, due to land conversion and habitat destruction for agricultural and residential housing construction (58 FR 25754). In the Lake Wales Ridge, the south portion of Carter Creek, including the refuge managed unit and the unprotected unit to the south, have the largest known population of *Polygala lewtonii* (Service 1999).

Polygala lewtonii is a relatively short-lived (5- to 10-year) perennial herb. Each plant produces one to several annual stems. This species is closely related to the widespread *P. polygama*. *Polygala lewtonii* occurs in scrub and high pine communities of Highlands, Polk, Osceola, Orange, Lake, and Marion Counties within the Lake Wales and Mount Dora ridges of central Florida (Service 1999).

Polygala lewtonii is not strictly a scrub species and is found in widely scattered populations that frequently occur in transitional habitats between high pine and turkey oak barrens. *Polygala lewtonii* also occurs in both habitats (Wunderlin et al. 1981, Christman 1988). It depends on fire to maintain its habitat. It is found in sunny openings and often colonizes disturbed sites, such as roadsides and fire lanes. Its preference for transitional habitats between high pine and turkey oak barrens suggests a preference for a burn frequency that is less frequent than high pine, but more frequent than turkey oak barrens (Service 1999). It seems to favor the ecotonal habitat where the burn frequency is highly variable. In general, this species responds favorably to fire, as it resprouts quickly and there is an increase in seedling recruitment. After an initial increase in recruitment, populations tend to fluctuate widely. However, large changes in population size coupled with its cryptic nature makes monitoring difficult in many situations. Though more research is needed on the species' response to fire frequencies and intensities, it is clear that periodic fire is needed for the persistence of this species (Service 1999).

Polygala lewtonii may have experienced some degree of range expansion due to artificial fire regimes (Clutts 1995). The practice of winter burning may have allowed *Polygala lewtonii* to expand its distribution from scrub vegetation into high pine. Winter burns prohibit the sexual reproduction of wiregrasses in the high pine habitat and have resulted in an increase in the openings that would have naturally occurred in this habitat. More open areas favor establishment and persistence of *Polygala lewtonii* (Service 1999).

***Polygonella basiramia* (Wireweed)**
Polygonella basiramia is an herbaceous perennial endemic to the central ridges of the Florida peninsula and is one of a suite of herbs found primarily in the rosemary phase of sand pine scrub. *Polygonella basiramia* was federally listed as endangered in January 1987 (52 FR 2234), because of habitat loss and modification. It is restricted in distribution with a small number of remaining sires and is faced with continued and dramatic habitat loss. In addition, trampling and off-road vehicles impact

the species (Service 1999). Turner et al. (2006) reports its occurrence on the Flamingo Villas Unit while Schultz et al. (1999) reports its occurrence on both the Carter Creek and Lake McLeod Units.

The Lake Wales Ridge in central Florida is the center of diversity for the genus *Polygonella*, whose species have remarkably diverse growth habits ranging from tall and leafy, to upright and virtually leafless (wireweeds), to prostrate (Horton 1960). Wireweed is endemic to Lake Wales and Winter Haven Ridges of central peninsular Florida. It ranges from Lake Pierce in Polk County southward to Venus near the southern tip of the Lake Wales Ridge in Highlands County. Christman (1988) found *Polygonella basiramia* at 123 scrub sites (Service 1999).

Polygonella basiramia is most commonly found in rosemary scrub, also known as rosemary phase of sand pine (Abrahamson et al. 1984, Menges and Kohfeldt 1995). *Polygonella basiramia* occupies open spaces or gaps between shrubs and can be found in abundance along sandy fire lanes, which provide similar habitat. Open space (bare sand) in rosemary scrub was found to be a good indicator of *Polygonella basiramia* density: higher plant densities are associated with greater amounts of open space (Hawkes and Menges 1995). Within rosemary scrub sites at ABS, density of *Polygonella basiramia* ranged from 0.000 to 0.085 plants per square meter. Along fire lanes where open sand is abundant, densities were much higher, with a mean of 8.1 plants per square meter (Hawkes and Menges 1995). Compared to other herbs, *Polygonella basiramia* can persist in gaps of smaller size and is often found in the small, ephemeral gaps of scrubby flatwoods which boarder rosemary scrub (Hawkes pers. comm. 1995 *in* Service 1999). As gaps begin to close, there may be a shift in species composition among *Eryngium cuneifolium*, *Hypericum cumulicola*, and *Polygonella basiramia*; with the bare sand specialist *Eryngium cuneifolium* being lost to fire, followed by *Hypericum cumulicola*, then *Polygonella basiramia* (Quintana-Ascencio, ABS, pers. comm. 1995 *in* Service 1999), (Service 1999).

In rosemary scrub, open space decreases from nearly 100 percent immediately after fire to approximately 30 percent 4 years after fire when a great deal of habitat variation exists (Hawkes and Menges 1996). Gaps are affected by the fire cycle, because they are originally created by fires. No relationship, however, was found between time-since-fire and *Polygonella basiramia* density (Hawkes and Menges 1995). Small-scale gap dynamics may be more important than the fire regime for *Polygonella basiramia* (Hawkes and Menges 1995). *Polygonella basiramia* is an obligate seeder (Menges and Kohfeldt 1995) often not present in the first few years after fire, but whether it recovers through delayed post fire germination from soil seed bank or disperses into sites remains unknown (Service 1999).

Density and seed production of *Polygonella basiramia*, in relation to open sand and time post fire was studied by Hawkes and Menges (1995). Their analysis showed that its densities and burn interval were not related, so it appears that it can persist for many years without fire in the long-lasting sandy areas of rosemary balds. However, this species may require small-scale disruptions of the soil crust for populations to persist. Density and seed production both increased with the area of open sand and were highest along firelanes where the soil curst had been disturbed by chopping (Hawkes, University of Pennsylvania, pers. comm. 1998 *in* Service 1999). Large areas of open sand have especially dense populations of the plant, and seed production is greater on high-density than it is on low-density sties. They suggest that *Polygonella basiramia* plants are sensitive to competition from shrubs, and only slightly sensitive to competition from each other. The lack of intraspecific competition probably is due to *Polygonella basiramia* plants having shallow root systems bearing their leaves at ground level. Dense populations may also be especially attractive to pollinators that may also account for the high seed production (Service 1999).

Persistence of appropriate habitat for *Polygonella basiramia* is dependent on disturbance processes which periodically create gaps. Historically, fire has been a large-scale disturbance with maintained open patches of different ages across the landscape. Although it also appears to be able to take advantage of smaller-scale disturbances which disrupt soil crust and create space (such as animal paths and burrow mounds), this has not been studied and such disturbances may only be suitable for colonization if created at the right place and time. In unmanaged areas, lack of disturbance, especially in less xeric sites where open space is fleeting, is a major threat to *Polygonella basiramia* (Service 1999).

Florida scrub is a fire-adapted community experiencing shifting fire intensity and frequency (Myers 1990). The fire cycle for rosemary scrub can range from 10 years to as long as 100 years (Johnson 1982, Myers 1990). This species is an obligate seeder that does not mature from 10 to 15 years and is adapted for a 10- to 40-year fire interval (Johnson 1982). Unlike oak-dominated scrubs, rosemary scrubs recover slowly from burns (Johnson et al. 1986) and openings persist longer. Using fire to manage the habitat is the preferred option for *Polygonella basiramia*. Menges and Kohfeldt (1995) suggest a 15- to 49-year burn interval with mosaic burns on large pieces of property (Service 1999).

***Polygonella myrophylla* (Sandlace)**
Polygonella myrophylla is found in moderately disturbed scrub and is one of many plants endemic to central Florida's upland ridge that have been listed as endangered (April 1993) because of increasing threats from agricultural, commercial, residential, and recreational conversion of natural habitat. Schultz et al. (1999) reports the occurrence of *Polygonella myriophylla* at the Flamingo Villas, Carter Creek, and the Lake McLeod Units of the refuge (Service 1999).

Polygonella myriophylla is a sprawling shrub that forms many branches that zigzag along the ground and root at the nodes, forming low mats. The species occurs in scrub habitats along the Lake Wales Ridge in the Davenport-Poinciana area in Polk County and in Highlands County south to ABS. *Polygonella myriophylla* has also been found in Orange and Osceola Counties (Service 1999).

This low, spreading shrub thrives in areas of bare white or yellow sand created by moderate disturbance. It is not known whether regular fires are needed to maintain bare sand habitat for this species. *Polygonella myriophylla* is believed to be an allelopathic species (Richardson 1985). This allelopathic nature may create suitable habitat conditions to maintain sufficient bare sand for the species to persist. Where found, *Polygonella myriophylla* is a dominant part of the ground cover vegetation in young scrubs. In many localities, however, the herbaceous layer of this habitat is dominated by oaks (*Quercus* spp.) and ericaceous plants. Any overstory trees are usually widely spaced, forming an open canopy (Wunderlin et al. 1980) (Service 1999).

Polygonella myriophylla can become established in bare spots within scrub that are created by intense fires within sand pine scrub. Once established, the allelopathic tendencies of this species may limit growth and survival of other herbs and shrubs (Service 1999).

Polygonella myriophylla persists in scrub habitats with substantial bare ground. These patchy habitats are commonly found after intense fires in sand-pine scrub. This habitat condition is also common within rosemary scrub due to extreme xeric conditions and the allelopathic nature of several species that limits vegetative growth. Persistent, patchy, open sands are not prevalent in oak dominated scrubs, since fires are more frequent and less devastating. Many of the factors that influence *Polygonella basiramia* distribution, abundance, and recruitment may also affect *Polygonella myriophylla* (Service 1999).

***Prunus geniculata* (Scrub plum)**
Prunus geniculata is a small shrub endemic to the oak scrub and high pine communities of the Lake Wales Ridge. *Prunus geniculata* has declined with the destruction and fragmentation of its scrub habitat for agriculture and residential housing and was federally listed as endangered in January 1987 (52 FR 2234). It is also collected by ornamentalists because of its small, fragrant flowers. Schultz et al. (1999) describes *Prunus geniculata* at the Lake McLeod, Carter Creek, and the Flamingo Villas Units of the refuge.

Prunus geniculata is a scrub endemic known to occur on the ridges of central Florida in Lake, Orange, Osceola, Polk and Highlands Counties. In these areas, *Prunus geniculata* occurs in both high pine and in oak scrub communities (Johnson 1982, Stout 1982) (Service 1999).

Prunus geniculata prefers dry, sunny, nutrient-poor sites (Harper 1911). It has been found on soils of the St. Lucie series and on other fine sands or fine sand Entisols that are excessively drained. These soils are acidic; are subject to rapid drying; and have little silt, clay, or organic matter (Service 1999).

Prunus geniculata is native to the high pine and oak scrub community types. The high pine community has a grassy understory and is subject to frequent fires (every 1 to 5 years) of low intensity. The oak scrub community has shrubby vegetation and is subject to infrequent fires of greater intensity. Fires are important for the maintenance of both habitats. In the absence of fires, high pine vegetation is typically invaded by sand pines and evergreen oaks, eventually succeeding to upland hardwood forest if fires do not occur for long periods (Myers 1985). Similarly, scrub is likely to succeed toward upland hardwood forest if fire is absent from the habitat for long periods (Myers 1985). This succession of scrub to upland hardwood forest is likely to result in the shading out of *Prunus geniculata* (Service 1999).

The demography of the species is generally well understood based on research initiated in 1996 by ABS staff (Weekley and Menges 2001, 2002, 2003, 2007, Menges et al. 2008a). From these research efforts, we now know that *Prunus geniculata*: (1) has a rare breeding system characterized by the presence of male and bisexual flowers on the same plant; (2) is partially self-incompatible and that inbreeding depression is high in self-compatible individuals; and (3) experiences high rates of fruit loss due to abortion and pre-dispersal predation. Recent research has also confirmed that scrub plum is long-lived and populations persist for long periods in the absence of fire (Pace-Aldana et al. 2006, Menges et al. 2008a). Current information also supports previous reports that this species is a strong postburn resprouter (Weekley et al. 2007a, Weekley and Menges 2003, 2007, Menges et al. 2007) and that recruitment is low (Service 1999, Weekley and Menges 2003, 2007). Weekley and Menges (2008b) are currently evaluating effects of various land management treatments on a number of scrub-endemic plants, including *Prunus geniculata* (Service 2009a).

Evaluating population trends for *Prunus geniculata* is difficult because this species is long-lived. Furthermore, efforts to monitor population trends could be confounded by the fact that this species experiences low non-seedling plant mortality, has low recruitment, can persist for long periods in fire-excluded habitat, and vigorously resprouts and flowers following fire. The two long-term monitoring efforts have shown the number of non-seedling plants to be in slight decline over the past 7 to 12 years (Pace-Aldana et al. 2006; Weekley et al. 2007a), but, more alarmingly, recruitment into these populations is extremely low (Service 2009a).

As described above, low recruitment appears to be one of the primary factors impacting this species, and it is believed this factor alone is sufficient to conclude that the demographic trend for this species is in decline. The cause for this poor demographic performance is not fully understood at this time, but pre-dispersal fruit predation and intra- and inter-plant incompatibility may be factors contributing to low recruitment (Weekley et al. 2007a, Service 2009a).

The majority of records maintained by the FNAI indicate this species occurs primarily on the Lake Wales Ridge (as defined by Weekley et al. 2008). However, six records occur on ridges that are not currently described as being part of the Lake Wales Ridge (Turner et al. 2006). All indications are that the spatial distribution of this species has declined because the number of extant populations representing element occurrence records has declined (Cox et al. 2004). During the 2004 survey, there was a net decline of 10 populations (19 destroyed and nine new records) (Cox et al. 2004). Using the number of known populations as an indicator of spatial distribution, one could conclude that the distribution of *Prunus geniculata* in the recent past declined by about 10 percent during the timeframe that the FNAI has maintained records. This methodology assumes that the fate of known populations accurately represents the fate of all unknown populations as well (Service 2009a).

Prunus geniculata evolved in fire-maintained white and yellow sand xeric vegetative communities, including rosemary and oak scrub, scrubby flatwoods, and sandhills (Service 1999, Weekley and Menges 2003, Menges et al. 2007). Menges (2007) described natural fire return intervals of 2 to 5 years in sandhill and scrubby flatwoods, 7 to 15 years in oak scrub, and 15 to 30 years in rosemary scrub. These intervals would likely maintain suitable habitat for *Prunus geniculata*, although population fluctuations might be greater in the rosemary and oak scrub because plants probably senesce and decline in habitats with longer fire-return intervals (Service 2009a).

The 2004 survey of EORs found that the most robust plants were found in white xeric soils with exposed sand areas and predominately native vegetation (Cox et al. 2004). High-quality habitat was typically found on recently burned public lands. Field notes accompanying the 2004 survey results suggest that many occurrence records on private lands were on small parcels that had few plants and were in degraded habitat (e.g., pastures, fence rows, and overgrown areas). Habitat conditions on private lands probably have not improved since the 2004 survey, and in most instances have likely gotten worse with the continued exclusion of fire or other management efforts. Fire suppression leads to changes in composition and structure within vegetative communities (Weekley and Menges 2003). Fire exclusion typically results in taller and denser vegetation that may shade-out *Prunus geniculata*, leading to a decline in the number of stems, number of individual plants flowering, and general vigor of individual plants (as suggested by more lichen covered stems) (Menges et al. 2008a, Cox et al. 2004). The overall health of *Prunus geniculata* declines with increasing time since fire. Consequently, it is believed that habitat conditions on unmanaged private lands are poor and will probably continue to decline in the future (Service 2009a).

The most pervasive threat to the species on public land is habitat degradation due to fire suppression. Most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, FDEP, pers. comm. 2007 *in* Service 2009a). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of the species' habitat in some areas (Service 2009a).

Prunus geniculata on private lands is also threatened long-term with fire suppression, but habitat destruction is a more immediate concern in many locations. Except for several privately owned conservation parcels, most other private landowners are unlikely to use habitat management techniques such as prescribed fire to maintain or enhance *Prunus geniculata* habitat. At present,

there are no incentives available that would encourage private landowners to undertake prescribed fire, especially for those who own relatively small parcels embedded in urban matrices. As a result, it is believed that many locality records for *Prunus geniculata* on non-conservation parcels in private ownership are threatened with habitat modification due to fire suppression (Service 2009a).

Prunus geniculata that occurs on non-conservation private lands is also vulnerable to destruction due to urban development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial development. The species on each private parcel is vulnerable to this threat at any time; however, we are not aware of any imminent loss due to development (Service 1999). Despite the destruction of suitable habitat resulting from land conversion, the species still occurs within most of its historic range; however, within range distribution has been decreased. Fire suppression also poses a threat to *Prunus geniculata*. Fire suppression has degraded the quality of scrub and high pine habitats of the species. In addition, seedling establishment in the wild is low in this species, suggesting that it may not be sufficiently reproducing (Service 1999).

Fire, or equivalent artificial disturbance, appears to be necessary for the perpetuation of *Prunus geniculata* (Kral 1983, Myers 1985). This species readily resprouts after fires or mechanical disturbances (Service 1996a). In addition, fires may benefit the species by regulating the numbers or sizes of plants that shade or otherwise compete with it (Kral 1983). Though the optimum frequency of disturbance is unknown, the fire frequencies typical of high pine (2 to 5 years) and scrub (15 to 20 years) are understood (Service 1999).

***Warea carteri* (Carter's warea, Carter's mustard)**
Warea carteri is a fire-dependent annual herb occurring in xeric, shrub dominated habitats on the Lake Wales Ridge of central Florida. The primary threats to *Warea carteri* are habitat loss to citrus grove operations and residential developments and long-term fire suppression, both of which cause local extirpations (Service 1999). *Warea carteri* was listed as an endangered species in 1987 due to habitat loss (52 FR 2234). The primary threats to *Warea carteri's* persistence are habitat destruction and fire suppression. Fire suppression is a threat to this species because its demography and reproduction seem to be closely tied to fire (Service 1999). For the refuge, Tuner et al. 2006 identifies *Warea carteri* on both Flamingo Villas and Carter Creek Units while Schultz et al. 1999 identifies the species on the Carter Creek Unit. The Service has also identified the species on the Lake McLeod Management Unit.

From what is known of the historic distribution of *Warea carteri*, it occurred in scrubby flatwoods and sandhills of the Lake Wales Ridge in Highlands, Polk, and Lake Counties, in south Florida slash pine forests in the Miami area, and in coastal scrub in Brevard County (Service 1999). *Warea carteri* has occurred through the entire length of the LWR, as well as the WHR (Schultz et al. 1999, Turner et al. 2006) (Service 2008h). The two largest populations of *Warea carteri* on the LWR occur at ABS and TNC's Tiger Creek Preserve. At ABS, *Warea carteri* occur in scrubby flatwoods and in turkey oak and hickory dominated sandhills, and is often found in the ecotone between these two vegetation types. Because sandhills occur on yellow sands, *Warea carteri* is often found in or near yellow sands. Several populations of *Warea carteri* at ABS are adjacent to roads, firelanes, or in areas with historic human disturbance. At Tiger Creek Preserve, *Warea carteri* is found in degraded sandhill habitat where turkey oak is abundant, in scrubby flatwoods, and in xeric hammocks (Menges, ABS per.comm.1995 *in* Service 1999) (Service 2008h).

Warea carteri is found almost exclusively in upland areas and is a soil generalist, being found in yellow, gray, or white sands (Menges et al. 2007). It is found primarily in sandhills and scrubby flatwoods, and often at the ecotone between these two vegetation types. In the northern part of its range, most sites are on sandhill. This is also true for sites at Tiger Creek Preserve, a site in the

central part of its range, which supports the greatest number of plants. At this site, the species is found in both high-quality, frequently burned sandhill, as well as in overgrown sandhill that could also be termed xeric hammock (Menges in litt. 2008b *in* Service 2008h). Near the end of its range (e.g., ABS), *Warea carteri* is found primarily in scrubby flatwoods, often just downhill from a ridge of yellow sand (Menges in litt. 2008c *in* Service 2008h) (Service 2008h).

These habitats have a range of fire return intervals from 2 to 15 years (Menges 2007). Although *Warea carteri* has large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire (Menges in litt. 2008d *in* Service 2008h). Although preferring post-fire or disturbed sites, the species is not a gap specialist. Plants often grow among dense shrubs in scrubby flatwoods or shrubby sandhill sites. It responds well to fire, but its response to other habitat manipulations such as roller chopping and mowing, is not known. Although several research projects are examining these effects on sandhill and Florida scrub, *Warea carteri* is not abundant enough at these sites to test its responses to treatments (Service 2008h).

Currently, 49 EORs are listed for *Warea carteri* as compiled FNAI. Of these, 43 are located on protected sites. One of these sites occurs on Van Pelt Road to the east of the Carter Creek Unit (Menges in litt. 2008e *in* Service 2008h) (Service 2008h).

Fire suppression has caused habitat degradation even in some protected areas. Although the exact fire return interval that would best benefit *Warea carteri* is not known, the species clearly benefits from periodic prescribed fires that are used to manage its habitat (Menges and Gordon 1996, Quintana-Ascencio et al. 2008). Exotic plant invasion, especially of cogongrass (*Imperata cylindrica*) into sandhills, is of concern (Service 2008h).

Sites managed to maintain the scrubby flatwoods and turkey oak (*Quercus laevis*) dominated by high pine provide support for the species. It currently occurs in 13 managed areas, most of which receive at least occasional prescribed fire. However, site-specific information and associated analysis on past and planned fire regimes are not readily available. Most observers would agree that many sites are behind schedule in applying fire. Fire management should maintain scrubby flatwoods and turkey oak dominated high pine, although there is no consistent monitoring effort to evaluate whether these vegetation types are benefiting from the current management regimes. Both types of vegetation require prescribed fire, although at different intervals (Menges 2007) (Service 2008h).

Warea carteri populations fluctuate widely from year-to-year (Menges and Gordon 1996). For burned populations especially, these fluctuations are biennial (peak every 2 years) and damp over time (Quintana-Ascencio et al. 2008). Fires usually initiate cycles, with the largest population sizes occurring the year following a fire. These population cycles are caused by demographic delay in seed germination (Quintana-Ascencio et al. 2008). Seeds produced in the fall on one year generally enter the persistent soil seed bank, with the first (and largest) pulse of germination in the second winter following seed production. Because fires remove a cohort of plants, a single cycling post-fire cohort will create the damped 2-year cycle (Quintana-Ascencio et al. 2008). Population sizes that are noted in the FNAI EORs are mainly small, often fewer than 10 plants. The largest populations in the FNAI records were at TNC's Tiger Creek Preserve. These populations were noted as being as large as 1,000 plants, consistent with data collected there by Menges and others (Quintana-Ascencio et al. 2008) (Service 2008h).

A survey of rare species locations on conservation lands, used to assess soil preferences in a recent analysis (Menges et al. 2007), collected GPS data and density estimates from 20 species, 10 sites, 1,173 GPS points, and 2,577 species occurrences in Highlands County. These points included 63 occurrences of *Warea carteri* at five sites [i.e., ABS, Carter Creek North (FDEP), Carter Creek South

(refuge), Flamingo Villas (refuge), and Lake June in Winter Scrub State Park (FDEP)]. The only repeated monitoring of *Warea carteri* is being conducted at TNC's Tiger Creek Preserve (Pace-Aldana in litt. 2008 *in* Service 2008h) to determine presence/absence in grids composed of contiguous 10 m by 10 m cells. The Flamingo Villas occurrence, as listed by Turner et al. (2006), was discovered in the 1990s by ABS scientists. The species has been found at the refuge's Lake McLeod Unit since publication of Turner et al. (2006). According to refuge staff, one individual was found next to a fireline (Service 2008h).

More so than other plant species, *Warea carteri* distributional information may be incomplete, with occupied sites being unknown and formerly known sites now lacking the species. Its fluctuating population size, inconspicuous nature when not flowering, and annual habit make assessment of its distribution and conservation status more difficult than is the case for perennial herbs or shrubs (Service 2008h).

Warea carteri is threatened by habitat modification due to fire suppression. Fire suppression has caused habitat degradation even in some protected areas. Although the exact fire return interval that would best benefit the species is not known, it clearly benefits from periodic prescribed fires that are used to manage habitats (Menges and Gordon 1996, Quintana-Ascencio et al. 2008). The effect of mechanical surrogates or pre-treatments for fire, which are widely used by land managers on the Lake Wales Ridge, is not known for *Warea carteri*. We believe that the inadequate application of fire in these habitats is a primary threat to existing populations of *Warea carteri* (Service 2008h).

***Ziziphus celata* (Florida ziziphus)**

Ziziphus celata is a thorny shrub in the Buckthorn family (Rhamnaceae), endemic to the Lake Wales Ridge in Polk and Highlands Counties, Florida. *Ziziphus celata* was listed as an endangered species in July 1989 (54 FR 31190) due to habitat loss, potential and genetic limitations, exotic species invasion, and the potential for over collection and vandalism (54 FR 31190). The species was believed to be extinct when it was described in 1984 from a 36-year old herbarium specimen. Between 1987 and 2007, 14 remnant populations were discovered. Ten of the 14 extant populations are located on private land (Service 2009b). In the most recent survey (2008), a total of 1,088 plants were counted in the 14 wild populations. Two introduced populations totaled 396 plants. Planted individuals at two augmented wild sites totaled approximately 60 plants (FNAI 2008, Weekley and Menges 2008c). *Ziziphus celata* is found on the refuge's Carter Creek Unit where 82 individuals still survive from an introduction in 2002 (Weekley and Menges 2006, 2008c) (Service 2009b).

All *Ziziphus celata* populations occupy yellow sand sites that historically supported longleaf pine (*Pinus palustris*) wiregrass (*Aristida stricta* var. *beyrichiana*) sandhills or oak (*Quercus myrtifolia)* hickory (*Carya floridana*) scrub, but most have been converted to pastures or other uses (Weekley and Menges 2006). Habitat fragmentation has likely played a large role in the current abundance and distribution of *Ziziphus celata*. The loss and fragmentation of habitat, which has taken place over the last few decades, have resulted in scattered remnant, genetically depauperate, and largely sterile populations persisting on degraded sites (Service 2009b).

Ziziphus celata plants have high annual survival rates, variable rates of clonal reproduction, and populations lack recruitment from seed (Ellis et al. 2007, Weekley and Menges 2008c). Failure of sexual reproduction is the factor with the greatest influence on the species' long-term viability. Studies have identified the genetic basis of the species' breeding system that is the primary factor. It has a gametophytic self-incompatibility system (GSI) in which individual plants carry an allele that determines it compatibility with mates. Pollen donor and recipient must have different self-incompatibility (S-) alleles for successful seed production. Populations that have failed to reproduce sexually are doomed to eventual extirpation unless they are augmented with individuals from cross-compatible genotypes

(Weller 1994, Weekley et al. 2002) (Service 2009b). As a result, the populations consisting of a single extensive clone are effectively sterile; they cannot reproduce sexually. Compatible crosses that result in seed production are possible only in the populations that contain multiple genotypes and compatible mating types (Service 2009b). Three of the wild populations with multiple genotypes have produced seeds, but no recruitment from seed has been observed at these sites (C. Weekley, ABS, pers. comm. 2008e). Four primary factors (self-sterile uniclonal populations, low seed set, low germination rates, and low seedling recruitment rates) explain in large part why recruitment from seed has not been observed in any wild populations of *Ziziphus celata* (recruitment from seed has been observed in the *ex situ* plantings at HBS) (Service 2009b).

Recovery efforts include habitat protection, controlled propagation, reintroduction into unoccupied, suitable habitats, and management of scrubby flatwoods and high pine communities (Service 1999). Turner et al. (2006) identified *Ziziphus celata* as one of at least eight Lake Wales Ridge species in which translocation and/or captive propagation may be necessary to ensure their survival due to inadequate representation on conservation lands (Turner et al. 2006) (Service 2009b).

Augmenting populations and the translocation of cross-compatible genotypes to augment single genotype populations is necessary for long-term persistence of *Ziziphus celata*. Reintroductions have occurred at TNC's Tiger Creek preserve and at the Flamingo Villas Unit. These efforts utilized multiple genotypes propagated from seed harvested from the HBS *ex situ* collection (FNAI 2008, Weekley and Menges 2008c). Cumulative survival for transplants was 56.9 percent after 6 years at Carter Creek, and 64.7 percent after 3 years at Tiger Creek Preserve (Weekley and Menges 2008c). All of the plants in reintroduction and augmentation efforts are currently small, vegetative individuals. Until these plants reach maturity, it is not possible to completely evaluate the effectiveness of these efforts to creating reproductively viable populations (Service 2009b). *In situ* seed germination rate is low, for example the seed germination rate was 2.75 percent for the Tiger Creek 2007 reintroduction site (33 seedlings resulted from 1,200 seeds). At the refuge's Carter Creek Unit reintroduction site, seed germination rates were less than 5 percent. Of the seeds that germinated, survival was 32.4 percent after 3 years at Tiger Creek Preserve and less than 10 percent after 6 years at Lake Wales Ridge NWR's Carter Creek (Weekley and Menges 2008c) (Service 2009b).

The fire ecology of *Ziziphus celata* is not fully understood. Research by ABS is ongoing at the refuge's Carter Creek Unit where an introduced population has been included in a prescribed burn. Numerous small scale burns have been conducted on populations to control invasive pasture weeds. These efforts have shown that *Ziziphus celata* can survive and regenerate after fire by resprouting. Ongoing monitoring of burned populations aims to provide insight into the post-fire survival and growth of the species (Weekley and Menges 2006) (Service 2009b). In studies of *Ziziphus celata* introduced to a sandhill site at the refuge's Carter Creek Unit, Menges et al. (2008a) found that resprouting oaks encroached with negative effects on plant survival. The dominance of oaks increases under fire suppressed conditions. Weekley and Menges (2006) suggest a fire return interval of 2 to 8 years for sandhill habitat on the Lake Wales Ridge to reduce cover of oaks and produce an open understory (Service 2009b).

WILDLIFE

No studies specifically directed towards identifying the complete suite of wildlife on the refuge have been conducted. However, the survey by FNAI (Schultz et al. 1999) recorded rare, threatened, and endangered species occurrence throughout the Lake Wales Ridge system. Our conservation partners have provided valuable species account lists on adjacent lands, including ABS, TNC, FNAI, and APAFR. Table 15 reflects known occurrences of rare fauna by refuge management units. Some species are known to actively utilize refuge resources for most or all of life needs including Florida

scrub-jay and sand and bluetail mole skinks, while others are thought to utilize refuge units as part of a larger corridor system including the Florida panther and the Florida black bear. An active bald eagle nest (Vehrs, pers. comm. *in* Service 2005) has been identified on the Carter Creek Unit, and there is an active bald eagle nest on the south side of the Flamingo Villas Unit. Florida panthers (*Puma concolor coryi*) may use the refuge's Flamingo Villas, Carter Creek, and Snell Creek Units and signs of Florida black bear (*Ursus americanus floridanus*) have been observed by ABS researchers and volunteers. In December 2006 and September 2009, a motion triggered camera used at the Flamingo Villas Unit to document the presence and location of feral hogs for trapping purposes photographed a black bear. In addition, as part of a landscape scale black bear project, ABS researchers set traps, captured, and radio collard a large male black bear on the Flamingo Villas Unit in September 2009. In January 2007, an image of a large cat was captured at the same hog baiting station where the 2006 black bear image was taken; however, the species is unconfirmed. Service telemetry data verify the occurrence of Florida panthers ranging in close proximity to the refuge's Flamingo Villas (one-tenth of a mile), Carter Creek (one-half a mile), and Snell Creek (roughly one mile) Units, although no telemetry data records occurrence on refuge managed units.

Birds

There are over 100 bird species that have been documented to occur frequently on the LWR and migratory birds have been detected as flyovers in the area, however, the refuge lacks complete baseline information concerning bird use. Typically, birds occurring on the refuge utilize oaks and pines for nesting and perching among other life needs. Other birds such as the wood duck (*Aix sponsa*), snipe (*Gallinago gallinago*), and wading birds use the canals, ephemeral ponds, and Red Beach Lake at the Flamingo Villas Unit. There are threatened and endangered species of birds that occur, flyover, or are likely to occur on the refuge such as the crested caracara (*Polyborus plancus*), bald eagle (Haliaeetus leucocephalus), peregrine falcon (*Falco peregrinus*), sandhill crane (*Grus Canadensis*), wood stork (*Mycteria americana*), red-cockaded woodpecker (*Picoides borealis*), and Florida scrub-jay (*Aphelocoma coerulescens*). The red-cockaded woodpecker and peregrine falcon have not been documented on the refuge but do utilize pine dominated habitat types found on conservation lands in the area, particularly Avon Park bombing range (red-cockaded woodpecker, peregrine falcon) and ABS lands (peregrine falcon) (FWC 2009b). The scrub-jay is extensively monitored and managed for on the LWR and on protected lands where it exists throughout Florida, including the refuge. The application of prescribed fire is an important management tool for developing suitable habitat conditions to establish and support scrub-jays.

Mammals

The refuge's mammalian fauna consists of many species of bats and small mammals, including the Florida mouse (*Podomys floridanus*), which is a state listed species of special concern and endemic to Florida. Other mammals that use the refuge regularly include the white-tailed deer (*Odocoileus virginianus)*, bobcat (*Lynx rufus)*, eastern cottontail (*Sylvilagus floridanus)*, and raccoon (*Procyon lotor).* As mentioned, Service telemetry data of the federally listed Florida panther have been documented to about one-tenth of a mile from the Flamingo Villas Unit, while signs and presence of the state listed Florida black bear have been observed by staff, volunteers, and researchers. Additionally, motion triggered cameras have captured images of Florida black bear and a large, but unconfirmed cat on the Flamingo Villas Unit. As part of a landscape scale black bear project, ABS researchers set traps, captured, and radio collard a large male black bear on the Flamingo Villas Unit in September 2009. These and other megafaunal species suffer from habitat loss and reduced food resources throughout their ranges. Most of the larger mammals tend to roam in and out of the scrub habitat and are not permanent residents. Invasive feral hogs (*Sus scrofa*) are abundant on the Flamingo Villas Unit of the refuge and have severely disturbed cutthroat seeps and similar ephemeral wetlands by rooting up the ground in search of food.

Reptiles
There is a high diversity of reptiles on Lake Wales and Winter Haven Ridges, with over 30 species occurring on the refuge. Most of the reptiles are secretive and some swim through the lose sands of the refuge's desert-like scrub habitats. Common inhabitants include a variety of snakes, turtles, and lizards. Federally listed species include the American alligator (*Alligator mississippiensis)* and eastern indigo snake (*Drymarchon corais)*, bluetail mole skink (*Eumeces egregious),* and sand skink (*Neoseps reynoldsi*). Both skinks are endemic to scrub habitat with the bluetail mole skink occurring only on the Lake Wales Ridge. The state listed short-tailed snake (*Stilosoma extenuatum*) and scrub lizard (*Sceloporus woodi)* have, like many species on the refuge and throughout the region, been impacted by loss of habitat. The gopher tortoise (*Gopherus polyphemus)* is a state listed threatened species due to habitat loss and illegal harvesting. It inhabits sandhill, scrub, and other upland areas. Tortoise burrows are opportunistically utilized by a wide range of wildlife species for a host of life needs including but not limited to protection from predators, fire, daytime heat, nesting, and feeding sites.

Amphibians
Over 15 different species of toads, frogs, and salamanders occur on neighboring partner lands and have been documented on the ridge. Most amphibians rely on a source of freshwater lacking aquatic predators thus tend to be found utilizing non-permanent wetlands such as ephemeral wetlands. Amphibians are noted for being ecological indicators and are very sensitive to climate change and pollution. Future research would be conducted in an effort to monitor any changes in these animals' abundance and behavior. In Florida, the Florida gopher frog (*Rana capito*) is a species of special concern due to habitat loss, mismanagement of habitat, and fire suppression. Schultz et al. (1999) identified Florida gopher frog on the Flamingo Villas Unit. The invasive Cuban tree frog (*Osteopilus septentrionalis*) has been documented in the area.

Fish
Fish utilize Red Beach Lake at the Flamingo Villas Unit, borrow pits, ponds, and canals. These waters contain game fish and other freshwater species, such as gar (*Micropterus salmoides*) and mosquito fish (*Elassoma evergladei*). There are high numbers of exotic fish in the canals such as brown hoplo (*Hoplosternum littorale*) and walking catfish (*Clarias batrachus*).

Insects
Arthropods are abundant on the refuge and adjacent lands. There are over 60 species of ants, 70 species of bees, 45 species of spiders, and 120 species of beetles occurring on the ridge. Extensive research and species documentation has been conducted by staff at ABS on partner and refuge managed lands. There are a large number of endemic insects including emerald moth (*Nemouria outina*) which feeds soely on rosemary, the bee fly (*Bombyliidae* sp.) which is the primary pollinator for the scrub balm, and the scrub millipede (*Floridobolus penneri*). The scarab beetle (*Scarabaeidae* sp.) and gopher cricket (*Gryllus* sp.) are both obligate commensals that are only found in gopher tortoise burrows. The Highlands tiger beetle (*Cicindela highlandensis*) is a federal candidate species due primarily to habitat loss within its original range.

Rare, Threatened, and Endangered Species
Rare, threatened, and endangered wildlife species known to occur on the refuge are identified in Table 15.

Table 15. Rare fauna known to occur or potentially occurring on Lake Wales Ridge NWR

Scientific Names	Common Names	Agency Status in Florida		Occurance			
		Federal	State	FV	CC	LM	SC
Invertebrates							
Cicindela highlandensis	Highlands tiger beetle	C	N	X	X		X
Amphibians and Reptiles							
Alligator mississippiensis	American alligator	T(S/A)	SSC	X			
Drymarchon corais couperi	Eastern indigo snake	T	T	X			
Eumeces egregius lividus	bluetail mole skink	T	T			X	
Rana capito	Florida gopher frog	N	SSC	X			
Sceloporus woodi	Florida scrub lizard	N	N	X	X	X	X
Gopherus polyphemus	gopher tortoise	N	T	X	X	X	X
Neoseps reynoldsi	sand skink	E	E	X	X	X	X
Stilosoma extenuatum	short-tailed snake	N	T				
Birds							
Aphelocoma coerulescens	Florida scrub-jay	T	T	X	X		
Haliaeetus leucocephalus	bald eagle	N	T	X	X		
Mycteria americana	wood stork	E	E	X			
Polyborus plancus audubonii	crested caracara	T	T				
Grus canadensis pratensis	sandhill crane	N	T				
Falco peregrinus	peregrine falcon	N	E				
Picoides borealis	red-cockaded woodpecker	E	T				
Mammals							
Podomys floridanus	Florida mouse	N	SCC	X			
Puma concolor coryi	Florida panther	E	E	X*			
Ursus americanus floridanus	Florida black bear	N	T	X			
Eumops floridanus	Florida bonneted bat	C	E				

Key: E = endangered, T = threatened, T(S/A) = listed due to similarity in appearance of a threatened species (American crocodile), C = candidate (FWS), SSC = species of special concern (State), N = Not listed or not being considered, X - unconfirmed*

The following discussions summarize the biologic condition of primary rare wildlife present on the refuge as described by Service staff, partners, research, and synthesis reporting. Much of the information used to prepare this section was compiled through the Service's South Florida Multi-Species Recovery Plan of 1999, current Service 5-year reviews where available, and Florida's Comprehensive Wildlife Conservation Strategy. Literature cited from these documents are provided for in the body of the biological summaries and referenced in Appendix B.

American Alligator (Alligator mississippiensis)
Historically, the American alligator (*Alligator mississippiensis*) was depleted from many parts of its range as a result of market hunting and habitat loss, and 40 years ago the species was nearing extinction in the wild. Subsequently, the alligator was listed as an endangered species in 1967. A combined effort by the Service and State wildlife agencies in the southeast allowed the species to recover. In 1987, the Service pronounced the American alligator fully recovered. The species remains federally listed in Florida due to its similarity in appearance to the endangered American crocodile (*Crocodylus actus*) and it is additionally protected by state laws. On the refuge, alligators are rare, utilizing Red Beach Lake and drainage ditches of the Flamingo Villas Unit. Alligators are presumed to exist in Lake McLeod and may utilize wetland habitats associated with Carter Creek and Snell Creek Units.

Bald Eagle (Haliaeetus leucocephalus)
Pre-colonial era population estimates of bald eagles (*Haliaeetus leucocephalus*) are in the hundreds of thousands. Due to hunting, organopesticide use, and habitat destruction, the numbers of these large raptors fell to threatened levels in the continental United States of less than 10,000 nesting pairs by the 1950s, and to endangered levels of less than 500 pairs by the early 1960s. Bald eagles were protected by the Endangered Species Act of 1973 and designated as a threatened species in the lower 48 states. Due to a successful recovery effort, the species was de-listed in August 2007 (50 CFR 17). The bald eagle continues to be protected by the Bald and Golden Eagle Protection and Migratory Bird Treaty Acts. In addition, Florida populations remain designated by the state as threatened. Bald eagles have historically nested on the Flamingo Villas Unit and a nest currently exists on the Carter Creek Unit.

Bluetail Mole Skink (Eumeces egregius lividus)
The bluetail mole skink (*Eumeces egregius lividus*) is a small, slender lizard that occupies xeric upland habitats of the central ridge system in peninsular Florida. It requires open, sandy patches interspersed with sclerophyllous vegetation. Much of the bluetail mole skink's habitat had been destroyed or degraded due to residential, commercial, and agricultural development. Habitat protection and management are essential for the survival of the species.

The bluetail mole skink occurs in suitable habitat on the LWR in Highlands, Polk, and Osceola Counties in central Florida and populations are known to occur on the refuge's Lake McLeod Unit (Schultz et al. 1999) east of Gerber-Dairy road. It is apparently rare throughout its range, even in the most favorable of habitats (Christman 1992), and is not uniformly distributed within xeric upland communities. A study conducted by Turner et al. (2006) on scrub habitat along the central ridge of Florida indicated that bluetail mole skinks are known to occur in 23 locations, 22 of which are located on the Lake Wales Ridge. Of the 23 locations on which bluetail mole skink is reported to occur, 12.5 sites are protected and, as of 2004, 10 were managed (Turner et al. 2006). Bluetail mole skinks seem to be underrepresented in the reserve network of protected public lands, but Turner et al. (2006) could not determine if their absence reflects actual exclusion or a lack of survey effort.

Over the last 20 years, a concerted effort by public and private institutions to protect the remaining undeveloped areas of the Lake Wales Ridge has resulted in the acquisition of 21,498 acres of scrub and sandhill habitat (Turner et al. 2006). A variety of state and federal agencies and private organizations are responsible for management of these areas. All of these efforts have greatly contributed to the protection of imperiled species on the Lake Wales Ridge (Turner et al. 2006).

Little is currently known about the status and trends of the bluetail mole skink and the Service is not currently able to determine population stability (Service 2007b). The bluetail mole skink occupies habitat similar to that of the sand skink (*Neoseps reynoldsi*), however, these species do not compete because of resource partitioning. Sand skinks are primarily fossorial and take prey below the surface, whereas the bluetail mole skink hunts at the surface and consumes mostly terrestrial arthropods (Smith 1977, 1982).

Except for a few locations, we have little information about the abundance and population trends of the sand skink and bluetail mole skink. Because both species spend much of their time beneath the surface of the sand, they are relatively difficult to study. More recent studies have merely looked for presence or absence or densities and had not provided population estimates (Service 2007b).

Density estimates were not available for bluetail mole skinks, as only two individuals were captured in the Polk and Highlands study (Christman 2005). This was not unexpected because densities of bluetail mole skinks are typically lower than those of sand skinks (e.g., only 1 bluetail mole skink may be captured for every 20 sand skinks) (Christman 1986, pers. comm. *in* Service 1999). However, Telford (2007 in litt.) suggests that this disparity in relative abundance of the two species may be explained by seasonal variation in activity and movements, and that year-round surveys should be conducted over an adequate number of years to minimize the effect of variation in rainfall in order to obtain better estimates.

Demographic information has been obtained for sand skinks, but no new information is available for bluetail mole skinks (Service 2007b).

The historic and anticipated future modification and destruction of xeric upland communities in central Florida were primary considerations in listing bluetail mole skinks as threatened under the ESA in 1987 (52 FR 42662). Protection and recovery of bluetail mole skinks require that habitat loss be stopped and that unoccupied, but potentially suitable habitat be restored (Service 1999). Fire has been used and is a preferred tool for managing xeric communities, such as those containing skinks. The natural patchiness resulting from fire provides suitable bluetail mole skink habitat (Service 1999). Current efforts to expand the system of protected xeric upland habitats on the Lake Wales Ridge, in concert with implementation of aggressive land management practices, represent the most likely opportunity for securing the future of this species (Service 1999).

Eastern Indigo Snake (Drymarchon corais couperi)

The eastern indigo snake (*Drymarchon corais couperi*) is a large, black, non-venomous snake found in the southeastern United States. It is widely distributed throughout central and south Florida, but primarily occurs in sandhill habitats in northern Florida and southern Georgia and has been identified as an occupant of the refuge's Flamingo Villas Unit (Schultz et al. 1999).

The eastern indigo snake was listed as a threatened species (43 FR 4028) as result of dramatic population declines caused by over-collecting for the domestic and international pet trade, as well as by mortalities caused by rattlesnake collectors who gassed gopher tortoise burrows to collect snakes. Since its listing, habitat loss and fragmentation by residential and commercial expansion have become much more significant threats to the eastern indigo snake (Service 1999). Presence of the

eastern indigo snake has been documented on the Flamingo Villas Unit, however, due to large home ranges (48.2-114.2 acres) and the use of a variety of habitat types (Legare et al. 1998-2002), it is difficult to determine presence at a site or monitor population status on the refuge. Due to the fragmentation of conservation lands along the ridge, a clear threat to indigo snakes using the refuge is roadway mortality.

Historically, the eastern indigo snake occurred throughout Florida and in the coastal plain of Georgia, Alabama and Mississippi (Loding 1922, Haltom 1931, Carr 1940, Cook 1954, Diemer and Speake 1983, Moler 1985a). It may have occurred in southern South Carolina, but its occurrence there cannot be confirmed. Georgia and Florida currently support the remaining, endemic populations of the eastern indigo snake (Lawler 1977). In 1982, only a few populations remained in the Florida panhandle, and the species was considered rare in that region. In south Florida, the eastern indigo snake is thought to be widely distributed.

Over most of its range, the eastern indigo snake frequents several habitat types, including flatwoods, scrubby flatwoods, high pine, dry prarie, tropical hardwood hammocks, freshwater marsh edges, agricultural fields, coastal dunes, and human-altered habitats. Eastern indigo snakes need a mosaic of habitats to complete their annual cycle. Interspersion of tortoise-inhabited sandhills and wetlands improves habitat quality for this species (Landers and Speake 1980, Auffenberg and Franz 1982). Wherever eastern indigo snakes occur in xeric habitats, it is closely associated with the gopher tortoise (*Gopherus polyphemus*), the burrows of which provide shelter from winter cold and desiccation (Bogert and Cowles 1947, Speake et al. 1978, Layne and Steiner 1996).

In milder climates of central and south Florida, eastern indigo snakes exist in a more stable thermal environment, where availability of thermal refugia may not be as critical to the snake's survival as is the case in its northern range. In central and coastal Florida, eastern indigo snakes are mainly found within many of the state's high, sandy ridges. Even though thermal stress may not be a limiting factor throughout the year in south Florida, eastern indigo snakes still seek and use underground refugia in the region. On the sandy central ridge of south Florida, eastern indigo snakes use gopher tortoise burrows more (62 percent) than other underground refugia (Layne and Steiner 1996, Service 1999).

The eastern indigo snake is an active terrestrial and fossorial predator that will eat any vertebrate small enough to be overpowered. Layne and Steiner (1996) documented several instances of indigo snakes flushing prey from cover and then chasing it. While rare, these snakes may also climb shrubs or tress in search of prey and the overall diet may include fish, frogs, toads, snakes (venomous, as well as nonvenemous), lizards, turtles, turtle eggs, juvenile gopher tortoises, small alligators, birds, and small mammals. Indigo snakes range over large areas and into various habitats throughout the year, with most activity occurring in the summer and fall (Smith 1987, Moler 1985b, Speake 1993, Service 1999).

Florida Scrub-Jay (Aphelocoma coerulescens)

The Florida scrub-jay (*Aphelocoma coerulescens*) is a relict species of fire dominated oak scrub habitat that occurs on well-drained sandy soils in peninsular Florida. Scrub-jays are extremely habitat specific, sedentary, and territorial. Florida scrub-jays form family groups; fledglings remain with their parents in their natal territory as helpers. The Florida scrub-jay was listed as a threatened species because of loss, fragmentation, and degradation of scrub habitats throughout Florida, due primarily to urbanization, agriculture, and fire suppression. During the last 10 to 12 years (era prior to 1999), the population has declined by an estimated 25 to 50 percent, and they have been extirpated from seven counties statewide. The distribution of scrub-jays has been most noticeably reduced along northeastern and southeastern extremes of their former range along the Atlantic coast. Elsewhere, scrub-jay distribution has declined locally, but they are still found throughout much of their historic

range (Fitzpatrick et al. 1994) (Service 2007a). Conservation measures for Florida scrub-jays involve protection and long-term management of suitable scrub habitat (Service 1999).

In 2002, TNC, working closely with ABS, developed Jay Watch by engaging volunteer citizens and scientists to annually survey scrub-jays, consistently using standardized protocols to detect population trends along the Lake Wales Ridge (TNC 2007a). The refuge relies on Jay Watch for survey efforts on refuge units, specifically at Flamingo Villas and Carter Creek. According to 2008 survey results, seven groups totaling 29 birds (20 adults and 9 juveniles) were identified on the Flamingo Villas Unit in 2008 (TNC 2008). Group size averaged 3.63 birds (2.34 adults) and 1.29 juveniles per group (TNC 2008). In 2007, survey results identified eight groups with an average group size of 3.13 birds and 0.88 juveniles occupied the Flamingo Villas Unit. Total number of groups at Flamingo Villas ranged from zero groups in 2002 to 11 identified in 2004, while average group size ranged from zero in 2002 to a high of 4.13 groups in 2006, and juveniles per group ranged from zero in 2002 to 1.29 in 2005 (TNC 2007a). A single scrub-jay was identified in both the 2004 and 2005 reporting periods on the Carter Creek Unit, but none have been reported by the survey since. Stable populations of Florida scrub-jays are characterized by a mean group size of 3.0 adults, excluding young of the year (Bowman, pers comm. 2010)

A statewide scrub-jay survey was conducted in 1992-1993, at which time there were an estimated 4,000 pairs of scrub-jays in Florida (Fitzpatrick et al. 1994). Of 39 counties within the historic range of scrub-jays, 32 remained occupied (82 percent). However, 19 of those 32 counties had fewer than 30 pairs of scrub-jays remaining, and nine of these had 10 or fewer pairs. Thirteen counties within the historic range (33 percent) had 30 or more pairs of scrub-jays. Since the early 1980s, Fitzpatrick et al. (1994) estimated that in the northern third of the species' range, scrub-jays declined between 25 to 50 percent. Rangewide, the species may have declined by as much as 25 to 50 percent during the mid-1980s to mid-1990s (Stith et al. 1996) (Service 2007a).

Following the 1992-1993 census, no periodic, systematic surveys or censuses have been conducted for the scrub-jay throughout its range. Data exists for several areas where research or monitoring efforts have occurred or are ongoing, but these data are limited. Where data exists, it typically includes information about scrub-jay populations or metapopulations (groups of populations that are close enough for individual birds to periodically breed with birds from an adjacent population). Consequently, a rangewide assessment of abundance, population trends, and demographic features and trends since 1992-1993 cannot be provided for the species or metapopulations within the range of the species (Service 2007a).

On the Lake Wales Ridge, 15 monitored populations declined by an average of about 33 percent between the 1992-1993 survey and 2006 (R. Bowman, pers comm., ABS, 2007 *in* Service 2007a; TNC 2006a). Cumulative declines were greatest on public lands that were not managed and averaged 63 percent (from 146 to 54 groups), while the average cumulative decline on managed lands was 7 percent (from 91 to 85 groups) (R. Bowman, pers comm., ABS, 2007 *in* Service 2007a). Five of the 15 populations were small in 1992-1993 and increased in size as of 2006, but the greatest increase was only seven families. In total, 24 additional scrub-jay groups were found in these five populations compared to 1992-1993 levels. The total net decline in scrub-jay groups between 1992-1993 and 2006 was 229 (from 699 to 470 groups) in the 15 monitored populations (R. Bowman, pers comm., ABS *in* Service 2007a) (Service 2007a).

Bowman and others have been conducting long-term studies of scrub-jay demography along a suburban-to-rural gradient since 1991 in Highlands County (Bowman and Averill 1993, Bowman et al. 1996, Bowman 1998, Bowman and Woolfenden 2001). Suburban populations experience average to above average reproductive success through fledging, but survival of both juveniles and adults is

much lower than in unfragmented habitat (Bowman and Woolfenden 2001). As a result, scrub-jay populations occupying fragmented habitat interspersed in suburban development remain stable only through net immigration from surrounding areas. Furthermore, Bowman's data, together with those of Woolfenden and Fitzpatrick (1996a), indicate that unfragmented habitat does not serve as the source for suburban sinks. Instead, suburban populations draw their immigrants from nearby suboptimal and vanishing habitats (Service 2007a).

Habitat fragmentation increases the probability of inbreeding and genetic isolation, which is likely to increase local extirpations (Fitzpatrick et al. 1991, Woolfenden and Fitzpatrick 1991, Stith et al. 1996; Thaxton and Hingtgen 1996). Thaxton and Hingtgen (1996) concluded that female scrub-jays dispersing from urban areas have a higher mortality rate than those dispersing from natural scrub areas. They also suggested that habitat in suburban areas, if abandoned or unoccupied due to death of the mated pair, had a higher probability of remaining vacant, leading to the conclusion that populations of scrub-jays in suburban areas were likely to decrease and eventually be extirpated. In addition, they showed that scrub-jays dispersing in the good (restored) habitat outnumber those that emigrate into poor suburban patches (of 128 observed dispersals, no birds dispersed from preserve to suburban territories) and that dispersal distances of these immigrants were longer than those using intact scrub (Service 2007a).

The condition, or value, of scrub habitat to Florida scrub-jays is largely dependent on the successional stage of the xeric plant community and its relative size and juxtaposition in the landscape in relation to other xeric plant communities. In general, scrub-jays only persist long-term in early successional scrub communities that are relatively large or in close proximity to other scrub communities. Thus, high-quality or optimal habitat will be in early succession and large or close to adjacent scrub habitat patches. Habitat condition (i.e., quality) declines with vegetative height (i.e., mid- to late-succession) and degree of fragmentation (i.e., distance between habitat patches) (Service 2007a).

Historically, scrub vegetative communities were affected by, and responded to, periodic lightning-generated wildfires (Myers 1985, Robbins and Myers 1989). Wildfires burned scrub communities when adequate fuel loads were present. Natural fire return intervals varied between scrub vegetative communities and probably ranged from 5 to 60 years (Fitzpatrick et al. 1991, Woolfenden and Fitzpatrick 1996). However, an increasing human population, fear of property destruction, and safety concerns resulted in suppression of most naturally occurring fires (Duncan and Schmalzer 2004). Historical suppression of fire resulted in the degradation of fire-dependant ecosystems, including scrub (Myers 1985, Brevard County 2007). As a result, scrub-jay habitat typically became degraded because fire suppression resulted in a succession of scrub vegetative communities from relatively open, shrub-dominated habitat to a more tree-dominated, mesic environment. Reduced habitat quality, caused by disrupted fire regimes, was a major fragmentation effect that greatly magnified impacts of habitat loss (Breininger et al. 2006) (Service 2007a).

Territory-scale habitat conditions are largely unknown throughout much of the range of the scrub-jay. The only exceptions are for extensively studied scrub-jay populations in central and south Brevard County. In the Merritt Island-Cape Canaveral scrub-jay metapopulation, Breininger (pers comm., cited *in* Johnson et al. 2006) estimated that only about 13 percent of potential scrub-jay habitat was in optimal condition, despite mechanical treatment and use of prescribed fire for nearly 15 years. In the southern Brevard-Indian River-St. Lucie metapopulation recent observations suggest that scrub-jay populations on several intensively managed parcels in Brevard County may be reversing historic declining trends (Breininger 2006), but the majority of scrub-jay habitat within this metapopulation has not been evaluated at the territory scale (Service 2007a).

Stith et al. (1996) estimated that at least 2,100 breeding pairs of scrub-jays were living in overgrown habitat statewide. Population declines of scrub-jays within Brevard County between 1991 and 1999 were attributed mainly to habitat degradation resulting from fire exclusion and resulting vegetative overgrowth of remaining habitat patches (Breininger et al. 2001). Overgrowth of scrub results not only in the decline of species diversity and abundance but also a reduction in the percentage of open sandy patches (Fernald 1989; Woolfenden and Fitzpatrick 1996b). In the northern third of the scrub-jay's range, fire suppression was likely responsible for the decline of the scrub-jay (Fitzpatrick et al. 1994) (Service 2007a).

Habitat degradation due to fire suppression may exceed habitat destruction as the single most important limiting factor (Woolfenden and Fitzpatrick 1991, 1996b, Fitzpatrick et al. 1994). Fire is important in the cyclical maintenance of scrub habitat (Nash 1895, Harper 1927, Webber 1935, Davis 1943, Laessle 1968, Abrahamson et al. 1984). Under natural fire regimes, late successional scrub habitats would have burned periodically to create early succession habitats (those with no or few canopy trees). Prevention and/or control of natural fires essentially lock scrub habitats into late successional stage vegetative communities that are not occupied by scrub-jays. Fire suppression is likely to continue on private lands and result in further declines of scrub-jays in these areas (Fernald 1989; Fitzpatrick et al. 1994, unpublished data; Percival et al. 1995; Stith et al. 1996; Thaxton and Hingtgen 1996; Woolfenden and Fitzpatrick 1990, 1996a; Toland 1999) (Service 2007a). The Florida Scrub-jay Fire Strike Team was organized in 1999 to provide prescribed burning assistance to various land managers in the LWR. Since 1999, TNC-led Florida Scrub-Jay Fire Strike Team has helped restore more than 20,000 acres of habitat in central Florida (TNC 2009b).

Destruction of scrub-jay habitat due to land use changes threatens scrub-jays on private property. Habitat destruction is difficult to quantify but is anticipated based on past and projected human population growth in Florida. Ten scrub-jay metapopulations are most vulnerable to habitat destruction on private lands (Service 2007a).

Disease or predation will likely have a greater effect on this species in the future. We expect scrub-jay populations will become increasingly vulnerable to extirpation due to disease because many populations are already small and further declines in population sizes can be expected with habitat destruction and fragmentation. The ability of scrub-jays to recover from episodic disease outbreaks appears to be significantly improved when population sizes are large and habitat is managed in optimal condition; however, current trends in population size suggest vulnerability to disease will increase in the future (Service 2007a).

Florida Panther (Puma concolor coryi)

The Florida panther (*Puma concolor coryi*) is the last subspecies of puma still surviving in the eastern United States. Historically occurring throughout the southeastern United States, today the panther is restricted to less than 5 percent of its historic range in one breeding population located in south Florida. The panther population has increased from an estimated 12-20 (excluding kittens) in the early 1970s to an estimated 100-120 in 2007, with the breeding component of this population located on approximately 3,548 square miles (9,189 square kilometers) (Kautz et al. 2006) south of the Caloosahatchee River in southern Florida. However, the panther continues to face numerous threats due to an increasing human population and development.

The Florida panther was listed as endangered throughout its range in 1967 (32 FR 4001) and received federal protection under the passage of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 et seq.) and is on the state endangered lists for Florida, Georgia, Louisiana, and Mississippi. Because it is listed pursuant to the ESA, the panther and its habitat are protected by the ESA. The panther has a recovery priority number of 6c (Service 2008i). This priority

number identifies the panther as a subspecies with a high degree of threat of extinction, but low recovery potential because recovery is in conflict with construction, other development projects, or other forms of economic activity.

Panthers are wide ranging, secretive, and occur at low densities. They require large contiguous areas to meet their social, reproductive, and energetic needs. Panther habitat selection is related to prey availability (i.e., habitats that make prey vulnerable to stalking and capturing are selected). Dense understory vegetation provides some of the most important feeding, resting, and denning cover for panthers. Telemetry monitoring and ground tracking indicate that panthers select forested habitat types interspersed with other habitat types that are used in proportion to their availability (Service 2008i).

Limiting factors for the Florida panther are habitat availability, prey availability, and lack of human tolerance. Habitat loss, degradation, and fragmentation are the greatest threat to panther survival, while lack of human tolerance threatens panther recovery. Panther mortality due to collisions with vehicles threatens potential population expansion. Potential panther habitat throughout the southeast continues to be affected by urbanization, residential development, road construction, conversion to agriculture, mining and mineral exploration, and lack of land use planning that recognizes panther needs. Public support is critical to attainment of recovery goals and reintroduction efforts. Political and social issues are the most difficult aspects of panther recovery and must be addressed before reintroduction efforts are initiated (Service 2008i).

Based on 1998 Service telemetry data, Florida panther presence was documented to one-tenth of a mile from the refuge's Flamingo Villas Unit, roughly one-half a mile from the Carter Creek Unit and roughly one mile from the Snell Creek Unit. In addition, motion triggered cameras used to identify feral hog presence at the Flamingo Villas Unit photographed a large cat in January 2007; however, the species was not confirmed. Florida panthers presumably utilize the unit as a travel corridor and may seek prey opportunities made available from feral hog presence, although no documentation has been conducted to verify. The refuge has not conducted research or monitoring specific to the Florida panther on refuge units.

Florida Black Bear (Ursus americanus floridanus)

The Florida black bear (*Ursus americanus floridanus*) is one of three subspecies of American black bear recognized in the southeastern United States. Although these subspecies are nearly indistinguishable in the field, they can be differentiated by slight variations in several skull measurements. Its highly arched forehead and long, narrow braincase generally characterize the Florida black bear. As with all American black bears, Florida black bears are large, powerful mammals with a shy, secretive demeanor. Adult males normally weigh 250-450 pounds and adult females normally weigh 125-250 pounds. Both sexes have soft, black hair, often with blonde chest markings; small, round ears; short tails; stout, curved claws; and large canine teeth. Black bears are omnivores that mostly eat vegetation, nuts, berries, and insects, but also consume some meat. In Florida, black bears are dependent upon saw palmetto plants, black gum, and oak trees for a significant portion of their diet. They may prey upon animals such as armadillos, deer fawns, and hogs; but, overall, these food sources make up a small percentage of their diet (FWC 2003)

Florida black bears are habitat generalists that utilize their surroundings at the landscape level. They are dependent upon forest vegetation, but are not limited to specific forest types. In December 2006, an image of a black bear was taken at the Flamingo Villas Unit by a motion triggered camera and signs of black bear have been observed by researchers and volunteers on the Flamingo Villas Unit in August 2009. Motion trigger camera images of a black bear were captured in September 2009 as well. As part of a landscape scale black bear project, ABS researchers set traps, captured, and radio collared a large

male black bear on the Flamingo Villas Unit in September 2009. In addition, black bears are known to occur off refuge on private lands adjacent to the refuge and in natural areas in close proximity to the refuge, including ABS lands. Florida black bear use is presumably a condition of utilizing forage and resting opportunities and using movement corridors from other natural areas within their wide range (FWC 2003). A clear threat to black bears using the refuge is vehicle collisions.

Forested wetlands and bottomland hardwoods provide optimal habitat, but any forested areas of large size with diverse foods and dispersed cover can support bears. Home range sizes vary greatly among individuals, age classes, and populations, but average approximately 14.4 miles^2 (37 km^2) for females and 62.1 miles^2 (161 km^2) for males. Florida black bears are not territorial in the strict sense of the word and tolerate considerable overlap in home ranges. Individuals tend to be solitary, except for females with young and groups at abundant food sites (FWC 2003).

Historically, black bears ranged throughout the southeast, with the Florida subspecies inhabiting all of Florida, including the upper keys and portions of southern Georgia, Alabama, and Mississippi. This widespread distribution has been severely reduced and fragmented by human activity. Large-scale land clearing in the early 1900s along with unregulated killing, which occurred up to the mid-1900s, had the greatest negative impacts. Bear populations in Florida reached their low point between the 1950s and 1970s, with only several hundred to a thousand individuals estimated statewide (McDaniel 1974, Brady and Maehr 1985). Florida's bear population has since rebounded because of management actions and maturation of second growth forests across the state. More recently, however, development associated with Florida's burgeoning human population has begun to directly compete for space with the wide-ranging black bear (FWC 2003).

The primary range of bears in Florida has been restricted to six large (Apalachicola, Big Cypress, Eglin, Ocala, Osceola, and St. Johns) and two 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 existence. Dispersing bears may be found virtually anywhere in the state, and low numbers of bears inhabit lands surrounding the extant populations and some large undeveloped areas such as the Big Bend region of the state. Although not under the jurisdiction of FWC, populations of Florida black bears in neighboring states, such as at Okefenokee Swamp in southern Georgia and Mobile Bay in Alabama, must be considered when evaluating the status of the Florida subspecies. The Osceola bear population is continuous with the larger Okefenokee bear population in southern Georgia, and bear populations in the western panhandle may play an important role in maintenance of small bear populations in Alabama. The distinct geographic nature of bear populations in Florida in conjunction with their limited connectivity via dispersal and low-density linkage zones represents a metapopulation, or overall population, that is influenced by both localized and regional factors. Consequently, because of their fragmented distribution, the individual populations are more vulnerable to impacts than a single large population of similar total size would be (FWC 2003).

Currently, there is no accurate, scientifically generated estimate of the number of black bears in Florida. In 1998, FWC staff estimated the statewide bear population to be 1,282 bears based on density estimates from past studies and estimates of occupied range (FWC 2003). Results from more recent studies and consistently increasing trends in bear roadkill, nuisance complaints, and sightings suggest that bear abundance and distribution are increasing in many bear populations, particularly in Ocala and Apalachicola National Forests and surrounding areas (FWC 2003).

Black bears are protected by state statute as a threatened species throughout Florida except those in Baker and Columbia Counties and Apalachicola National Forest and those held in captivity under permit. Bears in Baker and Columbia Counties and Apalachicola National Forest were listed as a game mammal and were hunted until seasons were closed in 1994 (FWC 2003).

Gopher Tortoise (Gopherus polyphemus)

Once abundant, gopher tortoise (*Gopherus polyphemus*) populations have dwindled to less than 30 percent of their historic population in Florida. Major causes of their decline include loss of habitat, human consumption, road mortality, and disease (Franz and Puckett 2007). According to Schultz et al. 1999, *Gopherus polyphemus* is known to occur on the refuge's Flamingo Villas and Carter Creek Units, while refuge staff has observed *Gopherus polyphemus* at the Lake McLeod Unit where it is thought that individuals are being released on the unit by members of the public.

The Gopher tortoise prefers xeric habitats with an abundance of herbaceous ground cover, an open canopy, and sparse shrub cover (Franz 1986, FWC 1987, Fernald 1989). Tortoise dig burrows into well-drained sandy soil to prevent desiccation and to regulate body temperatures. The gopher tortoise is a keystone species in scrub and sandhill habitats of the refuge. Without their presence, many other species would be rare or non-existent. Burrows are known to provide habitat for up to 81 species of vertebrates and invertebrates, some of which are found on the refuge. Thirty-two commensal vertebrate species use the burrows, including eastern indigo snake, which is previously described. In addition, tortoise dung provides major food resources for many invertebrates, which are subsequent food resources for birds and reptiles (Jackson and Milstrey 1989, FWC 1987, Fenald 1989).

The species' state protection was upgraded from Species of Special Concern to Threatened in June 2006; however, it is not federally listed in Florida. Gopher tortoises are most abundant in scrub and sandhill communities and may occur on all refuge units where these habitats exist. The primary threat to gopher tortoises on the refuge is infrequent prescribed fire in fire-dependent habitats. Presumably, road related mortality is an additional threat to gopher tortoise populations.

Sand Skink (Neoseps reynoldsi)

Sand skinks are endemic to the sandy ridges of central Florida, occurring on the Lake Wales, Winter Haven, and Mount Dora Ridges in Highlands, Lake, Marion, Orange, Osceola, Polk, and Putnam Counties (Service 1999). Schultz et al. (1999) and Turner et al. (2006) reported the occurrence of sand skinks on the refuge's Flamingo Villas Unit and Service staff (2009) have reported sand skink occurrence at the Flamingo Villas, Lake McLeod, and Snell Creek Units, although population estimates are lacking. It appears that skinks (sand and bluetail mole) are distributed throughout their historic range, although it is believed their numbers have likely declined substantially because of habitat loss and degradation (Service 2007b). One study found that sand skink populations were patchily distributed on the landscape, and distribution was clumped (Gianopulos et al. 2001), but additional work is needed in this area. The degree of soil compaction affects sand skink activity, with low soil compaction being favored (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999, Gianopulos 2001, Mushinsky et al. 2001, Christman 2005). Sand skink presence is also positively related to soils with a greater proportion of large particle sizes, low soil moisture, and low soil temperature (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999, Gianopulos 2001, Mushinsky et al. 2001). Although studies have not determined exact classes of soil sizes that are preferred by skinks, particles sifted through sieves with 0.38-mm and 0.23-mm mesh openings have been shown to be positively correlated with skink presence (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999). Vegetation also seemed to affect sand skink presence, as percent of bare, loose surficial sand and low average understory vegetation are important factors (Collazos 1998, Hill 1999, Mushinsky and McCoy 1999, Gianopulos 2001, Mushinsky et al. 2001, Christman 2005). It is generally thought that bluetail mole skinks require similar microhabitat conditions (Service 2007b)

These microhabitat conditions are necessary to enable thermoregulation. Presence of vegetation and loose soils moderate soil temperatures, providing a range of temperature options available to sand skinks (Hill 1999, Mushinsky and McCoy 1999, Gianopulos et al. 2001). Based on Collazos' (1998) findings that sand skink density was positively correlated with canopy density, Gianopulos et al. (2001) surmised that skinks may not do well in areas that have been recently burned or cleared. Conditions within the soil are still more important to sand skinks than vegetation above it, however, and vegetation alone cannot be used to predict abundance or distribution (Hill 1999). Sand skink distribution appears correlated with microhabitat conditions (Service 2007b).

Based upon recapture data, Gianopulos (2001) found that sand skinks did not appear to move large distances within an active season, probably not much farther than 35 meters (115 feet). However, this study did indicate that sand skinks may move father at some times of the year than others. Other studies indicate that dispersal capabilities of sand skinks are generally underestimated but vary among individuals, with some adults moving more than 140 meters (459 feet) (Mushinsky et al. 2001, Penney 2001, Penny et al. 2001). Mushinsky et al. (2001) reported that some sand skinks in their study moved up to 140 meters (459 feet within a 14-day time period and found some evidence that smaller individuals may move longer distances than large ones. They indicated that this may still be an underestimate of skink dispersal capability (Service 2007b).

Penney (2001) stated that the movement of a few adults over large distance may be a response to limited resources, a reflection of large home range sizes, or an indicator that some adults act as "floaters" and tend to move more than others. Because of these dispersal abilities, natural colonization of individuals may occur in restored habitat in close proximity to suitable scrub habitat, but establishment may be difficult or impossible in restored isolated patches of habitat (Mushinsky et al. 2001, Penney 2001) (Service 2007b).

Approximately 60 enclosures (0.1 acres) (Sutton et al. 1996) have been constructed on the LWR to calculate absolute densities of sand skinks (Mushinsky 2007a in litt. *in* Service 2007b). Results indicate that time since fire is an important factor in determining densities. That is, a greater potential for high densities exists with longer times since fire. For example, preliminary results from 36 enclosures (0.1 acres) installed March 2007 at ABS show that the mean number of sand skinks is 5.33 ($\pm$1.04) in recently burned units, 5.58 ($\pm$1.58) in units burned 6-20 years ago, and 11.58 ($\pm$1.10) in units burned more than 20 years ago (Mushinsky 2007a *in* Service 2007b) (Service 2007b).

Other density estimates of sand skinks in various scrub habitats regardless of fire history in Orange and Osceola Counties ranged from 100 to 600 skinks per hectare (HA) or approximately 11 skinks per 0.1 ac (Sutton 1996, Collazos 1998, Mushinsky and McCoy 1999). Christman (2005) estimated densities to be much lower in Polk and Highlands Counties, averaging approximately six sand skinks per 0.1-acre. Removing the sites from density calculations where skinks are completely absent, the averages for Orange and Osceola Counties were 15.6 per 0.1-acre and for Polk and Highlands Counties were 6.5 per 0.1-acre (Christman 2005). Christman (2005) found possible weak correlations between sand skink density and depth of loose surface sand, percent cover of bare sand, percent of soil particles >0.23 millimeter in diameter, and time since fire. Densities of skinks tended to be higher when the depth of loose surface sand was greater (Collazos 1998, Christman 2005). To get true baseline information, additional research is needed to address density, habitat, and microhabitat throughout the range of both species (sand and bluetail mole skink) (Malatesta 2007 *in* Service 2007b) (Service 2007b).

Recent demographic studies of sand skinks by Ashton (2005) resulted in findings similar to those of Telford (1959). Telford (1959) assumed that sand skinks become sexually mature during the first year following hatching, as the measured distance between snout and vent reaches a length of 45

mm. He suspected that most of the breeders in his study were in their second year and measured between 45mm and 57mm snout-vent length (Telford 1959). However, Ashton (2005) determined that sand skinks become sexually mature between 19 and 23 months of age and have a single mating period each year from February through May. A single clutch is produced each year between May and June with a clutch size apparently fixed at two (Ashton 2005). This is similar to Telford's (1959) findings in which he examined three gravid females and found each to have two eggs. In field studies of 2007, sand skinks have been observed with three or four eggs (Mushinsky 2007b, University of South Florida pers. comm. *in* Service 2007b) (Service 2007b).

Experimental studies were conducted to investigate the effects of management techniques such as clear-cutting and prescribed burning on sand skink populations inhabiting sand pine scrub over 5 years (Mushinsky and McCoy 1999, Gianopulos 2001, Gianopulos et al. 2001, Mushinsky et al. 2001). There was a decrease in relative abundance of skinks immediately following treatments associated with both clear-cutting and burning and then a significant increase in skink captures in the clear-cut plots over the 5-year period, but there was no apparent trend in the burned plots (Gianopulos et al. 2001, Mushinsky et al. 2001). Mushinsky et al. (2001) noted significantly larger skinks captured in the burned plots, indicating that more insect prey may have been available from decaying logs or that older skinks inhabited these sites (Service 2007b).

Mushinsky and McCoy (1999) reported that the first year after management treatment showed the greatest effects on sand skink abundance on the plots. Skink populations may take time to increase after the application of treatments (Mushinsky et al. 2001). Navratil (1999) stated that it was too early to surmise whether or not there was a difference in skink response to treatment method with only 3 years of data from this study. The most appropriate land management technique for skink conservation appears to depend more on the microhabitat conditions of the area treated than the treatment method, as sand skink distribution is correlated with various microhabitat features (Gianopulos et al. 2001, Mushinsky et al. 2001) (Service 2007b).

Comparisons of persistence, recruitment, and survival were used to determine translocation causes of sand skinks on two restored scrub sites for 6 years following relocation (Mushinsky et al. 2001, Penney 2001, Penny et al. 2001). One site established a self-sustaining population, while the other did not. It was determined that site location, habitat suitability, and initial propagule size were the factors affecting success (Mushinsky et al. 2001, Penney et al. 2001). Researchers concluded that the chances of long-term survival may improve when habitat is restored and skinks are introduced to sites close to intact scrub, rather than to isolated sites (Mushinsky et al. 2001, Penney 2001) (Service 2007b).

Continued habitat loss, fragmentation, and changes in land use threaten the existence of bluetail and sand skinks. Although many of populations are on sites that are publically owned, populations on private sites are threatened by destruction or habitat modification due to improper or lack of management. In addition, improper habitat management and invasion by exotic plant species continues to threaten the existence of skinks. Active management is necessary to maintain suitable habitat for skinks. Habitat degradation on protected and private sites continues to be a threat because vegetation restoration and management programs are costly and depend upon availability of funding. Where prescribed fire is not feasible as a management technique because of smoke management or other concerns, mechanical treatment is sometimes used. However, heavy machinery disturbs the soil more than prescribed burning, and it removes often limited nutrients from the soil (Mushinsky et al. 2001). This changes the nutrient levels in the topsoil, affecting the vegetative composition of the site, whereas fire releases nutrients (Mushinsky et al. 2001). Also, if logs are removed from the site after mechanical treatment, prey abundance (termites) may be lower than it would be after a fire (Mushinsky et al. 2001) (Service 2007b).

Highlands Tiger Beetle (Cicindela highlandensis)
The Highlands tiger beetle (*Cicindela highlandensis*) is a member of the beetle family *Cicindelidae* (tiger beetles), which includes more than 2,000 species worldwide, more than 100 in the United States (Pearson and Cassola 1992), and about 25 in Florida (Knisley and Hill 1992) (Service 2008j). Schultz et al. (1999) and Turner et al. (2006) report occurrence of Highlands tiger beetle at the Flamingo Villas Unit while Turner et al. (2006) reports occurrence at the Carter Creek Unit. In addition, staff has observed occurrence at the Snell Creek Unit. The species is thought to occur on all refuge management units due to its range of distribution over habitats occurring on refuge units.

The Highlands tiger beetle is often associated with evergreen scrub oaks, as well as with high pineland with deciduous turkey oak (*Quercus laevis*) and longleaf pines (*Pinus palustris*). Knisley and Hill (1996) view high quality habitat as primarily scrub or pine woodland with a high percent of open sand (greater than 50 percent) and with many natural openings which are continuous or connected to adjacent open patches, or connected by lightly disturbed trails or paths. Adult tiger beetles were never found in areas of dense scrub (except along the edges of trails) nor in areas of low shrubs (Knisley and Hill 1996). The tiger beetle was regularly found on trails with evidence of at least moderate off-road vehicle traffic and where there was evidence of past vegetation clearing or other ground disturbance (Knisley and Hill 1992a). This suggests that because of fire suppression, the vegetation has become artificially dense, harming the beetle. The need for prescribed burning of the vegetation or alternative methods of clearing openings, such as scraping, has been suggested Knisley and Hill (1996) and Knisley (2005) (Service 2008j).

Results from surveys conducted during 2004-2005 by Knisley (2005) support previous conclusions that the Highlands tiger beetle occurs in a diversity of habitats and that there are no key plant or other specific indicators of habitat, other than open sandy areas within or adjacent to pine-oak woodlands or scrub. The amount of open area was usually the primary indicator of suitable habitat (Knisley 2005). Knisley (2005) found adults to be most common along the middle and immediate edges of trails and paths; larvae were more common on the trail edges, closer to vegetation. This suggests that adults use the open trails for thermoregulation and foraging, but move away from these areas to oviposit in more shaded microhabitats (Knisley 2005) (Service 2008j).

Analyses by Turner et al. (2006) indicate that while conservation efforts to date have contributed greatly to protecting imperiled species on the Lake Wales Ridge, many species are likely to remain at great risk of extinction despite ongoing conservation efforts, primarily because even under the most optimistic acquisition scenarios, little more than seven percent of the original habitats will be protected since most have already been destroyed. Habitat conditions for the tiger beetle will likely remain suitable only with active management. Fragmentation of habitat and in-holdings within protected sites may limit application of fire and other management (Service 2008j).

Because the Highlands tiger beetle has only been known since it was described in 1984, there are no records of its past distribution and abundance. It seems likely that it was common, widespread, and well established throughout the scrub and possibly high pine communities of the Lake Wales Ridge in Highlands and Polk Counties prior to the widespread destruction of these habitats over the past 50 years (Knisley and Hill 1992a) (Service 2008j).

The northern limit of the Highlands tiger beetle is near the refuge's Snell Creek Unit, north of Lake Marion, about four miles east of Haines City (Knisley and Hill 1996). The beetle has been found southeast of Lake Marion, in the vicinity of the Poinciana development and in the Allen David Broussard Catfish Creek Preserve east of Lake Pierce and northeast of Lake Wales. The range continues south through TNC's Tiger Creek Preserve, the LWRSF's Walk-in-Water tract, Lake Weohyakapka and the west side of Lake Arbuckle (LWRSF), and Carter Creek (LWRWEA) (Service 2008j).

The Highlands tiger beetle depends on open, sandy areas within the Lake Wales Ridge upland vegetation. This vegetation has largely been converted to citrus groves and residential areas. Roughly 85 percent of the scrub and sandhills on Lake Wales Ridge has been lost to development and agriculture (Friedman et al. 1993 as cited in Turner et al. 2006). This loss of habitat has resulted in a concomitant reduction in the frequency and extent of wildfires (Turner et al. 2006). An estimated two-thirds of the species' habitat has been lost and much of the remaining is degraded (NatureServe 2007). However, it is unlikely that the tiger beetle has declined by only two-thirds and it is possible that it has declined by more than 90 percent (NatureServe 2007). Further habitat loss is a widespread threat as development and citriculture continue (NatureServe 2007). Of more than 40 sites supporting the species (Knisley 2005), at least nine are less than 2.47 acres (1 ha) in size and it is very likely that fewer than five represent viable occurrences (NatureServe 2007) (Service 2008j).

The threat of habitat loss also occurs from increasing vegetation density from ecological succession and fire suppression (NatureServe 2007). Lack of management of the remaining scrub and high pineland vegetation may constitute a threat as serious as habitat loss (Knisley and Hill 1992a, 1992b, 1996). The vegetation in which the Highlands tiger beetle occurs is subject to fire, ranging from relatively frequent and low-intensity in high pineland to infrequent and high intensity in some scrub (Myers 1990). Years of fire suppression in most upland habitats of the Lake Wales Ridge led to the vegetation becoming much thicker, with few patches of bare ground. One indicator of ecological problems caused by fire suppression is that small scrub plants (herbs and smaller shrubs) are now typically most abundant in artificially disturbed areas such as firebreaks (Service 2008j).

Populations of the Highlands tiger beetle are isolated and appear to occupy relatively small patches of habitat. Because increased extinction rates are directly correlated with reduction of available habitat area and increased distances between small populations (Gilpin 1987), the small, isolated populations may be vulnerable to local extinction from normal fluctuations in population size, genetic problems from small population size, or environmental catastrophes. Small populations of about 100 adult Highlands tiger beetles in an area of roughly 2.5 to 5 acres (1-2 ha) can persist over the long term (Knisley and Hill 1996). However, population sizes have not been studied in detail and metapopulation viability studies have not been conducted. The small sizes of occupied habitat also reduce the ability of the habitats to buffer against edge effects and other influences from adjacent developed areas, such as pesticide drift (Service 2008j).

Land managers in the Lake Wales Ridge area have begun to conduct more prescribed burning to enhance or restore scrub habitat. Prescribed burning on private and public conservation lands has likely improved habitat for this species and may provide improved habitat conditions in the future (Service 2008j).

Wood Stork (Mycteria americana)

Wood storks (*Mycteria americana*) are one of two species of storks that breed in North America. Since the 1930s, the U.S. breeding population of wood storks has declined from an estimated 20,000 pairs to approximately 10,000 pairs in 1960. Fewer than 5,000 breeding pairs have been documented since 1978, and the species was federally listed as endangered in 1984 (Service 1996b). In Florida, wood storks have also been designated endangered by FWC. The two dominant factors cited in the decline of wood storks are changes in suitable habitat and loss of preferred breeding sites (Ogden and Patty 1981). Wood storks are large wading birds that use a unique grope-feeding technique (tacto-location) which requires specific water levels and food densities. In addition, wood storks are colonial breeders that form colonies in large cypress or mangroves which limits nest depredation from terrestrial predators. Each of these specific life-history characteristics has been negatively affected by alterations in water regimes and habitat loss, especially in the Everglades where historic wood stork densities were highest. Presently,

wood stork populations are believed to be stable or increasing (Service 2007c). Although wood storks are not known to breed on the refuge and foraging opportunities are limited, they may utilize various wetland features within the refuge, including littoral habitats of lake shores.

Non-Native and Nuisance Species

Species that have established sustaining populations outside their natural range are considered exotic or non-native. Some non-native species can cause ecological and/or economic damage. South Florida, in particular, hosts a large number of non-native species compared to many other areas of the United States (Simberloff, et.al. 1997). Nuisance species are native plants and wildlife that, under certain conditions, can negatively affect natural resources beyond what is considered sustainable for that area. Table 16 lists non-native plants and animals documented either on the refuge or within range to be considered a threat to the refuge.

In Florida, almost one-third of plants occurring in the wild are exotic, and even though a relatively small percentage of these plants become weeds, their impacts can be harmful and expensive, especially in natural areas (Langland and Burks 1998). The Florida Exotic Pest Plant Council (FLEPPC) maintains a list of Category I invasive plants that are altering native plant communities and Category II invasive exotic plants that have increased, but have not yet altered native plant communities (FLEPPC 2007). By FLEPPC definition, Category I species are invasive exotics which are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives. This definition does not rely on the economic severity or geographic range of the problem, but on the documented ecological damage caused (FLEPPC 2007). Category II species are invasive exotics that have increased in abundance or frequency, but have not yet altered Florida plant communities to the extent shown by Category I species. These species may become ranked Category I, if ecological damage is demonstrated (FLEPPC 2007).

Refuge management units were intensively surveyed by North Wind, Inc., under contract to the Service, for invasive exotic plant species in February 2006. Locations of invasive exotic species on the 2005 FLEPPC list were recorded. Locations and density of threatened and endangered plant species in close proximity (within 50 feet) to invasive exotic species were also recorded (North Wind, Inc., 2006).

Lake Wales Ridge NWR was methodically surveyed by: 1) walking all roads, trails, and boundaries and 2) covering remaining areas by walking straight-line transects spaced 100 feet apart. This transect distance was modified to 200 feet in areas that were discovered to be highly resistant to exotic species invasion, principally densely vegetated, intact scrublands dominated by scrub oak. Each location of invasive exotic species was recorded, together with a density assessment for the species in the immediate area consisting of the following values: 1= single occurrence, 2= scattered individuals, 3= abundant. Any individuals within an approximately 50-foot radius were considered to be part of the same occurrence. Individuals more than 50 feet apart were logged as separate data points. In areas with widespread infestations of an exotic species, data points for that species were collected every 100 feet (North Wind, Inc., 2006).

The refuge has several Category I and II plants (Table 16) that are of management concern. Non-native species can negatively affect native species through increased competition for resources, alteration of habitat, and other biological interactions. Once invasive species become established, eradication becomes difficult and long-term management the norm, which is time consuming and expensive. Infestations of Brazilian pepper and Old-World climbing fern on refuge ponds are of particular concern (North Wind, Inc., 2006). The survey identified the location of invasive exotic plants and listed plants in close proximity to invasive exotic plants on the four refuge management units. The total number of data points collected for each invasive exotic species is summarized in Table 16. Table 17 lists rare species occurring in close proximity to invasive exotics.

Table 16. Invasive exotic plants occurring on the Lake Wales Ridge NWR

Scientific Name	Common Name	FLEPPC Category**	Density*			Total
			1	2	3	
Flamingo Villas						
Abrus precatorius	rosary pea	I	3	27	7	37
Albizia julibrissin	Mimosa	I	3	1	1	5
Casuarina equisetifolia	Australian pine	I	0	0	3	3
Cinnamomum camphora	camphor tree	I	2	1	0	3
Imperata cylindrica	cogon grass	I	0	8	14	22
Lygodium microphyllum	Old World climbing fern	I	2	12	2	16
Melinis repens	natal grass	I	4	80	12	96
Panicum repens	torpedo grass	I	0	2	3	5
Ricinus communis	castor bean	II	1	1	0	2
Sansevieria hyacinthoides	bowstring hemp	II	0	1	0	1
Schinus terebinthifolius	Brazilian pepper	I	7	21	4	32
Solanum viarum	tropical soda apple	I	0	3	0	3
Urena lobata	Caesar's weed	II	4	48	13	65
Flamingo Villas Total			**26**	**205**	**59**	**290**
Carter Creek						
Abrus precatorius	rosary pea	I	0	3	0	3
Imperata cylindrica	cogon grass	I	0	3	3	6
Melinis repens	natal grass	I	0	54	10	64

Scientific Name	Common Name	FLEPPC Category**	Density*			Total
			1	2	3	
Carter Creek Total			**0**	**60**	**13**	**73**
Lake McLeod						
Abrus precatorius	rosary pea	I	6	21	10	37
Sansevieria hyacinthoides	bowstring hemp	II	0	1	0	1
Catharanthus roseus	Madagascar periwinkle		1	3	0	4
Imperata cylindrica	cogon grass	I	1	2	0	3
Lantana camara	lantana	I	7	18	1	26
Melinis repens	natal grass	I	6	94	7	107
Rhoeo spathacea	oyster plant	II	1	0	0	1
Schinus terebinthifolius	Brazilian pepper	I	3	16	1	20
Urena lobata	Caesar's weed	II	3	16	5	24
Lake McLeod Total			**28**	**171**	**24**	**223**
Snell Creek						
Melinis repens	natal grass	I	0	6	0	6
Lake Wales Ridge Total			***54***	***444***	***96***	***594***

**Density Key: 1=single occurrence, 2=scattered, 3=abundant (North Wind, Inc., 2006)*
***FLEPPC 2007*
Source: North Wind, Inc., (2006)

Table 17. Rare plants in close proximity to exotic plants on the Lake Wales Ridge NWR

Scientific Name	Common Name
Flamingo Villas Management Unit	
Tillandsia fasciculate	cardinal airplant
Ziziphus celata	Florida ziziphus
Carter Creek Management Unit	
Dicerandra frutescens	scrub mint
Eriogonum longifolium	scrub buckwheat
Nolina brittoniana	Britton's beargrass
Polygala lewtonii	Lewton's polygala
Prunus geniculata	scrub plum
Lake McLeod Management Unit	
Bonamia grandiflora	Florida bonamia
Chionanthus pygmaeus	pygmy fringe tree
Ilex cumulicola	scrub holly
Lechea cernua	nodding pinweed
Paronychia chartacea	papery nailwort
Persea humilis	scrub bay
Polygonella basiramia	Florida jointweed
Polygonella myriophylla	Small's jointweed
Prunus geniculata	scrub plum
Lupinus aridorum	scrub lupine
Snell Creek Management Unit	
No rare species found in proximity to invasive exotic plants	

Source: North Wind, Inc., (2006)

Nonnative animals also occur on refuge management units, including feral pigs (Sus scrofa). A complete inventory of nonnative animals has not been conducted on the refuge, however, other common nonnative and nuisance species are expected to occur based on proximity to agricultural and urban areas (Table 18). Feral pigs, Nile monitor lizards, walking catfish (Clarias batrachus), and brown hoplo (Hoplosternum littorale) have been identified on the Flamingo Villas Unit. Refuge volunteers provide opportunistic control of feral hogs; however, control of nonnative fish has not been conducted.

Table 18. Nonnative fauna occurring or potentially occurring on the Lake Wales Ridge NWR

Common Name	Scientific Name
Anolis sagrei	brown anole
Dasypus novemcinctus	nine-banded armadillo
Felis silvestris catus	feral cat
Hemidactylus garnoti	Indo-Pacific gecko
Hemidactylus turcicus	Mediterranean gecko
Mus musculus	house mouse
Rattus norvegicus	Norway rat
Rattus rattus	black rat
Osteopilus septentrionalis	Cuban tree frog
Eleutherodactylus planirostris	greenhouse frog
Clarias batrachus	walking catfish
Sarotherodon melanotheron	blackchin tilapia
Hoplosternum littorale	brown hoplo
Solenopsis invicta	red imported fire ant
Metamasius callizona	bromeliad-eating weevil
Xyleborus glabratus	Asian ambrosia beetle
Sus scrofa	feral pig
Varanus niloticus	nile monitor lizard

CULTURAL RESOURCES

To date, no cultural or archaeological resources have been identified on the refuge. The refuge's four management units are located along the western periphery of Florida's Central Lake District. This district is poorly known archaeologically, although a number of freshwater shell and black earth middens have been identified along the Kissimmee River and its associated lakes and the north portion of the Okeechobee Basin (Milanich 1993). Milanich (1994), however, places this area into the Okeechobee Region, which includes much of the Kissimmee River watershed in Okeechobee, Highlands, Osceola, and Polk Counties. A finger of the central highlands extends into eastern Polk and Highlands Counties giving the area that contains the refuge more topographic relief than the rest of the Okeechobee Basin.

The Nalcrest Site (8PO15), one of the earliest sites in Polk County with occupation ranging between 7 and 10,000 years ago (Bullen and Beilman 1973), is situated on Lake Weohyakapka, located approximately 20 miles (32.2 km) northeast of the Flamingo Villas Unit. A microlithic tool assemblage was recovered from the submerged lake margins. These small artifacts, which included stemmed points, drills, end scrapers, spurred gravers, and cores, are often associated with Late Paleoindian-Early Archaic Bolen points. Milanich (1994) observed that this site was occupied during a period of greater aridity than is present today.

Another group of Middle to Late Archaic sites in other parts of Florida demonstrates the importance of watercraft. Dugout canoes documented at the Newnans Lake Site (8AL4792), the Lakeland Site (8PO6496), and the IMC 1 Site (8PO6495) yielded calibrated radiocarbon dates ranging from 2500-5000 years before present (BP). The canoes were manufactured from southern hard pine, though older examples at Newnans Lake and DeLeon Springs 2 were constructed from cypress. Dugout canoes not only served as transportation, but also enabled Archaic Period and later groups to exploit a range of aquatic resources in the Central Lake District and the coastal margins and estuaries of Florida.

Closer to the refuge, shell middens and black earth middens along the Kissimmee River and its associated lakes have yielded St. Johns, Glades, and Belle Glade ceramics. These ceramic styles and cultures date from 500 B.C. to 1565 A.D. It is unclear whether these chalky and sand-tempered wares were independently developed in the Central Lake District or derived from ceramic traditions of the St. Johns region, the Okeechobee Basin, or the Indian River area. The best known Belle Glade site is Fort Center, located on the west side of Lake Okeechobee and south of the refuge and the Central Lake District. The site, named after a nearby Second Seminole War-period fort (ca. 1830s), is a complex of mounds, linear embankments, a burial mound, an artificial pond, extensive middens, and overlapping circular ditches that stretch over a mile along Fisheating Creek. It was first occupied during the Late Archaic between ca. 1000 and 500 B.C. Occupation continued until at least 1700 A.D. One of the more intriguing items were maize pollen grains recovered from the fill of one of the circular ditches, a lime-based paint on a wooden carving excavated from the pond, paleofeces from the midden deposit adjacent to the pond, and other soil samples. The maize pollen from the circular ditch was dated to ca. 450 B.C. The role of maize in the Belle Glade culture and subsistence remains unclear, though Milanich and Ruhl (1986) postulated that the plant was grown as a high-status food or some other special purpose and not as a dietary staple. The linear embankments constructed after 1200-1400 A.D. further muddles the debate as these have been interpreted as raised agricultural fields similar to those seen elsewhere in the circum-Caribbean region and other areas of North and South America. Milanich (1994) notes that the Fort Center embankments do not contain features intended to enhance crop yield, such as deposition of organic matter in the fields, or to prevent erosion.

The arrival of European groups, primarily the Spanish, in the 16th century marked a major turning point for Florida's aboriginal population. This population, estimated as 100,000, was greatly impacted by introduced European diseases (i.e., small pox, measles, and influenza), armed conflicts between competing European powers, and the slave trade.

During the early 18th century, the Florida Seminoles emerge out of Creek and related groups who migrated into peninsular Florida. Today, they are divided into three federally recognized tribes: the Seminole Indian Tribe of Florida, the Seminole Nation of Oklahoma, and the Miccosukee Indian Tribe. Carr and Steele (1993) compiled a list of archaeological sites and cultural landscapes associated with the Seminoles. Nine sites were listed for Polk County and no sites were identified in Highlands County. The sites include the Willoughby Tillis Battle Site (8PO1856) and several towns or camps. One village or camp site, the Lake Hamilton Island Site (8PO1545), was associated with Chipco's band, which resided there for about 10 years prior to relocating to Lake Pierce, Lake Rosalie, and finally the Everglades. Chief Tallahassee or Taluska hide his band on an island in Lake

Marion during the Third Seminole War (1855-1858). The band moved to an island in Lake Rosalie after observing the scouts of federal troops. They remained at Lake Rosalie until game became sparse and then moved to the Everglades. A third site, the Snodgrass Island Site (8PO3866), may also be associated with Chief Tallahassee. This site, which is situated on the north end of Lake Pierce, also has two earlier precolumbian mounds and a later historic period occupation (Carr and Steele 1993). However, no sites are known to occur on or near the refuge.

The Seminoles and the Miccosukees have a rich history, a sliver of which can be glimpsed on each tribe's official web site. More detailed accounts can be found in Covington (1993), Kersey (1987), Sturtevant (1987), and Weisman (1999 and 2000).

SOCIOECONOMIC ENVIRONMENT

The refuge is located in Polk and Highlands Counties in central Florida along the Lake Wales and Winter Haven Ridges. Little more than a hundred years ago, this area was a wilderness and escaped the development and settling of coastal and northern portions of Florida due, in part, to the harsh environmental conditions and perceived inability to farm the scrubby, parched highlands. Cattle ranching was one of central Florida's first main industries around the time of the Civil War (Martin 1998). The introduction of the railroad system developed throughout Florida in the early 1900s enhanced the ability to export citrus fruit, increasing the value of the central highlands for agricultural purposes (Martin 1998). At one point, the central Florida citrus industry was considered the most intense concentration of citrus in the world, despite the fact that citrus production was susceptible to occasional killing freezes (Martin 1998). The timber industry also gained momentum utilizing old-growth long leaf (*Pinus palustris*) pines for pitch and turpentine, and wood for boat and housing construction (Martin 1998). Florida land booms of the 1920s fell to the economic pressures of the Great Depression. Tourism, which had begun in the 1800s, has steadily increased as Florida continues to grow (Martin 1998), currently ranking as the fourth most populated state in America (U.S. Census Bureau 2008).

From 2000 to 2008, Florida's population had soared to over 18 million, an increase of over 2.3 million since 2000, or almost 13 percent over the 8-year period (U.S Census Bureau 2008). Highlands and Polk Counties grew at similar rates as compared to the Florida average (U.S. Census Bureau 2008). Highlands County population grew from 87,366 people in 2000 to an estimated 100,011 in 2008 (12.6 percent increase), while Polk County population increased over 16 percent from 483,924 in 2000 to 544,373 people in 2008, ranking these counties as the 34th and 9th populous of Florida's 67 counties, respectively (U.S. Census Bureau 2008). Florida population is expected to continue to grow over the next 51 years, anticipated to reach 21 million by 2015 (Zwick and Carr 2006), over 28 million by 2030 (U.S. Census Bureau 2005-2007), and over 35 million by 2060 (Zwick and Carr 2006).

Economic conditions are dissimilar for the two resident counties of the refuge. According to the U.S. Census Bureau 2005-2007 American Community Survey statewide, 2007 median household income grew to less than the national household average of $50,007 to $46,602, however, Florida experienced an increase of almost 17 percent from year 2000 or 1 percent greater than the national average of 16 percent over the same period (U.S. Census Bureau 2005-2007). Polk and Highlands Counties fell below national and State of Florida averages (U.S. Census Bureau 2005-2007). While median household income in Polk County grew from 2000 by 15 percent, which is quite close to state and national averages, total income in the County is $42,534 or more than $4,000 below Florida's 2007 average (U.S. Census Bureau 2005-2007). Highlands County fell well below national and state averages as median household income grew only 8 percent to $32,903 from 2000 to 2007 or less than half that experienced by the rest of Florida on average (U.S. Census Bureau 2005-2007). Nationally, 13.3 percent of the population lives below poverty level in 2007, and in Florida poverty

levels are less than national levels at 12.6 percent. Highlands County individual poverty levels exceed national and state levels at 15.3 percent while Polk County is at the national average of 13.3 percent (U.S. Census Bureau 2005-2007). Further, in 2007, unemployment rates for Polk County (5.6 percent) were below state (6.0 percent) and national (6.6 percent) rates, however, Highlands County rates exceeded both national and state rates at 7.5 percent (U.S. Census Bureau 2005-2007). In 2007, populations of Polk and Highlands Counties continue to be predominantly white (76.8 and 84.5 respectively), both exceeding national (74.1) and state (76.3) averages. Hispanic/Latino (of any race) populations grew the most of any group over the two counties since 2000 (Polk up 5 percent, Highlands up 3.5 percent), both exceeding state (3.3 percent) and national (2.2 percent) rates (U.S. Census Bureau 2005-2007). Both Polk and Highlands Counties median age has decreased between 2000 and 2007, while state and national average median ages have increased over the same period. Highlands County (47.2) is over 7 years older than the state (39.8) average with 31.4 percent aged 65 and over while Polk County median age is relatively the same (38.2) as the state average with 17.4 percent aged 65 and over. Both counties rank above the state population average of 16.9 percent aged 65 and older (U.S. Census 2005-2007).

According to the 2008 Florida Price Level Index, both Polk and Highlands Counties fell below the state average index value (101.06) and population-weighted average for the state (100) in 2008 due in part to low population levels in relation to other counties and lower costs associated with the hiring of equally qualified personnel (University of Florida 2009). According to the Florida County Retail Price and Wage Indices for 2007, costs for food, housing, medical care, transportation, and other goods and services in the two counties were below the state average (University of Florida 2008).

Population projections though 2060 indicate that the refuge's home and neighboring counties are expected to grow substantially (Zwick and Carr 2006) (Table 19). The projected population of the State of Florida is expected to more than double by 2060 to over 35 million (Zwick and Carr 2006). Highest area population growth rates are expected in Osceola County, east of Polk County where 2060 populations are expected to triple from 2008 estimates. Polk County is expected to more than double its population while Highlands County is estimated to experience a 41 percent increase.

Table 19. Projected population growth of area counties

County	1990 Population*	2000 Population*	2008 Estimates*	% increase (1990-2008)	Predicted 2015 Population**	Predicted 2060 Population**	Annual Change**
Polk	405,382	483,924	580,594	30.2	631,895	1,257,078	9,095
Highlands	68,432	87,366	100,011	31.6	108,714	170,038	1,378
Okeechobee	29,627	35,910	40,359	26.6	42,716	61,292	423
Desoto	23,865	32,209	33,991	29.8	42,299	69,717	625
Hardee	19,499	26,938	28,888	32.5	31,242	43,922	283
Glades	7,591	10,576	11,175	32.1	12,329	17,768	120
Osceola	107,728	172,493	263,676	59.1	335,899	779,319	10,114

*Source: * U.S. Census Bureau 2005-2007 American Community Survey*
***Zwick and Carr 2006*

Cities near refuge units grew at an average rate of 27.6 percent from 1990 to 2007 (U.S. Census Bureau 2005-2007), ranging from 37.1 percent in Haines City to 17.4 percent in Sebring (Table 20. Values do not take into account increases in population growth in unincorporated areas of Polk and Highlands Counties.

Table 20. Populations change of nearby cities - 1990-2007

Lake Wales Ridge NWR Management Unit	Nearby City	1990 Population	2000 Population	2007 Population	Percent Population Change 1990-2007
Flamingo Villas/Carter Creek	Sebring (4.5 miles)	8,900	9,667	10,780	17.4
Lake McLeod	Winter Haven (2.85 miles)	24,725	26,487	32,577	24.1
	Eagle Lake (1.16 miles)	1,758	2,496	2,670	34.1
	Wahneta (1.27 miles)	4,024	4,731	5,226*	22.9
Snell Creek	Haines City (5.14 miles)	11,683	13,174	18,569	37.1
	Davenport (3.78 miles)	1,529	1,924	2,181	29.9

Source: U.S. Census Bureau 2005-2007 American Community Survey
**U.S. Census data unavailable. Estimate based on average yearly growth rate from 1990 and 2000 = 70.7.*

The threat of habitat loss, degradation, and fragmentation is expected to continue and increase. Zwick and Carr (2006) used geographic information systems to develop a series of graphics depicting what land use might look like in Florida in the years 2020, 2040, and 2060, assuming a continuation of current development patterns. Between 2005 and 2060 Florida's population is projected to double from approximately 18 to 36 million people (Zwick and Carr 2006). Highlands County, with a 2005-2007 estimated population of 97,392 is projected to nearly double (75 percent increase) to 170,038 by 2060 (Zwick and Carr 2006). Polk County, with a population of 483,924 in 2000, is projected to more than double (126 percent increase) to 1,029,606 by 2060 (Zwick and Carr 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006). Analyses by Zwick and Carr (2006) indicate that the central Florida region is expected to experience explosive growth, with continuous urban development from Ocala to Sebring; virtually all of the natural systems and wildlife corridors in this region will be fragmented, if not replaced, by urban development.

Zwick and Carr (2006) performed an analysis to determine the composition of lands within a 1-mile buffer of existing conservation lands in Florida. Of the roughly 8 million acres in that 1-mile buffer, almost 1.5 million are already in urban use and it appears an additional 1.9 million acres could be converted by 2060, or as much as 41 percent of the lands within the 1-mile buffer could be urbanized by 2060 (Zwick and Carr 2006). Zwick and Carr (2006) concluded that the implications are great for the long-term management or conservation lands in Florida. According to Zwick and Carr (2006), in

the worst cases this will leave conservation lands isolated, surrounded by urbanization. In the best cases management strategies dependent on natural processes like flooding and fire will be compromised to accommodate new neighbors (Zwick and Carr 2006).

Florida's economy relies heavily on tourism, but other sectors play important roles in Florida's economy. Nearly 40 percent of all U.S. exports to Latin America and South America move through Florida. The space industry represents $4.5 billion of the state's economy with average annual wage of aerospace workers at approximately $52,000. The number employed at Kennedy Space Center alone is 15,000 and Florida ranks 4th among the states in overall aerospace employment with 23,000 jobs. In terms of agriculture, Florida leads the southeast in farm income, producing about 75 percent of the U.S. oranges and roughly 40 percent of the world's orange juice supply. The construction industry is particularly strong, resulting from the steady stream of new residents and visitors to Florida each year. Growth in high tech, finance, and back office operations is also strong with many small entrepreneurial software companies recently established. Additionally, more than $500 million per year in sponsored research at Florida universities provide another major economic factor (Visit Florida 2008).

Florida is the top travel destination in the world (Visit Florida 2008). An estimated 84.5 million people visited Florida in 2007, up from 72.8 million in 2000 (Visit Florida 2008). Tourism spending increased over the same period to 65.5 billion dollars from 50.9 billion (Table 21), providing state sales tax revenue of over 3.9 billion dollars and employing 991,300 people in 2007 (Visit Florida 2008).

Table 21. Total tourism spending in Florida from 1999 to 2007

Year	Spending (in billions)*
1999	$47.2
2000	$50.9
2001	$50.8
2002	$51.1
2003	$51.5
2004	$57.1
2005	$62.0
2006	$65.0
2007	$65.5

**As a measure of recreation taxable sales*
Source: Visit Florida (2008)

REFUGE ADMINISTRATION AND MANAGEMENT

The Service has been an active partner in acquisition; however, limited funding has restricted the extent to which active management of owned lands could occur. By working with partners, utilizing volunteers through the Ridge Ranger Program, and using staff from the Merritt Island NWR and Pelican Island NWR Complex, projects such as fencing, trash removal, boundary posting, limited prescribed burning, exotic plant control, and vegetative mapping have occurred. Since the refuge has no refuge-specific staff and no dedicated funding source, the Pelican Island NWR staff relies heavily on the Service's South Florida Ecological Services Field Office, researchers, the LWREWG, and other partners.

LAND PROTECTION AND CONSERVATION

In response to the substantial development pressures experienced throughout central Florida and the Lake Wales Ridge area, a coordinated effort to purchase scrub and highlands along the ridge by the Service, State of Florida, local municipalities, and non-governmental entities has been and is currently underway. Protecting the Lake Wales Ridge has become the mission of not only the Service, but of several levels of state and local governments as well as conservation groups. Land acquisition became a joint venture between the State of Florida (originally through the CARL program), TNC, SWFWMD, SFWMD, Polk and Highlands Counties, ABS, and the Service. Additionally, land acquisition partners who have acquired lands for conservation and public enjoyment include the Green Horizons Land Trust. This collaborative effort shares the resource demands of land acquisition among the partners. Each management entity is responsible for managing its property and developing management plans. However, partnerships have been forged between the various organizations to accomplish the overarching mission of conserving the unique flora and fauna endemic to the ridge habitat. And, the partners continue to coordinate land acquisition and management activities through the LWREWG. This combined effort has contributed to the purchase and protection of over 87 square kilometers of scrub and sandhill habitat (Turner et al. 2006).

Since 1992, the State of Florida has spent over $68 million to acquire nearly 24,711 acres (10,000 ha) of land on the ridge, with plans to acquire an additional 24,000 plus acres (10,000 ha) (Turner et al. 2006). Non-profit purchases also protected significant amounts of scrub and sandhill habitats on the ridge. To date, a total of 282 km^2 (69,684 acres or 28,200 ha) of land on the ridge has been protected in parks, refuges, state forests, and wildlife and environmental areas, as well as on private lands. Some of these acquisitions have been from single owners or from a few owners (such as Lake June in Winter State Park and the LWRWEA), while others have been added to incrementally over the years, such as LWRSF. Particularly problematic and challenging have been the acquisition projects known as megaparcel sites, which include extensive areas of scrub habitat that were previously subdivided and sold to numerous lot owners (e.g., Flamingo Villas). To date, over 14,000 such lots have been purchased for conservation within the megaparcel sites, in a checkerboard manner, but nearly as many lots remain to be purchased (Turner et al. 2006).

The Service's existing land and water management partners in the Lake Wales Ridge NWR area include: the State of Florida (e.g., FDEP, including the FPS; FWC; SFWMD; and SWFWMD); local governments, including Polk and Highlands Counties; and federal partners, including US Air Force at the APAFR and the U.S. Bureau of Land Management. Research partners include: TNC, ABS, HBS, the University of Central Florida, the University of South Florida, and the LWREWG. Additionally, other partners include local residents and neighbors, including the Ridge Rangers, businesses, and political representatives. The local partnerships have proven successful for land acquisition, research, and public outreach.

Acquisition Strategy

Efforts to finalize purchase of remaining inholdings of the refuge management units are based on a willing-seller approach. Currently, the refuge is targeting inholdings of Flamingo Villas and Lake McLeod Units. Currently, inholders receive inquiries from the Service's Realty Division for purchase at fair market value when federal funding is available through either the Federal Land and Water Conservation Fund or the Inholdings Fund. There is no dedicated land purchase funding for the refuge. The refuge competes for funding with other federal organizations, including other refuges.

Alternative Acquisition Strategies
Various alternative acquisition strategies have already taken place or are in the planning stages. In February 2008, the Service suggested changes to Highlands County to the current land use and zoning designations for the Flamingo Villas Unit and suggested alternative actions to assist with the final acquisition of the Flamingo Villas Unit, including working with the partners to: 1) change the zoning from R-1 to Conservation; 2) change the future land use from Agriculture to Conservation; 3) vacate all of the road and other rights-of-way, especially those where they occur on wetlands or where the Service owns lots on both sides of the road and public access is not required; 4) use a quit claim deed to transfer ownership to the Service of the common areas labeled in the plat as parks, lakes, and churches; and 5) condemn the lots where the owners cannot be located or the owners are unwilling sellers. The refuge is currently pursuing these suggested possibilities with Highlands County.

An effective, temporary policy moratorium has been in place in Flamingo Villas since October 2000, which provides additional policy structure in the case where a property owner applies for a building permit in Flamingo Villas. In this case, the property owner must come before the Highlands County Board of County Commissioners. Additionally, friendly condemnation in Flamingo Villas was approved by the Highlands County Board of County Commissioners in 2000, providing additional acquisition support for the Service and partners.

Gap funding has also been suggested as a possibility at Flamingo Villas, whereby Highlands County may enter into a Multi-Party Acquisition Agreement and identify a source of gap funding in instances when fair market value, established by an appraisal, is close to what the property owner will accept. In instances, such as this, where the Service can only pay up to fair market value, the Highlands County NRAC may be willing to recommend using the Highlands County Conservation Trust Fund to pay the difference. This process has proven successful through TNC to facilitate FDEP purchase of lots in Carter Creek North through the development of a Multi-Party Acquisition Agreement. In addition, interest in supporting Flamingo Villas inholding acquisition has been provided for by the NRAC, which oversees and provides guidance and recommendations to the Highlands County Board of County Commissioners for land acquisition funding though the Conservation Trust Fund.

Through the refuge partners, the Sebring Airport Authority has been approached to ascertain its willingness to provide funding and have indicated a strong interest in mitigating expansion of the Sebring Airport through assisting with lot acquisition in Flamingo Villas.

VISITOR SERVICES

The refuge was established to protect rare, threatened, and endangered species and is closed to public access. The resources on the refuge units are extremely sensitive to human disturbance and in many areas, the ground is literally covered with rare endemic plants where disturbing them is difficult to avoid. Very limited approved public access is controlled through a refuge special use permit and has generally occurred with a Service escort. To date, the Service has determined that keeping the properties closed is the best strategy to protect rare,

threatened, and endangered species and the habitats they occupy. Visitor access is available within the area and throughout the ridge, however, and partners provide numerous opportunities for public access on their properties (Table 22).

Table 22. Lake Wales Ridge regional visitor service areas

Public Access	Ownership & Management	Main Public Use Opportunities
Lakeland Highlands Scrub	Polk County	Hiking, Horses, Biking,
A.D. Broussard Catfish Creek Preserve State Park	Polk County	Hiking, Horses
Historic Bok Sanctuary	Polk County	Hiking, Kiosks, Visitor Center,
Mountain Lake Scrub	Polk Count	Hiking (planned)
Ridge Audubon Center	Polk County	Hiking, Visitor Center
Crooked Lake Sandhill	Polk County	Hiking, Visitor Kiosk
Tiger Creek Preserve	Polk County	Hiking, Visitor Kiosk
Lake Wales Ridge State Forest Walk in the Water Tract	Polk County	Hiking, Visitor Kiosk, Hunting Horses, Camping
Lake Wales Ridge State Forest Arbuckle Tract	Polk County	Hiking, Visitor Kiosk ,Hunting, Horses, Non-motorized Boating, Fishing, Camping
SUMICA	Polk County	Hiking, Horses, Camping, Fishing, Biking, Visitor Kiosks
Hickory Lake Scrub	Polk County	Hiking, Kiosk
Lake Kissimmee State Park	Polk County	Hiking, Camping, Non-motorized Boating, Horses, Fishing, Motorized Boating, Visitor Kiosk
Lake Marion and Reedy Creek Management Area	Polk and Osceola Counties	Hunting, Fishing
Avon Park Air Force Range	Highlands and Polk Counties	Hiking, Camping, Fishing, Hunting, Horses, Visitor Kiosk, Non-motorized Boating
Highlands Hammock State Park	Highlands County	Hiking, Biking, Visitor Center, Guided Tours, Camping
Jack Creek	Highlands County	Hiking
Lake June in Winter Scrub State Park	Highlands County	Hiking
Royce Unit	Highlands County	Hiking, Hunting
Lake Placid Scrub	Highlands County	Hiking
Archbold Biological Station	Highlands County	Hiking, Visitor Kiosk, Guided Tours,

(Source: LWREWG 2008)

PERSONNEL, OPERATIONS, AND MAINTENANCE

Currently, the refuge has no dedicated staff or funding and all refuge functions including management, biology, maintenance, and outreach/environmental education/interpretive programs are shared with Pelican Island and Archie Carr NWR's. The refuge was previously managed out of the Merritt Island NWR Complex headquarters in Titusville, Florida, but was transferred in 2009 to the staff at Pelican Island NWR in Vero Beach. The refuge's fire program is administered by Merritt Island NWR. Current staff (2009) for Pelican Island, Archie Carr, and Lake Wales Ridge NWRs includes the refuge manager, wildlife refuge specialist (assistant refuge manager), park ranger, term wildlife biologist, temporary biological science technician, and a term tractor operator (Figure 9). As part of the previous workforce planning efforts of the Service, a full-time administrative assistant, wildlife biologist, and two biological science technician positions were eliminated. Biological work and research activities are performed under special use permits or cooperating agreements, including with ABS, the University of Central Florida, and the University of South Florida, Historic Bok Sanctuary, and TNC.

Refuge maintenance activities are accomplished by PIC staff, contractors, and volunteers. There is one, 10-foot by 10-foot pole shed located on the Lake McLeod Unit and Service all-terrain vehicles are stored at a volunteer's home near the Lake McLeod Unit.

All refuge roads are small, unimproved sand roads. The Flamingo Villas Unit was fenced in 2005. Carter Creek Unit is fenced, as is a portion of the Lake McLeod Unit. Refuge signs are located on each unit, providing unit name and Service contact information.

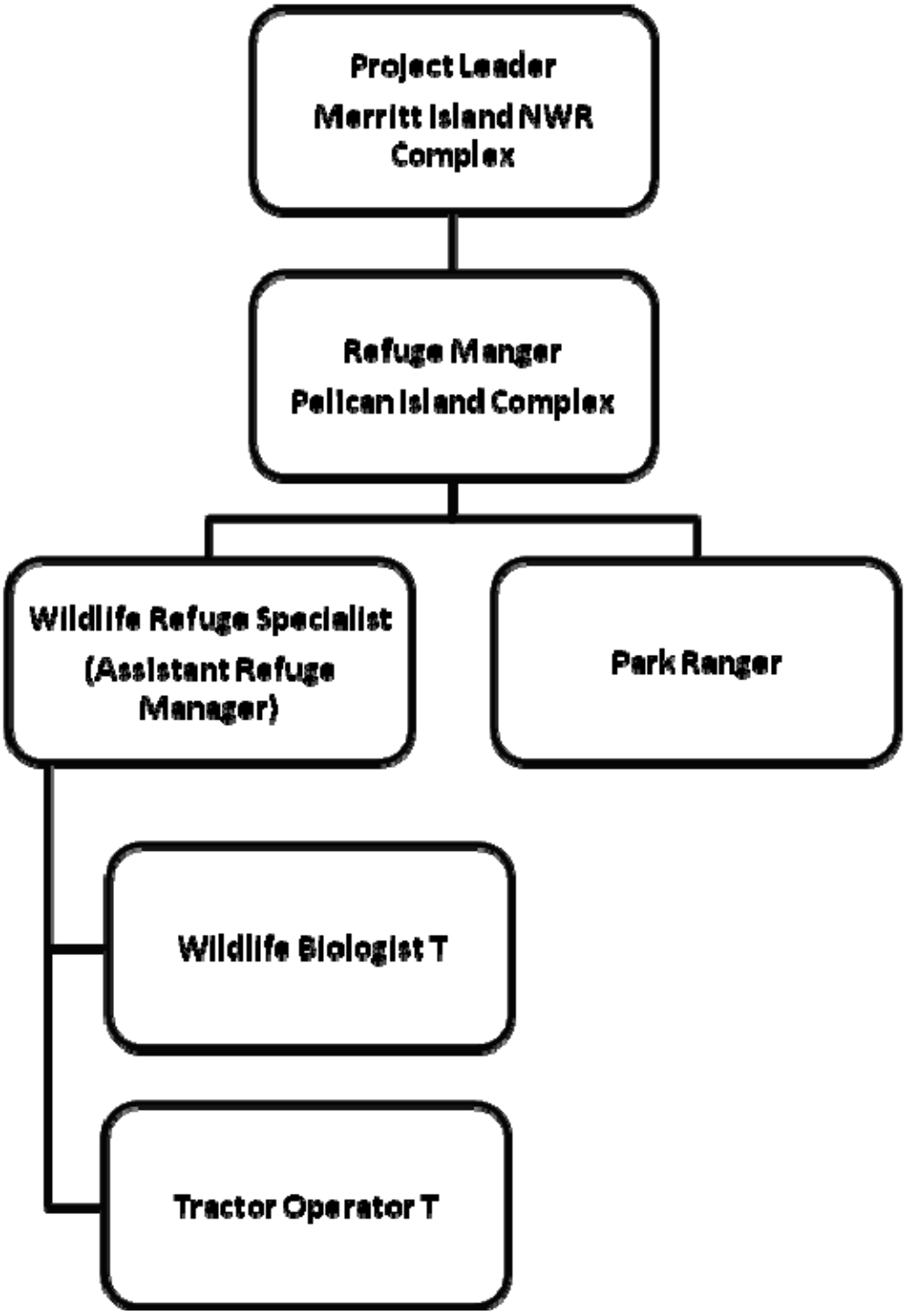
Refuge Fire Management

Fire management is provided for by the Merritt Island NWR, which is located 100 miles (161 km) away. Initial response responsibilities for unwanted wildland fire fall to the FDOF, with Merritt Island NWR personnel responding, if needed, as soon as possible. Most extended attack suppression activities would be handled jointly by the FDOF and Merritt Island NWR. In the past, maintenance of firelines and other presuppression activities have been conducted by contract or Merritt Island NWR personnel. Firelines have been successfully maintained and several successful prescribed burns have been accomplished, including a series of prescribed burns which were conducted during the week of June 8, 2009, at the Carter Creek (600 ac/243 ha) and Flamingo Villas (327 acres/132 ha) (Table 9). The Service and TNC have entered into a cooperative agreement to facilitate habitat restoration and improvement through the use of prescribed fire, primarily for the benefit of all federal trust resources that inhabit any fire-dependent wetland, riparian, and upland habitats on private lands in Florida.

Unwanted wildland fire initial attack is performed by the FDOF. The FDOF fire tower is located 1.5 miles (2.4 km) to the south of the Flamingo Villas Unit and the refuge depends heavily on the FDOF for initial attack fire suppression. The Service and FDOF currently manage unwanted wildland fire in Florida under a statewide MOU. Additionally, FDOF has operated under Service contract to maintain fire lines at the Flamingo Villas and Carter Creek Units. Local fire stations also assist with unwanted wildland fire response. Due to of the existence of small private in-holdings at some sites, the Service partners with FDOF to use the Hawkins Act to complete prescribed burns in those areas in an effort to control the negative impacts of unwanted wildland fire.

Figure 9. Pelican Island NWR Complex Organizational Chart (includes Pelican Island, Archie Carr, and Lake Wales Ridge NWRs). All staff are assigned to Pelican Island NWR Complex and shared with Archie Carr NWR.

Figure 9. Pelican Island NWR Complex organizational chart



III. Plan Development

SUMMARY OF ISSUES, CONCERNS, AND OPPORTUNITIES

The planning process officially began in January, 2008 with the initiation of preplanning activities such as collecting data and information, meeting with the Pelican Island NWR Complex and Merritt Island NWR Complex staff, visioning, and preparing for the public scoping phase of the planning process. Our public scoping phase began on September 25, 2008, and involved an intergovernmental meeting held during the day and a public scoping meeting held that evening. A myriad of issues, concerns, and opportunities, including existing and needed data, refuge resources, affected members of the public, vision ideas, and public participation, were raised by the public, organizations, and governmental agencies. Issue identification was a major element in determining future management goals and objectives, as well as future projects.

A Service Core Planning Team was assembled and a series of meetings were held in preparation for the planning effort and in advance of public scooping. Public scoping commenced on September 25, 2008, including a notice in the *Federal Register* on June 20, 2008, announcements in local papers during the week of September 22, 2008, and through the regional public radio website calendar of events. Additional information about the planning process and public scoping was provided through informational flyers and postings on the Service's Internet web site (http://www.fws.gov/merrittisland/subrefuges/LWR.html, later migrated to http://www.fws.gov/lakewalesridge/).

Utilizing existing refuge public mailing lists with current information provided by staff and various refuge partners, more than 200 informational flyers were mailed out inviting participation in the public scoping process. This flyer invited participation through a variety of means, including the public meeting, letters, faxes, telephone calls, emails to LakeWalesRidgeCCP@fws.gov, and personal visits. The flyer also announced the time and location of the public meeting, provided contact information, and described the primary purpose of the refuge.

The public meeting was attended by 23 individuals representing a variety of interests and organizations. A total of 11 individuals also submitted written comments by comment form at the meeting, through email, and written letter. Comments from the public were submitted by a variety of individuals covering diverse subjects, including the desire to contribute with volunteer efforts and the provision of input concerning management focus and refuge awareness.

In an effort to better include governmental partners in the planning process, an Intergovernmental Coordination Planning Team was formed (Appendix XII). A team meeting was conducted on September 25, 2008, where representatives of federal, state, and local governmental agencies met to discuss issues, concerns, and opportunities regarding future management of the refuge.

Coordination with governmental partners and the public is essential to ensure support for the CCP and the identified projects. While some of the issues and concerns raised during scoping are important to the future of the refuge, many are not within the Service's management jurisdiction or authority, and some are outside of its control.

After receiving issues from the public scoping and intergovernmental meetings, a Service Core Planning Team evaluated the issues raised, identified the priority issues to be addressed over the next 15 years, evaluated steps to rectify those issues and resource needs, and measured the impact

of CCP implementation. The Service then developed goals, objectives, and strategies to shape management of the refuge for the 15-year life of the CCP. The team considered all issues that were raised throughout the planning process and has developed a CCP that attempts to balance the competing opinions regarding important issues. All public and advisory team comments were considered; however, some issues important to the public fall outside the scope of the decision to be made within this planning process. The Service identified those issues that, in the Service's best professional judgment, are most important to future management of the refuge. The priority issues for future management of the refuge are listed.

- Declines in and threats to rare, threatened, and endangered species
- Lack of baseline information on refuge resources
- Lack of an effective approach to apply fire management and measure fire effects
- Existence, persistence, and spread of exotic, invasive, and nuisance species
- Management challenges resulting from fragmented conservation lands under multiple jurisdictions
- Inability to complete acquisition within the refuge's approved acquisition boundary
- Threats and impacts of an increasing human population
- Lack of on-site staff and resources to address refuge needs
- Lack of understanding on the effects of global climate change on refuge resources

The CCP identifies management strategies for priority issues in four management categories: wildlife and habitat management, resources protection, visitor services, and refuge administration. Several management priorities were identified in response to challenges resulting from the fragmented nature of protected natural areas of the greater Lake Wales and Winter Haven Ridge systems. These include identifying and managing through relationships with the partners the threats associated with ongoing human population growth of the area. Fragmented landscapes challenge many of the core management practices necessary to restore and maintain fire dependent habitats such as those found on the refuge. As wildlands are converted through development, the migration and establishment of species throughout the landscape will be more challenging. This magnifies the importance of regional initiatives that seek to connect natural areas.

WILDLIFE AND HABITAT MANAGEMENT

The refuge was established in April, 1994 to conserve one of the most imperiled ecosystems on the globe. About 80 percent of the pre-Columbian Lake Wales Ridge habitats have been cleared and converted to other land uses leaving only remnant scrub and ridge habitats, many of which are occupied by species found nowhere else.

As the landscape continues to develop, several impacts will continue to be experienced by the refuge which challenge the ability to provide management of these important resources, including: the loss and fragmentation of habitats throughout the Lake Wales and Winter Haven Ridge systems; spread and impacts of exotic, invasive, and nuisance species; threats and impacts to rare, threatened, and endangered species; threats and impacts to native wildlife; and decreased habitat quality. The refuge lacks baseline surveying and monitoring data for most species which impacts the ability to evaluate status and trends of refuge resources. The lack of an effective approach to apply fire management and to measure fire effects challenges the ability of the refuge to meet habitat requirements for a variety of species, including numerous state and federal listed species. And, the lack of understanding regarding the effects of global climate change on refuge resources also impacts the abilities of the refuge to manage and protect resources in response to these changes.

RESOURCE PROTECTION

Ongoing development of the landscape has direct impacts on the resource protection efforts of the refuge. While real estate prices have fallen from record highs seen in 2004/2005, overall development pressures experienced in this area have dramatically driven prices upwards, making it more difficult for the Service and Lake Wales Ridge partner organizations to acquire interests in these properties through fee title acquisition, easements, and agreements from willing parties. Further development has spread throughout the Lake Wales Ridge and south central Florida. Many properties which were undeveloped at the establishment of the refuge in 1994 have since been developed. This ongoing development of the landscape threatens wildlife and the habitat necessary to support them, especially for those lands in close proximity to or within the approved acquisition boundary of the refuge.

The acquisition boundary of the four refuge management units (i.e., Flamingo Villas, Carter Creek, Lake McLeod, and Snell Creek) encompasses 7,472.5 acres (3,024 ha). As of August 2010, the Service had acquired 1,843.9 acres (746.2 ha) within the four units, while the partners, including the State of Florida, TNC, and Polk and Highlands Counties, have acquired 2,586.1 acres (1,046.6 ha). The remaining 3,042.5 acres (1,231.2 ha) includes 514.5 acres (208.2 ha) of easements, common areas, and rights-of-way and 2,528 acres (1,023 ha) of mostly undeveloped inholdings. Developed lands do occur or are planned within each of the four management units, ranging from commercial uses including an antenna at the Snell Creek Unit, to residential uses including single family home development at the Lake McLeod and Carter Creek Units and an approved platted subdivision at the Flamingo Villas Unit. Continued development within the refuge's acquisition boundary directly impacts and threatens wildlife and habitat, represents ongoing impacts, and dramatically constrains management activities.

Beyond the fragmentation of conservation lands by developed lands, the refuge also faces management challenges that result from fragmented conservation lands that are managed under multiple jurisdictions.

VISITOR SERVICES

The refuge is closed to public access but a range of public use activities do occur on partner properties (Table 22). The refuge is likely to face increasing demands for recreational use of refuge properties due to a growing human population in the area. Further, the refuge, the sensitivity of its resources, and its management activities are impacted by a lack of public awareness and understanding of the refuge, its purposes, and its role in the landscape.

REFUGE ADMINISTRATION

In reviewing the current and future management needs to serve the purposes, vision, and goals of the refuge, the Service noted several administrative concerns. The first involves the unilateral ability for the refuge and its partnering agencies and organizations to manage for trust resources, given the fragmented and changing status of conservation lands throughout the Lake Wales and Winter Haven Ridge systems. Increasingly, this paradigm defines the role that the Service plays in meeting the refuge's purposes and includes such key elements as animal migration from one naturally managed area to the next and the development of habitat structure and composition necessary to provide for rare plant species, many of which are found nowhere else. The conversion of privately owned natural areas to development alters the direction for the remaining natural lands, especially for lands extremely susceptible to the developmental pressures witnessed throughout central Florida and the ridge system.

The Lake Wales Ridge contains one of the largest concentrations of federally listed species in the continental United States and emphasis as a national conservation priority is warranted. The refuge lacks a dedicated staff, budget, volunteers, and projects needed to pursue the purposes, vision, and goals of the refuge. The lack of on-site staff and resources impacts the abilities of the refuge to address refuge management priorities and needs. A distinct lack of law enforcement presence for these conservation lands is notable.

WILDERNESS REVIEW

Refuge planning policy requires a Wilderness Review as part of the comprehensive conservation planning process. A Wilderness Review for the refuge was conducted in 2006. The results of the wilderness review are included in Appendix VIII. In summary, no areas of the refuge were found to be suitable for designation as Wilderness at this time.

PUBLIC REVIEW AND COMMENT

Over 200 flyers were mailed to members on our mailing list providing an opportunity to request a CD or paper copy of the Draft CCP/EA to review. Additionally, a news release was provided to local media outlets announcing the desire to seek public comment and identifying how and where to receive a copy of the Draft CCP/EA. A second series of over 200 flyers were mailed to mailing list members early in the public review period announcing the completion of the Draft CCP/EA and its availability for review.

IV. Management Direction

INTRODUCTION

The Service manages fish and wildlife habitats considering the needs of all resources in decision-making. But first and foremost, fish and wildlife conservation assumes priority in refuge management. A requirement of the Improvement Act is for the Service to maintain the biological integrity, diversity, and environmental health of refuges. Public uses are allowed if they are appropriate and compatible with wildlife and habitat conservation. The Service has identified six priority wildlife-dependent public uses. These uses are: hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation.

Described below is the CCP, outlining management of Lake Wales Ridge NWR over the next 15 years. This management direction contains the goals, objectives, and strategies that will be used to achieve the refuge vision.

Three alternatives for managing the refuge were considered: A - Current Management (No Action); B - Rare, Threatened, and Endangered Species; and C - Wildlife and Habitat Diversity. Each of these alternatives was described in the Draft CCP/EA. The Service chose Alternative B as the preferred management direction.

Implementing the preferred alternative will provide increased protection for listed species and is anticipated to result in increased populations. In addition, other wildlife species and habitats as well as biodiversity are expected to benefit under this alternative. Prescribed burn activity will be implemented on a routine basis, enabling restoration and management of the refuge's fire dominant cover classes and pyrogenic habitat types. Research opportunities will be increased, providing opportunities for better understanding of listed species recovery efforts. Resource protection activities will be enhanced through a greater law enforcement presence and through enhanced management of inappropriate uses. Public awareness will improve through the implementation of an annual refuge day and participation in partner sponsored events throughout the refuge. Finally, refuge administration activities will focus on contributing to the recovery of listed species, as well as improving wildlife and habitat diversity through streamlined efforts and by strengthening local and regional partnerships.

VISION

Lake Wales Ridge National Wildlife Refuge is the first refuge of its kind, envisioned to protect the last vestiges of a globally imperiled ecosystem where plants found nowhere else on earth exist. The Lake Wales Ridge is a long, narrow series of ancient sand dunes and islands. The "Ridge" emerges from central Florida to proclaim its uniqueness in an otherwise flat landscape. Because of its age and once remote placement in North America, species evolved here that occur nowhere else on earth. Lake Wales Ridge National Wildlife Refuge is a living laboratory where researchers develop their understanding of the ecosystem. The refuge was established to help protect this ecosystem from being lost forever to developing Florida. Working with others, including state, local, and private partners, refuge staff and volunteers will use sound management and science to protect and provide a home for imperiled plants and animals and the habitats they require.

GOALS, OBJECTIVES, AND STRATEGIES

The goals, objectives, and strategies presented are the Service's response to the issues, concerns, and needs expressed by the planning team, the refuge staff and partners, and the public and are presented in hierarchical format. Chapter V, Plan Implementation, identifies the projects associated with the various strategies.

These goals, objectives, and strategies reflect the Service's commitment to achieve the mandates of the Improvement Act, the mission of the Refuge System, and the purposes and vision of the Lake Wales Ridge NWR. The Service intends to accomplish these goals, objectives, and strategies within the next 15 years.

WILDLIFE AND HABITAT MANAGEMENT

Discussion: Most vegetation types found on the refuge are in some way influenced or maintained by fire. Sandhills, scrub, flatwoods, and depression pond habitats require periodic fire to maintain viability. Many of the wetland and mesic communities are influenced by fire on occasion. For instance, bayheads do not burn during normal times. However, during periods of extreme drought, fires do move through these areas as evidenced by fire scars found on some of the larger trees. Fire also plays a role in determining the edges of these bayheads. Fires that occur in the normal dry season would burn the edges of bayheads, keeping them in check. Conversely, during very wet cycles, the bayhead species would gradually move out into the flatwoods and scrub communities. This oscillation has most likely occurred for thousands of years.

Back in the 1950s, there was a concerted effort to suppress all wildfires. As the scientific and land management communities began to realize the negative ecological effects of the removal of fire from many ecosystems, fire management began to change. While most unwanted wildland fires are still suppressed in the ridge, prescribed fire is now used on most conserved lands.

Lack of prescribed fire management on scrub lands leads to degradation of scrub habitat. Without fire, vegetation types gradually change, succeeding to fire intolerant types such as oak dominated hardwood, or in the case of fire intolerant habitat types such as bayheads, spatial extent expands. In the case of the refuge, species that rely on periodic fire to support niches are outcompeted by species more suited to fire-exclusion conditions. Most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, Florida DEP, pers. comm. *in* Service 2009a). Funding and staffing deficiencies have exacerbated implementation of routine, frequent prescribed fire management. Without increases, scrub habitat is likely to continue to degrade, becoming for some species the most pervasive threat on public lands. Additionally, some scrub conservation lands on the Lake Wales Ridge may not be managed in the near future because there are multiple private landowners with inholdings. These patchworks of private and public land make use of prescribed fire as a management tool difficult (R. Bowman, ABS, personal communication, 2007 *in* Service 2008a). Successful restoration of habitat on many public lands will take several years to achieve because multiple prescribed fires are necessary to get vegetative communities into early successional stages (Service 2008a). On public lands that have only recently begun to implement prescribed fire, including the refuge, habitat conditions suitable for listed species persistence may take several more years.

The primary focus over the 15-year life of this CCP will be recovering the landscape from the historic suppression of fire over the previous 50 years. It is hoped that by the end of 15 years the vegetation will have recovered to pre-fire exclusion conditions. After recovery, management activities should be directed towards maintaining the landscape. This rehabilitation phase will include the application of more frequent fire in the initial stages, with associated monitoring. As fuel loads are reduced and as habitat qualities increase, the refuge will adapt management and fire return intervals in accordance with information from research and experts, the results of monitoring, and best professional judgment. For all pyrogenic habitat types, as part of the Annual Habitat Work Plan, and in advance of the annual fire prescription planning process, an uplands ecologist with Lake Wales Ridge habitat management and fire experience will assess and decide the resource targets for the upcoming year. These targets will then be used to develop the annual habitat work plan and the fire prescriptions.

Mechanical treatments can be used to facilitate prescribed fire but may not be an appropriate surrogate to fire in the restoration objectives outlined in this plan. Mechanical treatments and herbicide often accelerate vegetation structure changes, but ecological benefits are generally greatest when they were combined with fire (Menges et al. 2010). When feasible, mechanical and herbicide treatments should be used as pretreatments for fire rather than as fire surrogates (Menges et al. 2010). Where scrub oaks have become overgrown, fire alone is not a practical method of restoring the landscape. Tall scrub oaks are difficult to burn under most prescribed fire conditions. When they do ignite, the resulting fires can be quite intense. The situation is similar in the sandhills where turkey oaks have become large single stemmed trees. Fires that would remove them would most likely take out the pine overstory as well. In these cases mechanical treatment methods can range from hand removal to the use of heavy equipment. Caution must be used in all cases to ensure that disturbance of rare, threatened, and endangered plants and soil disturbance are kept to a minimum. The refuge will also target an approach to minimize disturbance by minimizing fire line production, but allow for line development where necessary. The refuge will maintain existing mechanically provided fire plow lines and will coordinate introduction of new fire lines for implementation of prescribed burning with partners. The refuge will make all efforts possible and practicable to limit long-term wildlife impacts of fire management activities. Efforts to minimize undesired impacts to rare, threatened and endangered species include but are not limited to implementation of best management practices, fire management planning consultation with appropriate Ecological Services Field Stations, and coordination with partner agencies.

Goal A. Rare, Threatened, and Endangered Plants and Animals

Minimize the threats to and promote the recovery of the rare, threatened, and endangered species.

Discussion: Chapter II of this CCP identifies known occurrences of a host of federal and state listed animals and plants on the refuge. Listed species are plants and animals that have been designated by state and/or federal agencies with special protection or conservation needs. Those species with regulatory protection are protected by law, such as state and federal listed threatened and endangered species. Of the 57 rare, state, and federal listed species (including federal candidate species) that are known to occur on the Lake Wales Ridge (Table 6), 17 federally listed plants (Table 14), 6 federal listed animals, and 1 candidate species (Table 15) are known to occur on the refuge. Further, the State of Florida identified 974 species of mammals, birds, amphibians, reptiles, fish, and invertebrates as those of greatest conservation need in the state (FWC 2005), including rare, threatened, and endangered wildlife species that are of specific management concern to Lake Wales Ridge NWR.

Service telemetry data of collared Florida panthers have documented panther occurrence within approximately one-tenth of a mile from the Flamingo Villas Unit and signs of the Florida black bear have been observed at the Flamingo Villas Unit. Presence in or around refuge managed lands, particularly relating to the Florida panther is thought to result from periodic stopovers resulting from movement to other lands throughout their wide ranges. As part of a landscape scale black bear project, ABS researchers set traps, captured, and radio collared a large male black bear on the Flamingo Villas Unit in September 2009. Families of Florida scrub-jay occur in the scrub settings of Flamingo Villas and have historically been observed at the Carter Creek Unit. Sand skinks are known to occur on the Flamingo Villas, Lake McLeod, and Snell Creek Units, while bluetail mole skinks have been identified on the Carter Creek Unit. Signs of eastern indigo snake have been observed on the Flamingo Villas Unit. State listed animals including the Florida mouse, Florida gopher frog, and gopher tortoise have been identified on refuge management units including the Flamingo Villas Unit.

The refuge serves as a vital area for many plant species endemic to both the Lake Wales and Winter Haven Ridge ecosystems and serves as a living laboratory for the recovery efforts of a host of listed plants and animals. The endangered Florida ziziphus, an endemic plant to the Lake Wales Ridge in central Florida and thought to be extinct as recently as 1987, was reintroduced to the Carter Creek Unit in 2002. Among nine major protected areas in Highlands County, only on the refuge's Flamingo Villas Unit can the endangered Garrett's mint be found. The Lake McLeod Unit is currently one of two protected sites throughout its original range where the endangered scrub lupine is known to occur. Fourteen other federally listed plants and five state listed plants are also known to occur on the refuge.

Baseline inventories of common species presence and status on refuge management units are incomplete or nonexistent. Particularly lacking is a complete inventory of refuge biota for which this CCP intends to accommodate through partnerships. Working with partners, the refuge will develop baseline inventories of species throughout refuge habitats and update these inventories on regular intervals to support adaptive management principles. The refuge, working through partners, will support inventorying, monitoring, and research projects designed to provide for the recovery efforts of existing and newly identified rare, threatened, and endangered species. The refuge will act as a living laboratory for inventorying, monitoring, and researching and will target opportunities toward rare, threatened, and endangered species and the habitats they occupy.

Monitoring and Research

Objective A.1: Throughout the life of this CCP, monitor state and federal listed species of plants and animals and enhance their recovery through fostering scientific research on ridge resources and ecology.

Discussion: Through partnerships, rare, threatened, and endangered plants have been inventoried, monitored, and researched on the refuge including but not limited to Florida ziziphus, Garrett's mint, and scrub lupine. Archibold Biological Station has conducted demographic research on state listed Lake Wales Ridge endemic plants annually over the past 8 years. Much of this research involves frequent, intensive monitoring of individually tagged plants including Florida ziziphus at the Carter Creek Unit and Garrett's mint at the Flamingo Villas Unit, the results of which are designed to provide management direction that will ensure the long-term persistence and overall understanding of the biology of rare plants. Several other research contracts have been awarded since the refuge was established in 1994. Of particular importance are a completed land cover analysis and associated habitat maps using GIS conducted by ABS at Carter Creek and Flamingo Villas Units (Main 1999). The University of Central Florida received a grant to continue research on scrub lupine focused on conducting plant inventories, marking individual plants, determining cause of death, and monitoring seed dispersal. The University of Miami received a grant to determine response of seven listed plants

to fire. This project was done to inventory plant recovery at 6-month intervals for up to 2 years. ABS has conducted a suite of plant inventories including monitoring Garrett's mint at the Flamingo Villas Unit. ABS has also been instrumental in providing the refuge with regionally collected data, including data collected from refuge managed units in preparation of annual reporting to the Florida Department of Consumer Affairs, Division of Plant Industry Endangered and Threatened Plant Conservation Program. Additionally, Turner et al. (2006) conducted the State of the Scrub report on conservation progress, management responsibilities, and land acquisition priorities for imperiled species of LWR which included a synopsis of historic and current plant species occurrence information on Flamingo Villas, Carter Creek, and Snell Creek.

Apart from inventorying, monitoring, and researching of certain rare, threatened and endangered species, general inventories and presence data of refuge biota are lacking. Particularly lacking is a suite of wildlife on the refuge. However, through staff, partner, and volunteer observation in addition the FNAI conducted by Schultz et al. (1999), a suite of listed animals has been recorded on or around Service-owned land (Table 15). Presence and location of Florida scrub-jay family groups are inventoried on the refuge through the Jay Watch program provided for by TNC.

Conducting a refuge biota inventory of all refuge management units is fundamental to both current management strategies and as an aid in the development of alternative management direction based on an adaptive management approach. Working with partners, the refuge will conduct a complete biota inventory, targeting occurrence and presence of rare, threatened, and endangered species, as well as identifying presence and location of common species in addition to presence and location of exotic, invasive, and nuisance plants and animals. The refuge will work with partners to conduct inventories and update them at regular intervals.

The refuge will continue and expand partnerships for refuge inventorying, monitoring, and researching opportunities, placing emphasis on the collection of information to benefit recovery of rare, threatened, and endangered plants. Working with our partners, specifically ABS, the refuge will continue and where possible expand its participation in rare, threatened, and endangered plant inventorying, monitoring, and researching by providing opportunities for partners to conduct reproductive biology experiments, experiments to investigate germination requirements and seedling ecology, and application of experimental prescribed fire to determine how fire affects population dynamics. The refuge will actively seek funding support for assessment needs, including opportunities with the Service's Ecological Services recovery grant program to bolster fiscal support. In addition, the refuge will work closely with the research partners to avoid or minimize impacts to and disturbance of research plants and sites from refuge management activities.

Over the life of this CCP, the refuge will target management activities to restore habitat for the recovery and continued viability of rare, threatened, and endangered species in an effort to return habitats to a pre-fire exclusion state (Objective C.1). The historic lack of fire promotes unsuitable habitat structure and function for many of the rare, threatened, and endangered species for which the refuge was established to protect. The refuge will provide a routine prescribed fire program, instituting prescribed fire intervals in fire management units designed to return habitats to pre-fire exclusion conditions. Working with partners, the refuge will monitor fire effects during the restoration phase to assess habitat and rare, threatened, and endangered species response. Once pre-fire exclusion conditions have been met, the refuge will institute fire return intervals to provide for the maintenance of habitat structure and function in an effort to provide suitable habitat conditions for rare, threatened, and endangered species. The refuge will provide opportunities and conduct fire effects monitoring, including establishment of photo points strategically located on the refuge. For on the ground support, the refuge will recruit interns through the Student Conservation Association

(SCA) to assist in fire effects data collecting and reporting. In addition, the refuge will implement a fire monitoring plan and seek the assistance and direction of partners including the National Park Service to implement fire effects monitoring.

Florida Ziziphus (Ziziphus Celata)

Objective A.2: Continue to work with the partners to introduce Florida ziziphus to the Carter Creek Management Unit and within 1 year of the date of this CCP, continue to partner with ABS to survey for the survivability of planted Florida ziziphus and potential new Florida ziziphus populations at the Carter Creek Management Unit and other refuge units to promote recovery of the species.

Objective A.3: To restore sandhills at the Carter Creek and Flamingo Villas Units to pre-fire exclusion conditions and to promote recovery of Florida ziziphus, within 3 years of the date of this CCP, introduce low intensity and frequent prescribed fires with a 2- to 3-year fire return interval.

Objective A.4: Once sandhills have been restored to pre-fire exclusion conditions, extend the fire return interval to 2 to 8 years to promote recovery of Florida ziziphus populations.

Discussion: Florida ziziphus is one of the rarest (Ward at al. 2003) and most imperiled (Service 1999, Coile and Garland 2003) plants in Florida. It is listed by the Service and the State of Florida as an endangered species. A recent analysis of Florida scrub conservation progress based on land acquisition included Florida ziziphus among the 36 rare species of the Lake Wales Ridge. The refuge supports a reintroduced population of Florida ziziphus at the Carter Creek Unit, which is one of three locations within its historic range where Florida ziziphus has been reintroduced. Consequently, the refuge will prioritize continued management of this species over the 15-year life of the CCP.

Turner et al. (2006) calculated protection indices for each species and for three time periods (past, present, and future) based on number of locations, extent of occurrence, and area of occupancy and identified Florida ziziphus as a species of high conservation concern. In addition, the analysis identified Florida ziziphus as one of at least eight Lake Wales Ridge species in which translocation and/or captive propagation may be necessary to ensure their survival due to inadequate representation on conservation lands (Turner et al. 2006, Service 2009b). Eleven known remnant populations of Florida ziziphus occur along a 35-mile stretch of the Lake Wales Ridge in southern Polk and northern Highlands Counties. Seven of these eleven populations occur in pastures or in other highly disturbed sites, while only three populations occur on publicly protected sites. Most populations consist of a single genetic individual and are thus infertile. Only three populations are believed to contain compatible mating types and thus the potential for sexual reproduction. All populations occupy yellow sand xeric uplands that historically supported longleaf pine/wiregrass sandhills.

The Service's Recovery Plan for Florida ziziphus (Service 1999) calls for the establishment of new populations in appropriate habitat on publicly protected sites. Since 2002, experimental reintroductions of Florida ziziphus have been carried out at the refuge's Carter Creek Unit, at the Lake Wales Forest Mitigation Site, and at TNC's Tiger Creek Preserve. Following a 2001, 63-acre prescribed burn at the Carter Creek Unit, researchers from ABS, in cooperation with the Service and conservation horticulturalists from HBS, carried out the first experimental reintroduction of Florida ziziphus in July 2002. A total of 144 potted plants and 1,728 seeds were introduced into 36 macroplots, comprising a range of microhabitat conditions. Six years post-reintroduction, transplant survival has held steady at about 75 percent, while introduced seeds have yielded only four survivors. However, while most introduced plants appear healthy and robust, few have grown and none have flowered. The introduced population is and will continue to be monitored quarterly by the ABS Plant Ecology Lab.

The Recovery Plan also explicitly recognizes the need for employing prescribed fire to provide appropriate habitat and recognizes the need for research on the management needs of Florida ziziphus. Based on the available data (Weekley and Race 2001), it seems likely that Florida ziziphus historically occupied sandhill habitats subject to frequent low-intensity fire. In the absence of fire, plants die back at 3- to 10-year intervals, but generally resprout via root shoots, which take 2 to 3 years to flower. Given the apparent stasis in the introduced Carter Creek population, imposition of prescribed fire to part of the population could provide important information on the fire response, autecology, and reproductive biology of Florida ziziphus.

Over the 15-year life of the CCP, the refuge will target pyrogenic habitat restoration to pre-fire exclusion conditions, including sandhill communities of the Carter Creek Unit. Restoration of the Carter Creek Unit's sandhill habitat, long-unburned prior to 2001, requires frequent (2-3 years) application of prescribed fire. Fire regimes can be more variable once restoration has improved habitat quality. Utilization of existing fire breaks at the Carter Creek Unit will permit Service fire managers to burn some Florida ziziphus reintroduction plots while leaving others unburned. Florida ziziphus typically resprouts following fire and the experts do not anticipate significant mortality resulting from burning the plants. Moreover, it is expected that burning will promote rapid growth and flowering. Although the ideal fire return interval for Florida ziziphus has not yet been determined, a tentative 2- to 8-year fire return interval is recommended for maintenance of Florida ziziphus populations. More frequent fires (2 to 3 years) are recommended in the restoration phase, when previous fires have been patchy, and when deemed necessary for Florida ziziphus survival and flowering.

Where Florida ziziphus populations are high (e.g., in the reintroduced area of the Carter Creek Unit) the use of mechanical treatment will be minimized to protect reintroduced Florida ziziphus plants. The refuge and its partners will continue to adapt management as necessary to better manage resources from any undesired impacts of mechanical control activities.

Partnerships with ABS and universities will continue at the Carter Creek Management Unit to ensure that Florida ziziphus populations are perpetuated into the future. In coordination with the partners, the refuge will continue to augment the existing introduced population with additional plants/genotypes as they become available. The refuge will continue to act as a living laboratory for research opportunities to better understand genetic characteristics of Florida ziziphus.

Strategies:

- Maintain fire interval and frequency to promote an increase in habitats that support Florida ziziphus.
- Introduce fire to areas at the Carter Creek and Flamingo Villas Unit containing sandhill within 3 years of the date of this CCP, and monitor fire effects during the restoration phase to assess habitat and species response, including for Florida ziziphus.
- Work with the partners to conduct a variety of management actions, including:
    - Monitor pre- and post-fire effects, optimal fire frequency, intensity, and interval conditions. Fire monitoring should include but not be limited to analysis of fire behavior and vegetation response at the Carter Creek Unit to determine the most beneficial fire management techniques.
    - Provide for and contribute to the recovery efforts of Florida ziziphus on the refuge and throughout the Lake Wales Ridge ecosystem.
    - Adapt fire treatments, as necessary.
    - Promote research opportunities.

- Adapt management to scientific findings.
- Coordinate management strategies and efforts for the use of prescribed fire, mechanical control, and monitoring and researching on the refuge.
- Identify and provide new sites on the refuge for reintroduction of Florida ziziphus.
- Assist with development of strategic genetic management strategies for Florida ziziphus reintroduction projects.
- Augment existing introduced Florida ziziphus populations with additional plants/genotypes as they become available.

- Investigate the use of small scale treatments such as chain-sawing and/or targeted herbicide application to suppress oaks and shrubs locally in the ziziphus population area.
- Increase law enforcement presence to eliminate unauthorized use of off-road vehicles to specifically protect Florida ziziphus recovery areas.
- Maintain fencing throughout the Carter Creek Unit.
- Increase communication with the Service's Ecological Services North Florida and South Florida Field Offices for recovery and funding opportunities.
- Coordinate with the researchers and partners to investigate impacts of climate change on Florida ziziphus, including impacts from changing patterns of suitable habitat.

Garrett's Mint (Dicerandra christmanii)

Objective A.5: Throughout the 15-year life of this CCP, increase populations of Garrett's mint and other yellow sand scrub plants to maintain species diversity at existing levels on the refuge. Within 3 years of the date of this CCP, begin restoring habitats to pre-fire exclusion conditions and introducing fire to areas at the Flamingo Villas Unit containing yellow sand scrub with initial fire return intervals of 2 to 5 years and then by extending the fire return interval of 5 to 12 years where populations of Garrett's mint are concentrated. During the 15-year life of this CCP, burn each unit where Garrett's mint exists at least once.

Objective A.6: Throughout the 15-year life of this CCP, work with the partners to establish additional populations of Garrett's mint in suitable habitats at the Flamingo Villas Unit following fires, using seed collected from existing populations at Flamingo Villas Unit.

Objective A.7: Throughout the 15-year life of this CCP, work with the partners to evaluate the possibility of reintroduction of Garrett's mint to the other management units of the refuge.

Discussion: Garrett's mint is a federal and state listed endangered plant. This species is endemic to a small part of the Lake Wales Ridge in south-central Florida, encompassing only five populations near Sebring. Currently, the refuge's Flamingo Villas Unit is the only publicly owned site where populations of Garrett's mint are protected. Consequently, the refuge will target management actions specifically for these populations.

Garrett's mint is found exclusively on well-drained yellow sands (Astatula and Tavares) in oak-dominated Florida scrub. It also grows well in disturbed areas on appropriate soils, including roadsides, fireline edges, and powerline rights-of-way. Studies of its microhabitat preferences confirm that it is a specialist for gaps in Florida scrub dominated by evergreen, xeromorphic oaks (Menges et al. 1999). Microsite occupancy decreases with litter depth, litter cover, and shade. It appears to be a narrower microsite specialist than its congener *D. frutescens*. There have been no direct studies on how Garrett's mint responds to fire. However, based on data from *D. frutescens*, we believe that plants are generally killed by fire, although patchy fires may allow for the survival of individual plants. Population

recovery from complete fires is probably via dormant seeds in a persistent soil seed bank and seed dispersal is limited. Seeds can be produced by cross-pollination or by selfing, although pollinators are necessary for fruit set. Population sizes vary from year-to-year, with episodic periods of high seedling recruitment and low seedling survival during dry periods in late spring. Limited seed dispersal and gap closure between fires may combine to make habitat patches smaller and more isolated between fires, and larger and more connected shortly after fire (Service 2006).

The Flamingo Villas Unit has a large area of yellow sand scrub that is the only publically protected area for the endangered Garrett's mint. As a result, fire management of yellow sand scrub at this site will be focused on this species. A population viability analysis of *D. frutescens* suggests fires every 5 to 12 years promote persistence of individual populations. This interval will be a good starting point for the fire regime for Garrett's mint. The higher survival of Garrett's mint relative to *D. frutescens* suggests less frequent fires would be reasonable, but the relatively greater sensitivity to habitat closure (Menges et al. 1999) suggests that frequent fire would be necessary to maintain viable populations. Fires within a 5- to 12-year return interval are expected to benefit this species and should maintain shrub heights of 1 to 3 meters, since it would take about 20 years to reach 2.5 to 3 meters in height. Shrub cover should be maintained by these frequent fires, since fire intensities would not be high enough to kill many shrubs. Some shrub mortality with the intense initial fires may be useful in creating bare soil cover greater than 5 percent, since that cover may be currently lower than 5 percent. Canopy tree cover is currently within the refuge's target and these periodic fires should not have a large effect on canopy cover in yellow sand scrub.

Over the 15-year life of this CCP, fire management objectives and strategies will focus on restoration of yellow sand scrub habitat. Initial fire frequencies of 2 to 5 years will be implemented in order to restore yellow sand scrub to pre-fire exclusion conditions. Working with the partners during the restoration period, fire effects will be monitored to assess habitat response and adapt future fire management actions. Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, prescribed fires will be conducted so that fires typically burn greater than 70 percent of each burn unit containing yellow sand scrub to ensure a mosaic of varying aged scrub.

The objective for management is to burn often enough to expand populations within a mosaic of scrub habitat patches with different time-since-fire periods, including significant portions burned within the last 12 years. The use of mechanical treatment will be minimized, where appropriate, to protect yellow sand scrub and the Garrett's mint population at the Flamingo Villas Unit. The refuge and its partners will continue to adapt management as necessary to better manage resources from any undesired impacts of mechanical control activities.

Strategies:

- Introduce fire to areas at the Flamingo Villas Unit containing yellow sand scrub within 3 years of the date of this CCP.
- Increase law enforcement presence through partnerships and with Service staff.
- Continue to prevent access for unpermitted activities, especially off-road vehicle use and dumping.
- Increase communication with the Service's North Florida and South Florida Ecological Services Field Offices for recovery and funding opportunities.
- Coordinate with the researchers and partners to investigate the impacts of climate change on Garrett's mint, including impacts from changing patterns of suitable habitat.

- Apply adaptive management techniques to promote recovery efforts of Garrett's mint.
- Work with the partners to conduct a variety of management actions, including those listed below:
    - Extend monitoring efforts including pre- and post-fire effects monitoring for Garrett's mint. Fire monitoring should include but not be limited to analysis of fire behavior and vegetation response at the Flamingo Villas Unit to determine the most beneficial fire management techniques.
    - Contribute to the recovery efforts of Garrett's mint on the refuge and throughout its range in the Lake Wales Ridge ecosystem.
    - Coordinate management strategies and efforts for the use of prescribed fire, mechanical control, and monitoring and research on the refuge.
    - Adapt fire treatments as necessary to provide for the pyrogenic needs of Garrett's mint.

Scrub Lupine (Lupinus aridorum)

Objective A.8: Restore scrub habitat to promote the growth and flowering of scrub lupine at the Lake McLeod Unit. Restoration objectives include maintaining and where possible expanding current population levels by conducting regular prescribed burns of mechanically removed vegetation and where appropriate unit burns at Lake McLeod within 5 years of the date of this CCP.

Objective A.9: Within 2 years of the date of this CCP, work with the partners to identify and remove exotic and invasive plant species from the Lake McLeod Unit that may inhibit the growth of scrub lupine.

Objective A.10: Throughout the 15-year life of this CCP, work with the partners to investigate establishing additional populations of scrub lupine in suitable habitats on other refuge management units and/or on partner lands using seed collected from populations at the Lake McLeod Unit.

Discussion: Scrub lupine is listed by the Service and the State of Florida as an endangered species. Like many other Florida scrub endemics, scrub lupine has suffered from habitat loss due to urban and agricultural expansion. Scrub lupine is known to occur on the Lake McLeod Unit, one of two protected sites the species occupies within its historic range. Consequently, the refuge will target management of scrub lupine.

Currently, most of the estimated 1,000 individuals of this species occur in habitat that has already been highly modified or are threatened by future land clearing for residential housing; road construction and maintenance; pedestrian, horse, and off-road vehicles; and conversion to pasture land (Service 1999). Scrub lupine requires open sandy patches with high exposure to sunlight. Where fire has been suppressed for long periods, pine and oak canopy increases and understory vegetation density reduces open sandy patches (Stout 2004). Under these conditions, scrub lupine is outcompeted by surrounding vegetation. The majority of sites containing scrub lupine across the area are degraded due to fire exclusion or lack of mechanical vegetation management. Except for the refuge's Lake McLeod Unit and possibly Orange County's Shadow Bay Park, there are no plans elsewhere to use prescribed fire or mechanical vegetative management techniques to maintain or enhance scrub lupine habitat (Service 2008f).

Alternative mechanical and fire management approaches, adaptable by new information about the species, may be necessary to provide for the life needs of scrub lupine at the Lake McLeod Unit. The refuge will target removal of mature oak cover at the Lake McLeod Unit, encouraging stump sprouting and epicormic branch development of targeted overstory hardwoods in order to provide an assemblage of oak scrub and bare patch production. Controlled fuels will be reduced through the targeted application of prescribed fire to provide open patches and protection from the occurrence of unwanted wildland fire. The refuge will work with the partners to develop an understanding of the impacts of mechanical disturbance on scrub lupine. Exotic vegetation will be controlled. The fence system at the Lake McLeod Unit will be maintained to protect scrub lupine populations from illicit use including off-road vehicles. The refuge will continue to increase open, sandy patches through prescribed burning of controlled woody vegetation in an effort to increase scrub lupine populations, while protecting other listed plants, including Florida cladonia from the impacts of fire at the Lake McLeod Unit.

Research efforts will increase to expand the understanding of scrub lupine recovery. The refuge will continue to work with the partners and volunteers to provide for the recovery efforts of scrub lupine on the refuge and throughout its range. Working with the partners, the refuge will investigate establishing additional populations of scrub lupine in suitable habitats on other refuge management units and/or on partner lands using seed collected from populations at the Lake McLeod Unit.

Strategies:

- Promote the growth and flowering of scrub lupine at the Lake McLeod Unit to maintain and where possible, expand current population levels.
- Maintain/expand fencing of the Lake McLeod Unit to protect existing and new populations of scrub lupine.
- Increase communication with the Service's North Florida and South Florida Ecological Services Field Offices for recovery and funding opportunities.
- Control overstory hardwood cover through mechanical means and remove woody fuels through the targeted application of prescribed fire.
- Coordinate with researchers and partners to investigate the impacts of climate change on scrub lupine, including impacts from changing patterns of suitable habitat.
- Work with the partners to conduct a variety of management actions, including:
    - Monitor fire effects and identify optimal fire regime for scrub lupine. Fire monitoring should include but not be limited to analysis of fire behavior and vegetation response at the Lake McLeod Management Unit to determine the most beneficial fire management techniques.
    - Continue monitoring efforts to determine survival, population trend, and status, providing for the recovery of scrub lupine.
    - Provide a source population from the Lake McLeod Unit for reintroduction of scrub lupine to other conservation sites on and off the refuge.
    - Adapt fire treatments as necessary to provide for the pyrogenic needs of scrub lupine.
    - Coordinate with other law enforcement agencies and increase Service staff presence to protect scrub lupine from collection and damage from unpermitted activities, including off-road vehicle use.
    - Provide for and contribute to the recovery efforts of scrub lupine on the refuge and throughout its range.
    - Coordinate management strategies and efforts for the use of prescribed fire, mechanical control, and monitoring and research of scrub lupine.

Florida Cladonia (Cladonia perforata)

Objective A.11: Through prescribed burning and mechanical and exotic species control, promote opening sand gaps, scrub habitat, and niches for Florida cladonia at the Lake McLeod Unit.
Discussion: Florida cladonia is listed by the Service and the State of Florida as an endangered species. Management of Florida cladonia may conflict with management of other rare, threatened, and endangered species; specifically scrub lupine management at the Lake McLeod Unit which is a focal management species under this CCP. Special consideration is necessary to ensure that this species continues to exist and its recovery managed especially in relation to the occurrence of fire whether prescribed or wild.

Throughout the 15-year life of this CCP, the refuge will target restoration of habitats to pre-fire exclusion conditions through prescribed fire management. Florida cladonia is susceptible to fire and thus represents a management conundrum considering the necessity to implement prescribed fire on a routine and frequent basis during the refuge's planned restoration and maintenance phases. According to Menges and Kohfeldt (1995), while patch-level dynamics on a long time-scale, including local extirpation and recolonization events, are probably important in the persistence of Florida cladonia in fire-maintained landscapes, improper management may threaten the species at the site level. Due to Florida cladonia's presumed slow growth and observed slow recolonization (Menges and Kohfeldt 1995), land managers should avoid complete burns in large areas supporting it. Such fires likely reduce the possibility of recolonization from unburned patches within sites or from nearby sites. Yahr (2000a) stated that unburned refugia are crucial for the survival of this species, and precautions should be taken to ensure that areas of unburned occupied habitat persist through prescribed fires. In some cases, it may be necessary to artificially maintain gaps that are unlikely to carry fire (Yahr 2000a).

Complete lack of fire is also detrimental to the species. Fire suppression creates closed canopies and causes microsite characteristics to change, possibly encouraging complete burns when a fire does occur (Service 1999). Fire suppression causes the loss of open space and presumably the loss of Florida cladonia (Yahr 2000a). However, lichens are destroyed by fire, and recovery is a slow process (Yahr 1997, Yahr 2000a). Hawkes and Menges (1996) found species increased slowly with time since fire, not comprising more than 10 percent cover until more than 20 years post-fire. In general, species increased in cover and density with time since fire, but decreased in cover with open space (Hawkes and Menges 1996). Menges and Kohfeldt (1995) found Florida cladonia increased between 4 and 20 years post-fire, but not thereafter. According to Yahr 1997, Florida cladonia can only recolonize sites slowly, from a very local source (e.g., unburned patch within a site). However, the costs of fire-caused mortality in the short term are far outweighed by availability of habitat in a fire-maintained landscape over the long term (Yahr 2000a). Overgrown scrub with dense overstory and thick litter layers eventually excludes species dependent upon canopy openings; periodic disturbances, although initially destructive, can temporarily create gaps (Yahr 1997). Yahr (2000a) recommended that management plans balance the times-since-fire periods to maintain favorable habitats for species with varying microhabitat site tolerances, life histories, and colonization abilities.

The refuge will incorporate the unique needs of Florida cladonia and balance those needs with management of focal species, particularly scrub lupine at the Lake McLeod Unit. Restoration and maintenance of open sand gaps, scrub habitat, and niches for Florida cladonia at the Lake McLeod Unit will be provided through the implementation of prescribed burning, mechanical control where appropriate, and exotic plant species control. In order to provide for the recovery of Florida cladonia and listed plants including scrub lupine with differing fire requirements, the refuge will provide a more intensive approach to fire at the Lake McLeod Unit by targeting prescribed fire for fuel removal

accumulated through control efforts of hardwood canopy cover. This technique provides suitable oak scrub cover from stump resprouting, protects existing and establishes new recruitment areas for populations of Florida cladonia, and provides new and maintains existing open patches for establishment and recruitment of scrub lupine. In addition to prescribed burns of mechanically removed material, unit burning may be necessary to restore and maintain Lake McLeod Unit habitat. Due to the patchy nature of scrub habitat cover at the Lake McLeod Unit, prescribed fire is not expected to completely burn fuels thus preserving microsite characteristics necessary to provide source material recruitment where unit burning is prescribed. Given constraints and other logistical obligations, the refuge may manually move Florida cladonia prior to prescribed fire events of mechanically removed material, when and where feasible. The refuge will provide for adaptive management strategies to protect Florida cladonia over the life of this CCP given logistical constraints and obligations for other primary species.

To protect existing populations of Florida cladonia at the Lake McLeod Unit, the refuge will maintain fencing and will identify and monitor cladonia populations working with the partners and volunteers. In order to capture alternative funding for recovery efforts and to aid in refuge management, the refuge will increase communication with the Service's North Florida and South Florida Ecological Services Field Offices.

Rare Plant Suite

Objective A.12: To restore refuge habitats to pre-fire exclusion conditions, institute an initial fire return interval of 2 to 5 years and within 5 years of the date of this CCP, work with the partners to identify optimal fire frequency, intensity, and interval conditions. Through adaptive management strategies, adapt fire treatments as necessary to provide for the pyrogenic needs of the other rare, threatened, and endangered plants that comprise the rare plant suite

Objective A.13: Within 5 years of the date of this CCP, work with the partners to evaluate, identify, and monitor species and sites for reintroduction, and/or translocation to support recovery and conservation of the other rare, threatened, and endangered plants that comprise the rare plant suite.

Discussion: Over the 15-year life of this CCP, specific management direction will target the recovery of three listed plants due to the unique role that refuge-managed lands play in their recovery efforts. The plants are: Florida ziziphus, Garrett's mint, and scrub lupine. Additionally, due to the unique management consideration of Florida cladonia (*Cladonia perforata*), management strategies for this species are specifically addressed in this CCP. Refuge habitats are also home to a wide array of rare, threatened, and endangered plant populations and the refuge plays an important role in the recovery efforts of at least 23 rare, threatened, and endangered plants (Table 14). For this discussion, the rare plant suite includes the 18 species listed in Table 23.

Table 23. Suite of rare plants and their federal and state listing status

Plant	Fish and Wildlife Service	State of Florida
Britton's Beargrass (*Nolina brittoniana*)	Endangered	Endangered
Carter's Mustard (*Warea carteri*)	Endangered	Endangered
Florida Bonamia (*Bonamia grandiflora*)	Threatened	Endangered
Wireweed (*Polygonella basiramia*)	Endangered	Endangered
Highlands Scrub Hypericum (*Hypericum cumulicola*)	Endangered	Endangered
Lewton's Polygala (*Polygala lewtonii*)	Endangered	Endangered
Papery Whitlow-wort (*Paronychia chartacea*)	Threatened	Endangered
Pigeon Wings (*Clitoria fragrans*)	Threatened	Endangered
Pygmy Fringe-tree (*Chionanthus pygmaeus*)	Endangered	Endangered
Sandlace (*Polygonella myrophylla*)	Endangered	Endangered
Scrub Buckwheat (*Eriogonum longifolium var. gnaphalifolium*)	Threatened	Endangered
Scrub Plum (*Prunus geniculata*)	Endangered	Endangered
Scrub Blazing Star (*Liatris ohlingerae*)	Endangered	Endangered
Nodding Pinweed (*Lechea cernua*)	Not Listed	Threatened
Scrub Bay (*Persea humilis*)	Not Listed	Not Listed
Scrub Stylisma (*Stylisma abdita*)	Not Listed	Endangered
Curtiss' Milkweed (*Asclepias curtissii*)	Not Listed	Endangered
Cutthroat Grass (*Panicum abscissum*)	Not Listed	Endangered

Goals and objectives will target restoration of habitats to pre-fire exclusion conditions. Management actions, such as the application of prescribed fire on a routine and frequent basis, adaption of management based on monitoring efforts designed to identify species and habitat response, exotic species control efforts, and increased site protection from illicit uses benefit recovery efforts of the rare, threatened, and endangered plants included in the rare plant suite. As examples, over the 15-year life of this CCP, fire management will target restoration to pre-fire exclusion conditions of pyrogenic habitats including yellow sand scrub, sandhill, and scrubby flatwoods benefiting multiple species of rare, threatened, and endangered plants. Application of wet season prescribed burning will not be precluded from ephemeral wetlands, seeps, bayhead transitional zones, or other types of scrub and flatwoods communities to help restore habitat value for a wide array of rare, threatened, and endangered plants including those in the rare plant suite.

The refuge, working with the partners, will continue to provide for the recovery of a host of rare, threatened, and endangered plants, playing an important role in regional recovery efforts. The refuge will work with partners to manage and restore habitats through the use of prescribed fire, exotic plant control, and, where necessary, mechanical control to aid in the recovery efforts of listed plants, adapting management and coordinating strategies with the partners to ensure that resource management within the landscape provides for the recovery of rare, threatened, and endangered plants. Working with the partners, the refuge will inventory and monitor listed plants and provide for systematic updates of in-house and shared data sets to provide recent and updated information useful for recovery efforts. The refuge will work with the partners to support and provide for regional rare, threatened, and endangered plant recovery opportunities including translocation, when appropriate.

Trash and litter will be removed providing niches and openings for rare, threatened, and endangered plants. Law enforcement will be increased to provide protection from illicit uses including off-road vehicles. Working with the partners, inventorying, monitoring, and research projects will be continued, conducted, and coordinated to provide for regional recovery efforts, providing effects information from management actions including prescribed fire. Communication with the Service's North Florida and South Florida Ecological Services Field Offices will increase in addition to more communication among the partners to provide sound reasoning for adaptive management.

Strategies:

- Conduct prescribed burning on a consistent basis to promote suitable habitat development for rare, threatened, and endangered plants.
- Adapt fire treatments as necessary to provide for the pyrogenic needs of rare plants.
- Increase communication with Service's North Florida and South Florida Ecological Services Field Offices for recovery and funding opportunities.
- Support regional research and monitoring of the impacts of climate change to understand the impacts on rare, threatened, and endangered plants.
- Work with the partners to conduct a variety of management actions, including:
    - Identify fire effects, optimal fire frequency, intensity, and interval conditions, and through adaptive management strategies, adapt fire treatments as necessary to provide for the pyrogenic needs of rare, threatened, and endangered plants.
    - Adapt management as necessary to protect and recover rare, threatened, and endangered plants.
    - Support and provide for regional rare, threatened, and endangered plant recovery opportunities, including translocation when appropriate.

- Develop inventorying and monitoring strategies to determine the impacts of mechanical disturbance on rare, threatened, and endangered plants.
- Inventory and monitor rare, threatened, and endangered plants and provide for systematic updates of in-house and shared data sets (e.g., FNAI).
- Coordinate management strategies and efforts for the use of prescribed fire, mechanical control, and monitoring and research with the partners to ensure that management direction provides for the recovery of rare, threatened, and endangered plants.

Florida Scrub-jay (Aphelocoma coerulescens)

Discussion: The Florida scrub-jay is listed by the Service and State of Florida as a threatened species (FWC 2009c). The refuge's Flamingo Villas Unit is home to a population of Florida scrub-jays. TNC's Jay Watch program has been conducting scrub-jay surveys on the refuge's Flamingo Villas and Carter Creek units annually since 2002. According to survey results, seven groups totaling 29 birds (20 adults and 9 juveniles) were identified on the Flamingo Villas Unit in 2008 (TNC 2008). Group size averaged 3.63 birds (2.34 adults) and 1.29 juveniles per group (TNC 2008). A single scrub-jay was identified in both the 2004 and 2005 reporting periods on the Carter Creek Unit, but none have been reported by the survey since. Through the 15-year life of the CCP, the refuge will target expanding existing and/or recruiting additional scrub-jay groups through habitat management, including use of prescribed fire.

Over the 15-year life of this CCP, the refuge will target management designed to support existing and recruit new groups of scrub-jays which will aid regional recovery efforts. Stith et al. 1996 reported that range-wide, scrub-jays may have declined by as much as 25 to 50 percent during the mid-1980s to mid-1990s. A statewide scrub-jay survey was conducted in 1992-1993, at which time there were an estimated 4,000 pairs of scrub-jays in Florida (Fitzpatrick et al. 1994). Of 39 counties within the historic range of scrub-jays, 32 remained occupied, however, 19 of those 32 counties had fewer than 30 pairs of scrub-jays remaining, and 9 of these had 10 or fewer pairs. Following the 1992-1993 census, there has been no periodic, systematic surveys or censuses for scrub-jays throughout their range (Service 2007a). However, limited data exist for several areas where research and monitoring efforts have occurred or are ongoing. According to Bowman (R. Bowman pers. comm. ABS, April 2007 *in* Service 2007a) on the LWR, 15 monitored populations declined by an average of about 33 percent between the 1992-1993 survey and 2006. Cumulative declines were greatest on public lands that were not managed and averaged 63 percent (from 146 to 54 groups), while the average cumulative decline on managed lands was 7 percent (91 to 85 groups) (R. Bowman, pers. comm. ABS, April 2007). The total net decline in scrub-jay groups between 1992-1993 and 2006 was 229 (from 699 to 470 groups) in the 15 monitored populations (R. Bowman, pers. comm. ABS, April 30, 2007*in* Service 2007a).

The demography of scrub-jays is affected by habitat quality (e.g., vegetative structure, fragmentation, and proximity to human development). Bowman and others have been conducting long-term studies of scrub-jay demography along a suburban-to-rural gradient since 1991 in Highlands County (Bowman and Averill 1993; Bowman et al. 1996; Bowman 1998; Bowman and Woolfenden 2001). Suburban populations experience average to above average reproductive success through fledging, but survival of both juveniles and adults is much lower than in unfragmented habitat (Bowman and Woolfenden 2001). As a result, scrub-jay populations occupying fragmented habitat interspersed in suburban development remain stable only through net immigration from surrounding areas. Furthermore, Bowman's data, together with those of Woolfenden and Fitzpatrick (1996a) indicate that unfragmented habitat does not serve as the

source for suburban sinks. Instead, suburban populations draw their immigrants from nearby suboptimal and vanishing habitats. Threats from loss of privately owned habitat increase the emphasis to manage public lands occupied by or potentially occupied by scrub-jays.

Management of Florida scrub-jay habitat on the refuge must be considered in context with the regional distribution of scrub-jays and management activities on other public lands in the vicinity of the refuge. The historic loss of scrub habitat throughout the Lake Wales Ridge due to conversion of scrub to agriculture and residential development has resulted in fragmentation and isolation of habitat and of scrub-jay families. Particularly limiting are habitat connections to other public lands and the growing inability to manage public lands with fire for scrub-jay habitat due to an increasingly intricate wildland urban interface. In addition, the historic lack of fire on protected lands has resulted in habitat succession that has led to undesirable habitat and structure conditions. Fire exclusion has allowed vegetation to become overgrown, reducing its suitability as habitat for the scrub-jay and other scrub flora and fauna.

Habitat degradation remains a concern for scrub-jay habitat in public ownership because intensive management necessary to maintain suitable scrub-jay habitat is difficult to implement with limited staff and funding. Despite recent advances in land management efforts on many public lands, management applications may not be aggressive enough to maintain optimal scrub-jay habitat at the territory scale (Breininger and Carter 2003). Scrub-jay populations would likely continue to decline on public lands where intensive management efforts including prescribed fire are not undertaken (Service 2007a). This evaluation is particularly relevant for the refuge's scrub-jay population. The region's surrounding suburban settings are expected to grow over the life of this CCP, which limits options for scrub-jay expansion outside of protected lands. In turn, intensive management of protected lands will grow in importance as habitat on private lands is altered due to development or degraded due to lack of management.

It is important to consider that when altering the refuge's present landscape, scrub-jay management activities will be complimentary to the objectives pertaining to other rare, threatened, and endangered plants and the needs of native wildlife and scrub habitat management in general. Additionally, when planning scrub-jay habitat restoration and management, efforts will be focused on scrub and scrubby flatwoods systems adjacent to habitat that is already occupied by scrub-jays, particularly within the Flamingo Villas Unit.

Objective A.14: Within 5 years of the date of this CCP, and to support Florida scrub-jay recovery efforts, work with the partners to monitor and conduct research of scrub-jay populations present on the ridge to determine refuge carrying capacity, to encourage recruitment, and to support sustainable populations.

Objective A.15: Throughout the 15-year life of this CCP, to support Florida scrub-jay recovery efforts and to facilitate dispersal of scrub-jays, work with the partners to identify and prioritize potential connections between patches of suitable habitat between refuge units and surrounding partner lands. Work with the partners to evaluate and implement methods to conserve the highest priority connections.

Discussion: The refuge lacks baseline information concerning scrub-jay carrying capacity. It is reasonable to assume that given the restoration strategies outlined in this CCP, the application of a routine prescribed fire program will provide suitable habitat for existing scrub-jay groups and provide opportunities to expand existing groups from current numbers. Evaluation of scrub-jay presence will continue to be provided through the monitoring efforts of Jay Watch while habitat structure will be evaluated through refuge fire effects monitoring and staff and partner-provided surveys.

As mentioned, the refuge will continue partnering with TNC's Jay Watch program to annually monitor populations of Florida scrub-jays on refuge units. The Jay Watch Program is made up of a volunteer group that provides monitoring support for any protected property on the ridge. The refuge will encourage the group to continue surveying the Flamingo Villas and Carter Creek Units. The group will also be assisted by the Service (e.g., through grant applications, staffing support, and equipment use during surveys). The Service will promote partnerships with TNC, ABS, and universities to conduct specific scrub-jay research on the Flamingo Villas and Carter Creek Units. The refuge will continue banding efforts of Florida scrub-jays with ABS and/or Jay Watch at the Flamingo Villas Unit. Working with the partners, the refuge will seek to increase connections between patches of suitable habitat between refuge units and surrounding partner lands, to facilitate dispersal of scrub-jays. Once pre-fire exclusion conditions have been met and based on development of baseline data targeting unit carrying capacity levels, the refuge will work with the partners to investigate the opportunity to translocate scrub-jays in support of recovery efforts.

Working with the partners, the refuge will investigate the impacts of climate change on changing habitats and values. Interestingly, the management of ridge landscapes may be one area where the possible effect of climate change may be minimized and may actually help meet management goals and objectives. Here one might see the reduction of forest canopies through tree mortality. Li (2007) theorizes that elevated carbon dioxide (CO_2) levels in the atmosphere could help scrub oak ecosystems survive the consequences of the effects of increased greenhouse gasses, including more frequent droughts.

Objective A.16: Within 3 years of the date of this CCP, reintroduce fire to 60 percent of the scrub-jay habitat on all refuge management units of the refuge and monitor scrub-jay populations and habitat at the Flamingo Villas Unit to ensure the creation of more openings and lower scrub height compared to present conditions.

Discussion: The Florida scrub-jay is a characteristic and indicator species in scrubby flatwoods. Demographic rates of Florida scrub-jays are maximized when habitat is low and open, a structure usually maintained by a regime of frequent fire (5- to 20-year return interval). This management regime also benefits other wildlife species, such as gopher tortoise, sand skink, indigo snake, and scrub lizard. Fire is necessary to maintain scrub-jay habitat in a landscape, but inappropriately applied, has the potential to eliminate jays from small sites or have short-term negative effects on small populations. Where fuels have accumulated, prescribed fire may be intense and leave little cover for jays. Historically, fires in scrubby flatwoods and xeric oak scrub were heterogeneous, leaving unburned patches within the burn which provided cover and nesting sites for resident jays post-fire.

In support of scrub-jay recovery efforts, the refuge will implement a routine prescribed fire program to restore habitats that support scrub-jays, particularly scrubby flatwoods and depression/basin marsh systems. During the initial restoration phase of habitat management, short rotations of 2 to 5 years will be implemented to return scrubby flatwoods to a pre-fire exclusion condition. Prescribed fire will not be excluded from depression and basin marshes, allowing restoration of these habitat components. Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, particularly as a result of existing group reaction to prescribed fire events, the refuge will conduct prescribed fires so that no more than 40-60 percent of each burn unit is consumed where scrubby flatwoods exists to ensure a mosaic of varying aged scrub. The refuge will implement a prescribed fire program to provide strategic habitat for scrub-jays resulting from the implementation of prescribed fire. Units will be burned in a strategic pattern to increase the mosaic structure of habitats and management will be adapted, when necessary, based on known scrub-jay territories. The refuge will adjust fire frequency and intensity in

individual landscapes by using habitat structure (i.e., mean shrub height, openings, tree cover) to aid in determining burning objectives (i.e., adaptive management).

Once restored, the proper maintenance of scrub and scrubby flatwoods areas is essential. The re-treatment of scrubby flatwoods/scrub patches should be based on field inventory, rather than a pre-determined management rotation. In other words, rather than assigning a fire rotation of 4 years to a site, managers should periodically assess the area, scheduling a burn when average heights of scrub approaches 6 feet.

Strategies:

- Encourage Florida scrub-jay population growth on the refuge to support a sustainable ridge meta-population of Florida scrub-jays.
- Improve Florida scrub-jay habitat to support and enhance recruitment and long-term viability of Florida scrub-jays at the Flamingo Villas and Carter Creek Units.
- Work with the partners to develop baseline data on the amount and distribution of suitable and potential habitats for scrub-jays. Develop baseline data on the complexity of habitats that represent the historical landscape diversity and ecological functions that support wildlife populations, including scrub-jays.
- Reintroduce fire to scrub-jay habitat on the refuge and initiate prescribed fire management to restore a heterogeneous, productive scrub landscape.
- Through the 15-year life of this CCP, target restoration of scrubby flatwood habitat at the Flamingo Villas and Carter Creek Units to pre-fire exclusion conditions to support existing and to increase viable breeding family groups.
- During the restoration period, monitor fire effects to assess habitat and scrub-jay response and adapt future fire management actions.
- Adjust fire frequency and intensity in different scrub habitats by using habitat structure targeting mean shrub height, openings, tree cover, and other factors to aid in determining burning objectives (i.e., adaptive management).
- Work with the partners to seek to increase connections between patches of suitable habitat between refuge units and surrounding partner lands to facilitate dispersal of scrub-jays throughout the landscape.
- Work with the partners to monitor scrub-jay populations, including through TNC's Jay Watch surveys and banding efforts of TNC and ABS at the Flamingo Villas and Carter Creek Units.
- Through partnerships with TNC, ABS, and universities, encourage research on Florida scrub-jay populations present on the refuge.
- Coordinate with the researchers and partners to investigate impacts of climate change on Florida scrub-jay populations including identifying changing patterns of suitable habitat.

Bluetail Mole Skink (Eumeces egregious lividus) and Sand Skink (Neoseps reynoldsi)

Objective A.17: Within the 15-year life of this CCP, restore scrub and sandhill habitats to provide resource opportunities for existing bluetail mole and sand skink populations, and for the recruitment and reintroduction of additional individuals and populations.

Discussion: Both bluetail mole and sand skinks are listed by the Service and the State of Florida as threatened species (FWC 2009c). Sand skinks are endemic to the sandy ridges of central Florida, occurring in over seven central Florida counties including Polk and Highlands and on both Lake Wales and Winter Haven Ridges (Service 1999). Schultz et al. (1999) and Turner et al. (2006)

reported the occurrence of sand skinks on the refuge's Flamingo Villas Unit and Service staff (2009) have reported sand skink occurrence at the Flamingo Villas, Lake McLeod, and Snell Creek Units, although population estimates apart from these occurrence accounts and anecdotal observations by staff and visitors are lacking. Regionally, it appears that sand and bluetail mole skinks are distributed throughout their historic ranges, although it is believed that their numbers have likely declined substantially because of habitat loss and degradation (Service 2007b). One study found that sand skink populations were patchily distributed on the landscape, and distribution was clumped (Gianopulos et al. 2001).

In order to better understand the impact of fire and other management techniques on sand skink, experimental studies were conducted to investigate populations inhabiting sand pine scrub over 5 years (Mushinsky and McCoy 1999, Gianopulos 2001, Gianopulos et al. 2001, Mushinsky et al. 2001). There was a decrease in relative abundance of skinks immediately following treatments associated with both clear-cutting and burning and then a significant increase in skink captures in the clear-cut plots over the 5-year period, but there was no apparent trend in the burned plots (Gianopulos et al. 2001, Mushinsky et al. 2001). Mushinsky et al. (2001) noted significantly larger skinks captured in the burned plots, indicating that more insect prey may have been available from decaying logs or that older skinks inhabited these sites (Service 2007b). Mushinsky and McCoy (1999) reported that the first year after management treatment showed the greatest effects on sand skink abundance on the plots. Skink populations may take time to increase after the application of treatments (Mushinsky et al. 2001). Navratil (1999) stated that it was too early to surmise whether or not there was a difference in skink response to treatment method with only 3 years of data from this study. The most appropriate land management technique for skink conservation appears to depend more on the microhabitat conditions of the area treated than the treatment method, as sand skink distribution is correlated with various microhabitat features (Gianopulos et al. 2001, Mushinsky et al. 2001) (Service 2007b). To protect microhabitat conditions for skink conservation, soil disturbance will be limited and typically occur in relation to fire line maintenance.

In support of skink recovery efforts, the refuge will implement a routine prescribed fire program to restore habitats that support skinks, particularly scrub and sandhill systems. During the initial restoration phase of habitat management, short fire rotations of 2 to 5 years will be implemented to return scrub and sandhill to a pre-fire exclusion conditions. Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, the refuge will conduct prescribed fires to ensure a mosaic of varying aged habitats. Planned application of a routine fire management program may cause undesirable short-term impacts to skink populations. However, returning habitats to pre-fire exclusion conditions through the application of a routine prescribed fire management program provides long-term benefits to skink populations by increasing food resources and suitable habitats which promote recruitment opportunities for existing and/or new populations of skinks. Recognizing the potential of undesired short-term impacts to skink populations through the application of a routine prescribed fire program as outlined in the CCP, the refuge will examine skink response to planned prescribed fire program activities through monitoring and adapt management as necessary to reduce undesired sort-term impacts on skinks. Through partnerships, the refuge will investigate the impact of fire, including fire intensity and size on skink populations. Recovery of sand and bluetail mole skink will require protection and management of occupied and potentially restorable habitat. The refuge will investigate the reintroduction of bluetail mole skink into restored habitat as this may also be a valuable recovery tool. Throughout the 15-year life of this CCP, the refuge will work with the partners and keep current with new literature and apply adaptive management principles based on new discoveries concerning the life needs of sand and bluetail mole skink.

Strategies:

- Throughout the 15-year life of this CCP, target restoration of scrub and sandhill habitat to pre-fire exclusion conditions utilizing short fire rotations of 2 to 5 years to provide habitat opportunities for existing skink populations and for the recruitment of additional individuals and populations.
- During the restoration period, monitor fire effects to assess habitat response and adapt future fire management actions.
- Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, conduct prescribed fires to ensure a productive scrub and sandhill landscape.
- Adjust fire frequency and intensity in individual landscapes by using habitat structure targeting mean shrub height, openings, tree cover, and other factors to aid in determining burning objectives (i.e., adaptive management).
- Examine skink response to planned prescribed fire program activities through pre- and post-fire monitoring and adapt management as necessary to reduce undesired sort-term impacts to skinks.
- Examine population viability and occurrence on the Snell Creek Unit and improve skink habitat opportunities.
- Explore opportunities to enter into management agreements with neighbors to increase skink management scope on the refuge and within the ridge.
- Assess the need for relocation and translocation of skinks from Service and non-Service sites.
- Working with the partners, develop fixed point plots and provide for a consistent survey of skink population presence and absence, and monitor at routine intervals.
- Encourage protection of and adapt management actions for skinks at the Lake McLeod Unit.
- Work with the Service's North Florida and South Florida Ecological Services Field Offices to seek funding opportunities for skink research and management.
- Coordinate with the researchers and partners to investigate the impacts of climate change on skink populations, including identifying changing patterns of suitable habitat and effects of temperature change on microhabitat needs.

Eastern Indigo Snake (Drymarchon corais couperi)

Objective A.18: Within 5 years of the date of this CCP, work with the partners to develop baseline data and evaluate the amount and distribution of suitable eastern indigo snake habitat on the refuge.

Discussion: The eastern indigo snake is listed by the Service and the State of Florida as a threatened species (FWC 2009c). Eastern indigo snakes are widely distributed throughout central and south Florida and have been identified on the refuge's Flamingo Villas Unit. There is a general lack of information on the status and trends of the eastern indigo snake in south Florida and the refuge is no exception. The eastern indigo snake benefits from management activities targeted for other species including gopher tortoise, and management actions targeting plant species in scrub, sandhills, and wetlands. The species is known to utilize gopher tortoise burrows for refugia and forage opportunities but require larger areas than the gopher tortoise requires and have home ranges that can expand or contract depending on the time of year, habitat quality, and other factors. It is currently unknown how many individual snakes the refuge could optimally support. The eastern indigo snake is considered a generalist in terms of habitat use and condition requirements and is assumed to utilize most of the habitat types found on the refuge, specifically those found at the

Flamingo Villas and Carter Creek Units due to the mosaic of upland and ephemeral wetland habitats occurring there, offering cover and forage opportunities over relatively large areas.

Eastern indigo snake objectives will be secondary to the objectives of other priority management species specifically goals, objectives, and strategies necessary to provide for rare, threatened, and endangered plants. The refuge will integrate eastern indigo snake management with gopher tortoise management by protecting gopher tortoise burrows, where appropriate, from management actions including mechanical treatments, prescribed fire preparation, and exotic species control efforts. Through implementation of prescribed fire and invasive, exotic, and nuisance plant species control, the refuge will maintain wetland/upland interface functions important for this species. Working with the partners, the refuge will evaluate the amount and distribution of suitable eastern indigo snake habitat, and as part of an outreach campaign designed to promote awareness and protect movement of eastern indigo snake across management boundaries, the refuge will inform neighbors as to the benefits of eastern indigo snakes.

Gopher Tortoise (Gopherus polyphemus)

Objective A.19: Within 5 years of the date of this CCP, work with the partners to develop baseline data to evaluate the amount and distribution of active gopher tortoise burrows and provide suitable management in relation to discovered gopher tortoise populations on the refuge.

Discussion: The gopher tortoise is under review for listing under the Endangered Species Act and it is listed by the State of Florida as a threatened species (FWC 2009c). Gopher tortoise populations will benefit from management activities proposed for other species, specifically the implementation of fire proposed for scrub and sandhill habitats. Periodic natural fires play an important role in maintaining tortoise habitat by opening up the canopy and promoting growth of herbaceous food plants (Gopher Tortoise Council 2009). If natural fires are suppressed, habitats may become unsuitable for tortoises (Gopher Tortoise Council 2009). Threats to gopher tortoise survival include loss of habitat, road mortality, forest practices, disease, illegal hunting, and predation by domestic dogs among others. Importantly, the use of prescribed fire benefits gopher tortoise habitat production and is not considered a threat to tortoise survival (Gopher Tortoise Council 2009).

The refuge lacks baseline data on the distribution of active burrows and population sizes of gopher tortoises. Throughout the 15-year life of this CCP, the refuge will form a better understanding of the role the refuge plays in gopher tortoise management. An assessment of the amount and distribution of gopher tortoise, including distribution and periodic monitoring of active burrows, will help establish important baseline information upon which management decisions will be based. The refuge will work with the partners to conduct fire management activities including growing season burning to increase herbaceous plants as a food source. Where appropriate, gopher tortoise burrows will be protected from management actions including mechanical treatments, prescribed fire preparation, and exotic control efforts. Canopy cover reduction will be promoted in upland habitat types in an effort to provide conditions for established populations and to provide for recruitment opportunities. The refuge will evaluate the potential of refuge properties as recipient sites for gopher tortoise translocations. Working with the partners, the refuge will identify and mark existing gopher tortoise population at the Lake McLeod Unit to determine whether the Lake McLeod population is undergoing artificial increases resulting from unpermitted translocation/relocation. Gopher tortoise objectives will be secondary to the objectives of other priority management species specifically goals, objectives, and strategies necessary to provide for rare, threatened, and endangered plants.

Florida Panther (Puma concolor coryi) and Florida Black Bear (Ursus americanus floridanus)

Objective A.20: During the 15-year life of this CCP, work with the partners to develop an understanding of the role of the refuge for the Florida panther and Florida black bear and provide resource opportunities to serve these wide ranging species where appropriate.

Discussion: The Florida panther is listed by the Service and the State of Florida as an endangered species while the Florida black bear is listed by the State of Florida as a threatened species in most of Florida (FWC 2009c). The Florida panther may occur on the refuge and signs of the Florida black bear on the refuge and surrounding lands have been observed by researchers, volunteers, staff, and neighbors. Service telemetry data of Florida panthers have confirmed panther occurrence to within approximately one-tenth of a mile from the Flamingo Villas Unit, approximately half a mile from the Carter Creek Unit, and approximately one mile from the Snell Creek Unit. A motion triggered camera also recorded an image of a large cat in January 2007 on the Flamingo Villas Unit, however the species is unconfirmed and no more is known as the refuge lacks baseline data on the diversity of wildlife using the refuge. Panthers and similar species may use the unit opportunistically as a travel corridor and may seek prey opportunities available from feral hog presence, although no documentation has been conducted to verify. Evidence including tree marks, scats, and tracts of Florida black bear has been observed by ABS researchers and refuge volunteers at the Flamingo Villas Unit in August 2009. In addition, a motion triggered camera recorded an image of a Florida black bear in December 2006 and September 2009. As part of a landscape scale black bear project, ABS researchers set traps, captured, and radio collard a large male black bear on the Flamingo Villas Unit in September 2009. Black bear presence and use on the refuge is presumably more intensive as the refuge offers additional potential life needs including diverse cover and spatial composition, food, and resting opportunities. Both the Florida panther and the Florida black bear benefit from management activities proposed for other species, including the implementation of prescribed fire. Goals and objectives provided by this Plan will be secondary to those of other priority management species.

Over the 15-year life of this CCP, the refuge will work with partners to develop an understanding of the role of the refuge for Florida panther and Florida black bear, providing resource opportunities where appropriate. Working with the partners, the refuge will monitor for presence and patterns of use of Florida panther and Florida black bear on the refuge, adapting management as necessary to support the needs of these species. Working with the partners, the refuge will increase neighbors and area residents' awareness and understating of Florida panther and Florida black bear, their needs, occurrences, and associated management efforts. The refuge will coordinate with researchers and partners to investigate the impacts of climate change on Florida panther and Florida black bear and identify changing patterns of suitable habitat. A clear threat to Florida panther and Florida black bear are vehicle collisions whereby the refuge will support the installation of wildlife corridors to facilitate species dispersal beyond refuge lands.

Goal B. Protect, manage, and enhance the natural diversity of wildlife on the refuge including migratory and non-migratory birds to support naturally self-sustaining ridge populations.

Wildlife Diversity

Objective B.1: Secondary to the refuge's priority goals and objectives for rare, threatened, and endangered species, enhance management during the 15-year life of this CCP to benefit migrating and resident native birds, including neotropical migratory birds, native songbirds and terrestrial birds, waterfowl, shorebirds, wading birds, waterbirds, and invertebrate species.

Objective B.2: Throughout the 15-year life of this CCP, work with the partners to develop baseline data for neotropical migratory birds, raptors, shorebirds, waterfowl, wading birds, waterbirds, and non-migratory birds, as well as invertebrate species on the refuge and survey and monitor for wood stork use and bald eagle nests.

Objective B.3: Within 2 years of the date of this CCP, backfill channels on the Flamingo Villas Unit to improve and restore hydrologic function and ephemeral and permanent wetland resources to benefit wading birds and waterbirds.

Objective B.4: Throughout the 15-year life of this CCP, plant site and species appropriate pine trees along the shoreline of the Lake McLeod Unit to support future nest sites for bald eagles.

Discussion: Although they are not the management priorities for the refuge, a variety of native species benefit from the refuge including migratory and non-migratory birds and invertebrate species. The refuge currently lacks baseline information concerning the presence, absence, and status of wildlife species including wood stork, bald eagle, neotropical migratory birds, raptors, shorebirds, waterfowl, wading birds, waterbirds, and non-migratory birds. In addition, baseline inventories of the suite of invertebrate species utilizing the refuge are lacking. Throughout the 15-year life of this CCP, the refuge will work with the partners to collect baseline data and adapt management as appropriate to enhance the natural diversity of wildlife on the refuge and to support self-sustaining ridge populations of these groups of species.

The wood stork (*Mycteria americana*) (federal and state listed as endangered) and bald eagle (*Haliaeetus leucocephalus*) (federally delisted in 2007) use the refuge to some extent, however a lack of refuge specific data exists. Although these species are not the priority management species for the refuge, the refuge will play a role in regional conservation efforts to provide opportunities as they arise. Over the 15-year life of this CCP, refuge management will target restoration of habitats to pre-fire exclusion conditions and through monitoring efforts, adapt management in support of rare, threatened, and endangered species. Through the restoration process, the refuge will adapt fire management where necessary to also protect, manage, and enhance the natural diversity of wildlife on the refuge. To better understand the role that the refuge plays for migratory and non-migratory birds, the refuge will develop baseline data to identify the mix of birds using the refuge and apply management to support naturally, self-sustaining ridge populations including for the needs of wood storks, bald eagles, migratory neotropical birds, waterbirds, shorebirds, and waterfowl.

The refuge will enhance its role as a stopover site for neotropical migratory bird and resident songbird populations by providing resting, foraging, and potential nesting opportunities through the application of prescribed fire and exotic species control. The refuge will promote resting and forage opportunities for raptors known to utilize the Lake Wales and Winter Haven Ridge ecosystems as ancillary benefits of management for rare, threatened, and endangered species. Shorebird opportunities will be supported through litter and debris cleanups of the shorelines of Lake McLeod and Red Beach Lake and by encouraging prescribed fire in ephemeral wetlands to restore and provide habitat opportunities. Waterfowl will also benefit from prescribed fire implementation targeting restoration of ephemeral wetland communities. Wading birds and waterbirds will benefit from restoration of hydrologic settings, particularly proposed backfilling of channels at the Flamingo Villas Unit. In addition, non-migratory birds such as ground dwelling species including wild turkey (*Meleagris gallopavo)* will benefit from proposed habitat restoration activities, particularly benefitting from prescribed fire implementation. Habitat restoration will also benefit invertebrate species. Restoration of habitat structure through the use of prescribed fire will help increase the diversity of floral assemblages for pollinators.

Strategies - Wood Stork:

- Work with the partners to conduct surveys and monitor wood stork use on the refuge including roosting and nesting sites in bayhead communities.
- Protect colonies of wood storks if discovered and adapt management to protect colonies from disturbance following management guidelines.
- Maintain and where possible increase wetland function and value specific to resource requirements of wood storks.
- Coordinate with researchers and the partners to investigate the impacts of climate change on wood storks, including identifying changing patterns of suitable habitat.

Strategies - Bald Eagle:

- Coordinate with the State of Florida regarding aerial surveys of bald eagle nests on the refuge.
- Protect known bald eagle nests from disturbance by invasive species control efforts and protect nests from prescribed fire activity where necessary.
- Continue planting longleaf pine trees along the Lake McLeod Unit shoreline for use as bald eagle roosts or nest trees.

Strategy - Neotropical Migratory Birds:

- Promote habitats known to provide for the life needs of neotropical migratory birds. Resting and foraging opportunities for neotropical migratory birds known to utilize the Lake Wales and Winter Haven Ridge ecosystems will be provided as ancillary benefits of rare, threatened, and endangered species management for the refuge.

Strategy - Raptors:

- Promote habitats known to provide for the life needs of raptors. Resting and foraging opportunities for raptors known to utilize the Lake Wales and Winter Haven Ridge ecosystems will be provided as ancillary benefits of rare, threatened, and endangered species management of the refuge.

Strategies - Shorebirds:

- Maintain closed areas as necessary to minimize impacts to nesting shorebirds.
- Provide litter and debris cleanups along the refuge's Lake McLeod and Red Beach Lake shorelines.
- Promote prescribed fire in ephemeral wetlands to encourage use by shorebirds.

Strategy - Waterfowl:

- Promote prescribed fire in ephemeral wetlands to encourage use by Florida mottled duck.

Strategies - Wading Birds and Waterbirds:

- Utilize prescribed fire in seasonal wetlands to promote wading bird and waterbird forage opportunities targeting rare, threatened, and endangered wading birds and waterbirds.
- Backfill dredge channels in the Flamingo Villas Unit in an effort to improve and restore ephemeral and permanent wetland resources.

Strategy - Non-migratory Birds:

- Promote habitats known to provide for the life needs of non-migratory birds. All life history requirements for non-migratory birds will be provided as ancillary benefits of rare, threatened, and endangered species management of the refuge.

Strategies - Invertebrates:

- Working with the partners including ABS, provide an inventory of invertebrates on the refuge, including the Highlands Tiger beetle (*Cicindela highlandensis*).
- Provide research and survey opportunities on refuge lands, including identifying potentially undescribed species of invertebrates, including the genus *Polyphylla*.
- Provide habitat suitable for pollinators.
- Coordinate with researchers and the partners to investigate the impacts of climate change on rare, threatened, and endangered invertebrates, including identifying changing patterns of suitable habitat.

Goal C. Protect, manage, enhance, and restore a diverse and complex assemblage of Lake Wales Ridge habitats and natural processes to promote biological integrity and species diversity of native plants and animals.

Restoration to Pre-Fire Exclusion Conditions

Objective C.1: During the 15-year life of this CCP, restore refuge habitats through the application of prescribed fire at 2- to 5-year fire return intervals in order to attain pre-fire exclusion conditions. During this restoration period, monitor fire effects to assess habitat response and adapt future fire management actions. Once pre-fire exclusion conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, conduct prescribed fires in accordance with the objective(s) outlined for each habitat type.

Discussion: The predominant management theme over the 15-year life of this CCP will focus on restoring pyrogenic habitats to pre-fire exclusion conditions through frequent, routine implementation of prescribed fire for the benefit of rare, threatened, and endangered species. In order to fulfill refuge purposes and to accomplish restoration goals and objectives outlined in this CCP, prescribed fire will be implemented on short, 2- to 5-year rotations, adapting management as necessary through the assessment of habitat response. Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, prescribed fires will be conducted at revised fire return intervals specific to each habitat type to ensure a mosaic of varying aged habitats.

Habitat metrics will be used to aid in understanding whether burning objectives have been met. Targeted metrics change depending on habitat type and at times, depending on species management targets. For instance, maintaining a 5- to 20-year burn rotation to provide oak shrub height less than two meters with 10-50 percent cover of bare sand patches and sparse tree cover in scrubby flatwoods are important targets for scrub-jay management, while in yellow sand scrub where the only protected population of Garrett's mint is currently found, a 5- to 12-year prescribed fire rotation is expected to benefit this species, providing 1- to 3-meter oak shrub height with scrub cover at 50 to 95 percent and 5 to 15 percent bare soil cover.

Dominant habitat cover on the refuge includes scrubby flatwoods, rosemary scrub, yellow sand scrub, sandhill, depression marshes, cutthroat systems and associated wetlands, and bayheads, each of which will benefit either directly or indirectly through the application of routine, frequent prescribed fire and, in turn, offer increased habitat opportunities for rare, threatened, and endangered species, as well as for a mix of other native species. Management of scrubby flatwoods on the Flamingo Villas Unit will target the life needs of scrub-jays, while management actions in yellow sand scrub will target the needs of Garrett's mint. Prescribed fire will not be excluded from ephemeral wetlands, providing additional forage opportunities for wildlife and enhancing the production of cutthroat grass communities. The northern sandhill communities of the Carter Creek Unit will continue to be managed for the Florida ziziphus reintroduction project, as well as to provide habitat opportunities for a host of rare, threatened, and endangered and other native species. Sand skink populations will benefit through the development of increased sand patch openings in habitat. The extent of rosemary scrub habitat will be identified and prescribed fire implementation will be adapted depending on the extent and condition. Use of prescribed fire to reduce overstory cover will restore scrub habitat in the Lake McLeod Unit, benefiting scrub lupine and Florida cladonia recruitment. Bayhead communities will benefit as invasive and exotic control efforts coupled with prescribed fire in pyrogenic habitats will reduce exotic and nuisance plant infestation sources. Management actions will target the needs of rare, threatened, and endangered plants and, as most occur in habitat types where fire was once the frequent disturbance element, populations will benefit from the application of prescribed fire. Working with the partners the refuge will monitor results and adapt management as necessary to meet management targets.

Scrubby Flatwoods

Objective C.2: Over the 15-year life of this CCP, target the restoration of scrubby flatwoods habitat on the refuge to pre-fire exclusion conditions. Once pre-fire exclusion conditions have been met, maintain scrubby flatwoods to promote biodiversity of the scrub-dependent species on the refuge, including the Florida scrub-jay, using prescribed fire at 5- to 20-year intervals and, where appropriate, mechanical treatments to maintain oak shrub cover at 50 to 80 percent, and oak shrub height less than 3 meters, with 10 to 50 percent cover of bare sand patches and a sparse (0 to 20 percent cover) canopy of pine trees.

Discussion: Scrubby flatwoods habitat occurs over three of the four refuge management units including Flamingo Villas, Carter Creek and Snell Creek, totaling approximately 103.6 acres (41.9 ha), with the majority of acreage occurring on the Flamingo Villas Unit (89.1 acres, 36.0 ha). The Florida scrub-jay is a characteristic and indicator species in scrubby flatwoods. Consequently, the refuge will target management specifically for these populations. At present, the Flamingo Villas Unit is the only site in the refuge that has a population of scrub-jays. According to 2008 Jay Watch observations, seven groups occurred at Flamingo Villas (TNC 2008). Demographic rates of Florida scrub-jays are maximized when the habitat is low and open, a structure usually maintained by a regime of frequent fire (5- to 20-year fire return interval). This management regime will also benefit other species, such as gopher tortoise, sand skink, indigo snake, and scrub lizard. Fire is necessary

to maintain jays in a landscape, but inappropriately applied, it has the potential to eliminate jays from small sites or have short-term negative effects on small populations. Where fuels have accumulated, fires may be intense and leave little cover for jays. Historically, fires in scrubby flatwoods and xeric oak scrub were heterogeneous, leaving unburned patches within the burn which provided cover and nesting sites for resident jays post-fire. Due to a history of fire exclusion, habitat conditions have declined on the refuge, requiring restoration through the use of prescribed fire to return conditions to those more appropriate for scrubby flatwoods and more suitable for use by scrub-jay and other rare, threatened, and endangered species. Prescribed fire will be implemented through unit burns, utilizing existing fire breaks as fire unit boundaries to return habitat to pre-fire exclusion conditions. At the Flamingo Villas Unit where scrub-jay groups currently exist and to provide additional habitat opportunities for recruitment, prescribed fire will be implemented and adapted as a result of monitoring efforts including scrub-jay and habitat response. Units containing scrub jays will be managed to restore habitat conditions and to facilitate the life needs of existing scrub-jays through adaptive management strategies, including varying unit burns designed to provide recovery habitat for existing groups. Prescribed burns will be spatially planned to ensure that a mosaic distribution of burn units exist, providing refugia for existing scrub-jay groups. Once pre-fire exclusion conditions have been met, management should aim for making fires heterogeneous.

Although few if any jays occur at the Carter Creek Unit, scrubby flatwoods there might be suitable for scrub-jays after several burn rotations. Scrub-jays occur on the FWC portion of Carter Creek (north of Arbuckle Creek Road and north of the refuge's unit), but these jays have been declining due in part to a lack of prescribed burning (Service 2006). Emphasis should be placed on restoring habitats in Carter Creek before the local population is extirpated.

Once pre-fire exclusion conditions have been met, the refuge will maintain scrubby flatwoods to prevent vegetative succession in an effort to provide habitat for rare, threatened, and endangered species. The fire return interval will then be modified to 5 to 20 years, depending upon habitat conditions.

Strategies:

- Conduct growing season burns, when possible, to restore habitat quality of scrubby flatwoods.
- During the initial restoration phase of habitat management, short rotations of 2 to 5 years will be implemented to return scrubby flatwoods to pre-fire exclusion conditions.
- During the restoration period, monitor fire effects to assess habitat response and adapt future fire management actions.
- Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, conduct prescribed fires so that no more than 40 to 60 percent of each burn unit is consumed utilizing a 5- to 20-year prescribed fire rotation where scrubby flatwoods exist to ensure a mosaic of varying aged scrub.
- Adjust fire frequency and intensity in individual landscapes by using habitat structure targeting mean shrub height, openings, tree cover, and other factors to aid in determining burning objectives (i.e., adaptive management).
- Working with the partners, prepare a complete plant inventory in scrubby flatwood communities.
- Working with the partners, monitor for the impacts of climate change on scrubby flatwoods, particularly changing patterns of suitable habitat.

Rosemary Scrub

Objective C.3: Within 3 years of the date of this CCP, coordinate with the partners to inventory and monitor rosemary scrub habitat to determine location, extent, and habitat quality.

Discussion: Spatial extent information for rosemary scrub habitat on the refuge is lacking. In an effort to define rosemary scrub habitat extent and condition on the refuge, the refuge, working with the partners, will identify rosemary scrub locations and prepare a complete plant inventory of rosemary scrub communities. Working with the partners, the refuge will monitor gap dynamics of rosemary scrub habitat in an effort to maximize opportunities for rare, threatened, and endangered plants.

Objective C.4: Over the 15-year life of this CCP, use prescribed fire to manage rosemary scrub habitat on the refuge to maintain at existing levels or increase the level of scrub species diversity by burning each unit containing rosemary scrub. This will be done with a fire return interval targeted between 10 and 30 years to maintain shrub height at less than 3 meters and shrub cover at 40 to 85 percent, interspersed with 10 to 60 percent bare soil and containing less than 25 percent canopy pine cover.

Discussion: Rosemary scrub is a small piece of the larger scrub landscape. For refuge management purposes, this habitat type will not be a targeted habitat type for the application of prescribed fire, but will benefit from rehabilitation of other pyrogenic habitat types including yellow sand scrub and scrubby flatwoods.

Rosemary scrub is a variant of Florida scrub on xeric white sands and is maintained by infrequent fires. Reproductive maturity of Florida rosemary (11 to 16 years, Johnson 1982) defines the lower limit on fire return interval at about 15 years. Upper limits have generally been loosely based on the senescence of Florida rosemary, taken to be somewhere between 40 and 100 years (Myers 1990, Menges 1999). Recent population viability analyses on two herbs specializing in rosemary scrub, *Eryngium cuneifolium* and *Hypericum cumulicola*, suggest that a fire return interval of less than 15 years to promote viability of these species (Quintana-Ascencio et al. 2003, Menges and Quintana-Ascencio 2004). The target of 10 to 30 years is intended to balance the needs of Florida rosemary and endemic herb species, while variation in fire return intervals among burn units at the Lake McLeod Management Unit are prudent.

Effective management of rosemary balds and adjacent ecotones will require long-term protection, development, and implementation of appropriate fire regimes. Though dependent on site-specific characteristics, we know generally that rosemary balds burn every 40 to 60 years, while oak scrub should burn every 15 to 20 years. Under natural conditions, we expect oak scrub to burn up to and occasionally into rosemary balds. Over time, however, unburned rosemary balds develop canopies that are dense enough to support fire. While we have a basic understanding of the management requirements for rosemary balds and oak scrub, we know little of the requirements for rosemary bald-oak scrub ecotones. Because ecotones are dynamic areas with vegetative mosaics that change over time depending on fire frequency and intensity and other natural stochastic events, it is unlikely that specific management prescriptions can be developed independently of surrounding scrub habitats.

Based on results from fire effects monitoring, the refuge will assess habitat response and adapt future fire management actions of rosemary scrub habitat to maintain shrub height at less than three meters and shrub cover at 40 to 85 percent, interspersed with 15 to 60 percent bare soil, and containing less than 25 percent canopy pine cover (where all measures are taken at four years post-fire, if there has been a recent fire). It is anticipated that only monitoring will occur for rosemary scrub at the Lake McLeod Unit during the life of this CCP. However, the refuge will target prescribed fire opportunities

in areas that do not contain rosemary plants as soon as a prescribed fire is feasible there, which is not anticipated within the 15-year life of this CCP.

Rosemary scrub at the Lake McLeod Unit has been impacted by the persistent use of off-road vehicles. In these areas, the percent of open space appears to exceed the 15 to 60 percent typical of rosemary scrub (Menges and Hawkes 1998) and the cover of shrubs and herbs is atypically low. Fires will not carry through these areas and may not be necessary to provide open space for herbaceous plants. Protection of these areas from vehicles by maintaining fences will help the rosemary scrub recover.

Strategies:

- Continue law enforcement patrols to minimize the threat of off-road vehicles to rosemary scrub.
- Continue to limit off-road vehicle use of the Lake McLeod management Unit so that shrub cover can increase to at least 40 percent and bare soil cover can decrease to 60 percent or less.
- At the Lake McLeod Unit, allow the rosemary scrub on the east side of Gerber Dairy Road to recover before reintroducing fire which is likely to be beyond the 15-year life of the CCP.
- Where necessary adapt prescribed burn prescriptions to address the special needs of rosemary balds including providing habitat opportunities for rosemary scrub development at the Flamingo Villas Unit.
- Working with the partners, monitor impacts of climate change in rosemary scrub.

Yellow Sand Scrub

Objective C.5: Over the 15-year life of this CCP, target the restoration of yellow sand scrub habitat on the refuge to pre-fire exclusion conditions. Once pre-fire exclusion conditions have been met, use prescribed fire with fire return intervals of 5 to 12 years with fires typically burning greater than 70 percent of each burn unit and monitor vegetation structure to compare with objectives. Restored yellow sand scrub will exhibit shrub height at 1 to 3 meters and shrub cover at 50-95 percent, interspersed with 5 to 15 percent bare soil cover and 1 to 20 percent canopy tree cover.

Discussion: Over the 15-year life of this CCP, the refuge will target the reestablishment of ancient scrub habitat, including yellow sand scrub through ecological restoration to perpetuate the unique biological diversity for indigenous plants and resident and migratory wildlife. The Flamingo Villas Unit has a large area of yellow sand scrub that is the only protected area for the endangered Garrett's mint. Consequently, the refuge will target management specifically for these populations. In total, approximately 239.8 acres (97 ha) of yellow sand scrub exists on two of the four refuge units – Carter Creek (3.8 acres, 1.5 ha) and Flamingo Villas (236 acres, 95.5 ha). The refuge lacks baseline data of its yellow sand scrub communities and, working with partners, will form a better understanding of species occurrence and distribution during the life of the CCP.

Yellow sand scrub is a variant of Florida scrub found on xeric yellow sands, often dominated by myrtle oak and scrub hickory (Menges 1999). It has also been called oak-hickory scrub and southern ridge sandhill – hickory phase (Abrahamson et al. 1984), but is distinct from typical sandhill or high pine (Myers 1990). Yellow sand scrub regrows rapidly after fires and fires can re-burn the same site within a few years. Nonetheless, fire return intervals have rarely been specified for this type of scrub, although Menges (1999) posits an interval of 10 to 20 years. A recent population viability analysis of

Dicerandra frutescens, a specialist for scrub on yellow sand and closely related to *Dicerandra christmanii*, suggests an optimal fire return interval of 5 to 12 years (Menges et al. in press *in* Service 2005). This interval may be a good starting point for fire management in yellow sand scrub. Such an interval will minimize the heavy fuel buildup that occurs in older yellow sand scrub and thus will make control of unwanted wildland fires easier. Restored yellow sand scrub will exhibit shrub height at 1 to 3 meters and shrub cover at 50 to 95 percent interspersed with 5 to 15 percent bare soil cover and one to 20 percent canopy tree cover.

Both the flatwoods scrub and the yellow sand scrub vegetation sprouts vigorously after fire. There is little change in species composition or richness, but dominance changes for a short period of time, since palmetto recovers quicker than oaks (Schmalzer and Hinkle 1991). Scrub communities soon recover to their preburn structure and species composition (Menges and Hawkes 1998). Most of the larger plants sprout, while many herbaceous species are obligate seeders (Menges and Kohfeldt 1995).

One of the important influences of fire in the scrub lands is the alteration of the height of the vegetation. Obviously, after a fire, the resprouting plants are shorter than before the fire. This is important to many of the animal species that inhabit these areas. If fires do not occur in scrub, it continues to get taller. Extended periods of time without fire will allow some of the scrub sites to develop into a xeric oak hammock. The exclusion of fire has other detrimental effects. Woods (1993) reports that fourteen scrub plants flower and grow well only after fire. The abundance of plant species declines where fire has been excluded for long periods of time.

Restoration objectives will provide 2- to 5-year fire return intervals to return yellow sand scrub to pre-fire exclusion conditions over the life of the CCP. Once pre-fire exclusion conditions have been met, targeted after three burn rotations, fires return intervals will be implemented to maintain shrub height at 1 to 3 meters. Shrub cover should be maintained by these frequent fires, as fire intensities will not be high enough to kill many shrubs and periodic fires should not have a large effect on canopy cover, as canopy tree cover is currently within targeted ranges. Some shrub mortality with the intense initial restoration fires may be useful in creating bare soil cover greater than 5 percent, since that cover may be currently less than 5 percent.

Strategies:

- Conduct growing season burns, when possible, to restore habitat quality for yellow sand scrub.
- Within 3 years of the date of this CCP, introduce fire to areas of the Flamingo Villas Unit containing yellow sand scrub.
- During the initial restoration phase of habitat management, short rotations of 2 to 5 years will be implemented to return yellow sand scrub to a pre-fire exclusion conditions.
- During the restoration period, monitor fire effects to assess habitat response and adapt future fire management actions.
- Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations and utilizing monitoring results to adapt management, conduct prescribed fires so that fires typically burn greater than 70 percent of each burn unit containing yellow sand scrub to ensure a mosaic of varying aged scrub.
- Adjust fire frequency and intensity in individual landscapes by using habitat structure targeting mean shrub height, openings, tree cover, and other factors to aid in determining burning objectives (i.e., adaptive management).

- Working with the partners, prepare a complete plant inventory in yellow sand scrub communities.
- Working with the partners, monitor and inventory populations of rare, threatened, and endangered plants, including Garrett's mint, at the Flamingo Villas Unit.
- Work with the partners to monitor and inventory populations of rare, threatened, and endangered plants, including Garrett's mint, in an effort to adapt fire management strategies where necessary.
- Working with the partners, monitor the impacts of climate change in yellow sand scrub.

Sandhill Communities

Objective C.6: Over the 10-year life of this CCP, target the restoration of sandhill habitat on the refuge to pre-fire exclusion conditions. Once pre-fire exclusion conditions have been met, use prescribed fire with a fire return interval of 2 to 8 years and monitor vegetation structure to compare objectives. Restored sandhill targets will include bare soil at 5 to 30 percent, herbaceous cover at 25 to 70 percent, total shrub cover at 10 to 35 percent, pine cover at 10 to 50 percent, average shrub height at less than 2 meters, pine basal area at 20 to 60 square feet per acre, a sub-canopy of hardwoods that are greater than 2 meter stem density per acre, and sand pine cover at less than 10 percent.

Discussion: Sandhill is an important component of the mosaic of natural communities that comprises the Lake Wales Ridge NWR, specifically the Flamingo Villas and Carter Creek Units. Many federally listed species occur in sandhill habitats on the refuge, including Lewton's polygala, scrub plum, Florida ziziphus (introduced), and sand skinks. The health of the sandhill community and its resident rare species is dependent upon the frequent occurrence of fire in this habitat. The refuge lacks baseline data of its sandhill communities and, working with the partners, will form a better understanding of species occurrence and distribution over the life of this CCP.

The current extent of sandhill has been greatly reduced from its former range of millions of acres across the southeastern United States. Likewise, on the Lake Wales Ridge, very few protected patches remain. Sandhill habitat on the refuge totals approximately 436.6 acres (176.7 ha) and is found on the Flamingo Villas (58.3 acres, 23.6 ha) and Carter Creek (378.3 acres, 153.1 ha) units. The sandhill at the Carter Creek Unit is one of the largest remaining on the Lake Wales Ridge and supports a reintroduced population of Florida ziziphus, one of three locations within its historic range where Florida ziziphus has been reintroduced. Consequently, the refuge will target management of this species over the 15-year life of this CCP.

Sandhill is a natural community that depends on frequent fire to maintain it as an open pine savanna or woodland with a diverse understory of grasses, herbs, and low shrubs. A fire frequency of 2 to 8 years is required to maintain sandhill in this optimal state. More frequent fires (2- to 4-year intervals, perhaps) may be useful in the restoration phase or if previous fires have been particularly patchy. Growing season fires stimulate wiregrass and other understory plants in sandhill to produce seeds and are most effective at keeping hardwoods, such as turkey oaks, in the understory. In its natural state, the understory of wiregrass, along with pine straw and oak leaf litter, allowed for frequent, low intensity surface fires in sandhill communities. Through much of the time period when this community evolved, lightning was the ignition source of these fires. Hence, many of the ground cover species in the sandhill respond favorably to fires that occur in the late spring and summer months. The most widely recognized of these is wiregrass, which shows an increase in flowering after fires that occur during this season.

When longleaf pine was the dominant overstory tree, these fires were important to its survival also. Fire created bare ground for seedling germination. The dense needles of grass stage longleaf pines protected terminal bud from the low intensity fires that burned through the area. Fires were also important in reducing diseases in the pines, such as leaf spot.

The wiregrass ground cover in this type responds well to fire. Sufficient fuel is available to carry fire within 18 months of a burn. Fire return interval is believed to be between 2 to 5 years. Fires are low in intensity and move across the landscape rapidly. Burn out of the grasses is quick and residence time of the flaming front is short.

Perhaps the best way to illustrate the importance of fire in the sandhills is to look at what happens when fire is excluded. In the absence of fire, the sandhill community is readily invaded by species from adjacent communities (Myers 1990). As these species invade, the area gradually changes to either a xeric or mesic hardwood forest. Many of the sandhill patches on the refuge have succeeded to xeric hammock as a result of decades without fire. Oaks, formerly kept in the understory by frequent fires, now dominate the overstory, creating dense shade, which has caused decline of the herbs and grasses in the understory. Although xeric hammock is a natural community recognized by the FNAI, the xeric hammock found at the refuge's Carter Creek Unit is a result of fire suppression. Even if there is not a rapid change in species composition, an increased fire interval will cause fuel loads to increase to the point where an unwanted wildland fire could be severe enough such that the natural resistance of pines to fire is overcome. The destruction of pine stands can be assumed to have happened periodically throughout history without serious impacts region-wide. However, as the acreage of wildlands decreased, the loss of smaller stands becomes increasingly damaging to the total matrix of ecosystems in the area. Whatever the end result is, it is obvious that changes in the fire regime in the sandhills will result in significant changes in the vegetation, which will in turn impact fauna that utilize the site.

During the restoration phase, targeted over the 15-year life of this CCP, the refuge will implement prescribed fire on relatively short return intervals of 2 to 5 years to return sandhills to pre-fire exclusion conditions. The refuge will investigate the use of chemical and/or mechanical control of hardwood cover in sandhill communities to aid in achieving restoration goals and objectives. Restored sandhill targets will include bare soil at 5 to 30 percent, herbaceous cover at 25 to 70 percent, total shrub cover at 10 to 35 percent, pine cover at 10 to 50 percent, average shrub height at less than 2 meters, pine basal area at 20 to 60 square feet/acre, a sub-canopy of hardwoods that are greater than 2 meter stem density per acre, and sand pine cover at less than 10 percent. Once restoration targets have been achieved, after roughly three burn rotations, the use of prescribed fire will continue targeting maintenance of restored sandhill.

The reintroduction of fire will likely reduce the xeric oak hammock to promote more open areas, herbaceous plants, and lower mid-story tree height that will promote health in sandhill plant species. Management may need to utilize dry conditions to effectively use fire to restore xeric hammocks to pine and wiregrass dominated sandhill, however, growing season burns will initially be targeted.

Strategies:

- Increase the use of prescribed fire in sandhills and conduct growing season burns, when possible, to restore habitat quality for sandhill communities.
- During the initial restoration phase of habitat management, short rotations of 2 to 5 years will be implemented to return sandhill to a pre-fire exclusion conditions.

- During the restoration period, monitor fire effects to assess habitat response and adapt future fire management actions.
- Once pre-fire exclusion habitat conditions have been achieved, roughly after three burn rotations, utilize monitoring results to adapt management.
- Working with the partners, prepare a complete plant inventory in sandhill communities.
- Working with the partners, continue monitoring for rare, threatened, and endangered plants of sandhill communities.
- Where xeric oak height is unmanageable by prescribed fire alone, utilize mechanical methods to control hardwood cover.
- Explore the option of chemical control of oaks, followed by prescribed fire.
- Working with the partners, monitor the impacts of climate change on sandhill communities.

Depression Marshes

Objective C.7: Over the 15-year life of this CCP, target the restoration of depression marsh habitat on the refuge to pre-fire exclusion conditions. Once pre-fire exclusion conditions have been met, manage depression marshes to reflect natural diversity and conduct prescribed burns with sufficient frequency such that community structure is maintained. The desired future condition for depression marsh systems on the refuge will consist of the following: 50 to 100 percent native, emergent wetland vegetation, including cutthroat grass; 0 to 50 percent open water; 0 to 20 percent bare soil, which may be sand or organic soil; less than 10 percent woody vegetation having a diameter at breast height of greater than one inch; and 0 to 10 percent canopy cover.

Discussion: Depression marshes, also known as seasonal ponds, are usually sinkholes caused by the gradual dissolution of the underlying limestone. While often not imposing when considered on an individual basis, they serve several functions when considered in aggregate. A total of 274.6 acres (111.1 ha) of depression marsh occur on the Flamingo Villas (196.1 acres, 79.4 ha) and Carter Creek (78.5 acres, 31.7 ha) Units. These wetlands can serve as groundwater recharge or discharge areas, depending on the extent of hydrologic connection to the water table, depth to water table, recent precipitation, and surface topography. Often, however, depression marshes capture precipitation, thereby decreasing runoff and increasing groundwater recharge. This buffers the surrounding plant community from the effects of drought. Conversely, ditching and draining these marshes, which has been common practice on the Lake Wales Ridge for agricultural development, can reverse this effect and cause the favoring of more xeric vegetation communities (Rochow 1985). Further, the lowering of groundwater tables from ditching and development of well fields can cause destabilization of the porous limestone, accelerating the formation of sinkholes. This, in turn, permanently decreases the available volume of water the aquifer can hold, as well as decreasing the hydrological function of the aquifer and ecological function of the overlying lands. Ditches exist on the refuge's Flamingo Villas Unit and where they are located, they either function to drain wetland resources or provide inputs from off-refuge settings, threatening refuge water quality.

Depression marshes tend to have standing water more than 200 days per year, which, when combined with limited nutrient inputs, favors a low pH and low primary productivity, thereby suggesting that the habitat may not be of particularly high value to some bird species for foraging habitat. However, these wetlands are home to the cutthroat grass (*Panicum abscissum*) community which may be comprised of several plant species endemic to central peninsular Florida. State-listed species within this community include the endangered many flowered grass-pink (*Calopogon multiflorus*) and Edison's ascyrum (*Hypericum edisonianum*), as well as 10 federally threatened

plants (Service 1999). Plant species other than cutthroat grass have not been verified on the refuge, as the refuge lacks baseline species composition data.

It is also believed that the eastern indigo snake (*Drymarchon corais couperi*) occurs in these wet areas, and the ephemeral wetlands are essential to the life cycles of amphibians. Fourteen native frog species, including the Florida gopher frog, as well as five salamander species were found in a survey of the nearby Avon Park Bombing Range (Franz et al. 1998). (A list of these species can be found at http://www.flmnh.ufl.edu/herpetology/FLherps/Avonherp.htm.)

The majority of depression marshes on the refuge occur on the Flamingo Villas Unit. The property is unique in having many islands of scrub virtually surrounded by some type of wetland habitat. There are also many large scrub sections that are dotted with small depression marshes. At this time, most of the small wetlands occur on the north end of the Flamingo Villas Unit (north of the railroad tracks). Because of feral hogs, the southern section of the Flamingo Villas Unit has more disturbed wetlands and the ephemeral wetlands here may have been permanently altered by feral hogs. The water quality and plant diversity have been drastically disturbed such that some species have been locally eradicated (e.g., cutthroat grass).

Ground cover of depression marsh habitat is primarily cutthroat and other grasses. There are clumps of palmetto, and in many cases, other woody brush species that are occurring. Some of the ponds have slash pine. The primary vegetation which carries fire is cutthroat grass. Since grasses typically rebound quickly after a fire, one would think that these areas would have a very short fire return interval. However, the marshes are of small size and surrounded, in most cases, by the flatwoods vegetation type which has a longer fire return interval. It is believed that most of the depression marshes burned at the same time the surrounding flatwoods burned. This would give a fire return interval between 6 and 9 years.

The grasses in freshwater marshes and swales respond quickly to fire. Resprouting from the roots can begin in as little as a week. Within a few months, the grasses have obtained continuous cover (although it may take 1 year to 18 months for a sufficient mixture of living and dead fuels to accumulate to sustain a fire) (Schmalzer et al. 1991). The caution here is that the roots must survive the fire. These systems can burn while water is standing on the soil. Even in drier periods, the soil remains moist. However, during periods of extended drought, these soils can become dry enough for root kill to occur.

The most important effect fire has in the marshes is limiting the invasion of woody vegetation. When fire is removed from the system, the marshes can quickly change from an easily burned grass type to brush types that cannot be managed by fire. Once these plants take hold, it is difficult or impossible to reestablish the native marsh vegetation using fire alone.

As mentioned, baseline species inventories of refuge depression marsh systems are lacking. In addition, other than an overall view of how depression marsh systems function in a scrub landscape, nothing more is known about refuge hydrologic function. Understanding the hydrology on the refuge, particularly the Flamingo Villas Unit where the majority of depression marshes exist will be necessary to identify threats to surface and groundwater resources.

Over the 15-year life of this CCP, habitat restoration will be a principle theme utilizing prescribed fire on short return intervals of 2 to 5 years to return habitats to pre-fire exclusion conditions. Prescribed fire will not be suppressed within units allowing fire to carry through depression marsh systems. Based on results from fire effects monitoring, the refuge will assess habitat response and adapt future

fire management actions. The desired future condition for depression marsh systems on the refuge will consist of the following: 50 to 100 percent native, emergent wetland vegetation, including cutthroat grass; 0 to 50 percent open water; 0 to 20 percent bare soil, which may be sand or organic soil; less than 10 percent woody vegetation having a diameter at breast height of greater than 1 inch; and 0 to 10 percent canopy cover. The refuge will target growing season prescribed fire events to minimize the threat of root kill to depression marsh floral assemblages and soil disturbance/loss.

Strategies:

- Use prescribed fire and mechanical control, where appropriate, to restore and manage the depression marshes of the refuge.
- During the first 10 years of this CCP, and as compatible with other habitat management activities, plug all ditches that currently drain depression marshes on the refuge, particularly in the Flamingo Villas Unit.
- Construct and maintain perimeter fencing and any needed barriers to preclude feral hogs from further degrading depression marshes.
- During the first 10 years of this CCP, work with the partners to conduct a baseline inventory of wetland associated plants and animals on the refuge.
- Working with the partners, monitor depression marshes, specifically addressing use by listed species.
- During the 15-year life of this CCP, encourage Service private lands biologists to acquire conservation easements on depression marsh areas within and adjacent to the approved refuge acquisition boundary.
- Through partnerships, acquire conservation easements on private lands to protect refuge depression marshes from the dredging of off-site marshes.
- Working with the partners, prepare a hydrologic inventory of the refuge, specifically addressing the relationship of wetland resources to changing regional hydrologic patterns at the Flamingo Villas Unit.
- Working with the partners, monitor the impacts of climate change on depression marshes.

Cutthroat Systems and Associated Wetlands

Objective C.8: Over the 15-year life of this CCP, target the restoration of cutthroat systems and associated wetland habitats on the refuge to pre-fire exclusion conditions. Once pre-fire exclusion conditions have been met, use prescribed fire at a fire return interval of 2 to 5 years and monitor and manage vegetation structure to compare objectives. The desired future condition for cutthroat seep systems on the refuge will consist of maintaining 50 percent of cutthroat seeps with less than 50 percent pine cover, where no more than 20 percent has greater than 70 percent pine cover; less than 25 percent shrub cover; and 50 to100 percent cutthroat grass cover.

Discussion: Cutthroat seeps occur on the refuge and are considered a flatwoods variant, however, baseline information including spatial extent and species composition is lacking. This category of mesic flatwoods occurs on moist soils where cutthroat grass is the dominant ground cover and where wiregrass is not present. Palmetto midstory is typical with an average height of less than 3 feet. Areas of bare ground are seldom found. The overstory of pines is denser than that of the wiregrass flatwoods, covering over 40 percent of the area. Cutthroat habitats and associated wetlands on the refuge have been seriously impacted by feral hog disturbance, especially south of the railroad tracks on the Flamingo Villas Unit where most ephemeral wetland systems including cutthroat seeps have been impacted. Additionally, hydrologic functions of the Flamingo Villas Unit's cutthroat seep and

associated wetland systems are impacted by existing ditches both on and off the refuge. Existing ditches drain refuge wetland resources and provide off-site water inputs; however, due to a lack of hydrologic pattern baseline information, these impacts are not fully understood.

Over the 15-year life of this CCP, the refuge will target the restoration of existing cutthroat seeps to pre-fire exclusion conditions through the application of prescribed fire and mechanical management, where applicable, providing controlled levels of pine, shrub cover, and cutthroat grass cover. Based on results from fire effects monitoring, the refuge will assess habitat response and adapt future fire management actions. The desired future condition for cutthroat seep systems on the refuge will consist of maintaining 50 percent of cutthroat seeps with less than 50 percent pine cover, where no more than 20 percent has greater than 70 percent pine cover; less than 25 percent shrub cover; and 50 to100 percent cutthroat grass cover. The refuge will target growing season prescribed fire events to minimize the threat of root kill to cutthroat marsh floral assemblages and soil disturbance/loss.

Strategies:

- Use prescribe fire and mechanical control, where appropriate, to restore and manage cutthroat systems on the refuge.
- Working with the partners, prepare a baseline biologic inventory of cutthroat seeps at the Carter Creek and Flamingo Villas Units to determine spatial extent, species composition, and condition of cutthroat seeps that occur on the refuge.
- Monitor cutthroat seeps, specifically addressing use by listed species.
- Use growing season burns at frequent (2- to 5-year) intervals to manage cutthroat seeps, especially when cutthroat wetlands are dry and bayheads are wet.
- Working with the partners, prepare a hydrologic inventory of the refuge, specifically addressing the relationship of wetland resources to changing regional hydrologic patterns at the Flamingo Villas Unit.
- Conduct control activities to reduce the impact of feral hogs on cutthroat wetlands.
- Working with the partners, monitor the impacts of climate change on cutthroat systems and associated wetlands.

Bayheads

Objective C.9: Within 1 year of approval of this CCP, monitor the status of the ecotonal maintenance between the bayhead communities and the surrounding habitats on the refuge using historic and current aerial photographs.

Objective C.10: Within 3 years of approval of this CCP, apply habitat restoration strategies using prescribed fire to maintain the ecotone between the bayhead communities and the surrounding habitats on the refuge to reflect historic conditions.

Discussion: Bayhead swamps are forested wetlands found on saturated, organic, or peat soils that are wet, but are not normally inundated. On the refuge, bayhead systems occur over approximately 352 acres (143 ha) and are the dominant habitat feature along the western portion of the Flamingo Villas Unit (307 acres, 124 ha), and the southwestern portion of the Carter Creek Unit (45 acres, 19 ha). Baseline information on species composition, hydrologic function, condition, and use by rare, threatened, and endangered species is lacking for refuge bayhead systems. Bayheads are threatened by a host of sources, including anthropogenic changes to water quality, quantity, and flow, invasion of exotic species - particularly Old World climbing fern on the Flamingo Villas Unit where

treatment efforts have been performed. Restoration targets for other habitat types through the initial implementation of prescribed fire on 2- to 5-year return intervals will tend to limit bayhead expansion; however, bayhead systems will benefit from these restoration objectives as potential invasive plant seed and spore sources on the refuge will be controlled.

Soil saturation in bayhead systems is characteristically in the form of seepage from contiguous upland areas or from surrounding wetlands. As mentioned, refuge specific hydrologic information is lacking but threats to bayhead systems may include impacts from ditching originally designed to drain wetlands both from and to the refuge from surrounding wetland systems potentially impacting water quality and quantity.

An emerging threat of bayhead habitat throughout the region is laurel wilt fungal (*Raffaelea lauricola*) colonization of red bays (*Persea borbonia*) vectored by the exotic ambrosia beetle (*Xyleborus glabratus*), which is currently migrating from Georgia southward through Florida. Refuge-specific information on red bay occurrence is lacking but the species is a codominant in bayheads, the habitat type defined in part by the occurrence of red bay. Red bays on the refuge may decline over time due to this pathogen and its associated vector. The refuge will work through the partners to monitor infestation trends in central Florida, and where applicable work with the U.S. Department of Agriculture (USDA) to release approved biological control agents to combat the potential spread of the pathogen and its vector.

Bayheads have an extremely long fire return interval and due to the historic lack of fire on the refuge, may have encroached upon the pyrogenic habitat types that the refuge is targeting for restoration. However, due to the lack of baseline information, the historic extent of bayheads is not known. Several authors, including Ewel (1990) and Main and Menges (1997) estimate fire return intervals for bayheads between 70 and 100 years. When they do burn, very intense stand replacing fires can be expected. In cases where there is a pine overstory, such as the refuge, one could expect the pines to be removed. Mostly, fires from other vegetation types run into bayheads and burn some of the vegetation along the edge then burn out. This has little effect on the site and the vegetation quickly reestablishes. In periods of drought, intense stand replacing fires can occur. Most of the bay trees will come back, but the overstory of pines will most likely be removed. During the refuge's restoration phase, the use of historic and current aerial photos will be used to identify historic spatial extent, providing management guidance for the implementation of prescribed fire in relation to habitats adjacent to bayhead communities.

Throughout the 15-year life of this CCP, the refuge will target restoration of altered or maintain existing extent of the bayhead landscape. Where prescribed fire is targeted in adjacent habitat types, including flatwoods and sandhill communities, fires will not be suppressed from burning bayhead ecotones and/or bayheads to discourage bayhead expansion. Implementation of prescribed fire will target the growing season, providing protection for bayhead systems. Working with the partners and through the implementation of fire effects monitoring, ecotonal restoration and maintenance will be monitored and management adapted as necessary.

Strategies:

- Monitor, maintain, and protect bayhead wetlands to ensure that they maintain their natural functionality as a transitional, wetland community.
- Use prescribed fire to maintain the ecotone between bayhead communities and surrounding habitats to reflect historic conditions. When appropriate, allow prescribed fires to burn into

saturated bayheads to maintain the ecotone and discourage bayhead expansion into cutthroat seeps and other adjoining communities.

- Determine historical size and characteristics of bayheads through the use of historical aerial photographs and monitor the size of the bayheads. Monitor the success of the ecotonal maintenance using historic and current aerial photographs. Adapt management as necessary to reflect historic conditions and sizes.
- Working with the partners, prepare a baseline biologic inventory of bayheads at the Carter Creek and Flamingo Villas Units.
- Monitor bayheads, specifically addressing use by listed species and the potential impact of ambrosia beetle/laurel wilt on red bay populations.
- Coordinate with adjacent landowners and managers to protect bayheads from drainage or overflow.
- Working with the partners, prepare a hydrologic inventory of the refuge, specifically addressing the relationship of wetland resources to changing regional hydrologic patterns at the Flamingo Villas Unit.
- Working with the partners, coordinate exotic control efforts specifically targeting Old World climbing fern spread to bayhead resources.
- Working with the partners, monitor the impacts of climate change on bayhead communities.

Goal D. Exotic, Invasive, and Nuisance Species

Control and eliminate, where feasible, exotic, invasive, and nuisance species impacting the refuge to maintain and enhance biological integrity of the refuge and to support the ridge system.

Objective D.1: Within 2 years of the date of this CCP, work with the partners to develop and maintain a baseline exotic plant database for all refuge management units in priority order: (1) Flamingo Villas, (2) Carter Creek, (3) Lake McLeod, and (4) Snell Creek.

Objective D.2: Within 2 years of the date of this CCP, work with the partners to increase efforts to control or eradicate pest plants from refuge and adjacent lands that are classified as Category I or Category II by the FDEP Exotic Pest Plant Council.

Objective D.3: Within 2 years of the date of this CCP, work with the partners to identify exotic, invasive, and nuisance wildlife species impacting ridge wildlife and habitats and develop priorities for refuge management and control efforts.

Discussion: Non-native, invasive, and nuisance plants and animals have negatively impacted refuge resources generally by displacing native plants and animals. On the refuge's Flamingo Villas Unit, Old World climbing fern (*Lygodium microphyllum*) infestations occur most notably in the bayhead systems. If left unmanaged, this species has the potential to infest all habitat types to varying extents. Particularly vulnerable are flatwoods, ephemeral wetlands, and bayheads, where conditions occur for proliferation, including soil moisture for germination and availability of pine overstory which ladders ferns and increases spore cast opportunities. Brazilian pepper (*Schinus terebinthifolius*) occupies similar habitat niches as Old World climbing fern and is found on the refuge in all habitat types at varying infestation levels, preferring wetlands, mesic hammocks, and bayhead systems. Natal grass (*Melinis repens)* has infested each refuge unit (North Wind Inc., 2006) and is particularly invasive in disturbed sites associated with roadsides and firelines. On the refuge, natal grass is a primary invader of habitats after disturbance, including sandhill communities post fire. Feral hogs have nearly destroyed ephemeral wetlands of the Flamingo Villas Unit, rooting cutthroat grass and furrowing wetland soils,

potentially promoting long-term alterations to wetland hydrology and function and increasing potential invasion by non-native invasive plants. Walking catfish and brown hoplo infest wetlands and channel ditches (these species have been documented by staff at the Carter Creek and Flamingo Villas Units) where they have opportunities to prey on resident amphibian populations.

When possible, non-native species of wildlife or plants should be eradicated. In many cases, invasive, exotic, and nuisance species cannot be eradicated and, in those cases, the refuge will target maintenance control through the implementation of an Integrated Pest Management Plan. Priorities should be placed on non-native species that are strongly invasive or are capable of altering ecosystem functions or causing local extinctions of native species. The refuge will increase efforts to secure grant opportunities and will increase projects designed to identify and remove exotic and invasive plant species through the support of partners and volunteers. In order to combat the spread and reduce the likelihood of repeat invasions of non-native, invasive, and nuisance species from off-site sources, the refuge will work with the neighbors, targeting increased education and awareness.

Strategies - Exotic, Invasive, and Nuisance Plants:

- Partner with the FDEP's Lygodium Strike Team to control Old World climbing fern at the Flamingo Villas Unit.
- Use the Service's Invasive Species Strike Team to help control infestations of exotics on all refuge units.
- Integrate exotic pest plant control activities with fire management to optimize control efforts.
- Work with the partners to monitor the spread of laurel wilt and, where possible, treat through integrative management approach, including the release of approved biological control agents.
- Working with researchers and the partners, monitor the impacts of climate change on the spread and proliferation of exotic, invasive, and nuisance species, emphasizing high-priority habitats serving rare, threatened, and endangered species.

Strategies - Exotic, Invasive, Nuisance Animals:

- Increase feral hog control efforts on the refuge, including through the use of private contractors.
- Remove feral hogs, including by trapping, from (in priority order by refuge unit): Flamingo Villas, Carter Creek, Snell Creek, and Lake McLeod.
- Work with adjacent landowners and managers to control source populations of feral hogs.
- Coordinate with the partners to control feral and free-roaming animals to minimize adverse impacts to rare, threatened, and endangered species.
- Working with researchers and the partners, monitor the impacts of climate change on the spread and proliferation of exotic animals, emphasizing high-priority habitats serving rare, threatened, and endangered species.

Goal E. Understand the impacts of climate change on refuge resources to plan for and adapt management as necessary to protect rare, threatened, and endangered species; ridge habitats; and cultural resources of the refuge.

Objective E.1: Within the 15-year life of this CCP, work with the partners to investigate the impacts of climate change on refuge resources to better understand changes in habitat structure and function and the related impacts on rare, threatened, and endangered species.

Discussion: The direct effects of climate change on central Florida ridge systems are thought to include increased frequency and intensity of drought conditions, increased wildfire occurrence which may alter habitats on the refuge and increase the proliferation of exotic, invasive, and nuisance species although baseline information concerning the impact of a changing climate on the refuge is lacking. Interestingly, habitats and landscapes that make up the Lake Wales and central Florida ridges are perhaps some of the most resilient habitats in Florida as these systems have evolved for millions of years through climate changes producing similar impacts as those seen and expected. In order to better understand and address the consequences of climate change on refuge resources, the refuge will work with the partners to investigate the impacts of climate change in relation to habitat structure and function on rare, threatened, and endangered species and the habitats they occupy. Working with the partners, the refuge will promote refuge management lands as living laboratories for regional climate change research, specifically addressing impacts to rare, threatened, and endangered species and will participate in regional recognition of the role climate change plays on habitat changes and species adaptation.

Over the 15-year life of this CPP, the refuge will target restoration of habitats to pre-fire exclusion conditions through the implementation of prescribed fire on a routine basis. Many fire-dominated habitats exist on the refuge, home to at least 17 federally listed plants, 6 federally listed animals, and 1 federally listed candidate species, many of which utilize and, in some cases, specifically require habitat structure and function provided by frequent fire. The lack of frequent fire, a reality in non-intensively managed, fire dominated ridge habitats, plays an important role in reducing recovery potential of listed species and is likely to have detrimental impacts on recovery efforts.

Misperceptions exist regarding the relationship of prescribed fire management and forest carbon sequestration, specifically a perceived reduction in the ability of forest systems to sequester carbon. The debate centers on the role forest management and, in particular, prescribed fire plays on the global carbon budget. Recent research evaluating this relationship has discovered neutral to positive impacts. Robertson (unpublished information, Tall Timbers Research Station 2008) reports that in general, carbon released by prescribed fire is regained through vegetative growth and the effects of prescribed fire on forest soil carbon appears to be neutral or positive (Robertson, unpublished information, Tall Timbers Research Station 2008). Additionally, prescribed fire mitigation of wildfire may provide a net benefit in reducing green house gasses (Robertson, unpublished information, Tall Timbers Research Station 2008). Also, fuel reduction reduces severity of wildfires and has little to no negative effect on soil fauna, carbon, structure, and stability (Robertson, unpublished information, Tall Timbers Research Station 2008). In Canada, the carbon dioxide released by prescribed fire is about 3 percent of that produced by automobiles and industry (Robertson, unpublished information, Tall Timbers Research Station 2008). Furthermore, vigorous plant growth after a fire helps recapture carbon dioxide through photosynthesis (Robertson, unpublished information, Tall Timbers Research Station 2008). Banff National Parks of Canada (website FAQs http://www.pc.gc.ca/pn-np/ab/Banff/plan/plan16_e.asp *in* Robertson, Tall Timbers Research Station 2008) reports Canada's forestry practices, including prescribed fire, have a negligible impact on the global carbon budget. In order to develop a better understanding of the relationship of climate change with respect to the role of prescribed fire management, the refuge will work with the partners addressing the role of carbon sequestration in prescribed fire management. Upon discovery of new information regarding the impact of climate change, the refuge will adapt management as necessary specifically to protect rare, threatened, and endangered species and the habitats they occupy. The refuge will implement operational and administrative strategies and procedures, including implementing green technologies in an effort to reduce carbon emissions.

A potential indirect consequence of climate change to central Florida and ridge systems is the anticipated threat of human population movement and migration from coastal settings to inland Florida. Land use is anticipated to continue to change from rural to urban over the life of this CCP and it is thought this fate may partially be a consequence of and accelerated by threats from climate change to coastal Florida communities, including sea level rise and increased tropical cyclone development and intensity. Increased urbanization will impact the refuge specifically reducing management choices, including potentially limiting the use of prescribed fire in an expanding urban interface. With human population shift as a potential impact of climate change, the refuge will work with the partners and engage in regional land development planning potentially influencing management actions, including smoke management, species movement and corridor patterns, and water management. The refuge will reprioritize land acquisition efforts, including providing buffers for and inholding purchases to respond to anticipated impacts of climate change.

Goal F. Land Acquisition and Management

Protect and conserve the landscape of Lake Wales and Winter Haven Ridges to enhance the recovery of rare, threatened, and endangered species of this ancient and rapidly disappearing ecosystem.

Discussion: The threat of habitat loss, degradation, and fragmentation is expected to continue and increase across the landscape. Between 2005 and 2060, Florida's population is projected to double from approximately 18 to 36 million people (Zwick and Carr 2006). Highlands County, with a 2005-2007 estimated population of 97,392, is projected to nearly double (75 percent increase) to 170,038 by 2060 (Zwick and Carr 2006). Polk County, with a population of 483,924 in 2000, is projected to more than double (126 percent increase) to 1,029,606 by 2060 (Zwick and Carr 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006). Analyses by Zwick and Carr (2006) indicate that the central Florida region is expected to experience explosive growth, with continuous urban development from Ocala to Sebring; virtually all of the natural systems and wildlife corridors in this region would be fragmented, if not replaced, by urban development.

All units of the refuge are currently adjacent to developed lands with new development planned, approved, or under construction adjacent to or in close enough proximity to threaten refuge interests. Completing acquisition of the refuge boundary will directly protect rare, threatened, and endangered species and the habitats they occupy while increasing resource management options, particularly the implementation of prescribed fire. The refuge will prioritize land acquisition efforts based on biological significance and existing and potential threats to listed species protection and the ability to manage refuge interests. In order to improve land management of the Lake Wales and Winter Haven Ridge resources and to meet the purposes of the refuge, management will target protection of refuge, partner, and adjacent lands exhibiting features important to resource management through varying methods of acquisition from willing sellers and participants. These mechanisms include, but are not limited to, fee title acquisition, development of conservation easements, donations, management agreements with partner agencies, and land swaps with partner agencies. In order to manage refuge lands designed to meet the refuge purposes and the goals and objectives of this CCP, creative management solutions may be needed, including the facilitation of management authority to public or non-governmental partners of refuge owned/managed lands through mechanisms such as a memorandum of understanding. As mentioned, the refuge may need to investigate consolidating ownership by swapping lands with another agency to ease management constraints across the ridge landscape.

Objective F.1: Working with the partners, acquire or otherwise protect targeted inholdings within the refuge's acquisition boundary throughout the 15-year life of this CCP.

The Final Environmental Assessment and Land Protection Plan for Lake Wales Ridge NWR (November 1993) identified 12 distinct units within the approved acquisition boundary along the Lake Wales and Winter Haven Ridge Systems (Figure 2). The land protection plan grouped each of the 12 units into one of two priorities based on biological significance, existing and potential threats, importance of the site to refuge management and administration, and existing commitments to purchase protected lands. For lands within priority group one, recommended acquisition includes cooperative management agreements with the State of Florida, considered the minimum proprietary interest necessary to successfully implement desired protection management, with fee title acquisition a recommended alternative if the sites were/are not acquired by the State of Florida. Priority group one sites include the Flamingo Villas and Carter Creek Units and contain the highest number of threatened and endangered plant species, while representing the habitats most threatened by development at the time. Priority group two sites contain good diversity of threatened and endangered plants and faced low to moderate developmental pressures. The Lake McLeod and Snell Creek Units are considered priority group two where the recommended minimum proprietary interest acquisition method consists of cooperative agreements (Lake McLeod) and easements (Snell Creek).

When the Service began acquiring lands for the refuge in the early 1990s, the strategy was to focus on five properties that were not targeted by other agencies including the Flamingo Villas, Lake McLeod, and Snell Creek Units, along with the Horse Creek and Polk #52 Units (Figure 2). Through fee title acquisition from willing sellers, a total of 1,843.9 acres (746.2 ha) within four refuge units of the approved refuge acquisition boundary were acquired: Flamingo Villas, Carter Creek, Lake McLeod, and Snell Creek. Acquisition of the 1,436.2-acre (581.2 ha) Flamingo Villas Unit began in April 1994, based on a willing-seller approach and as of August 2010, 1,039.1 acres (420.5 ha) have been acquired in the Unit. In 1995, the Service began acquiring inholdings from willing sellers at the Lake McLeod Unit and acquired the 139.3-acre (56.4 ha) Snell Creek Unit during this time. The Service purchased 627.5 acres (253.9 ha) of the Carter Creek Unit through TNC in 1998. The Horse Creek Unit was acquired by the SFWMD through TNC, along with portions of the Snell Creek Unit. After further analysis, the priority group two Polk #52 Unit was dropped as a priority of the Service to focus acquisition efforts on the four units where acquisitions had been made.

The Flamingo Villas Unit provides the most difficulty in terms of acquisition due to the existence of a platted, approved subdivision with over 1,050-quarter-acre (0.1 ha) lots under multiple ownerships. Seventy-two percent of lands within the Flamingo Villas Unit have been acquired by the Service (1,039.1 acres/420.5 ha) and State of Florida (1 acres/0.4 ha), leaving 397.1 acres (160.7 ha) under varying private ownerships including easements, rights-of-way, common areas, and privately held inholdings. The Flamingo Villas Unit is considered a priority one acquisition site according to the 1993 land protection plan and acquisition of remaining inholdings here will remain a high priority throughout the 15-year life of this CCP.

An analysis to prioritize acquisition of remaining inholdings of the four refuge management units was conducted as part of this CCP. Parcels identified for priority acquisition are represented in Figures 10.1 through 10.4 and include five priorities - Very High, High, Medium, and Low. Priorities were based on the position of a particular inholding in the landscape, existing conditions, and ability to provide connectivity and corridor connections to other Service or partner lands. Inholdings of each refuge management unit were analyzed using basemaps developed through the course of this CCP. A total of 1,259 acres (509.9 ha) of Very High priority inholdings occur within the acquisition boundaries of the four refuge management units: Flamingo Villas, Carter Creek, Lake McLeod, and Snell Creek (Table 24, Figures 10.1-10.4). The Service presently does not own or manage lands north of Arbuckle Creek Road in the Carter Creek portion of the acquisition boundary. However, FWC and TNC have acquired and collectively manage over 2,100 acres (849.8 ha) north of Arbuckle

Creek Road as part of the LWRWEA. Continued acquisition by the State and TNC of lands north of Arbuckle Creek Road is anticipated throughout the 15-year life of this CCP in an effort to connect remaining inholdings to publically managed areas. For these reasons, and to maintain continuity with lands presently managed by the refuge, the Service assigns lands north or Arbuckle Creek Road within the Carter Creek portion of the acquisition boundary as low acquisition priority (Figure 10.2).

- Very High - Undeveloped inholdings with limited to no disturbance; provides connectivity to conservation lands, enabling best management capabilities; limited logistical constraints from location in the landscape and juxtaposition to existing refuge managed lands; exhibits high habitat value and function for rare, threatened, and endangered species.

- High - Minimally developed inholdings; provides connectivity to conservation managed lands, enabling best management capabilities; limited logistical constraints form location in the landscape and juxtaposition to existing refuge managed lands; exhibits habitat value and function, however minimal development lessens the value of habitat.

- Medium - Moderately developed inholdings; provides connectivity to conservation managed lands or is strategically located and juxtapositioned to refuge managed or potentially managed lands if acquired as identified under higher priority inholdings; exhibits habitat value and function (Carter Creek south parcel priority - due to relationship to very high priority lands, this particular block would be considered very high but is rated as moderate due to existing single family homes).

- Low - Intensely developed inholdings; provides connectivity to conservation managed lands; provides connectivity to conservation lands; exhibits minimal to no habitat value or function; Carter Creek Unit lands north of Arbuckle Creek Road.

Table 24. Total area of inholdings of refuge management units by priority acquisition

Priority	Flamingo Villas acres/ hectares	Carter Creek acres/ hectares	Lake McLeod acres/ hectares	Snell Creek acres/ hectares	Total acres/ hectares
Very High	96.6a 39.1h	1,121.6a 453.9h	0.5a 0.2h	40.3a 16.3h	1,259a 509.5h
High	148.2a 60.0h			71.1a 28.8h	219.3a 88.8h
Medium		2.5a 1.0h	5.0a 2.0h		7.5a 3.0h
Low		1039.9a 420.8h	2.3a 0.9h		1042.2a 421.7h
Total	**244.8a 99.1h**	**2164a 875.7h**	**7.8a 3.1h**	**111.4a 45.1h**	**2528a 1023h**

Figure 10.1. Refuge priority acquisitions – Flamingo Villas Unit

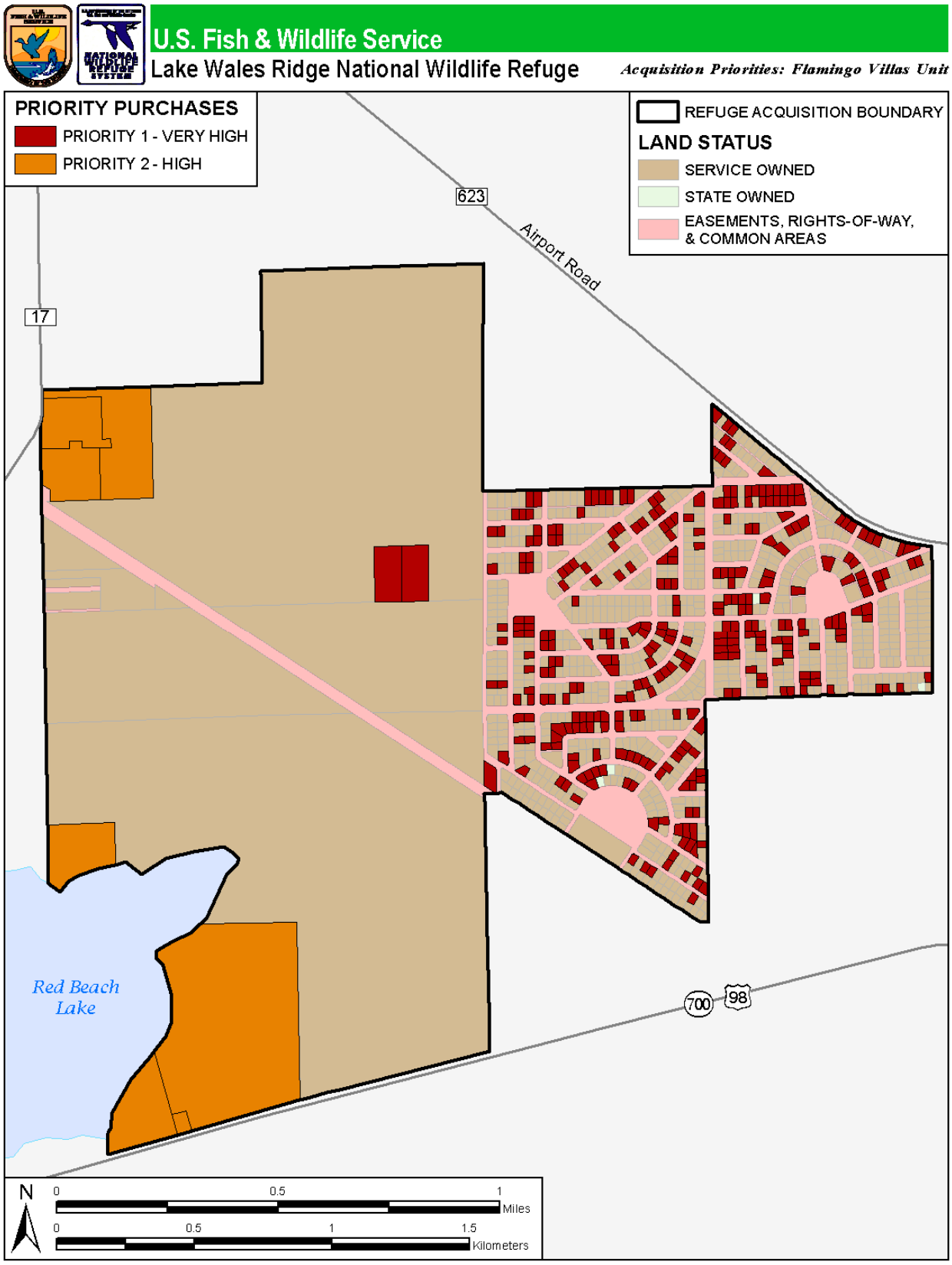


Figure 10.2. Refuge priority acquisitions – Carter Creek Unit

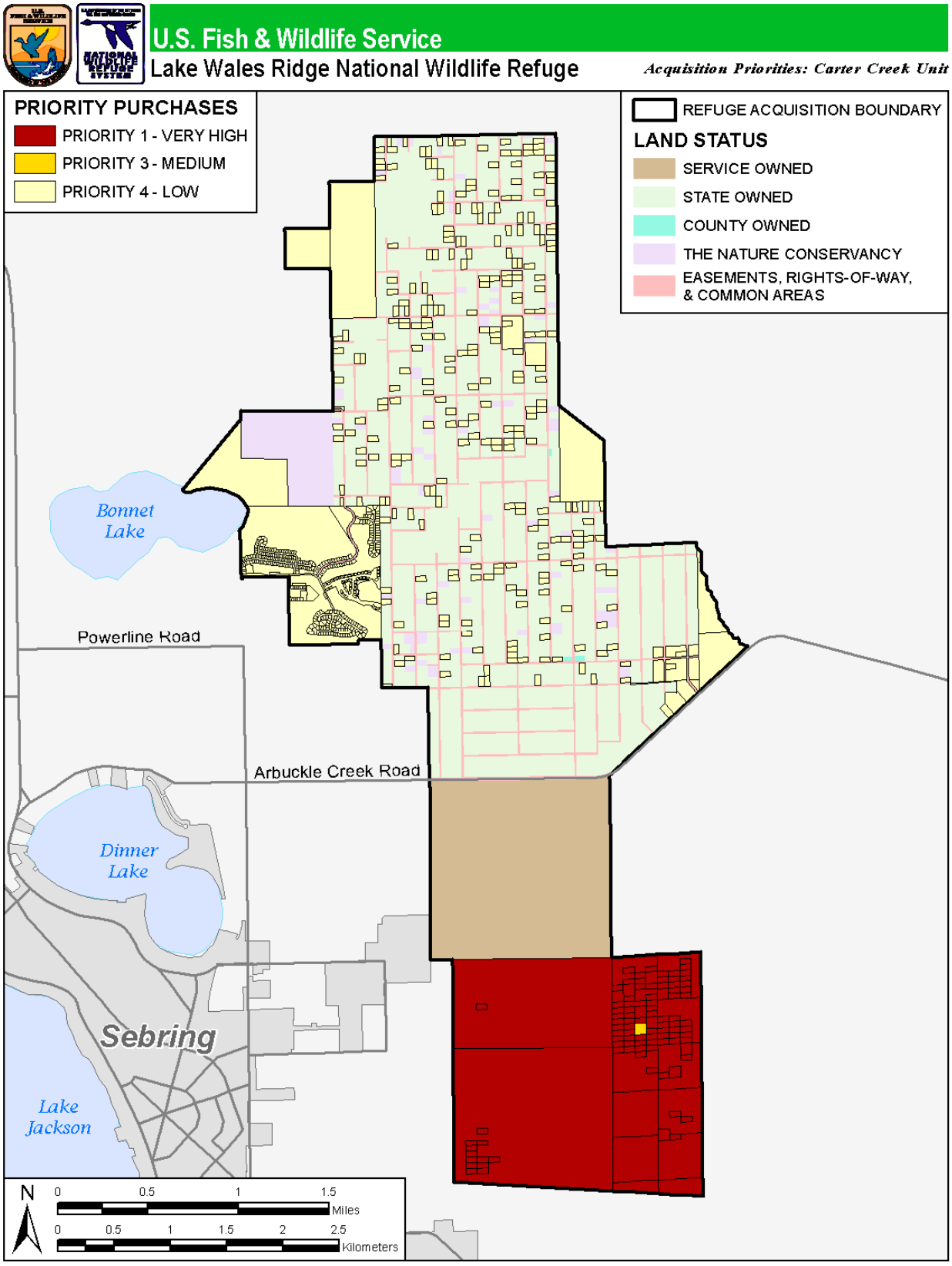


Figure 10.3. Refuge priority acquisitions – Lake McLeod Unit

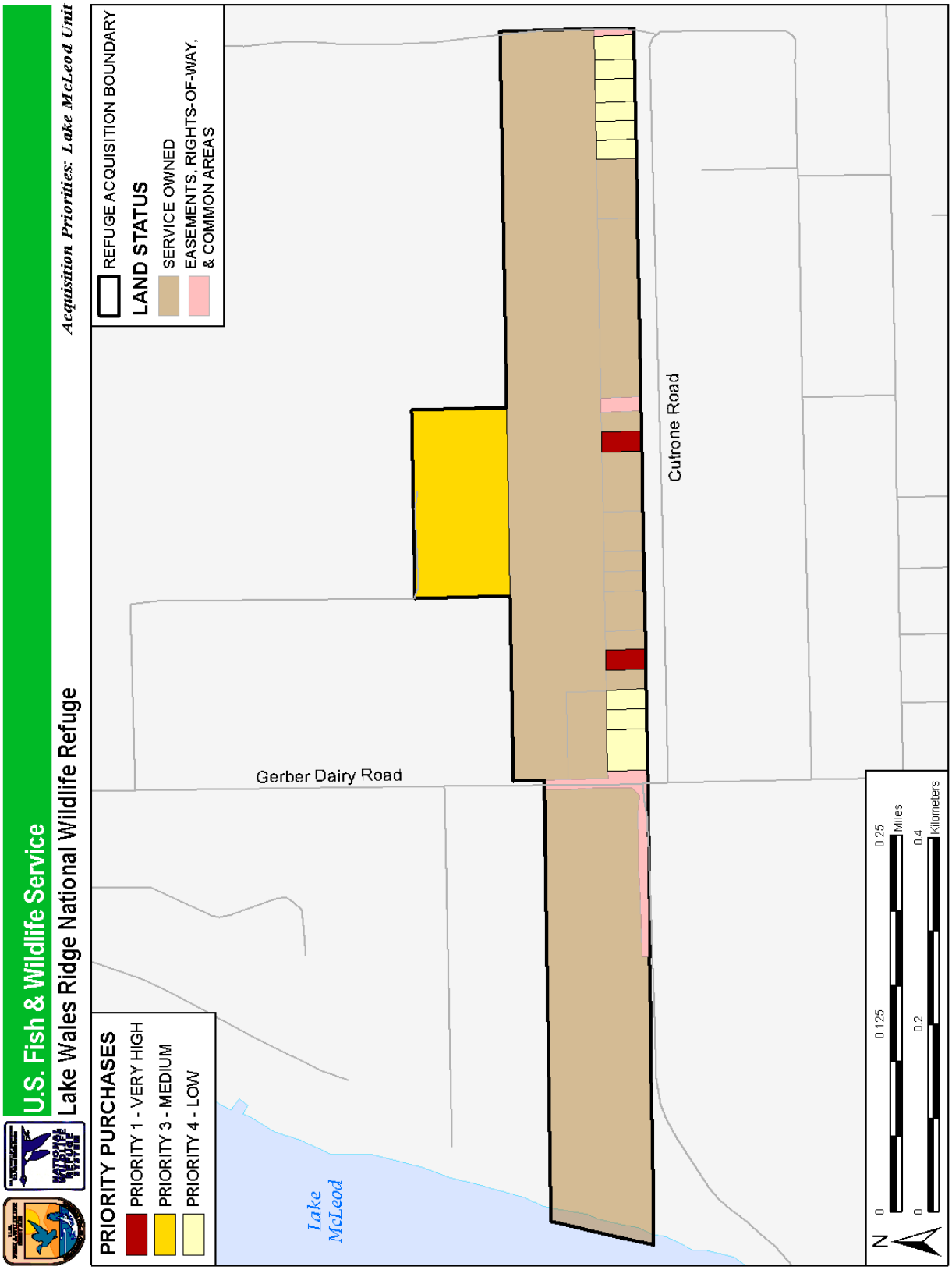
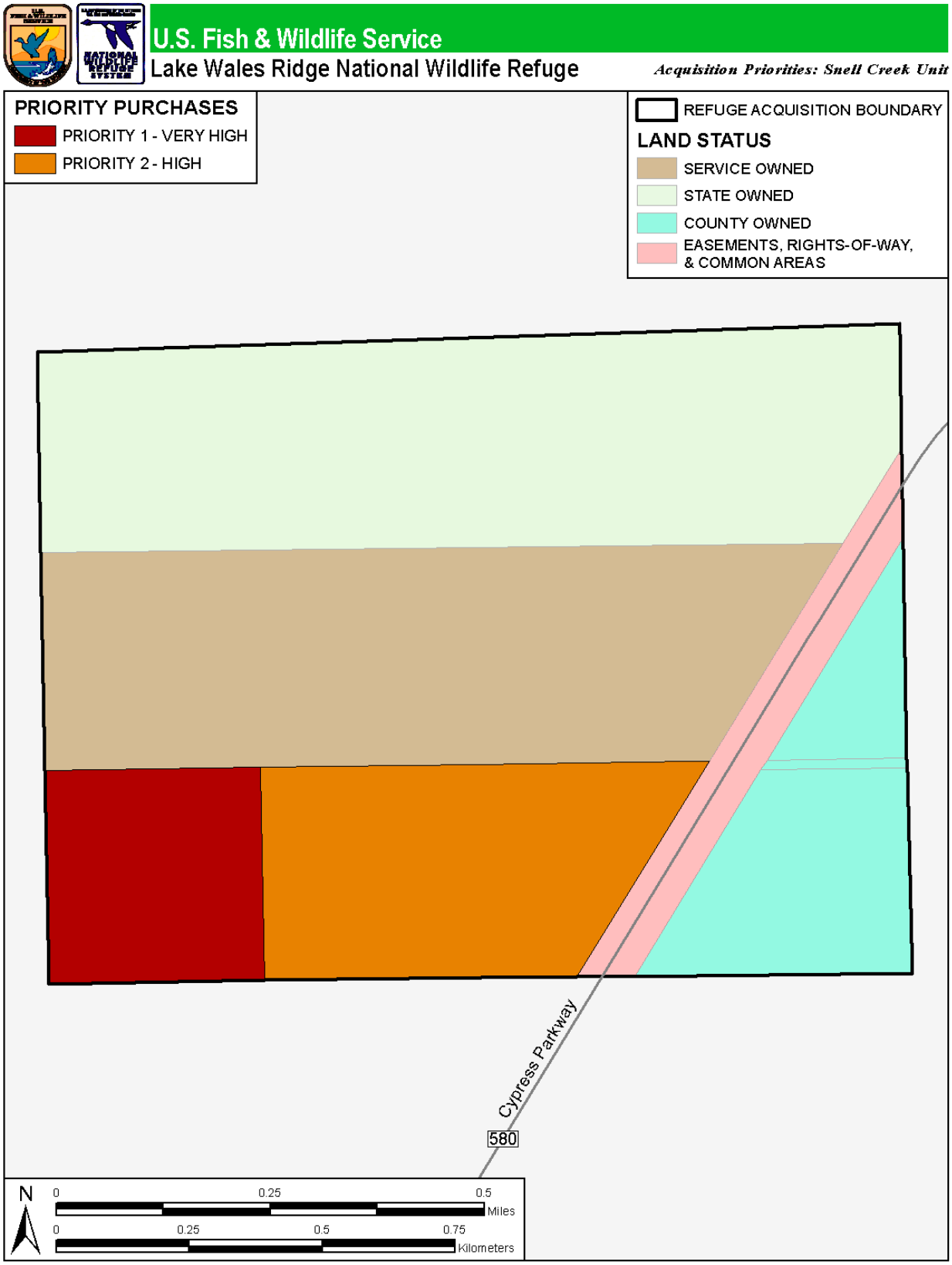


Figure 10.4. Refuge priority acquisitions – Snell Creek Unit



In order to serve the purposes of the refuge and achieve the goals, objectives, and strategies targeted in this CCP, the refuge will work with the partners to continue acquiring inholdings, targeting very high and high priority lands within the approved refuge acquisition boundary of the four units where the Service currently has management interest: Flamingo Villas, Carter Creek, Lake McLeod, and Snell Creek. The refuge will continue to acquire lands opportunistically based on a willing-seller approach. Land acquisition efforts will be bolstered by continued and increased partnerships and involvement in regional land use planning and natural area land purchase efforts. The refuge will investigate all forms of land acquisition opportunities including but not limited to land swaps with partner agencies and establishment of easements with private inholders. In order to increase funding possibilities, the refuge will continue to submit Lake Wale Ridge NWR for ranking in the Service's Service Land Acquisition Priority System (LAPS) and will work with the Florida Forever Program (and its possible successor) to maintain refuge units targeted for acquisition on the A list of the State of Florida's land acquisition priorities. In addition, the refuge will work to mesh existing data sources, including land cover imagery to enable best management decision-making with regard to land acquisition.

Strategies:

- Work with the partners to acquire or otherwise protect targeted inholdings within the refuge's acquisition boundary, prioritizing the completion of Flamingo Villas, Lake McLeod, and the southern portion of Carter Creek, and the undeveloped portion of Snell Creek.
- Support local initiatives concerning land conservation of the Flamingo Villas Unit, including efforts by Highlands County's Natural Resources Advisory Commission (NRAC).
- Work with local governments to abandon any unneeded easements or rights-of-way within the refuge's management units.
- Continue to pursue Service funding venues, including Inholdings Fund and Land and Water Conservation Trust Fund.
- Formalize existing land acquisition partnerships and engage in new partnerships with non-governmental organizations, other federal agencies, other state agencies, and Highlands and Polk Counties.
- Coordinate with the Service's Realty Division to update the acquisition and management boundaries of the refuge.

Objective F.2: Within 1 year of the date of this CCP, coordinate with Service's Realty Division to update the acquisition and management boundaries of the refuge.

Discussion: During the development of this CCP, the Service discovered discrepancies between the Division of Realty's boundary shapefile that represents the Lake Wales Ridge NWR parcel information, the original paper maps of the 1993 Lake Wales Ridge NWR Land Protection Plan, and boundary information generated for this CCP. Based on staff knowledge of the area and best available information, the refuge's parcels and boundaries were mapped using parcel data from both counties as these data reflect the most current representation of parcel and boundary information.

During the preparation of this CCP, digitally rectified shapefiles of the 1993 Land Protection Plan maps were not available. These maps were originally used by the Service's Division of Realty to establish the digital boundary basemaps (found at http://www.fws.gov/data/r4gis/boundary.html). Due to the coarse nature of the 1993 paper maps and inherent digitizing errors frequent with past mapping technologies and software, the Lake Wales Ridge NWR boundary basemaps do not reflect land use conditions with the precision of current GIS technology. In addition, according to the Service's Division of Realty staff, projects to update refuge boundaries are currently underway using

new GIS technologies and based on updated parcel information; however, these coverage's are not presently available for most refuges in the State of Florida, including Lake Wales Ridge NWR. For the purposes of this CCP, it was necessary to represent boundary and parcel information based on staff and partner knowledge of the area and best available information including 2007 aerial imagery and parcel data from Highlands and Polk Counties to define parcel information, refuge acquisition boundary, and refuge management boundary.

By overlaying the refuge's parcels, generated using Highlands and Polk Counties data with the Realty GIS layer for the refuge, discrepancies became apparent. One of the differences appeared to be a shift and stretch of the Realty parcel coverage for the Flamingo Villas Unit, where a checkerboard mix of inholdings and refuge parcels occur (Figures 5.3.1 and 5.3.2). This discrepancy was thought to be the result of the now antiquated process of migrating the coarse land protection plan maps into digital coverage's. One result of this shift and stretch was the inability to overlay Realty basemaps with updated aerial imagery or other baseline information including habitat coverage. County parcel data from Polk and Highlands Counties were used after comparing, through an intensive heads-up digitizing process, all parcels in Realty's coverage with spatially rectified coverage's from the Polk and Highlands Counties in order to provide the most accurate and up-to-date reflection of parcel coverage. Other discrepancies included identification of parcels that were owned by the Service that were not actually Service-owned, and identification of parcels not reflected as Service-owned that were, in fact, owned by the Service. These discrepancies were rectified using the same techniques described above.

Another discrepancy included the digital depiction of the Lake McLeod Unit which did not include an area of land that appeared to be considered in the land protection plan maps. During the GIS mapping efforts for this CCP, we reviewed historic aerial imagery of the Lake McLeod Unit and determined that this area appeared to be habitat during the development of the land protection plan and was represented within the acquisition boundary but was not reflected in later developed digital coverages. We feel this area of land was intended to be included in the acquisition boundary for the Unit and is represented in CCP maps. Other discrepancies were rectified through heads up digitizing and included most notably, boundary snapping to current parcel data. An attribute field was created in the parcel layers for each unit to identify records where discrepancies were found.

Maps represented in this CCP reflect updated refuge acquisition and management boundaries and consequential information provided by this update include: new total acreage calculations of Service lands within the acquisition boundary; updated refuge management boundary; updated total acreage represented by the management boundary; and updates to the status of all lands of the refuge's acquisition boundary. Again, these updates were based on an intensive GIS review and by cross referencing different sources of data including current and digital historic aerial imagery, images of maps digitally represented, and the most current digital data from the Division of Realty and Highlands and Polk Counties. The refuge will work with the Division of Realty to recognize the GIS layer created for this CCP as the most accurate representation of parcel information available for the refuge. Utilizing mapping information provided by the GIS layers, the refuge will work with the Division of Realty to develop a more accurate representation of the refuge's acquisition boundary, total acreage contained within the acquisition boundary, the refuge's management boundary, the total acreage represented by the management boundary, and the status of all lands and waters of the refuge's acquisition boundary.

Objective F.3: Over the 15-year life of this CCP, within the refuge's acquisition boundary, evaluate the need to establish management agreements with partners and refuge neighbors, including through lease agreements, memoranda of understanding, and easements to benefit rare, threatened, and endangered species.

Discussion: The refuge currently has no specific full-time employees or budget, which, coupled with the distance refuge lands are to complex headquarters in Vero Beach and Merritt Island, severely limits the ability of the Service to implement management on the refuge. The lack of habitat management, particularly the application of prescribed fire, plays an important role in reducing recovery potential of listed species and is likely to have detrimental impacts on recovery efforts. In fact, habitat degradation due to fire suppression is becoming a pervasive threat to listed species, particularly listed plants for which the refuge is purposed to protect. Most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, FDEP, pers. comm. 2007 *in* Service 2009a; Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of habitat in some areas. In order to restore and maintain habitats for listed species consistent with the goals, objectives, and strategies outlined in this CCP, a Service staff compliment will be proposed that, coupled with increased partnerships, will provide habitat management services. Without specific staff and funding, creative solutions will be necessary to manage refuge lands that may include entering into agreements with partner organizations to delegate management authority consistent with the goals, objectives, and strategies outlined in this CCP.

The refuge will investigate entering into agreements (e.g., MOUs) to allow management of refuge resources by partner entities. Partners will play a primary role in achieving the goals and objectives of this CCP. Many refuge partners are located in close proximity to refuge interests and are currently more operationally and logistically equipped to manage public lands including Service-owned lands of the refuge. Particularly, agreements of Service interests within the Snell Creek Unit where the State of Florida (SFWMD under FWC Type II Wildlife Management Area) currently manages lands of similar habitat type and function adjacent and in close proximity to the refuge's Snell Creek Unit will be investigated. All management agreements entered into will be consistent with the purposes, goals, and objectives of the refuge.

The Snell Creek Unit, as is the case with all Lake Wales Ridge NWR interests, is closed except for refuge approved and permitted activities including refuge-led tours for wildlife observation, photography, and environmental education and interpretation. Throughout the 15-year life of this CCP, the refuge will remain closed due to the sensitivity of habitats and species, particularly the vulnerability of listed plants to disturbance, except for the activities listed above. Where an activity is not considered under these general opportunities, management will evaluate use requests on a case-by-case basis through the special use permit process. As mentioned, agreements with partner agencies will be consistent with this CCP and will target refuge management opportunities and may include but not be limited to research and science discovery, implementation of prescribed fire, guided tours, and exotic and nuisance species control.

As mentioned, land swaps will also be investigated as a possible way to consolidate refuge lands with partner lands. Transferring ownership of lands owned by the Service to partners who are logistically better suited to manage the Lake Wales and Winter Haven Ridge Systems will reduce habitat management constraints, particularly prescribed fire and law enforcement which are viewed as primary components to habitat restoration initiatives. In turn, the Service would be provided lands that are logistically better suited for management by existing staffs of Merritt Island NWR Complex and Pelican Island NWR Complex.

Strategies:

- Evaluate the establishment of management agreements with partners and refuge neighbors, including through lease agreements, memoranda of understanding, and easements to benefit high-priority habitats serving rare, threatened, and endangered species.
- Investigate MOU and other agreement options with partners to authorize management of refuge resources by partners consistent with this CCP.
- Within 3 years of the date of this CCP, work with partners to investigate the development of a management agreement with the State of Florida to manage the resources of the Snell Creek Unit.
- Continue to provide management agreements for research opportunities in response to management activities through the use of memoranda of understanding, special use permits, or other agreement platforms.
- Identify the status of partner lands within the refuge's acquisition boundary and explore appropriate management agreements for these lands.

Objective F.4: Throughout the 15-year life of this CCP, work with the partners to identify and protect conservation focus areas outside of the refuge's acquisition boundary to better provide for wide-ranging rare, threatened, and endangered species and for recruitment and dispersal to support conservation and recovery efforts.

Discussion: Throughout the central Florida landscape, land use patterns are anticipated to shift from rural to urban over the 15-year life of this CCP, the outcome of which is likely to be further fragmentation of habitats and species movement corridors. Zwick and Carr (2006) performed an analysis to determine the composition of lands within a 1-mile buffer of existing conservation lands in Florida. Of the roughly 8 million acres in that 1-mile buffer, almost 1.5 million are already in urban use and it appears an additional 1.9 million acres could be converted by 2060, or as much as 41 percent of the lands within the 1-mile buffer could be urbanized by 2060 (Zwick and Carr 2006). Zwick and Carr (2006) concluded that the implications are great for the long-term management of conservation lands in Florida. According to Zwick and Carr (2006), in the worst cases this will leave conservation lands isolated, surrounded by urbanization. In the best cases, management strategies dependent on natural processes, such as flooding and fire, will be compromised to accommodate new neighbors (Zwick and Carr 2006).

Providing connectivity (wildlife corridors) and enlarging conservation lands are two important tools that can be used to better protect and manage refuge resources. The four refuge management units are linearly spread over a 60-mile (96.5 km) area from Haines City, Florida, to Sebring, Florida, but exist in a landscape of protected lands occurring throughout the Lake Wales and Winter Haven Ridge ecosystems (Figure 3). The refuge units exist with other ridge system natural areas within a much larger matrix of developed and non-developed private lands, sharing boundaries with major road rights-of-way, developed private lands of varying intensities from residential to commercial and agricultural, and non-developed private lands that together limit opportunities for wildlife movement and species recruitment. Strategies to provide connections and corridors benefiting species movement and recruitment will include investigating land swaps as a means to consolidate public lands under a single ownership and/or management entity. This process may include the acquisition of lands outside of the refuge's approved acquisition boundary. Any important properties fulfilling the Service interests to consolidate or provide connectivity opportunities outside the approved acquisition boundary will by proposed for addition under a minor expansion proposal of less than 10 percent of the approved acquisition boundary. The refuge will work with the partners to identify and protect

future conservation focus areas discovered through this process. Where consolidation of lands provides the best opportunity for habitat management and species protection, the refuge will work with the partners and enter into management agreements either transferring management authority to partner agencies best suited to manage habitats, or where the refuge is best suited, acquire or otherwise obtain management authority of important habitats, habitat connections, and wildlife corridors (e.g., through conservation easements).

The Service is increasingly aware of the importance of protecting habitats within the Lake Wales Ridge region of the Greater Everglades Ecosystem as human populations increase and anticipated changes in sea level are expected to impact freshwater resources and encroach on existing wildlife habitat in southern Florida. The Lake Wales Ridge region is an area of national significance for biodiversity conservation within this ecosystem. As a significant portion of the Everglades headwaters and home to over 30 federal- and state-listed plants and wildlife species, this region offers one of the greatest opportunities to: protect and manage habitat for endangered species; restore, manage, and protect the upper watershed of Greater Everglades Ecosystem; provide habitat for species being displaced by climate change impacts; work with private landowners in developing a landscape-scale network of wild lands; and provide wildlife-dependent education and recreation opportunities. In working with multiple conservation organizations, agencies and the general public, the Service will continue to explore opportunities for acquisition, restoration, and management within the Lake Wales Ridge region of the Greater Everglades Ecosystem.

The refuge will work with the partners to support development of wildlife corridors, connecting surrounding conservation areas and supporting movement and recruitment of rare, threatened, and endangered species. Movement of species including Florida black bear, Florida panther and Florida scrub-jay will benefit from increased habitat connections made possible through land acquisition and partnerships. The Flamingo Villas Unit is the only refuge unit with groups of Florida scrub-jays. This property is nearly surrounded by suburban development; however, available agricultural lands and undeveloped parcels exist to the north of County Road 623 (Kenilworth Road) and to the south of State Road 98. In 2008, seven scrub-jay groups were documented on the refuge. These groups are restricted to the Flamingo Villas Unit and the railroad right-of-way. The refuge will target the needs of scrub-jay recruitment and dispersal and other primary species through acquisition and management of remaining private inholdings within the acquisition boundary and working with partners and neighbors, through the establishment of management agreements including conservation easements. Road construction will likely be a major concern in the future. Plans to widen State Road 98 and County Road 623 are well underway and would impact Florida black bear or potential Florida panther movement on or off the refuge. The refuge will support the development of wildlife underpasses to secure availability of large landscapes for wide-ranging species including Florida panther and Florida black bear in addition to providing alternative movement options to and from refuge properties.

The refuge will participate with the partners in regional land use and land development planning organizations and initiatives including the Heartland 2060 initiative, Highlands County Natural Resources Advisory Council, Highlands and Polk Counties' Growth Management and Natural Resources Divisions, and other regional land planning/management efforts for the purposes of future land use decision-making throughout the ridge and specific to the protection of refuge trust resources.

Strategies:

- Work with the partners to identify and protect conservation focus areas outside of the refuge's acquisition boundary to better provide conservation and recovery efforts for rare, threatened, and endangered species.

- Work with partners to pursue conservation easements on privately owned lands within and adjacent to the refuge's acquisition boundary.
- Encourage partners (e.g., TNC and Green Horizons Land Trust) to purchase property between the Flamingo Villas and Carter Creek Units and/or work with the partners (e.g., Sebring Airport) to provide a corridor connection between the Carter Creek and Flamingo Villas Units.
- Work with the partners to locate and install wildlife underpasses to facilitate wildlife movement under State Road 98 and County Road 623 (adjacent to the refuge's boundary).
- Work with the partners to identify challenges and develop understanding of the impact of climate change on habitat value, specifically relating to climate-related shifts in rare, threatened, and endangered species' ranges.

Goal G. Identify and protect archaeological and historical resources reflecting the natural and cultural history of the unique and ancient Lake Wales and Winter Haven Ridge ecosystems.

Objective G.1: Within 5 years of the date of this CCP, work with the Service's Regional Archaeologist and the State Historic Preservation Officer to survey all units of the refuge for the presence of archaeological and historical resources. Adapt management activities as necessary to protect any discovered cultural resources.

Discussion: The presence and extent of cultural resources on the refuge are unknown since no comprehensive cultural resource surveys exist. During the establishment period of the refuge, a State of Florida assessment and review of the Florida Site File (Florida Department of State 1992) indicated that there were no archaeological or historical sites recorded within the various units of the proposed refuge acquisition boundary. However, the assessment identified that the lack of recorded historical properties was due, in part, to a lack of systematic, professional surveys to locate such properties. Data from environmentally similar areas in Polk and Highlands Counties indicate that archaeological and historical sites, especially the former, are likely to occur in the study area that includes the refuge units. The assessment recommended that, prior to initiating project-related land clearing or ground disturbing activities within refuge units, the projects should undergo systematic professional archaeological and historical surveys to locate and assess the significance of any properties present. If archaeological and historical amenities eligible for listing in the National Register were discovered, appropriate avoidance, minimization, or mitigation strategies will need to be employed as a condition of approval of refuge establishment from the State of Florida, Division of Historical Resources, and the State Historic Preservation Officer. The refuge will continue to work with the partners, the Service's Regional Archaeologist, and the State Historic Preservation Officer to identify and protect cultural resources in advance of land disturbing activities. The refuge will report all suspected sites to the refuge manager (e.g., resources discovered during mechanical maintenance of fire lines).

Goal H. Develop public understanding, appreciation, awareness, and support for the ancient scrub ecosystem and unique resources of the Lake Wales and Winter Haven Ridge systems and the refuge.

Discussion: Due to the sensitivity of refuge habitats and species, particularly the vulnerability of listed plants to disturbance, the refuge will remain closed to use by the public over the 15-year life of this CCP, except for approved and permitted activities including refuge-led tours for wildlife observation, photography, and environmental education and interpretation. Where an activity is not considered under these general opportunities, management will evaluate use requests on a case-by-case basis through the special use permit process. Agreements with partner agencies will be consistent with this

CCP and will target management opportunities and may include, but not be limited to, research and scientific discovery, implementation of prescribed fire, guided tours, and exotic and nuisance species control to provide for the purposes and goals and objectives of the refuge.

Management will target an increase in public awareness by providing environmental education, wildlife observation, and outreach opportunities. In order to increase public understanding, appreciation, awareness, and support for the refuge's unique resources, while providing for the life needs of the many rare, threatened, and endangered species, the refuge will provide for and participate with partners in existing education programs, including continued participation with the LWREWG environmental education subcommittee. Through the subcommittee, the refuge will actively participate in education programs, including the Archbold Educational Program, and where appropriate, facilitate on-site educational programs. The refuge will host an annual event designed as an outreach opportunity to further refuge awareness and bolster public interest of the unique Lake Wales and Winter Haven Ridge ecosystems, focusing messages on rare, threatened, and endangered species and the minimization of human impacts. To bolster the existing volunteer base and to recruit additional volunteers to assist with planned projects, the refuge will continue to work with the partners to recruit volunteers to participate in environmental education opportunities. Throughout the 15-year life of this CCP, the refuge will provide for and update information through the refuge's website, including providing links to partner websites to provide visitor use information about the Lake Wales and Winter Haven Ridge Systems.

Objective H.1: Continue to provide limited guided tours of the refuge through the special use permit program and within 1 year of the date of this CCP, coordinate with the partners to develop a small-scale event (yearly) to build community support for the refuge and the Lake Wales and Winter Haven Ridge Systems.

Discussion: In order to promote the importance of and develop interest in the ridge ecosystems, the refuge will provide guided tours led by staff or volunteers through the special use permit process on a case-by-case basis. Tours will be either independent of or in concert with partner outreach events, with key messages focused on the importance of the refuge to rare, threatened, and endangered species, the habitats they occupy, and the minimization of human impacts. The refuge will integrate key messages with partner messages, focusing on the importance of the ridge ecosystem to the many rare plants and animals. The refuge will participate in outreach events of the partners to increase public understanding and appreciation for the Lake Wales Ridge. The refuge will review available materials from the partners and develop refuge informational materials to present key messages that can be provided at partner outreach events and sites as needed. To bolster community support for the refuge and the ridge systems, the refuge will host an annual event where environmental education and interpretation will be focused on the unique resources of the refuge and where wildlife observation and photography opportunities will be made available under limited and controlled conditions. Increasing volunteer participation will be needed to support visitor services opportunities, including approved visits. The refuge will participate with the state and other land managers in conducting events, programs, news releases, and interpretive materials that will educate the public on the ridge systems.

Goal I. Coordinate with the partners to focus ridge outreach efforts on rare, threatened, and endangered species and the minimization of human impacts to build support for resource management and land acquisition activities of the refuge and ridge conservation partners.

Discussion: Through partnerships, develop support for prescribed fire, land acquisition, and corridor development. Participate with partners to implement outreach activities and focus messages on rare, threatened, and endangered species and the minimization of human impacts. As mentioned, in order

to increase public awareness as to the uniqueness of the refuge and to bolster community support for the refuge and ridge ecosystems, the refuge will host an annual event. The refuge will provide for and update information through its website, with links to partner sites; will develop media contacts and relationships to convey the positive attributes of fire on the ridge to the public; and will develop a refuge specific brochure to gain appreciation among residents and visitors and as a way to disseminate information about the refuge.

Objective I.1: Within 1 year of the date of this CCP, participate in select outreach events held by the partners and coordinate with them to develop a small-scale annual event to build community support for the refuge and the ridge systems.

Objective I.2: Communicate key messages and issues with off-site audiences to build support within the local community and beyond for the refuge, its purposes, and its management.

Strategies:

- Develop key messages for the refuge. Focus messages on rare, threatened, and endangered species and the minimization of human impacts. Coordinate a fire mission message with the LWREWG describing the benefits of prescribed fire on the ridge.
- Update and keep current the refuge's website.
- Develop limited informative materials about the refuge to provide to the public.

Goal J. The refuge will be free of litter and debris.

Objective J.1: Within 5 years of the date of this CCP, remove the remaining debris at the Flamingo Villas Unit and throughout the 15-year life of this CCP maintain an adequate fence to prevent additional dumping.

Objective J.2: Throughout the 15-year life of this CCP, maintain adequate fences to prevent additional dumping at the Carter Creek and Lake McLeod Units and within 5 years of the date of this CCP, remove the remaining debris from both units.

Objective J.3: Within 5 years of the date of this CCP, fence the south and west side of the Snell Creek Unit adjacent to private property to prevent additional dumping.

Objective J.4: Within 5 years of the date of this CCP, develop a litter and debris maintenance program for the refuge.

Discussion: Litter and debris negatively impact refuge wildlife and habitats. The Flamingo Villas Unit has a long history as a litter and debris dumping site and of the four refuge units, is considered the most problematic with widely scattered, large piles of litter and debris that require continuous cleanups. Major cleanup efforts have occurred on the refuge, including the Flamingo Villas Unit, and continued emphasis on cleanups there will further benefit rare, threatened, and endangered species. Currently, the Carter Creek Unit has scattered debris, as does the Lake McLeod Unit, both of which will require continual litter and debris removal maintenance over the 15-year life of this CCP. To date, the Snell Creek Unit has not had the same level of litter and debris dumping as other refuge units. In order to improve conditions for rare, threatened, and endangered species and the habitats they occupy, the refuge will work with the partners and volunteers to develop a regular cleanup program. Periodic

assessments will facilitate the need to conduct additional cleanups. Additionally, establishing new partnerships will increase and bolster cleanup efforts.

Strategies:

- Develop an aggressive trash removal program and decrease dumping on the refuge through community outreach.
- Work with the partners to conduct random law enforcement patrols of each property to control dumping activities on the refuge.
- Maintain fences and posting on all Service properties.
- Continue promoting the use of volunteers to remove trash from all refuge units.
- Implement a partnership with the Highlands County Sheriff's Department to use prisoner road work crews on the Flamingo Villas Unit.
- Continue to run the trash removal program with volunteer workers.

REFUGE ADMINISTRATION

Goal K. Provide sufficient infrastructure, operations, volunteers, and staff to protect and manage the natural resources of Lake Wales Ridge NWR.

Discussion: Currently, the refuge has no dedicated staff or funding to manage resources at the levels necessary to restore habitats to pre-fire exclusion conditions as provided for in this CCP. The refuge is directly managed as a shared responsibility by the Pelican Island NWR Complex, which also manages Archie Carr NWR, providing, as needed, refuge management, biology, and limited visitor services functions. Additional administrative, law enforcement, and fire support is provided through the Merritt Island NWR Complex. In part, the lack of dedicated staff, funding, and the refuge's remote location to the Merritt Island NWR Complex (100 miles away) and to the Pelican Island NWR Complex (60 miles away) challenges management options and reduces management opportunities necessary to administer the goals, objectives, and strategies identified in this CCP. Threats to rare, threatened, and endangered species on the Lake Wales and Winter Haven Ridge Systems are many and varied, but include the absence of land management, particularly prescribed fire. This causes habitat succession to types that limit the establishment of new and protection of existing rare, threatened, and endangered species for which the refuge is purposed to protect and some of which are protected nowhere else but on the refuge. In addition, impacts from an increasingly developing landscape adjacent to and in close proximity to refuge interests threaten application of the intensive management necessary to restore habitat value and function provided by this CCP. An adequately staffed and funded refuge, coupled with increased management partnerships, will provide for the purposes of the refuge and support the goals and objectives outlined in this CCP, maintaining the Service's legacy as an active participator in protecting the last vestiges of the Lake Wales and Winter Haven Ridge ecosystems.

Objective K.1: Develop refuge-specific staff, including a wildlife refuge specialist (assistant manager), private lands biologist, fire/forestry technician, biological science technician, wildlife biologist/botanist, and share a refuge officer and refuge ranger with the other refuges within the Pelican Island NWR Complex.

Discussion: Currently, the refuge has no dedicated staff or funding and all refuge functions, including management, biology, maintenance, and outreach/environmental education/interpretive programs are shared with Pelican Island and Archie Carr NWRs. Additional support and fire program management are currently conducted by the Merritt Island NWR Complex. Refuge management, biology, and fire

management full-time staff will be necessary to implement the goals, objectives, and strategies outlined in this CCP. Law enforcement presence will continue to be a shared responsibility through a previously identified position within the CCPs for Pelican Island and Archie Carr NWRs. Outreach and environmental education programs will be facilitated through the Pelican Island NWR Complex. Prescribed and unwanted wildland fire management, administration, and most maintenance will continue to be provided for by the Merritt Island NWR Complex. Priorities for filling the positions are listed.

- Wildlife refuge specialist (assistant refuge manager)
- Private lands biologist
- Fire/forestry technician
- Biological science technician
- Botanist/biologist

Objective K.2: Over the 15-year life of this CCP, develop a volunteer base and build support from existing friends groups for refuges in the Merritt Island NWR Complex to compliment and facilitate refuge management needs.

Discussion: The refuge currently has a small, but dedicated cadre of eight volunteers who are trained based on specific work and projects. Volunteers have provided important refuge management support with trash and debris removal; control of non-native and nuisance species; fencing; prescribed fire; vegetation mapping; and monitoring of rare, threatened, and endangered species. The refuge also utilizes the State of Florida's Ridge Rangers to assist in litter and debris cleanups, and TNC's Jay Watch provides scrub-jay surveys at the Flamingo Villas and Carter Creek Units. The Lake McLeod Unit receives support through volunteers who provide survey information for rare, threatened, and endangered species. The Merritt Island Wildlife Association has provided material and logistical support for refuge projects. Without the help of volunteers and friends, many refuge management projects will not be facilitated.

The refuge will target expansion and mature the volunteer program as refuge-specific staff is acquired and located on-site, focusing projects on those that benefit rare, threatened, and endangered species and habitat restoration. The refuge will continue to regularly utilize the Ridge Rangers, Jay Watch, and other existing volunteers in its base to provide project support. Working through the partners, the refuge will develop organized training programs to better educate volunteers on rare, threatened, and endangered species relative to the specific work element. The refuge will work with the Merritt Island Wildlife Association, the Pelican Island Preservation Society, and Friends of the Carr Refuge to build refuge support and will continue to utilize the Pelican Island NWR Complex to facilitate and support volunteer and partner efforts.

Objective K.3: Within 5 years of the date of this CCP, provide infrastructure and operations to facilitate, protect, and manage the natural resources of Lake Wales Ridge NWR.

Discussion: The refuge has no on-site facilities to house operational equipment. The refuge will seek partnerships to provide infrastructure support, including storage facilities and office space to accommodate equipment, materials, and program support, including for fire, biology, and resource management administrative support. Where facility development on Service lands is appropriate, facility citing will be directed away from sensitive sites and to disturbed, developed sites.

Strategies:

- Provide Service or partner facility for equipment to support refuge operations.
- Move equipment from volunteer properties to Service or partner-managed facility.
- Work with the partners to provide office space for refuge administration needs.

Goal L. Foster a strong and effective working relationship with existing and new partners, including local, state, and federal governmental agencies and non-governmental entities, to support conservation of the unique resources of the Lake Wales and Winter Haven Ridge Systems.

Objective L.1: Actively participate in the LWREWG to develop and improve relationships with local land management and conservation partners of the Lake Wales and Winter Haven Ridge Systems.

Discussion: The refuge currently participates as a member of the LWREWG, where information is exchanged concerning research, land management plans, challenges, solutions, and coordination of training. The LWREWG serves as a venue to foster public awareness and support for the ridge. The refuge will continue to cooperate with all governmental agencies and non-governmental organizations primarily through the LWREWG to find creative solutions and to share limited resources to protect, conserve, enhance, and manage the rare, threatened, and endangered species and the habitats they occupy on the ridge systems.

Strategies:

- Send at least one Service representative from the refuge to each working group meeting.
- Coordinate with the partners to determine how they could assist with the various refuge management units (e.g., wildlife and plant surveys, burning, fire break maintenance, litter removal, and law enforcement).

Goal M. Promote and increase fire management on the refuge sufficient to meet its purposes, goals, and objectives, restoring these ridge habitats to pre-fire exclusion conditions to best support the rare, threatened, and endangered species of the refuge.

Discussion: The application of prescribed fire targeting restoration of habitats for the benefit of rare, threatened, and endangered species to pre-fire exclusion conditions is a primary focus over the 15-year life of this CCP. Fire management is provided for by the Merritt Island NWR Complex, located 100 miles or 2 to 3 hours from Lake Wales Ridge NWR. Initial response responsibilities for unwanted wildland fire fall to the FDOF, with Merritt Island NWR personnel responding, if needed, as soon as possible. Most extended attack suppression activities will be handled jointly by the FDOF and Merritt Island NWR. In the past, maintenance of firelines and other presuppression activities have been conducted by contract or by Merritt Island NWR personnel. These methods present challenges due to logistical constraints, as all equipment needed for the burn must be transported to the refuge. Frequently, the burn crew must wait for several days for proper burning conditions. There have been several times when proper conditions never occur and the burn project has been cancelled. Fire lines have been successfully maintained and several successful prescribed burns have been accomplished.

Objective M.1: Within 3 years of the date of this CCP, fully integrate the Service's prescribed fire program into the refuge's biological program to support protection and recovery efforts of rare, threatened, and endangered species.

Discussion: Fire management plans, updated on 5-year intervals, will integrate the needs of refuge biology and resource management, including the needs of rare, threatened, and endangered species and the habitats they occupy. Goals and objectives outlined in this CCP will be addressed and, through monitoring habitat and species response, application of prescribed fire will follow adaptive management strategies and principles in order to achieve targeted restoration goals and objectives.

Objective M.2: Within 1 year of the date of this CCP, institute a routine prescribed burn program and through the LWEWG, actively coordinate with fire management partners and foster new partnerships to meet the needs of the prescribed fire program on the refuge to support protection and recovery efforts of rare, threatened, and endangered species.

Discussion: The establishment of a frequent, routine prescribed fire program on the refuge will be a central management theme over the 15-year life of this CCP. Its implementation will be considered the principle management component to provide for many of the refuge's purposes, goals, and objectives, including restoration of habitat structure and function for rare, threatened, and endangered species. Also, the reduction of the threat and impact of unwanted wildland fire will be a goal. To help meet the refuge's annual prescribed burning targets, refuge fire managers will incorporate local resources, when appropriate, such as the Florida Scrub-Jay Prescribed Fire Strike Team, ABS, FDOF, and FWC. The refuge will enter into memoranda of understanding between the Service and non-national wildfire coordinating group (NWCG) partners to accommodate the differences in training standards. The refuge will revise, update, and develop these memoranda with partners, including TNC's Prescribed Fire Strike Team, to facilitate prescribed burning and unwanted wildland fire response and will continue working with TNC to promote the use of prescribed fire on the ridge. The refuge will make all efforts possible and practicable to limit long-term wildlife impacts of fire management activities. Efforts to minimize undesired impacts to rare, threatened, and endangered species include, but are not limited to, implementation of best management practices, prescribed burn plan consultation with appropriate Ecological Services field offices, and coordination with partner agencies.

Strategies:

- Focus fire management priorities on the needs of rare, threatened, and endangered species.
- Actively coordinate with existing ridge land management and fire management partners and foster new ridge partnerships to help meet the prescribed fire needs of the refuge.
- Coordinate with the fire management officer at Merritt Island NWR to prepare fire prescriptions and other needed paperwork as much as 2 years in advance of prescribed burns.
- Support funding for the Florida Scrub-Jay Prescribed Fire Strike Team.
- Develop and implement Service wildland urban interface (WUI) projects and document results and benefits through first order fire effects monitoring.
- Support FDOF implementation of State of Florida Hawkins Act activities on the refuge.
- Require NWCG training for partners.
- Within 5 years of the date of this CCP, establish and maintain fire lines in a condition to limit the use of fire plows on the Flamingo Villas and Carter Creek Units.
- Prepare and update the refuge's fire management plan at 5-year intervals.
- Revise, update, and develop MOUs with partners, including TNC's Prescribed Fire Strike Team, to facilitate prescribed burning and unwanted wildland fire response and continue working with TNC to promote the use of prescribed fire on the ridge.
- Implement MOUs and/or other cooperative agreements to support the fire needs of the refuge.

- Consult with North and South Florida Ecological Services field offices as necessary for prescribed fire management program planning to promote the recovery and protection of rare, threatened, and endangered species.

Objective M.3: Protect the resources of the refuge from the potential negative impacts of unwanted wildland fire.

Discussion: Unwanted wildland fire can pose a safety risk to neighbors and can have negative impacts on refuge resources, including rare, threatened, and endangered species and the habitats they occupy. Control of unwanted wildland fire will be provided through the implementation of a routine prescribed fire program designed to provide a mosaic of varying aged habitats for rare, threatened, and endangered species, and to reduce fuel loads to pre-fire exclusion conditions. Unwanted wildland fire support through initial attack and suppression services has and will continue to be provided by the FDOF for all refuge units.

The FDOF will continue to provide primary responsibility for initial attack fire suppression and the Service will support these resources through grants and cooperative agreements. The refuge will investigate the formation of an official annual operating plan and potentially an MOU with FDOF's Okeechobee and Lakeland districts, continuing and bolstering interagency cooperation and management of unwanted wildland fire. Due to of the existence of small private inholdings at some sites, the Service will continue partnering with FDOF to use the Hawkins Act to complete prescribed burns in those areas in an effort to control the negative impacts of unwanted wildland fire.

Tactics used to control unwanted wildland fires can seriously impact certain populations. The refuge and partners will implement minimum impact suppression tactics (MIST) at all refuge units whenever safe and tactically possible to protect federal and state listed species. The use of MIST will likely help minimize the destruction of plants near roadways, reduce soil disturbance, and reduce fragmentation of burn units.

Strategies:

- Continue to cooperate with the FDOF to adequately provide for initial attack and extended attack unwanted wildland fire response.
- Increase involvement of FDOF staff (e.g., invite FDOF staff on a tour of the Flamingo Villas and Carter Creek Units to introduce them to rare, threatened, and endangered species).
- Create an annual operating plan with the Okeechobee and Lakeland districts of FDOF.
- Implement MOUs and/or other cooperative agreements to support the fire needs of the refuge.

V. Plan Implementation

INTRODUCTION

As required by the Improvement Act, the Service will manage all refuges in accordance with an approved CCP, which, when implemented, will achieve refuge purposes; help fulfill the Refuge System mission; maintain and where appropriate, restore the biological integrity, diversity, and environmental health of the refuge; help achieve the goals of the National Wilderness Preservation System; and meet other mandates.

This chapter summarizes the implementation strategy for the purposes, vision, goals, and objectives outlined in this CCP, addressing refuge projects, funding and personnel needs, volunteers, partnership opportunities, step-down management plans, a monitoring and adaptive management plan, and CCP review and revision.

PROPOSED PROJECTS

The proposed projects reflect the basic needs identified by Service staff, the public, and planning team members for the management of species, including rare, threatened, and endangered species; habitats; land protection; environmental education; and visitor services to address the identified priority issues and to serve the vision and goals developed for the refuge. Among these projects is a list of step-down management plans to be developed. Step-down plans provide more details concerning the delivery of specific tasks. The Service prepares step-down plans in conjunction with provisions set forth in the National Environmental Policy Act of 1969.

Annual funding for staff, facilities, operations, and maintenance is an integral part of project implementation. The general cost estimates provided will be updated and adjusted annually. Essential needs are addressed, such as eliminating biological threats and problems, meeting Refuge System mission requirements, and fulfilling the purposes for which the refuge was established. There are no assurances that these projects will be either partially or fully funded. However, with the help and cooperation of conservation partners, the Service will use this CCP to focus attention on funding the operations and maintenance needs of the refuge.

The Service developed 34 projects to address priority issues identified through the internal and public review processes. Projects are not in priority rank as they are all priorities to the refuge to accomplish the goals, objectives, and strategies set forth in this CCP. Unless otherwise noted, projects will be implemented on all refuge managed units and are separated into the four management categories: Wildlife and Habitat Management, Resource Protection, Visitor Services, and Refuge Administration. Supporting objectives are listed.

WILDLIFE AND HABITAT MANAGEMENT

Project 1. Standardize surveying and monitoring program and conduct baseline inventories for the refuge.

The refuge lacks baseline inventories of species and the conditions of habitats they occupy. Certain rare, threatened, and endangered species are regularly inventoried through the help of volunteers and partners and through research projects, including Florida ziziphus, Garrett's mint, and scrub lupine. However, baseline data of common species and habitat responses to management actions are lacking.

In addition, a standardized, systematic survey method for collecting data is lacking. Systematic surveys based on standardized protocols will be conducted to determine presence and distribution of species and habitat conditions. This project will provide baseline data to assist refuge managers in habitat management practices, including restoration of habitats to pre-fire exclusion conditions. A full-time wildlife biologist/botanist will assist in implementing the monitoring program. Information gathered in a systematic way is the foundation for implementing this CCP, formulating habitat management, and developing adaptive management strategies for species of conservation concern.

Wildlife and Habitat Management Objectives: A.1, A.2, A.6-7, A.10, A.12-20, B.1-2, C.1-9, D.1, D.3, E.1
Resource Protection Objectives: F.2-4, G.1
Visitor Services Objectives: H.1, I.2
Refuge Administration Objectives: K.1-2, L.1, M.1-2

Project 2. Conduct rare plant monitoring to determine population status, demographics, and response to management on the refuge.

Seventeen federally listed plants and at least five state listed plants are known to occur on the refuge, but apart from a few species, namely Florida ziziphus, Garrett's mint, and scrub lupine, little is currently known about the status, trends, demographics, and location of most species specific to refuge lands. This project will provide detailed monitoring of rare plant species and will continue and expand a program already established with ABS. The status of rare plant populations and their responses to management of the refuge will be regularly monitored and evaluated, utilizing a standardized monitoring protocol that will be applied to multiple sites across the Lake Wales Ridge for populations of the same species and will be aimed at resolving fundamental research questions. Utilizing ABS Population Dynamics of Endemic Plants (PDEP) protocol, additional permanent monitoring plots will be established at the refuge's Carter Creek and Flamingo Villas Units and new sites will be established at the refuge's Snell Creek and Lake McLeod Units. Regular sampling activities at the Carter Creek and Flamingo Villas Units will continue to be conducted by the partners including ABS staff, and monitoring will expand to include rare plant population status and response to management. The opportunity to collect pre-treatment information prior to prescribed fire events, firebreak maintenance, or mechanical treatments and management activities will be available and refuge management will be communicated to researchers in an effort to limit damage to permanent research plots. Regular reports will be expected from these research partners to include monitoring schedules, any lapse or expansion in monitoring, and any significant observations that warrant immediate action. In addition, as refuge management at Lake Wales Ridge NWR is closely associated with the recovery of federally listed species, surveys and information collected will be developed with the cooperation of the Service's Ecological Services field offices in both north Florida and south Florida, both of which are involved in recovery efforts of species found on the refuge. A commitment by Ecological Services to assist in the implementation of the project will be an important contribution.

Wildlife and Habitat Management Objectives: A.1-22 A.5-13, C.1-9, D.1-3, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2
Refuge Administration Objectives: K.1-2, L.1, M.1-2

Project 3. Continue and expand *Ziziphus celata* reintroduction at the Carter Creek Unit.

The Carter Creek Unit is one of four sites where *Ziziphus celata* is protected. The Carter Creek population is one of two introduced populations that carry the best potential for the long-term survival of the species. There are so few protected sites for this species and the conservation challenges require the establishment of additional populations on protected lands. This species re-sprouts after

fire and is adapted to fire maintained sandhill habitat such as that found in the northern section of the Carter Creek Unit. Successful reintroduction of this species requires careful planning. This species is restricted in part due to a complex breeding system that requires strict outcrossing with compatible mates. The introduced population is being designed to account for this factor through careful analysis of the plants used for reintroduction stock. ABS staff has carried out the population design and installation of plants and has provided temporary irrigation for this project in past years. Permanent monitoring plots have been established at Carter Creek as part of the existing reintroduction project. Working with partners, the refuge will continue the reintroduction project through the life of this CCP, providing for recurring assessments and monitoring efforts to determine that the new population is reproducing sexually and generating new plants by recruitment from seed. In addition, as refuge management at Lake Wales Ridge NWR is closely associated with the recovery of federally listed species, surveys and information collected will be developed with the cooperation of the Service's Ecological Services field offices in both north and south Florida, both of which are involved in recovery efforts of species found on the refuge. A commitment by Ecological Services to assist in the implementation of the project will be an important contribution.

Wildlife and Habitat Management Objectives: A.1-2, A.4, A.12-13, C.1, C.6, D.1-2, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2, J.1
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 4. Enhance *Dicerandra christmanii* habitat and population on the refuge.

The Flamingo Villas Unit is the only protected site for *D. christmanii*. It supports the largest population and is critical to the recovery of the species. In collaboration with the partners, including ABS and HBS, the refuge will work to enhance habitat for this species. The Service will determine the desirability of translocating seeds and plants to unoccupied suitable habitat at the Flamingo Villas Unit. Habitat enhancement could also involve selective removal of scrubby oaks to create the larger gaps required by this species. This is warranted because the habitat is currently so overgrown that additional measures may be needed to re-establish sizable gaps for *D. christmanii* to occupy in the short term. The long un-burned condition has promoted the development of dense stands of oaks with greater underground reserves that will re-sprout and quickly retake the site. Several episodes of frequent fire may be needed to sap reserves and reduce the density of oak stems. Over the long-term, a routine prescribed fire program should restore these habitats to pre-suppression structure, including diversity of patch sizes and times-since-fire.

At the Carter Creek Unit, the Service will consider the reintroduction of a *D. christmanii* population founded by plants from the nearby unprotected Carter Creek east scrub site. This will secure the genetic material from the unprotected population and provide an additional population on conservation lands. Translocation is warranted for *D. christmanii* because so few populations are extant (4 or less) and there is only one additional site that may be a worthy target for acquisition. These plants produce large quantities of seed annually and reproduce prolifically from seed after fire, so it should be relatively easy to establish new populations in suitable habitat. Suitable habitat exists in the southeast corner of the Carter Creek Unit on an extension of the same yellow sand ridge upon which this species occurs at the Flamingo Villas Unit. This corner of Carter Creek and the surrounding lands, if possible, should be thoroughly searched to ensure that *D. christmanii* is not already present.

Translocations efforts for other *Dicerandra* species have been very successful elsewhere in Florida. These plants mature from seed in 1 to 3 years, so the success of these efforts could be evaluated within 3 to 5 years of reintroduction. Multiple research questions should be addressed as needed prior to and through implementation of this project. In addition, as refuge management at Lake Wales Ridge NWR is closely associated with the recovery of federally listed species, surveys and information collected will be developed with the cooperation of the Service's Ecological Services Field Offices in both north and south Florida, both of which are involved in recovery efforts of species found on the refuge. A commitment by Ecological Services to assist in the implementation of the project will be an important contribution.

Wildlife and Habitat Management Objectives: A.1, A.5-7, A.12-13, A.16, C.1, C.5, D.1-2, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2, J.1-3
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 5. Identify Florida scrub-jay dispersal patterns, including home range changes.

The Flamingo Villas Unit supports a small population of scrub-jays. TNC's Jay Watch Program annually surveys for scrub-jay occurrence on the refuge's Flamingo Villas and Carter Creek Units. Apart from TNC's occurrence information, little else is known about the refuge's scrub-jay population, including scrub-jay dispersal patterns and home range changes. This project will continue existing survey efforts conducted by the partners and expand the refuge's understanding of its scrub-jay population, centering on developing a broader understanding of dispersal patterns and home range changes, in particular as a response to refuge management. And, the project will include implementation of prescribed fire as a response to regional changes of land use and changing patterns of suitable habitat resulting from climate change. Over the 15-year life of this CCP, the refuge will use prescribed fire to restore habitats to pre-fire exclusion conditions, benefitting species such as the scrub-jay through the promotion of a heterogeneous, productive scrub landscape. Monitoring efforts will be expanded from scrub settings to include wetland systems proximal to scrub lands, providing a better understanding of the role wetland systems play for scrub-jays. Partnerships will be expanded as the scope of scrub-jay dispersal pattern and home range change monitoring efforts will include coordination and collaboration with efforts of surrounding partner-managed lands. Through partnerships, scrub-jay banding efforts will continue. Results will provide valuable input for adapting refuge management to provide suitable habitat for scrub-jays and will provide a better understanding of the role the refuge plays in state-wide scrub-jay recovery efforts.

Wildlife and Habitat Management Objectives: A.1, A.14-16, B.1-2, C.1-2, C.5, C.7-8, D.2, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2, J.1
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 6. Conduct demographic monitoring of refuge skink populations.

Both sand and bluetail mole skinks have been documented within scrub habitats on refuge units, however, baseline information concerning population estimates, distribution, and demography are lacking. Working with the partners and volunteers, this project will develop and implement a standardized monitoring protocol to better understand the demographic relationships of skink populations on the refuge. Both sand and bluetail mole skinks are federally listed species and Service recovery plans have been drafted to guide recovery efforts. Due to a history of fire suppression on the refuge, scrub habitats are overgrown. This vegetative cover class condition may

limit the maintenance of existing and expansion of future skink populations. A central theme over the 15-year life of this CCP is to restore habitats to pre-fire exclusion conditions, which will benefit skink populations evolved to conditions enabled by frequent fire, such as open sand gaps. In addition, prey resources (e.g., insects and larvae) are created and more readily available to skinks as mature biomass niches, which may hold prey above skink level decay and offer longer term prey resources at skink level. Recognizing the potential of undesired short-term negative impacts to skink populations through the application of a routine prescribed fire program as outlined in this CCP, the refuge will examine skink response to planned prescribed fire program activities through monitoring and adapt management as necessary to reduce undesired sort-term impacts on skinks. Analysis will include fire response in order to better understand the relationship of skinks to this important and critical management need. By implementing standardized protocols used by partner agencies and organizations for demographic monitoring, results will be comparable on regional levels. This will enable the refuge to share information across its boarders, bolstering cooperation and collaboration among the refuge and its partners.

Wildlife and Habitat Management Objectives: A.1, A.8-9, A.11, A.17, C.1-6, D.2, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2, J.3
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 7. Evaluate habitat response to mechanical disturbance on the refuge.

Mechanical treatment on the refuge may take many forms from hand clearing vegetation using chainsaws to heavy equipment used to create and maintain fire lines. In some cases where prescribed fire is not an option, to provide pre-fire exclusion conditions, mechanically altering vegetation through mowing or use of a Gyrotrac may be used. Many of the habitats that occur on the refuge impart a composition of sandy soils, which are thought to be particularly sensitive to mechanical disturbance. This project will measure habitat response to differing methods of mechanical disturbance to determine the most appropriate types of disturbances for refuge management.

Wildlife and Habitat Management Objectives: A.1-13, A.15-20, B.1, B.3, C.1-10, D.2, E.1
Resource Protection Objective: F.2
Visitor Services Objectives: I.2, J.1, J.4
Refuge Administration Objectives: K.1, K.3, L.1, M.1-3

Project 8. Establish and prepare a baseline inventory of invertebrates on the refuge.

The refuge is home to a large number of endemic insects, including the emerald moth (*Nemouria outina*) which feeds soely on rosemary, the bee fly (*Bombyliidae* sp.) which is the primary pollinator for the scrub balm, and the scrub millipede (*Floridobolus penneri*). The scarab beetle (*Scarabaeidae* sp.) and gopher cricket (*Gryllus* sp.) are both obligate commensals that are only found in gopher tortoise burrows. The federally listed candidate Highlands tiger beetle (*Cicindela highlandensis*) has been documented on the refuge and is threatened due primarily to habitat loss within its original range. In addition to the refuge's importance as a place for endemic insects, the general suite of invertebrates provide important life needs for the many birds, amphibians, reptiles, and rare plants that occur on the refuge, serving as food resources and primary pollinators. Apart from occurrence data, baseline information concerning invertebrate species is lacking on the refuge. Working with the partners, this project will implement a systematic survey protocol consistent with partner efforts to inventory at regular intervals the invertebrate species on the refuge in an effort to better understand invertebrate species relationships with rare, threatened, and endangered plants and animals found on the refuge.

Wildlife and Habitat Management Objectives: A.1, A.17, B.1, C.1, D.2, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2, J.1-4
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 9. Survey the refuge for cavity nesting opportunities.

Many species of cavity-nesting birds have declined because of habitat reduction (USFS 1997). Some 85 species of North American birds excavate nesting holes, use cavities resulting from decay (natural cavities), or use holes created by other species in dead or deteriorating trees (USFS 1977). Such tress, commonly called snags, have often been considered undesirable by forest and recreation managers and are often removed because they conflict with other forest management practices, may harbor forest insect pests, or may be fire or safety hazards (USFS 1977). The majority of cavity-nesting birds are insectivorous and several of the birds that nest in cavities tend to be resident species and thus more amenable to local habitat management practices than migratory species (von Haartman 1968 *in* USFS 1977). On the refuge, very little is known about the status of cavity nesters or the adequacy of habitats and host trees to provide nesting opportunities. Cavity-nesting and snag-dependent wildlife species, including woodpeckers, wood ducks, black bear, and bat species occur on the refuge or in similar habitats on partner lands in close proximity to the refuge where they utilize snags for a host of life needs, including nesting and foraging. This project will provide baseline information concerning cavity-nesting species, snag species, quality, and density of existing and potential cavity trees that are needed to maintain viable, self-sustaining populations of cavity-nesting and snag-dependent wildlife species.

Wildlife and Habitat Management Objectives: A.1, A.14, A.20, B.1-2, B.4, C.1-9, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 10. Evaluate and survey bird use on the refuge.

Little is known about bird populations on the refuge and, apart from scrub-jay surveys conducted on a yearly basis through the support of Jay Watch and observations by staff, volunteers and partners, no comprehensive surveys of bird use have been conducted on the refuge. The refuge is utilized by both resident and migratory birds and the refuge may play an important role in providing for the life needs of both state and federal listed bird species of which three are known to occur on the refuge: Florida scrub-jay, bald eagle, and wood stork. In addition, Audubon's crested caracara, sandhill crane, peregrine falcon, grasshopper sparrow, and the red-cockaded woodpecker may utilize the refuge as these species are found in the Lake Wales and Winter Haven Ridge Systems, utilizing same or similar habitats. However, as the refuge lacks baseline information, particularly presence, absence, and status of bird species, including rare, threatened, and endangered species, the status of bird species is unknown. Working through partnerships and volunteers, this project will provide systematic surveys on regular intervals to evaluate bird use on the refuge. The project will partner and coincide with other bird surveys in the area and state, including, but not limited to, the Christmas Bird Count, enabling full integration of information gathered with similar efforts provided for by partner agencies and organizations, thus bolstering partnerships and integration of the refuge with other ridge areas.

Wildlife and Habitat Management Objectives: A.1, A.14-16, B.1-2, B.4, C.1-9, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: H.1, I.2
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 11. Implement fire effects monitoring on the refuge.

Returning habitats through the application or prescribed fire to pre-fire exclusion conditions is a key management component over the 15-year life of this CCP. During the restoration phase, time-since-fire values may be initially lower than values targeted in a fully restored fire maintained setting for the habitats that occur on the refuge. Species response to prescribed fire both in the introductory restoration phase and over time as habitats evolve to pre-fire exclusion conditions is an important variable that will help shape and adapt fire management. Working with partners, this project will monitor the response from targeted restoration of habitats to pre-fire exclusion conditions on rare, threatened, and endangered species, providing information necessary to adapt prescribed fire management based in part on species response. A full suite of fire effects monitoring will include, but not be limited to, intensity, extent, and temporal and spatial changes in habitat patch size and distribution. In order to provide information relevant to both the refuge and regionally throughout the ridge systems, this project will implement a systematic survey protocol consistent with partner efforts. Utilizing appropriate surveying and monitoring approaches that are in place and currently utilized by land management partners will enable the refuge to readily share information, benefitting species and habitat management both locally and at the ecosystem level.

Wildlife and Habitat Management Objectives: A.1, A.3-8, A.10-12, A.15-20, B.1, C.1-2, C.4-10, D.2, E.1
Resource Protection Objective: F.3
Visitor Services Objective: I.2
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 12. Reduce fuels as a method to jumpstart fire management restoration objectives of the refuge.

Restoration of habitats to pre-fire exclusion conditions may involve more than application of prescribed fire alone. Hardwood cover, due to regional, historic suppression of fire, has been optimized and requires intensive management to return scrub and sandhill habitat conditions to more natural conditions to appropriate habitat values for the benefit of rare, threatened, and endangered species. In select instances, mechanical control and, where appropriate, follow up chemical control of mechanically treated hardwoods will help jump start habitat restoration beyond what could be achieved by prescribed fire alone. Hardwood cover at the Flamingo Villas, Carter Creek, and Lake McLeod Units are specific examples where the system has developed to the point that fire alone may not reduce cover to the levels necessary to provide appropriate habitat conditions for rare, threatened, and endangered species. In addition, instances of catastrophic fire may increase without additional control measures as mature canopy level hardwoods in fire dominated habitats may carry fire to and throughout forest canopies, threatening post-fire survival of overstory pine species. Fire management is inherently dangerous and mechanically reducing undesirable cover, where appropriate, provides a safer fire management environment both to fire crews and as a preventive response to protect neighboring properties and refuge resources from the threat of unwanted wildland fire. This project will provide removal of hardwood cover as needed and, where appropriate, through mechanical and, where appropriate, chemical treatment of mechanically removed hardwoods to facilitate restoration objectives. Projects include, but are not limited to, reducing fuels at the Lake McLeod Unit, conducting hardwood control at the Carter Creek Unit specifically to support the Florida ziziphus reintroduction project, and conducting mechanical control as appropriate and where the application of prescribed fire is limited by logistical or other constraints at the Flamingo Villas Unit.

Wildlife and Habitat Management Objectives: A.1, A.3-5, A.8-12, A.15-16, B.1, C.1-2, C.4-8, C.10, D.2, E.1
Resource Protection Objective: F.3
Visitor Services Objectives: I.2
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 13. Inventory and restore refuge wetland habitats.

The refuge is home to a diverse assemblage of wetland habitats ranging from ephemeral to permanent wetlands, including cutthroat seeps, flatwoods, depression marshes, basin marshes, and bayheads. The refuge lacks even a basic understanding of hydrologic patterns and connections of wetland resources, and the use by and relative importance of wetland resources to the wide array of species that occur on the refuge. This basic understanding is particularly important to the management of the Flamingo Villas Unit where, prior to Service management, ditches were designed and developed to drain water resources from the refuge and deliver untreated water to the refuge from adjacent agricultural and commercial lands. Apart from identifying and mapping the location of these important wetland habitats, little is known about wetland habitat conditions, including surface and groundwater hydrologic connections or the impact drainage ditches have on surface and groundwater resources. This project will evaluate hydrologic settings and connections to provide a better understanding of the impact that ditches and other disturbances have on refuge wetland resources, providing guidance for the execution of wetland/hydrologic restoration projects, specifically ecological lift provided by filling anthropogenically created ditches at the Flamingo Villas Unit. In addition, this project will provide an inventory of wetland habitat conditions on the refuge and identify potential or observed utility by rare, threatened, and endangered species.

Wildlife and Habitat Management Objectives: A.1, A.12, A.18, A.20, B.1-3, C.1-2, C.7-10, D.1-2, E.1
Resource Protection Objectives: F.3-4
Visitor Services Objectives: I.2, J.1-2, J.4
Refuge Administration Objectives: K.1-3, L.1

Project 14. Restore the Lake McLeod Unit.

The Lake McLeod Unit presents numerous challenges for management and restoration. The west side of the site (west of Gerber Dairy Road) has been altered by past agricultural use. Some restoration has occurred – namely exotic plant control, pile burning, and planting of slash pine. Incidents of unauthorized seed collection, supplemental watering, fertilization, and other manipulations of listed plant species have been performed by volunteers. *Chionanthus pygmaeus* from off-site were planted and seeds of *Nolina brittoniana* and *Lupinus aridorum* have been moved within the site by well-meaning volunteers. The impact of these translocations is unknown and a corrective response has not yet been identified. The east side of Gerber Dairy Road was impacted by long-term dumping and all-terrain vehicle use. Vegetation on the site is now sparser with scrub oaks and other shrubs at lower stem densities than in typical scrub. Numerous listed plants thrive in these disturbed areas of the site, and restoration plans should recognize that the abundant populations in this area are likely an artifact of the large gaps caused by years of all-terrain vehicle use of the site. The restoration of the Lake McLeod Unit should include key components, including conducting research into the historical floristics of the site, developing an appropriate species list, developing a site restoration plan, providing for logistical needs, providing supplemental irrigation, conducting follow-up exotic control, monitoring, and adequately maintaining plantings to ensure their survival. Restoration of the site should include an outreach element that educates neighboring landowners concerning refuge objectives and pertinent endangered species laws. Restoration activities at the Lake McLeod Unit will also include considerations for protecting the sparse population

of *Cladonia perforata* that occurs there. Fire and mechanical treatments cause mortality of these ground-dwelling lichens. In consultation with Ecological Services and in collaboration with a lichenologist, individual lichen thalli could be moved out of the way of disturbance, should this be necessary to manage habitat on the site. A survey of the Lake McLeod Unit will be needed to locate and quantify the extent of the *C. perforata* occurrence on the site.

Wildlife and Habitat Management Objectives: A.1, A.8-13, A.17, A.19, B.1-2, B.4, C.1, C.3-4, D.1-D.3, E.1
Resource Protection Objective: F.1, F.3, G.1
Visitor Services Objectives: I.1-2, J.1-3
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 15. Continue to identify, locate, and control non-native, invasive species on the refuge.

The refuge contains a diversity of habitats, many of which have been impacted by non-native, invasive species. Generally, non-native invasive species impact habitat function by displacing native plants and animals. Management efforts to prevent, control, maintain, and, where possible, eradicate infestations of non-native, invasive species is a key management goal throughout the 15-year life of the CCP. Non-native, invasive plants, such as Old World climbing fern, Brazilian pepper, and natal grass have invested portions of the refuge and, if left unmanaged, threaten to out-compete native species. Invasive animals, including feral hog, occur on the refuge and have created extensive damage to once unaltered ephemeral wetlands, particularly cutthroat seeps and associated wetlands, which are home to the state listed cutthroat grass. Exotic fish have been documented occupying the canals at the Flamingo Villas Unit where large numbers of brown hoplo and walking catfish have washed ashore after major storm events. Non-native, invasive fish are known to predate amphibian resources. In addition, the brown hoplo is an armored catfish that, when ingested, is known to tear and clog the throats of wading birds and other predators. The spread of laurel wilt, a deadly disease of redbay (*Persea borbonia*) and other tree species in the laurel family (Lauraceae), is caused by a fungal pathogen vectored by a non-native insect, the redbay ambrosia beetle, and is increasing its range southward through Florida along the Atlantic coast, decimating laurel species. With encroaching development and the continued proliferation of non-native invasive species throughout Florida, non-native invasive species have an even greater potential to expand to refuge lands in the future without intensive management efforts to control them. This project will continue existing non-native, invasive species control efforts in a variety of ways. The project will consist of updating the refuge's 2006 invasive plant species inventory conducted through funding assistance of the Service's Southeast Region Invasive Species Strike Team to survey and map exotic plants on the refuge through the help of volunteers and consistent with national wildlife refuge weed mapping protocols. In addition, systematic control of all State Category I and Category II non-native, invasive plant species will be provided, prioritizing treatment efforts through an "outlier-in" approach that controls the spread, proliferation, and concentrated densities of plant infestations. The project will also provide for the identification and treatment of non-native fish found in ditches and canals, performed in cooperation with the Service's South Florida Fisheries Resources Office. In addition, the project will provide for preventive efforts to combating the potential spread of laurel wilt.

Wildlife and Habitat Management Objectives: A.1, A.9, A.12, B.1, C.1-2, C.4-8, C.10, D.1-3, E.1
Resource Protection Objective: F.3
Visitor Services Objective: I.2, J.2-3
Refuge Administration Objectives: K.1-3, L.1, M.1-2

Project 16. Protect refuge cutthroat seeps from feral hog damage.

Cutthroat grass is a state-listed endangered plant. Seasonal ponds on the refuge, particularly on the Flamingo Villas Unit, are being degraded by the foraging activities of feral hogs. Once these areas are tilled-up by hogs, invasive plants can colonize the ponds and change the floristics, fire regime, and value of the habitat for native wildlife species. The existing fence around the Flamingo Villas Unit is inadequate to prevent hog ingress and subsequent disturbance and no fences currently exist for the interior wetlands where hog damage is prevalent. In addition, current control measures are inadequate to control hog populations. Baiting for hogs to control populations may even increase the resident population, which then must forage in cutthroat ponds and other sensitive habitats when baiting ceases. The project will include a combination of equipping the refuge with adequate, hog-proof and fire proof perimeter fencing of seasonal ponds, such as those used in some natural areas in Hawaii, Australia, and New Zealand to eliminate animal ingress and physical control of hogs from the refuge. Vigilant monitoring of the fence line will be needed for an area such as the Flamingo Villas Unit where vandals may damage the fence to gain entrance or to protest hog control efforts.

Wildlife and Habitat Management Objectives: A.1, A.18, A.20, B.1, C.1, C.7-8, C.10, D.2, E.1
Resource Protection Objective: F.3-4
Visitor Services Objectives: I.2
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 17. Repair and replace existing refuge boundary fencing.

The refuge has installed perimeter fencing around the Carter Creek and Lake McLeod Units and portions of the Flamingo Villas and Snell Creek Units are fenced to protect the refuge from illicit uses, notably off-road vehicle use and trash and debris dumping present before fence installation. Existing fences do not adequately protect refuge resources and there are no provisions to maintain existing fence systems. In addition, controlling feral hog ingress will be an important management goal over the 15-year life of this CCP. Project 16 outlines an approach to limit feral hog damage through interior fencing of key wetlands and through control methods. This project will provide an additional level of protection by not only limiting hog ingress, but by also providing security and protection from illicit uses.

Wildlife and Habitat Management Objectives: A.12, A.17-20, B.1, D.1
Resource Protection Objective: F.3
Visitor Services Objectives: I.2, J.1-3
Refuge Administration Objectives: K.1-3, M.1, M.3

Project 18. Monitor for the impacts of climate change on refuge resources.

The refuge is home to an incredible diversity of species. Rising temperatures and sea level in the state will likely change the makeup of entire ecosystems, forcing fish and wildlife to shift their ranges or adapt. No one can be certain exactly how climate change affects refuge plants and animals; however, there is little doubt that the effect will be quite noticeable when comparing biological notations over a span of 30 to 80 years. At best, wildlife and plant species will adapt to the changed environment, but in a worse case situation, the refuge could lose many species of plants and animals. An added threat might be realized from potential human migration to inland areas in Florida, including Lake Wales and Winter Haven Ridge Systems, from coastal settings suffering from the direct effects of climate change, including sea level rise and increased frequency and intensity of tropical cyclone activity. Additionally, the refuge and partners do not have a clear concept as to how climate change impacts suitable habitat for rare, threatened, and endangered species, including migratory patterns and dispersal of primary species such as the Florida panther and Florida black bear. Working with

the partners, this project will commission a comprehensive study to better understand the impacts of climate change on the Lake Wales Ridge Ecosystem, specifically how sea level rise will impact migration of both human and wildlife populations to the ecosystem and the effects climate change may have on changing patterns of suitable habitat for rare, threatened, and endangered species. The project will be designed to provide systematic surveys that could feed into national and global climate change networks.

Wildlife and Habitat Management Objectives: A.1-2, A.5, A.7-8, A.10-20, B.1-2, C.1-10, D.2-3, E.1
Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: I.1-2
Refuge Administration Objectives: K.1-3, L.1, M.1-2

RESOURCE PROTECTION

Project 19. Develop management agreements with partner agencies.

This CCP identifies a critical need to refresh existing agreements and enter into new agreements with our partners to enable the refuge to restore habitats to pre-fire exclusion conditions over its 15-year life. Since the refuge was established in 1994, it has relied on the partners to provide research, law enforcement, unwanted wildland fire management, and a host of other refuge management needs. This project will provide for additional refuge management support from the partners, where appropriate, through the implementation of MOUs and other formal agreements. The refuge will provide fiscal assistance to partner agencies and groups, where appropriate, and in keeping with the purposes, vision, goals, objectives, and strategies established through the CCP, the refuge will enter into management agreements for, but not limited to, unwanted wildland fire support; law enforcement support; and refuge management support, including for non-native, invasive, and nuisance species control; surveys; monitoring; research; a full range of fire support; and other elements of refuge management as identified through this CCP necessary to restore and manage the refuge over the 15-year life of this CCP. This project will provide for Service support of inherently governmental responsibilities, including, but not limited to, the implementation of administrative functions, realty and acquisition management, and supervisory administration of refuge management action areas outlined in this CCP, including wildlife and habitat management, resource protection, visitor services, and refuge administration, while providing support to the partners for projects and management as expressed above.

Wildlife and Habitat Management Objectives: A.1-20, B.1-4, C.1-10, D.1-3, E.1
Resource Protection Objectives: F.1-4, G.1
Visitor Services Objectives: H.1, I.1, I.2, J.1-4
Refuge Administration Objectives: K.2, K.3, L.1, M.1-3

Project 20. Extend existing MOU/challenge cost-share agreement with TNC.

This project involves continued support of two existing MOU's between the Service and TNC. Modification and renewal of these agreements are also required. The first, a grant agreement (#1448-40181-01-02-G-141), provides fire management support for planned prescribed fire program management activities on existing refuge properties. The focus of this agreement is to conduct assessment; provide local outreach and education regarding the need for prescribed fire; and expand the efforts of the local Florida Scrub-jay Fire Strike Team to restore scrub habitats through the use of prescribed fire. The second, a cooperative agreement (#401817J095), provides for habitat restoration and improvement through the use of prescribed fire on private lands. The key Service contribution to these agreements is providing funding to TNC to complete projects covered by the

agreements. Both agreements are set to expire in September 2012. The last time funding was provided to TNC was in Fiscal Year 2007. The continued support of the prescribed fire program is critical to the restoration and management of scrub habitat on Lake Wales Ridge. By providing fiscal support, the refuge benefits by having a local fire staff presence, TNC's technical and educational assistance, and their staff support during prescribed fire activities. Both agreements need to be updated with current administrative and fiscal information.

Wildlife and Habitat Management Objectives: A.3-4, A.8, A.11-12, A.14-16, B.1, C.1-8, C.10, E.1
Resource Protection Objectives: F.3, F.4
Visitor Services Objectives: H.1, I.1-2
Refuge Administration Objectives: K.2, L.1, M.1-3

Project 21. Evaluate refuge inholdings for potential acquisition from willing sellers.

The refuge exists in a mosaic of public and private lands, which is especially evident in the case of the Flamingo Villas Unit where 322 individual, single-family owned lots checkerboard the western portion of the unit. Throughout the 15-year life of this CCP, the refuge will pursue outlined land acquisition priorities, where top priorities include the acquisition of these inholdings in addition to undeveloped inholdings at the Lake McLeod Unit and the approximately 1,124-acre southern component of the Carter Creek acquisition boundary (lands adjacent to and south of the current Carter Creek Unit). This CCP furthers acquisition strategies by outlining priorities of all remaining inholdings within the acquisition boundaries of the four units currently managed by the refuge based on a willing-seller approach within the approved acquisition boundary. This project will enable refuge staff to implement the purchase strategies as outlined in this CCP, providing consistent Service oversight and direction and enabling land acquisition priority amendments, where necessary, to increase habitat connections and refuge protection, decrease susceptibility from fragmentation, and further management efforts of refuge lands as identified in this CCP.

Resource Protection Objectives: F.1-4
Refuge Administration Objectives: K.1, L.1

Project 22. Develop wildlife underpasses and movement corridors for key area roadways.

As the region continues to develop, threats of wildlife mortality caused by vehicle collisions are expected to increase. As climate change emerges as a force impacting migratory behavior and location of species, wildlife species are expected to establish additional and/or change migratory ranges and patterns throughout the central Florida ecosystems. Currently, species movements throughout the Lake Wales and Winter Haven Ridge ecosystems involve migration across an increasingly established system of roads and highways to access natural areas and suitable open spaces. The four units the refuge currently manages are all adjacent to road systems. Vehicle/wildlife interaction is perhaps most predictable along the boundary of the Flamingo Villas Unit where State Road 98 defines the southern extent and Airport Road (County Road 623) the northern extent. The Flamingo Villas Unit lies approximately 4 miles south of the Carter Creek Unit, separated by natural and human altered open lands. The Carter Creek Unit is itself traversed by Arbuckle Creek Road at its northern border, which provides a physical barrier between refuge lands and the approximately 2,376-acre component of the state's LWRWEA across the road. Working through the LWREWG, this project will seek to partner with the FDOT and other partners to support plans that will increase corridor connections between and among these units, furthering partnerships, and adding protection for the movement of wildlife throughout these systems.

Wildlife and Habitat Management Objectives: A.1, A.17-20, B.1, E.1
Resource Protection Objectives: F.3-4
Visitor Services Objective: I.2
Refuge Administration Objective: L.1

Project 23. Provide archaeological and cultural resource surveys of the refuge.

Cultural resources of the Lake Wales Ridge NWR are unknown. A July 1992 State of Florida review of the Florida Site File, in preparation for the refuge's 1994 establishment, indicated that no archaeological or historic sites had been recorded within the original 12 units identified in the 1993 LPP. However, no systematic professional surveys have been conducted to confirm/disprove this. Refuge management has provided clear guidance for staff, volunteers, and partners to notify management in the event that historical or archaeological artifacts are discovered through the implementation of refuge projects. This project will provide a systematic survey of the four refuge management units in an effort to discover and thereby adapt management to protect discovered cultural resources.

Resource Protection Objectives: F.1. F.3-4, G.1
Visitor Services Objectives: H.1, I.1-2
Refuge Administration Objective: L.1

VISITOR SERVICES

Project 24. Increase outreach and opportunities for environmental education and interpretation.

The refuge is closed to visitor use, apart from limited and controlled refuge permitted guided events. Some 20 local, state, federal, and privately owned and managed natural areas occur throughout the Lake Wales Ridge where visitor services ranging from hunting and fishing to hiking and biking are provided. The refuge will remain closed due to the logistical challenges it faces being approximately 60 miles from administrative and management support provided by the Pelican Island NWR Complex in Vero Beach, and as a result of providing optimal restoration conditions over the 15-year life of the CCP for rare, threatened, and endangered plants, which could be severely impacted from well-intentioned visitors. The refuge will implement a series of refuge managed opportunities, through the special use permit process and other approved mechanisms, to provide visitor access on a per activity basis in support of regional efforts by partners and friends, providing a better understanding and appreciation of this unique refuge, its value in the scrub landscape, and the importance of the ecosystems that make up the Lake Wales and Winter Haven Ridge Systems. These projects will include:

- Conducting an annual refuge event.
- Updating the refuge's webpage and including partner website links for area recreational/visitor service opportunities.
- Developing a refuge specific general brochure to be made available to the public through the partners and on request.
- Participating in and contributing to regional environmental education opportunities through the LWREWG.
- Working through partners, including the LWREWG, to provide a message concerning the impacts that trash and debris dumping has on the refuge and throughout the ridge systems. As part of this element, the refuge will increase signage, including boundary markers and informational signs throughout the refuge.

Visitor Services Objectives: H.1, I-2, J.1, J.3
Refuge Administration Objectives: K.1-2, L.1, M.3

Project 25. Support refuge volunteers.

A small, but dedicated cadre of volunteers help support the many and varied management needs of the refuge, including through litter and debris cleanups; assistance with surveys for rare, threatened, and endangered species; feral hog and non-native, invasive plant control; and the provision of a general presence in the field that helps to limit illicit uses. This project will provide continued support for refuge volunteers, including the state-managed Ridge Rangers, which have provided the bulk of the support for refuge litter and debris cleanup efforts.

Visitor Services Objectives: H.1, I-2, J.1, J.3
Refuge Administration Objective: K.2

REFUGE ADMINISTRATION

Project 26. Develop a refuge fire management program.

The refuge has a few dedicated tools and pieces of equipment to conduct very basic management on the refuge, but it must rely on the partners to provide routine investigations and initial management of refuge resources in preparation for prescribed fire and in the event of unwanted wildland fire. Throughout the 15-year life of the CCP, management of fire program needs will be conducted by the Merritt Island NWR Fire Management Program, including prescribed fire planning, execution, fire effects monitoring, site preparation, and all other program aspects. In addition, the refuge will seek to bolster existing agreements and partnerships or enter into new partnerships with partner agencies and organizations, including TNC, to fulfill the goals, objectives, and strategies identified throughout the CCP, many of which include the implementation of prescribed fire and fire management as a key component. Furthermore, the refuge will continue to bolster its partnerships with FDOF for continued support with initial attack of unwanted wildlife fire either on or threatening refuge lands. Due to its location, roughly 100 miles from fire management program staff and equipment located at Merritt Island NWR, the refuge will continue to lack on-site operational components necessary to carry out routine fire management program needs. This project will provide for the local needs necessary to conduct the fire management program. The project will utilize a fire/forestry technician for coordination of site preparation and monitoring and to increase prescribed fire readiness and response in the event of unwanted wildland fire both on refuge and with partners off the refuge. It will provide necessary equipment, including a tool cache, all-terrain vehicle to provide access and management, and a water tank/slip-on to increase response times, provide valuable assistance to partner land management agencies and organizations, and provide for day-to-day management of the fire program on the refuge.

Wildlife and Habitat Management Objectives: A.1, A.3-6, A.8, A.11-12, A.15-20, B.1, C.1-2, C.4-10, D.2-3, E.1
Resource Protection Objectives: F.2-3, G.1
Visitor Services Objective: I.2
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 27. Hire a law enforcement officer to share with the Pelican Island NWR Complex.

The refuge is closed to public use, except for limited and controlled special use permitted activities. In an effort to protect refuge resources, fencing and signage have been installed to deter illicit uses in an effort to minimize off-road vehicle use, trespass, and trash and debris dumping. However, the

threat from these illicit uses is a constant paradigm and even the best fence installation and appropriate boundary postings provide an inadequate level of deterrence. Fences and signs are vandalized and trespass still occurs, threatening habitats and the rare, threatened, and endangered species that, in some case, are protected nowhere else but on refuge lands. Projects outlined above will provide additional and maintain existing fencing to continue to provide protection of refuge resources from illicit uses and will increase boundary posting and refuge informational signage. This project will provide partial funding to support this position for all three refuges in the Pelican Island NWR Complex. This project will add an additional level of resource protection by establishing a Service law enforcement presence, the result of which will further protect resources, including impacts to rare, threatened, and endangered species. A refuge law enforcement officer was proposed under both the Pelican Island NWR and Archie Carr NWR CCPs. This position will share duties with all three refuges as part of the Pelican Island NWR Complex. Regular law enforcement patrols will help deter wildlife take, vandalism, trespass, loitering, and other illegal activities and could respond to violations, complaints, and incidences when they occur.

Resource Protection Objectives: F.1, F.3-4
Visitor Services Objectives: I.1-2, J.1-4
Refuge Administration Objectives: K.1-2, L.1, M.3

Project 28. Hire a refuge ranger to be shared with the Pelican Island NWR Complex.

The Lake Wales Ridge NWR is administered as one of three refuges in the Pelican Island NWR Complex, which also includes Pelican Island and Archie Carr NWRs. The Pelican Island NWR and Archie Carr NWR CCPs propose additional refuge ranger positions, in addition to the supervisory refuge ranger currently employed, to address the complex visitor service program needs of these refuges. This project will provide for a portion of the shared refuge ranger position, providing administrative and functional support for Lake Wales Ridge NWR programs in addition to providing for visitor service programs of Pelican Island and Archie Carr NWRs.

Wildlife and Habitat Management Objective: E.1
Resource Protection Objective: G.1
Visitor Services Objectives: H.1, I.1-2, J.1-4
Refuge Administration Objectives: K.1-2, L.1, M.3

Project 29. Hire a full-time private lands biologist.

This project will secure funding to hire a full-time private lands biologist (GS-11) to facilitate and manage the complex array of land management issues and challenges the refuge will face over the 15-year life of the CCP. The refuge plays an important role in the conservation of rare, threatened, and endangered species and habitats of the endemic rich Lake Wales and Winter Haven Ridge ecosystems, and is a key member of a consortium of lands managed by partners for the benefit of conservation. Interests of privately held lands greatly contribute to the success of recovery efforts across the landscape. Developing hands-on relationships with our neighbors and friends will provide considerable benefit to the refuge and partners by providing outreach opportunities; promoting the value of rare, threatened, and endangered species; improving corridor development for wildlife movement across landscapes; and facilitating the importance of conservation lands for which the refuge is an integral part.

Wildlife and Habitat Management Objectives: A.1, A.14-15, A.17-20, D.1, E.1
Resource Protection Objectives: F.1-4, G.1
Visitor Services Objectives: H.1, I.1-2, J.2
Refuge Administration Objectives: K.1-2, L.1, M.1

Project 30. Hire a full-time fire/forestry technician.

This project will secure funding to hire a full-time fire/forestry technician (GS-09). This position will coordinate activities with Merritt Island NWR fire management and partner agencies, implementing and monitoring all aspects of the refuge's fire management program, including, but not limited to, fuels monitoring, site preparation, equipment maintenance, providing fast response in preparation for prescribed fire, and to secure refuge interests in the event of unwanted wildland fire, line maintenance and development, mechanical control where appropriate, and all other aspects of fire/forestry programs and projects.

Wildlife and Habitat Management Objectives: A.1, A.3-13, A.16-17, A.19, C.1-2, C.4-10
Visitor Services Objectives: I.1-2
Refuge Administration Objectives: K.1, K.3, L.1, M.1-3

Project 31. Hire a full-time refuge botanist/biologist.

This project will secure funding to hire a full-time botanist/biologist (GS-11). This position will coordinate, implement, and monitor all aspects of the refuge's biological program, including coordinating with the partners to develop and conduct inventories, monitoring, and research on demographics, trends, occurrence, restoration response, and threats to rare, threatened, and endangered species and the habitats they occupy. This position will also manage nuisance and non-native invasive species control efforts; develop hydrological inventories of refuge lands; oversee volunteer efforts; and will coordinate with partner agencies, institutions, and groups to develop large-scale habitat protection initiatives connecting partner lands.

Wildlife and Habitat Management Objectives: A.1-20, B1-4, C.1-10, D.1-3, E.1
Resource Protection Objectives: F.3-4, G.1
Visitor Services Objectives: H.1, I.1-2, J.1, J.3
Refuge Administration Objectives: K.1-2, L.1, M.1-3

Project 32. Hire a full-time Biological Science Technician

This project will secure funding to hire a full-time biological science technician (GS-09). This position will conduct inventorying and monitoring of rare, threatened, and endangered species and the habitats they occupy; provide trash and litter debris execution and oversight; provide non-native, invasive, and nuisance species monitoring and control; and coordinate refuge activities with partner efforts.

Wildlife and Habitat Management Objectives: A.1-20, B1-4, C.1-10, D.1-3, E.1
Visitor Services Objectives: H.1, I-2
Refuge Administration Objectives: K.1-2, L.1, M.1-3

Project 33. Hire a full-time wildlife refuge specialist (assistant manager).

This project will secure funding to hire a full-time wildlife refuge specialist (assistant manager) (GS-11). The position will provide necessary managerial and supervisory oversight for the wide array of refuge projects and will provide the coordination necessary to carry out the purposes, goals, objectives, and strategies outlined in the CCP. These will include, but are not limited to, preparation of management agreements, providing input and coordinating habitat and wildlife connection projects, implementing and coordinating all aspects of land acquisition projects and initiatives, providing for contracting and purchasing needs, managing all Lake Wales Ridge NWR

staff, participating in regional level conservation strategies, and working with the partners to commission a study on the effects of climate change.

Wildlife and Habitat Management Objectives: C.1, E.1
Resource Protection Objectives: F.1-4, G.1
Visitor Services Objectives: H.1, I.1-2, J.1-4
Refuge Administration Objectives: K.1-3, L.1, M.1-3

Project 34. Improve refuge maintenance, operations, and facilities management.

The refuge has no locally dedicated operational or logistical space to manage, administer, or sponsor projects provided in the CCP. This project will provide dedicated funding to enable the refuge to enter into agreements for the use of dedicated space for administrative, operational, and management functions necessary to implement and achieve the goals, objectives, and strategies provided in the CCP. In addition, the project will involve maintaining and improving the storage building located at the Lake McLeod Unit.

Resource Protection Objective: F.3
Refuge Administration Objectives: K.1-3, L.1, M.2-3

FUNDING AND PERSONNEL

Implementation of the CCP will require increased funding and personnel support from a variety of internal and external sources. New projects are identified in the Refuge Operating and Needs System (RONS), while maintenance needs for existing facilities and projects are identified through the Service Asset and Maintenance Management System (SAMMS). The CCP outlines proposed projects that are substantially above current budget allocations for the refuge. The CCP does not constitute a commitment (from Congress) for staffing increases, operational and maintenance increases, or funding for future land acquisition, but provides direction for future management and represents wildlife resource needs based on sound biological science and input from the public.

To achieve the goals, objectives, and strategies outlined in this CCP, additional personnel, operations, maintenance facilities, and funds are needed. Five additional, non-shared positions will be needed (Figure 11) in addition to the positions shared between Lake Wales Ridge, Archie Carr, and Pelican Island NWRs (Figure 9). The Pelican Island NWR Complex staff will need to increase from a total of six positions (where three are permanent full-time, two are term, and one is a temporary) shared with Pelican Island and Archie Carr NWRs in Fiscal Year 2009, to a total of 19 positions (most of which were approved in previous CCPs) for the Pelican Island NWR Complex (3.5 for Archie Carr NWR, 3.5 for Pelican Island NWR, 5 for Lake Wales Ridge NWR, and 7 to be shared by all three refuge) (Table 25 and Figure 11). The 5 positions for Lake Wales Ridge NWR will be located in close proximity to Lake Wales Ridge NWR interests. In addition, the CCP will provide partial funding for two shared positions - a refuge officer and a refuge ranger previously proposed in the Pelican Island NWR and Archie Carr NWR CCPs. This increase in staff will also necessitate an increase in base funding above standard yearly increases that allow only for inflation.

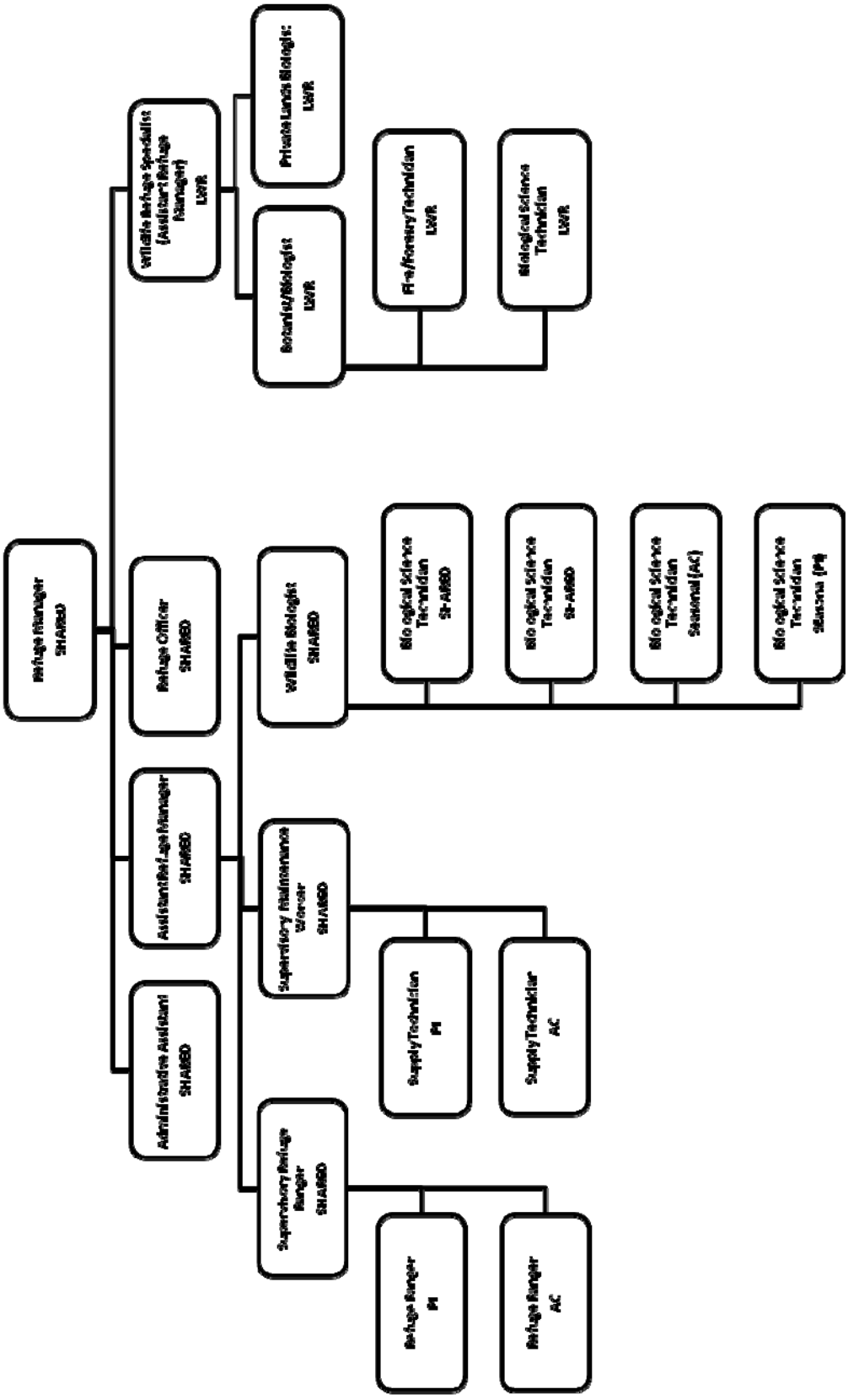
Table 25. Summary of projects

PROJECT NUMBER	PROJECT TITLE	FIRST YEAR COST ($1,000)	RECURRING ANNUAL COST ($1,000)	STAFF (FTES)
1	**Standardize surveys and monitoring program and conduct baseline inventories**	58	18	Botanist/Biologist
2	**Conduct rare plant monitoring to determine population status, demographics, and response to management**	25	25	Botanist/Biologist
3	**Continue and expand *Ziziphus celata* reintroduction at Carter Creek Unit**	21.4	21.4 (for four year of the five year project horizon)	Botanist/Biologist
4	**Enhance *Dicerandra christmanii* habitat and population**	15	15 (for four years of the five year project horizon)	Botanist/Biologist
5	**Identify Florida scrub-jay dispersal patterns, including home range changes**	35	30	Botanist/Biologist
6	**Conduct demographic monitoring of skink populations**	5	1 (5 every five years)	Botanist/Biologist
7	**Evaluate habitat response to mechanical disturbance**	50	20	Botanist/Biologist
8	**Establish and prepare a baseline inventory of invertebrates on the refuge**	20	4 (20 every five years)	Botanist/Biologist
9	**Survey the refuge for cavity nesting opportunities**	10	10	Biological Science Technician
10	**Evaluate and survey bird use on the refuge**	5	5	Biological Science Technician
11	**Implement fire effects monitoring**	50	20	Fire/Forestry Technician
12	**Reduce fuels as a method to jumpstart fire management restoration objectives**	30	10	Fire/Forestry Technician
13	**Inventory and restore wetland habitats**	160	10	Botanist/Biologist

PROJECT NUMBER	PROJECT TITLE	FIRST YEAR COST ($1,000)	RECURRING ANNUAL COST ($1,000)	STAFF (FTES)
14	**Restore Lake McLeod Unit**	200	50	Botanist/Biologist
15	**Continue to identify, locate, and control non-native, invasive species**	150	110	Biological Science Technician
16	**Protect cutthroat seeps from feral hog damage**	38	28	Biological Science Technician
17	**Repair and replace existing boundary fencing**	200	10	Biological Science Technician
18	**Monitor for the impacts of climate change on refuge resources**	500	150	Wildlife Refuge Specialist
19	**Develop management agreements with partner agencies**	260	260	Wildlife Refuge Specialist
20	**Extend existing MOU/challenge cost share agreement with TNC**	100	100	Wildlife Refuge Specialist
21	**Evaluate inholdings for potential acquisition from willing sellers**	20	20	Wildlife Refuge Specialist
22	**Develop wildlife underpasses and movement corridors for key area roadways**	20	10	Private Lands Biologist
23	**Provide archeological and cultural resource surveys**	50		Botanist/Biologist
24	**Increase outreach and opportunities for environmental education and interpretation**	60	35	Private Lands Biologist
25	**Support refuge volunteers**	10	10	Refuge Ranger (Shared, 0.33 FTE)
26	**Develop refuge fire management program**	80	65	Fire/Forestry Technician
27	**Hire shared Law Enforcement Officer**	18	18	Law Enforcement Officer (Shared, 0.33 FTE)
28	**Hire a Shared Refuge Ranger position for Pelican Island NWR Complex**	17	17	Refuge Ranger (Shared, 0.33 FTE)

PROJECT NUMBER	PROJECT TITLE	FIRST YEAR COST ($1,000)	RECURRING ANNUAL COST ($1,000)	STAFF (FTES)
29	**Hire a full-Time Private Lands Biologist**	75	75	1 FTE
30	**Hire a full –Time Fire/Forestry Technician**	62.5	62.5	1 FTE
31	**Hire a full-Time Botanist/Biologist**	75	75	1 FTE
32	**Hire a full-time Biological Science Technician**	62.5	62.5	1 FTE
33	**Hire a full-time Wildlife Refuge Specialist (Assistant Manager)**	75	75	1 FTE
34	**Improve maintenance, operations, and facilities management**	35	35	Wildlife Refuge Specialist

Figure 11. Proposed Organizational Chart for Lake Wales Ridge NWR



PARTNERSHIP/VOLUNTEERS OPPORTUNITIES

A key element of this CCP is to further existing and establish new partnerships with local volunteers, landowners, private organizations, and state and federal natural resource agencies. The Lake Wales Ridge NWR functions in partnership with a variety of land management partners through the LWREWG who together, help further the purposes, vision, goals, and objectives of the refuge and ridge ecosystems. The LWREWG provides a unique forum within which research, management, training, and information is exchanged among partner land management agencies and organizations, helping to foster collaboration, cooperation, and coordination benefitting the long-term protection of native plants, animals, and natural communities. Bringing together non-profit, research-oriented, and land management partners, the LWREWG provides a forum for interested parties and area land managers to exchange ideas and coordinate and integrate management activities. Through these efforts, public awareness and support for the naturally managed areas that constitute the remaining protected lands of the central Florida ridge ecosystems are developed and nurtured. The refuge will continue to work with existing and new partners where partnerships will predominantly operate through the LWREWG to provide interested public partners with consistent, coordinated, and collaborated natural resource messages, designed to increase public awareness and understanding of these unique systems.

STEP-DOWN MANAGEMENT PLANS

A CCP is a strategic plan that guides the direction of the refuge. A step-down management plan provides specific guidance on activities, such as habitat; fire; and rare, threatened, and endangered species. The Service will prepare several step-down plans to provide more detail, including strategies and implementation schedules for meeting the goals and objectives identified in this CCP. Table 26 lists the needed step-down management plans and their anticipated completion dates. The current Lake Wales Ridge NWR step-down plan is:

- Fire Management Plan (2009).

Table 26. Step-down management plans to be developed during the 15-year life of the CCP

Step-down Management Plan	Anticipated Completion Date
Inventorying, Monitoring, and Research Plan	2011
Habitat Management Plan	2012
Integrated Pest Management Plan	2013

MONITORING AND ADAPTIVE MANAGEMENT

Adaptive management is a flexible approach to long-term management of biotic resources that is directed over time by the results of ongoing monitoring activities and other information. More specifically, adaptive management is a process by which projects are implemented within a framework of scientifically driven experiments to test the predictions and assumptions outlined within a plan.

To apply adaptive management, specific surveying, inventorying, and monitoring protocols will be adopted for the refuge. The habitat management strategies will be systematically evaluated to determine management effects on wildlife populations. This information will be used to refine approaches and

determine how effectively the objectives were being accomplished. Evaluations will include ecosystem team and other appropriate partner participation. If monitoring and evaluating indicate undesirable effects for target or nontarget species and/or communities, then modifications or alternatives to the management projects will be developed. Subsequently, the CCP will be revised. Specific monitoring and evaluation activities will be described in the step-down management plans.

PLAN REVIEW AND REVISION

The Service will review the CCP annually to decide if revisions are required. The CCP will be modified along with associated management activities whenever this review or other monitoring and evaluation determine that changes are needed to achieve refuge purposes, vision, and goals. The Service will revise the CCP when significant new information becomes available, ecological conditions change, or a major refuge expansion occurs, or when the Service identifies the need to do so during CCP review. At a minimum, CCP revision will occur every 15 years. All revisions will follow the procedures outlined in current policy and will require compliance with the National Environmental Policy Act. The Service will conduct ongoing public involvement and continue informing and involving the public regarding management of this refuge.

APPENDICES

Appendix I. Glossary

Accidentals: Bird species that are observed on single or few occasions very far from their normal range.

Adaptive Management: Refers to a process in which policy decisions are implemented within a framework of scientifically driven experiments to test predictions and assumptions inherent in a management plan. Analysis of results helps managers determine whether current management should continue as is or whether it should be modified to achieve desired conditions.

Adjuvants: A substance added to a spray tank separate from the pesticide (herbicide) formulation that improves the performance of the pesticides.

Allele: One of a different form of gene, a variant form of a gene detected as different phenotypes (any observable characteristic or trait of an organism).

Allelopathic: The inhibition of growth in one species of plants by chemicals produced by another species

Alternative: 1. A reasonable way to fix the identified problem or satisfy the stated need (40 CFR 1500.2). 2. Alternatives are different sets of objectives and strategies or means of achieving refuge purposes and goals, helping fulfill the Refuge System mission, and resolving issues (Service Manual 602 FW 1.6B).

Biological Diversity: The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur (Service Manual 052 FW 1. 12B). The System's focus is on indigenous species, biotic communities, and ecological processes. Also referred to as biodiversity.

Carrying Capacity: The maximum population of a species able to be supported by a habitat or area.

Categorical Exclusion: A category of actions that does not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a federal agency pursuant to the National Environmental Policy Act (40 CFR 1508.4).

CFR: Code of Federal Regulations.

Clastic Upland Lake: Shallow to relatively deep, irregular-shaped depressions or basins occurring in uplands on clay substrates

Clonal Reproduction: A reproductive strategy in an organism by which a group of genetically identical individuals have grown in a given location, all originating vegetatively (not sexually) from a single ancestor.

Cohort: A group of subjects who have shared a particular experience during a particular life span.

Coleopterans A group of insects of the order Coleoptera, characterized by forewings modified to form tough protective covers for the membranous hind wings and including beetles, weevils, and fireflies.

Compatible Use: A proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the National Wildlife Refuge System mission or the purpose(s) of the national wildlife refuge [50 CFR 25.12 (a)]. A compatibility determination supports the selection of compatible uses and identifies stipulations or limits necessary to ensure compatibility.

Comprehensive Conservation Plan: A document that describes the desired future conditions of a refuge or planning unit and provides long-range guidance and management direction to achieve the purposes of the refuge; helps fulfill the mission of the Refuge System; maintains and, where appropriate, restores the ecological integrity of each refuge and the Refuge System; helps achieve the goals of the National Wilderness Preservation System; and meets other mandates (Service Manual 602 FW 1.6 E).

Concern: See Issue

Congener: An organism within the same genus (a taxonomic unit used in the classification of living and fossil organisms).

Cover Type: The present vegetation of an area.

Cultural Resource Inventory: A professionally conducted study designed to locate and evaluate evidence of cultural resources present within a defined geographic area. Inventories may involve various levels, including background literature search, comprehensive field examination to identify all exposed physical manifestations of cultural resources, or sample inventory to project site distribution and density over a larger area. Evaluation of identified cultural resources to determine eligibility for the National Register follows the criteria found in 36 CFR 60.4 (Service Manual 614 FW 1.7).

Cultural Resource Overview:	A comprehensive document prepared for a field office that discusses, among other things, its prehistory and cultural history, the nature and extent of known cultural resources, previous research, management objectives, resource management conflicts or issues, and a general statement on how program objectives should be met and conflicts resolved. An overview should reference or incorporate information from a field office's background or literature search described in Section VIII of the Cultural Resource Management Handbook (Service Manual 614 FW 1.7).
Cultural Resources:	The remains of sites, structures, or objects used by people in the past.
Demographic:	The selected population characteristics of a species relating to the dynamic balance of a population especially with regard to density and capacity for expansion or decline.
Depauperate:	Arrested in growth or development, stunted.
Designated Wilderness Area:	An area designated by the U.S. Congress to be managed as part of the National Wilderness Preservation System (Draft Service Manual 610 FW 1.5).
Desiccation:	The state of extreme dryness, or the process of extreme dryness.
Dioecious:	Species whose members can produce only one type of gamete.
Disturbance:	Significant alteration of habitat structure or composition. May be natural (e.g., fire) or human-caused events (e.g., aircraft overflight).
Endemic:	An organism exclusively native to a place or biota.
Ecosystem:	A dynamic and interrelating complex of plant and animal communities and their associated non-living environment.
Ecosystem Management:	Management of natural resources using system-wide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and basic ecosystem processes are perpetuated indefinitely.
Ecotone:	A transitional area between two adjacent but different plant communities, such as forest and wetlands.
Ephemeral Wetlands:	Depressional isolated wetlands that temporarily hold water during the rainy season or after heavy rains.
Endangered Species (Federal):	A plant or animal species listed under the Endangered Species Act that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species (State):	A plant or animal species in danger of becoming extinct or extirpated in the state within the near future if factors contributing to its decline continue. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a significant degree.
Endemism	Ecological state of being unique to a particular geographic location, such as a habitat type.
Environmental Assessment (EA):	A concise public document, prepared in compliance with the National Environmental Policy Act, that briefly discusses the purpose and need for an action, alternatives to such action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).
Environmental Impact Statement (EIS):	A detailed written statement required by section 102(2)(C) of the National Environmental Policy Act, analyzing the environmental impacts of a proposed action, adverse effects of the project that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance and enhancement of long-term productivity, and any irreversible and irretrievable commitment of resources (40 CFR 1508.11).
Ex Situ:	Off-site conservation – the process of protecting a rare species by removing part of the population from the impacted habitat and placing it in a new location, which may be a wild area or within the care of humans.
Extant:	A taxa (such as a species, genera, or families) that are still in existence (not extinct).
Extirpated:	Local extinction where a species ceases to exist in the chosen are of study, but still exists elsewhere.
Fecundity:	The potential reproductive capacity of an organism or population, measured by number of gametes (eggs), seed set or asexual propagules.
Federal Register:	Published by the Office of the Federal Register, National Archives and Records Administration (NARA), the Federal Register is the official daily publication for rules, proposed rules, and notices of Federal agencies and organizations, as well as executive orders and other presidential documents.
Finding of No Significant Impact (FONSI):	A document prepared in compliance with the National Environmental Policy Act, supported by an EA, that briefly presents why a federal action will have no significant effect on the human environment and for which an environmental impact statement, therefore, will not be prepared (40 CFR 1508.13).

Gamete:	A cell that fuses with another gamete during fertilization in organisms that reproduce sexually.
Genotype:	The genetic constitution of a cell, an organism, or an individual usually with reference to a specific character under consideration.
Goal:	Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units (Service Manual 620 FW 1.6J).
Habitat:	Suite of existing environmental conditions required by an organism for survival and reproduction. The place where an organism typically lives.
Habitat Restoration:	Management emphasis designed to move ecosystems to desired conditions and processes, and/or to healthy ecosystems.
Habitat Type:	See Vegetation Type.
Herbivore	An animal that is adapted to eat plants and not meat.
Improvement Act:	The National Wildlife Refuge System Improvement Act of 1997.
Informed Consent:	The grudging willingness of opponents to "go along" with a course of action that they actually oppose (Bleiker).
In Situ:	To examine a phenomenon exactly in the place where it occurs.
Issue:	Any unsettled matter that requires a management decision [e.g., an initiative, opportunity, resource management problem, threat to the resources of the unit, conflict in uses, public concern, or other presence of an undesirable resource condition (Service Manual 602 FW 1.6K)].
Lichen:	Composite organisms consisting of a symbiotic (mutualistic, parasitic or commensal in nature) association of a fungus with a photosynthetic partner usually a green algae or cyanobacterium.
Management Alternative:	See Alternative
Management Concern:	See Issue
Management Opportunity:	See Issue
Mesic Habitat:	A type of habitat characterized by a moderate or well-balanced supply of moisture.

Microhabitat:	A small, localized habitat within a larger ecosystem, as a decomposing log or sand patch in a forest, having conditions that sustain a limited range of animals and plants.
Migration:	The seasonal movement from one area to another and back.
Mission Statement:	Succinct statement of the unit's purpose and reason for being.
Monitoring:	The process of collecting information to track changes of selected parameters over time.
Monoecious	Organisms as having both sperm-producing and egg-producing reproductive organs in the same individual
Mosaic Habitat:	An area or site comprised of multiple habitat types.
National Environmental Policy Act of 1969 (NEPA):	Requires all agencies, including the Service, to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in the planning and implementation of all actions. Federal agencies must integrate NEPA with other planning requirements, and prepare appropriate NEPA documents to facilitate better environmental decision-making (40 CFR 1500).
National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57):	Under the Refuge Improvement Act, the Fish and Wildlife Service is required to develop 15-year comprehensive conservation plans for all national wildlife refuges outside Alaska. The Act also describes the six public uses given priority status within the Refuge System (i.e., hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation).
National Wildlife Refuge System Mission:	The mission is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.
National Wildlife Refuge System:	Various categories of areas administered by the Secretary of the Interior for the conservation of fish and wildlife, including species threatened with extinction; all lands, waters, and interests therein administered by the Secretary as wildlife refuges; areas for the protection and conservation of fish and wildlife that are threatened with extinction; wildlife ranges; game ranges; wildlife management areas; or waterfowl production areas.
National Wildlife Refuge:	A designated area of land, water, or an interest in land or water within the Refuge System.
Native Species:	Species that normally live and thrive in a particular ecosystem.

Notice of Availability: A notice that an environmental document is available. Published in the Federal Register.

Notice of Intent: A notice that an environmental document will be prepared and considered (40 CFR 1508.22). Published in the Federal Register.

Noxious Weed: A plant species designated by federal or state law as generally possessing one or more of the following characteristics: aggressive or difficult to manage; parasitic; a carrier or host of serious insect or disease; or non-native, new, or not common to the United States. According to the Federal Noxious Weed Act (P.L. 93-639), a noxious weed is one that causes disease or had adverse effects on man or his environment and therefore is detrimental to the agriculture and commerce of the United States and to the public health.

Objective: A concise statement of what we want to achieve, how much we want to achieve, when and where we want to achieve it, and who is responsible for the work. Objectives derive from goals and provide the basis for determining strategies, monitoring refuge accomplishments, and evaluating the success of strategies. Making objectives attainable, time-specific, and measurable (Service Manual 602 FW 1.6N).

Obligate: An organism able to exist or survive only in a particular environment of by assuming a particular role.

Orthopterans An order of insects with paurometabolous (incomplete metamorphosis), including grasshoppers, crickets, and locusts

Physiognomy: The general appearance of an object or terrain without reference to its implied characteristics.

Plant Association: A classification of plant communities based on the similarity in dominants of all layers of vascular species in a climax community.

Plant Community: An assemblage of plant species unique in its composition; occurs in particular locations under particular influences; a reflection or integration of the environmental influences on the site such as soils, temperature, elevation, solar radiation, slope, aspect, and rainfall; denotes a general kind of climax plant community.

Preferred Alternative: This is the alternative determined (by the decision-maker) to best achieve the refuge purpose, vision, and goals; contributes to the Refuge System mission, addresses the significant issues; and is consistent with principles of sound fish and wildlife management.

Prescribed Fire: The application of fire to wildland fuels to achieve identified land use objectives (Service Manual 621 FW 1.7). May occur from natural ignition or intentional ignition.

Priority Species:	Fish and wildlife species that require protective measures and/or management guidelines to ensure their perpetuation. Priority species include the following: (1) State-listed and candidate species; (2) species or groups of animals susceptible to significant population declines within a specific area or statewide by virtue of their inclination to aggregate (e.g., seabird colonies); and (3) species of recreation, commercial, and/or tribal importance.
Propagule:	Any plant material used for the purpose of plant propagation.
Public Involvement Plan:	Broad long-term guidance for involving the public in the comprehensive conservation planning process.
Public Involvement:	A process that offers impacted and interested individuals and organizations an opportunity to become informed about, and to express their opinions on Service actions and policies. In the process, these views are studied thoroughly and thoughtful consideration of public views is given in shaping decisions for refuge management.
Public:	Individuals, organizations, and groups; officials of federal, state, and local government agencies; Indian tribes; and foreign nations. It may include anyone outside the core planning team. It includes those who may or may not have indicated an interest in service issues and those who do or do not realize that Service decisions may affect them.
Purposes of the Refuge:	"The purposes specified in or derived from the law, proclamation, executive order, agreement, public land order, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge sub-unit." For refuges that encompass congressionally designated wilderness, the purposes of the Wilderness Act are additional purposes of the refuge (Service Manual 602 FW 106 S).
Pyrogenic Ecosystems:	Ecosystems commonly characterized by the frequency of fire, which is expressed as the return interval or average number of years between successive fires.
Recommended Wilderness:	Areas studied and found suitable for wilderness designation by both the Director of the Fish and Wildlife Service and the Secretary of the Department of the Interior, and recommended for designation by the President to Congress. These areas await only legislative action by Congress in order to become part of the Wilderness System. Such areas are also referred to as "pending in Congress" (Draft Service Manual 610 FW 1.5).

Record of Decision (ROD):	A concise public record of decision prepared by the federal agency, pursuant to NEPA, that contains a statement of the decision, identification of all alternatives considered, identification of the environmentally preferable alternative, a statement as to whether all practical means to avoid or minimize environmental harm from the alternative selected have been adopted (and if not, why they were not), and a summary of monitoring and enforcement where applicable for any mitigation (40 CFR 1505.2).
Refuge Goal:	See Goal
Refuge Purposes:	See Purposes of the Refuge
Reintroduction:	Re-establishment of species into suitable habitats within their historic range.
Seral Stage:	Any stage of development of an ecosystem from a disturbed, unvegetated state to a climax plan community.
Senesce:	The biological processes of a living organism approaching an advanced age.
Songbirds: (Also Passerines)	A category of birds that is medium to small, perching landbirds. Most are territorial singers and migratory.
Speciation:	The evolutionary process by which new biological species arise.
Step-down Management Plan:	A plan that provides specific guidance on management subjects (e.g., habitat, public use, fire, and safety) or groups of related subjects. It describes strategies and implementation schedules for meeting CCP goals and objectives (Service Manual 602 FW 1.6 U).
Strategy:	A specific action, tool, technique, or combination of actions, tools, and techniques used to meet unit objectives (Service Manual 602 FW 1.6 U).
Study Area:	The area reviewed in detail for wildlife, habitat, and public use potential. For purposes of this CCP, the study area includes the lands within the currently approved refuge boundary and potential refuge expansion areas.
Succession:	More-or-less predictable and orderly changes in the composition or structure of an ecological community.
Thalli	Plural form of thallus – an undifferentiated vegetative tissue of some non-mobile organisms.

Threatened Species (Federal): Species listed under the Endangered Species Act that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Threatened Species (State): A plant or animal species likely to become endangered in the state within the near future if factors contributing to population decline or habitat degradation or loss continue.

Tiering: The coverage of general matters in broader environmental impact statements with subsequent narrower statements of environmental analysis, incorporating by reference, the general discussions and concentrating on specific issues (40 CFR 1508.28).

Translocation: In wildlife conservation means the capture, transport and release or introduction of species, habitats, or other ecological material (such as soil) form one location to another.

U.S. Fish and Wildlife Service Mission: The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people.

Unit Objective: See Objective

Vegetation Type, Habitat Type, Forest Cover Type: A land classification system based upon the concept of distinct plant associations.

Vision Statement: A concise statement of what the planning unit should be, or what we hope to do, based primarily upon the Refuge System mission and specific refuge purposes, and other mandates. We will tie the vision statement for the refuge to the mission of the Refuge System; the purpose(s) of the refuge; the maintenance or restoration of the ecological integrity of each refuge and the Refuge System; and other mandates (Service Manual 602 FW 1.6 Z).

Wilderness Study Areas: Lands and waters identified through inventory as meeting the definition of wilderness and undergoing evaluation for recommendation for inclusion in the Wilderness System. A study area must meet the following criteria:

- Generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable;
- Has outstanding opportunities for solitude or a primitive and unconfined type of recreation; and
- Has at least 5,000 contiguous roadless acres or is sufficient in size as to make practicable its preservation and use in an unimpaired condition (Draft Service Manual 610 FW 1.5).

Wilderness:	See Designated Wilderness
Wildfire/Unwanted Wildland Fire:	A free-burning fire requiring a suppression response; all fire other than prescribed fire that occurs on wildlands (Service Manual 621 FW 1.7).
Wildland Fire:	Every wildland fire is either a wildfire or a prescribed fire (Service Manual 621 FW 1.3
Xeric Habitat:	A type of habitat of, or characterized by, or adapted to extremely dry environmental conditions.

ACRONYMS AND ABBREVIATIONS

ABS	Archbold Biological Station
ac	Acres
Act	Endangered Species Act of 1973, as amended
AICP	American Institute of Certified Planners
APAFR	United States Avon Park Air Force Range
AQI	Air Quality Index
ATV	All-terrain Vehicle
BCC	Birds of Conservation Concern
BRT	Biological Review Team
°C	Degrees Celsius
CARL	Conservation and Recreation Lands
CCP	Comprehensive Conservation Plan
CFR	Code of Federal Regulations
CFRPC	Central Florida Regional Planning Council
CFS	cubic feet per second
CLASAC	Conservation Land Acquisition Selection Advisory Committee (Polk County, Florida)
CLIP	Critical Lands and Waters Identification Project
cm	centimeter
CR	County Road
DOI	Department of the Interior
DU	Ducks Unlimited
EA	Environmental Assessment
EE	environmental education
EIS	Environmental Impact Statement
EOR	Element Occurrence Records
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
°F	Degrees Fahrenheit
FCWCS	Florida's Comprehensive Wildlife Conservation Strategy
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FDOF	Florida Division of Forestry
FLUCCS	Florida Land Use Land Cover Classification System
FNAI	Florida Natural Areas Inventory
FPS	Florida park Service
FWC	Florida Fish and Wildlife Conservation Commission
FWS	U.S. Fish and Wildlife Service (also Service)
°F	Degrees Fahrenheit
FR	Federal Register
FTE	full-time equivalent
FY	Fiscal Year
GFI `	Gametophytic Self-Incompatible System
GIS	Global Information System
GPS	Global Positioning System
ha	Hectares
HBS	Historic Bok Sanctuary
LAPS	Land Acquisition Priority System
LPP	Land Protection Plan

LWR	Lake Wales Ridge
LWREWG	Lake Wales Ridge Ecosystem Working Group
LWRNWR	Lake Wales Ridge National Wildlife Refuge
LWRSF	Lake Wales Ridge State Forest
LWRWEA	Lake Wales Ridge Wildlife and Management Area
m	meter
MINWR	Merritt Island National Wildlife Refuge
MIWA	Merritt Island Wildlife Association
MOU	Memorandum of Understanding
MSRP	Multi-Species Recover Plan
NAAQS	National Ambient Air Quality Standards
NAMS	National Ambient Monitoring Stations
NEPA	National Environmental Policy Act
NRAC	Natural Resources Advisory Council (Highlands County, Florida)
NRHP	National Register of Historic Places
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
ONF	Ocala National Forest
ORV	Off-road Vehicle
PDEP	Population Dynamics of Endemic Plants
PFT	Permanent Full Time
PIF	Partners in Flight
PINWR	Pelican Island National Wildlife Refuge
PIC	Pelican Island Complex
ppb	parts per billion
PUNA	Public Use Natural Area
PVA	Population Viability Analysis
Ridge	Lake Wales Ridge
RM	Refuge Manual
RNA	Research Natural Area
ROD	Record of Decision
RONS	Refuge Operating Needs System
RRP	Refuge Roads Program
SCC	Species of Special Concern
Service	U.S. Fish and Wildlife Service
SFWMD	South Florida Water Management District
SLAMS	State and Local Ambient Monitoring Stations
SR	State Road
SWFWMD	Southwest Florida Water Management District
TAG	Technical Advisory Group (Polk County, Florida)
TFT	Temporary Full Time
TNC	The Nature Conservancy
USFWS	U.S. Fish and Wildlife Service
USDA	United States Department of Agriculture
USC	United States Code
WHR	Winter Haven Ridge

Appendix II. References and Literature Citations

Abrahamson, W.G., A.F. Johnson, J.N. Layne, and P.A. Peroni. 1984. Vegetation of the Archibold Biological Station, Florida: An example of the southern Lake Wales Ridge, Florida Scientist 47(4): 209-250.

Abrahamson, W.G. 1984. Post-fire recovery of Florida Lake Wales Ridge vegetation. American Journal of Botany 71(1):9-21.

AIRNow. 2009. National air quality information website portal (http://airnow.gov/). Accessed January 2009.

Alden, P. 1998. National Audubon Society. "Field Guide to Florida".

Anderson, L. 1991. *Paronychia chartacea* ssp. *minima* (Caryophyllaceae): a new subspecies of a rare Florida endemic. Sida 14(3): 435-441.

Archaeological Perspectives on Florida Seminole Ethnogenesis. 2000. *In, Indians of the Greater Southeast: Historic Archaeology and Ethnohistory*, edited by Bonnie G. McEwan, pp. 299-318, University Press of Florida, Gainesville.

Archbold Biological Station. 2004. Annotated Checklist of Fishes of the Archbold Biological Station by Layne, J.N, 1999 and Nelson et al. 2004. Highlands County, FL. Webpage accessed September 2009. http://www.archbold-station.org/ABS/data/lists/fishlist.htm.

Archbold Biological Station. 2005. Checklist of Amphibians and Reptiles of the Archbold Biological Station by Layne, J.N. Highlands County, FL.. Webpage accessed September 2009. http://www.archbold-station.org/ABS/data/lists/herplist.htm.

Archbold Biological Station. 2009. Birds of the Archbold Biological Station by Lohrer, F.E., and Woolfenden, 1992, revised August 2009. Lake Placid, FL. Webpage accessed September 2009. http://www.archbold-station.org/ABS/data/lists/birdlist.htm.

Archbold Biological Station. 1999. Checklist of Mammals of the Archbold Biological Station by Layne, J.N. Highlands County, FL. Webpage accessed September 2009. http://www.archbold-station.org/abs/index.htm.

Archibold Biological Station. 2000. Lepidoptera of Archbold Biological Station. Highlands County, FL. Webpage: http://www.archbold-station.org/abs/index.htm.

Archbold Biological Station. 2000. Plants of Archbold Biological Station by Menges, E.S., C.W. Weekley, R. Yahr, C. Brand, and D. Mundell. Highlands County, FL. Website accessed September 2009. http://www.archbold-station.org/ABS/data/lists/Plantlist.htm.

Ashton, K.G. 2005. Life history of a fossorial lizard, *Neoseps reynoldsi*. Journal of Herpetology 39(3):389-395.

Auffenburg W. and R. Franz. 1982. The status and distribution of *Gopherus polyphemus*. Pages 95-126 in R.B. Bury, ed. North American tortoises: conservation ecology. U.S. Fish and Wildlife Service Research report No. 12. Government Printing Offices; Washington, D.C.

Avon Park Air Force Range. 1999. "Bird Species of Avon Park". Unpublished. Avon Park, Florida.

Avon Park Air Force Range. 2004. Flora of Avon Park. Unpublished. Avon Park, Florida.

Banff National Parks of Canada website FAQs (http://www.pc.gc.ca/pnnp/ab/banff/plan/plan16_e.asp. Excerpt from Robertson, K. 2008. Unpublished information from presentation: Carbon Sequestration and Carbon Credits: The Future with Regard to Fire. Tall Timbers Research Station Fire Summit presentation. January 16, 2008.

Bidenoff, N.L., J. Willebrand, V. Artale, A. Cazenave, J. Gregory, S. Gulev, K. Hanawa, C. Le Quere, S. Levitus, Y. Nojiri, C.K. Shum, L.D. Talley and A. Unnikrishnan. 2007. Observations: Oceanic Climate Change and Sea Level. In: Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S.D., D. Qin, M Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Bishop, E.W. 1956. Geology and ground water resources of Highlands County, Florida Report of investigation 15. Florida Geological Survey. Tallahassee FL 127p.

Bogert, C.M., and R.B. Cowles. 1947. Results of the Archbold expeditions. No 58. Moisture loss in relation to habitat selection in some Floridian reptiles. American Museum Novitates 1358:1-55.

Bowman, R. and L. Averill. 1993. Demography of a suburban population of Florida scrub jays. Annual progress report for Agreement No. 14-16-0004-91-950 with U.S. Fish and Wildlife Service. December 1993.

Bowman, R., G.E. Woolfenden, A.L. Fleischer, Jr., and L.M. Walton. 1996. Nest site selection by Florida scrub-jays in natural and modified habitats. Abstract, Archbold Biological Station 1996 Symposium. 12 September 1996. Lake Placid, Florida.

Bowman, R. 1998. Population dynamics, demography, and contributions to metapopulation dynamics by suburban populations of the Florida scrub-jay, Aphelocoma coerulescens. Final report on Project No. NG94-032 to Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Bowman, R. and G.E. Woolfenden. 2001. Nest success and the timing of nest failure of Florida scrub-jays in suburban and wildland habitats. Pages 383-402 in: J.M. Marzluff, R. Bowman, and R. Donnelly (eds.). Avian Ecology and Conservation in an Urbanizing World. Kluwer Academic Publishers, Norwell, Massachusetts.

Bowman, R. 2010. Personal Communication email received 21 June 2010.

Brady, J. R., and D. S. Maehr. 1982. A new method for dealing with apiary-raiding black bears. Proceedings of Annual Conference of Southeastern Association of Fish and Wildlife Agencies. 36:571-577.

Branch, L. and Hokit, G. 2000. "A Comparison of Scrub Herpetofauna on Two Central Florida Sand Ridges".

Brendemuehi, R.H. 1990. *Pinus clausa*, sand pine. In: Silvics of North America. USDA, Forest Service, Agricultural Handbook 654. Superintendent of Documents, US Government Printing Office, Washington, D. C. pgs 294-301.

Breininger, D.R. M.A. Burgman, and B.M. Stith. 1999. Influence of habitat quality, catastrophes, and population size on extinction risk of the Florida scrub-jay. Wildlife Society Bulletin 27(3):810-822.

Breininger, D.R., B. Toland, D. Oddy, M. Legare, J. Elseroad, and G. Carter. 2001. Biological criteria for the recovery of Florida scrub-jay populations on public lands in Brevard and Indian River county. Annual Progress Report to Endangered Species Office, U.S. Fish and Wildlife Service, Jacksonville, Florida.

Breininger, D.R. and G.M. Carter. 2003. Territory quality transitions and source-sink dynamics in a Florida scrub-jay population. Ecological Applications 13(2):516-529.

Breininger, D.R. and D.M. Oddy. 2004. Do habitat potential, population density, and fires influence scrub-jay source-sink dynamics? Ecological Applications 14(4):1079-1089.

Breininger, D.R. 2006. 2006 annual report of research activities conducted under Federal Fish and Wildlife threatened species permit #TE106005-0 and Florida Fish and Wildlife Conservation Commission special use permit #WX05535. On file, Fish and Wildlife Service, Jacksonville, Florida.

Breininger, D.R., B. Toland, D.M. Oddy, and M.L. Legare. 2006. Landcover characterizations and Florida scrub-jay (*Aphelocoma coerulescens*) population dynamics. Biological Conservation 128:169-181.

Brevard County. 2007. http://www.brevardparks.com/eel/education/fire/fire_2.htm. Accessed 23 April 2007.

Buckley, A., and T.O. Hendrickson. 1988. The distribution of *Cladonia perforata* Evans on the Southern Lake Wales Ridge in Highland County, Florida. The Bryologist 91(4):354-356.

Bullen, R.P and L.E. Beilman. 1973. The Nalcrest Site, Lake Weohyakapka, Florida *in* The Florida Anthropologist. Vol XXVI, No.1. March 1973. 46pp. Website: http://www.uflib.ufl.edu/ufdc/?m=hd2J&i=60539, accessed 22 September 2009.

Burger, J. 1981. The effects of human activity on birds at a coastal bay. *Biological Conservation* 21:231-241.

Campbell, K.M. 1986. Geology of Polk County, Florida. Open-File Report 13. Florida Geological Survey. Tallahassee, Florida.

Carr, A.E., Jr. 1940. A contribution to the herpetology of Florida. University of Florida Publications, Biological Science Series: Volume III, No. 1.

Carr, Robert S., and Willard Steele. 1993. Seminole Heritage Survey - Seminole Sites of Florida (Two Volumes). *AHC Technical Report #74*. Archaeological and Historical Conservancy, Miami.

Carter, L.J., D Lewis, L Crockett and J. Vega. 1989. Soil Survey of Highlands County Florida. USDA, Soil Conservation Service. On CD ROM.

Carver, E., and J. Caudill. 2007. Banking on Nature 2006: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation. Division of Economics, U.S. Fish and Wildlife Service. Washington, DC.

Caudill, J., and A. Laughland. 2003. Banking on Nature 2002. Division of Economics, U.S. Fish and Wildlife Service, Washington, D.C. 118 pp.

Caudill, J., and Henderson, E. 2005. Banking on Nature 2004: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation. Division of Economics, U.S. Fish and Wildlife Service, Washington, D.C. 435 pp.

Central Florida Regional Planning Council (CFRPC). 2009. Website accessed 17 June 2009 http://www.cfrpc.org/

Century Commission for Sustainable Florida. 2010. Website (https://www.communicationsmgr.com/projects/1349/home.asp) accessed July 22, 2010

Christman, S. 1986. Personal communication *in* U.S. Fish and Wildlife Service (1999). Biologist. Conversation with U.S. Fish and Wildlife Service, Vero Beach, Florida, handwritten notes dated October 8, 1986.

Christman, S.P. 1988. Endemism and Florida's interior sand pine scrub. Final project report submitted to Florida Game and Fresh Water Fish Commission, Nongame Wildlife Program project GFC-84-101; Tallahassee, Florida.

Christman, S.P., and W.S. Judd. 1990. Notes on plants endemic to Florida scrub. Florida Scientist. 53(1)52-73.

Christman, S.P. 1992. Endangered: blue-tailed mole skink, *Eumeces egregius lividus* (Mount). Pages 117-122 in P.E. Moler, ed. Rare and endangered biota of Florida. University Press of Florida, Gainesville, Florida.

Christman, S.P. 2005. Densities of *Neoseps reynoldsi* on the Lake Wales Ridge. Final report submitted to U.S. Fish and Wildlife Services, Vero Beach, Florida.

Clanton, K.B. 2005. Lake Wales Ridge State Forest plant monitoring and management, 2004-2005 final report from 1/2004 through 12/2004. Florida Plant Conservation Program, Florida Division of Forestry, Tallahassee, Florida.

Clanton, K. 2006. Lake Wales Ridge State Forest plant monitoring and management 2004-2005. E 9-13 final report 2004-2005. Florida statewide endangered and threatened plant conservation program, Florida Department of Agriculture and Consumer Services, Division of Forestry, Tallahassee, Florida.

Clanton, K. 2007a. Lake Wales Ridge State Forest plant monitoring and management report, final report from 1/2007 through 12/2007. Florida Plant Conservation Program, Florida Division of Forestry, Tallahassee, Florida.

Clanton, K. 2007b. Information and comments on federally listed plants on the Lake Wales Ridge State Forest in response to the U.S. Fish and Wildlife Service 5-year status review. Florida Division of Forestry. In U.S. Fish and Wildlife Service (2008g).

Clutts, J.L. 1995. Letter from national Forest Service to the U.S. Fish and Wildlife Service. 5 October 1995. On file at the U.S. Fish and Wildlife Service; Vero Beach, Florida.

Collazos, A. 1998. Microhabitat selection in *Neoseps reynoldsi*, the Florida sand swimming skink. M.S. Thesis, University of South Florida, Tampa, Florida.

Connery, C.B. 1984. Factors that influence plant species richness on habitat islands of sand pine scrub. M.S. Thesis, University of Central Florida. 91 pp.

Cook, F.A. 1954. Snakes of Mississippi. Mississippi Game and Fish Commission; Jackson Mississippi.

Corogin, P. 2008. "Floristic Inventory of Tiger Creek Preserve and Saddle Blanket Scrub Preserve, Polk County, Florida".

Covington, James W. 1993. *The Seminoles of Florida*. University Press of Florida, Gainesville.

Cox, A. 2003. Species Monitoring Report *Cladonia perforata*, Florida perforate Cladonia. Florida Plant Conservation Program, Florida Division of Forestry, Lake Wales Ridge State Forest. December 2003.

Cox, A.C., A.F. Johnson, S. Kane, and L.G. Chafin. 2004. Status survey for scrub plum, *Prunus geniculata*. Final report, Division of Forestry, Florida Department of Agriculture and Consumer Services Contract #008474, Tallahassee, Florida.

Cox, A. 2007. Comments on draft 5-year review form as official peer reviewer. Email to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated August 20, 2007. ecolo~G, Inc. Jupiter, FL.

Davis, J.G., Jr. 1943. The natural features of southern Florida: especially the vegetation and the Everglades. Florida Department of Conservation, Florida Geological Survey Bulletin 25. 311pp.

Defenders of Wildlife. 2002. Out of Control: The Impacts of Off-Road Vehicles and Roads on Wildlife and Habitat in Florida's National Forests. August 2002.

Diemer, J.E., and D.W. Speake. 1983. The distribution of the eastern indigo snake, Drymarchon corais couperi, in Georgia. Journal of Herpetology 17(3):256-264.

Dobb, E. 1998. Reality Check: The Debate behind the Lens. Audubon: Jan-Feb.

Dobson, A.P., J.P. Rodriguez, W.M. Roberts, and D.S. Wilcove *in* Turner et al. (2006). 1997. Geographic distribution of endangered species in the United States. Science 275:550-553.

Dolan, R.W., P.F. Quintana-Ascencio, and E.S. Menges. In revision i*n* U.S. Fish and Wildlife Service (2008e). Fire-induced genetic change in populations of a seed-banking perennial plant. Oecologia.

Duellman, W.E., and A. Schwartz. 1958. Amphibians and reptiles of southern Florida. Bulletin Florida State Museum, Biological Sciences 3:181-324.

Duncan, B.W. and P.A. Schmalzer. 2004. Anthropogenic influences on potential fire spread in a pyrogenic ecosystem of Florida. Landscape Ecology 19:153-165.

Dupree, A. Hunter. 1957. Science in the Federal Government: A History of Policies and Activities to 1940. Harvard University Press, Cambridge, Massachusetts. 460 pp.

Ellis, M.M., C.W. Weekley, and E.S. Menges. 2007. Evaluating stability in *Ziziphus celata*, a highly endangered clonal shrub endemic to central Florida's Lake Wales Ridge. Endangered Species Research 3:125-132.

Evans, A.W. 1952. The Cladoniae of Florida. Transactions of the Connecticut Academy of Arts and Sciences 38:249-336.

Evans, M.E.K., E.S. Menges, and D.R. Gordon. 2004. Mating systems and limits to seed production in two *Dicerandra* mints endemic to Florida scrub. Biodiversity and Conservation 13:1819-1832.

Ewel, K. C. 1990. Swamps. In *Ecosystems of Florida*. University of Central Florida Press. Orlando, Florida. Pages 281-322.

Faivre, A.E. 2008. Personal communication *in* U.S. Fish and Wildlife Service (2008c). Cedar Crest College. Email attachment of 18 April 2008.

Fantz, P.R. 1977. A monograph of the genus *Clitoria* (Leguminosae:Glycineae). PhD. dissertation, University of Florida; Gainesville, Florida.

Fantz, P.R. 1979. Pigeon wings. Pages 77-79 *in* D.B. Ward, ed. Rare and Endangered Biota of Florida, volume V: Plants. University Presses of Florida; Gainesville, Florida.

Fernald, R.T. 1989. Coastal xeric scrub communities of the Treasure Coast region of Florida: a summary of their distribution and ecology, with guidelines for their preservation and management. Florida Game and Fresh Water Fish Commission, Nongame Wildlife program, Technical Report No. 6, Tallahassee, Florida, USA.

Fitzpatrick, J.W., G.E. Woolfenden, and M.T. Kopeny. 1991. Ecology and development-related habitat requirements of the Florida scrub jay (*Aphelocoma coerulescens*). Florida Game and Fresh Water Fish Commission Nongame Wildlife Program Technical Report No. 8. Tallahassee, Florida.

Fitzpatrick, J.W., B. Pranty, and B. Stith. 1994. Florida scrub jay statewide map, 1992-1993. Archbold Biological Station. Lake Placid, Florida.

Fitzpatrick, J.W., R. Bowman, D.R. Breininger, M.A. O'Connell, B. Stith, J. Thaxton, B. Toland, and G.E. Woolfenden. 1998. Unpublished manuscript. Habitat conservation plans for the Florida scrub-jay: a biological framework. On file, Fish and Wildlife Service, Jacksonville, Florida.

Florida Exotic Pest Plant Council (FLEPPC). 2007. List of Florida's Invasive Plant Species. Florida Exotic Pest Plant Council. Internet: http://www.fleppc.org/list/07list.htm or Wildland Weeds Vol. 10(4), Fall 2007.

Florida Entomological Society. 2010. Florida Arthropod Conservation Webpage (http://www.flaentsoc.org/arthropdiversity/rosemary_grasshopper.htm). Accessed 13 July 2010.

Florida Department of Environmental Protection (FDEP). 2006. 2006 Florida Air Monitoring Report. Division of Air Resource Management, Tallahassee, FL. (http://www.dep.state.fl.us/Air/publications/techrpt/amr06.pdf). Accessed June 2008.

Florida Department of Environmental Protection (FDEP). 2007. http://www.dep.state.fl.us/lands/landmgmt/default.htm. Accessed April 27, 2007. *In* U.S. Fish and Wildlife Service (2009a).

Florida Department of Environmental Protection (FDEP). 2010. http://www.dep.state.fl.us/water/tmdl/. Accessed July 20, 2010.

Florida Department of State memorandum (1992) to U.S. Fish and Wildlife Service Project Development Planning Report for the Establishment of Lake Wales Ridge National Wildlife Refuge, Highlands and Polk Counties, Florida.

Florida Department of Transportation (FDOT). 1998. Summary of inventory of *Lupinus aridorum* on Florida's Turnpike right-of-way in Orange County. On file, Fish and Wildlife Service, Jacksonville, Florida.

Florida Department of Transportation (FDOT). 1999. Florida land Use, Cover and Forms Classification System Handbook (Third Edition). Florida Department of Transportation, Survey and Mapping Geographic Mapping Section. Tallahassee, Florida.

Florida Department of Transportation (FDOT) Annual Overview. 2008. http://www.dot.state.fl.us/financialplanning/AGENCY_OVERVIEW.pdf.

Florida Fish and Wildlife Conservation Commission (FWC). 1987. Ecology and Habitat Protection Needs of Gopher Tortoise (*Gopherus polyphemus*) Populations Found on lands Slated for Large-scale Developments in Florida. Nongame Wildlife Program Technical Report No. 4. Tallahassee, FL 75 pp.

Florida Fish and Wildlife Conservation Commission (FWC). 2003. Conservation Strategy for the Florida Black Bear in Florida. Compiled and Written by T. H. Eason from input and comments by the Florida Bear Conservation Working Group. 51 pp.

Florida Fish and Wildlife Conservation Commission (FWC) FY2004-2005. Progress Report on Activities of the Endangered/Threatened Species Management and Conservation Plan.

Florida Fish and Wildlife Conservation Commission (FWC). 2005. Florida's Wildlife Legacy Initiative. Florida's Comprehensive Wildlife Conservation Strategy. Tallahassee, Florida, USA. 472 pp.

Florida Fish and Wildlife Conservation Commission (FWC). 2009a. Lake Wales Ridge WEA webpage (http://myfwc.com/RECREATION/WMASites_LakeWalesRidge_index.htm). Website accessed January 2009.

Florida Fish and Wildlife Conservation Commission (FWC). 2009b. Ridge Rangers July-September 2009 Newsletter. Lake Placid, Florida.

Florida Fish and Wildlife Conservation Commission (FWC). 2009c. Florida's Endangered Species, Threatened Species, and Species of Special Concern. Species Conservation Planning Section, Division of Habitat and Species Conservation, Florida Fish and Wildlife Conservation Commission. Tallahassee, FL. 6 pp. (http://myfwc.com/docs/WildlifeHabitats/Threatened_Endangered_Species.pdf). Website accessed September 2009.

Florida Natural Areas Inventory (FNAI). 1985. Element occurrence data for: *Prunus geniculata*. Tallahassee, Florida.

Florida Natural Areas Inventory and Department of Natural Resources (FNAI). 1990. Guide to The Natural Communities of Florida. Florida Department of Natural Resources, Tallahassee Florida.

Florida Natural Areas Inventory (FNAI). 2008. Element population records for *Ziziphus celata*. Florida Natural Areas Inventory. Tallahassee, FL.

Florida Natural Areas Inventory. 2009a. Florida Conservation Lands GIS coverage webpage: http://data.labins.org. Accessed January 2009.

Florida Natural Areas Inventory (FNAI). 2009b. Element Tracking Summary June 2009. Website: http://www.fnai.org/trackinglist.cfm. Website accessed 21 September 2009.

Floridata. 2010. Website (http://www.floridata.com/ref/c/cyri_rac.cfm) accessed July 15, 2010

Franz, R. 1986. The Florida gopher frog and the Florida pine snake as burrow associates of the gopher tortoise in northern Florida. pp. 16-20 in D.R. Jackson and R.J. Bryant (eds.). The gopher tortoise and its community. Proc 5th Ann. Mtg. Gopher Tortoise Council, Gainesville, Florida.

Franz, R., D. Maehr, A. Kinlaw, C. O'Brien and R.D. Owen. 1998. Avon Park Air Force Range Project: distribution and abundance of sensitive wildlife species at Avon Park Air Force Range. Final report RWO-169.

Franz, R. and C. Puckett. 2007. Gopher tortoise: a species in decline. University of Florida Institute of Food and Agricultural Sciences. Accessed: 2 Aug 2007. http://edis.ifas.ufl.edu/UW048.

Friends of Istokpoga Newsletter. 2004. Lake Wales Ridge Wildlife and Environmental Area – Royce Unit Update *in* Friends of Istokpoga Newsletter. Friends of Istokpoga Lake Association Inc., Lake Placid, FL.. January 2004 Newsletter #22, 3pp. http://www.istokpoga.org/Documents/Newsletters/2022.pdf.

Gabrielson, Ira N. 1943. Wildlife Conservation. The Macmillan Company, New York, New York. 250 pp.

Gabrielson, G.W. and E.N. Smith. 1995. Physiological responses of wildlife to disturbance. Pages 95-107 in R.L. Knight and K.J. Gutzwiller, eds., *Wildlife and Recreation: Coexistence through Management and Research*. Island Press, Washington, D.C. 372 pp.

Gianopulos, K.D. 2001. Response of the threatened sand skink (*Neoseps reynoldsi*) and other herpetofaunal species to burning and clear-cutting in the Florida sand pine scrub habitat. M.S. Thesis, University of South Florida, Tampa, Florida.

Gianopulos, K.D., H.R. Mushinsky, and E.D. McCoy. 2001. Response of the threatened sand skink (*Neoseps reynoldsi*) to controlled burning and clear-cutting in Florida sand pine scrub habitat. Proceedings from the Florida Scrub Symposium, Orlando, Florida.

Gibson, D.J. and E.S. Menges. 1994. Population structure and spatial pattern in the dioecious shrub *Ceratiola ericoides*. Journal of Vegetation Science 5:337-346.

Gilpin, M.E. 1987. Spatial structure and population vulnerability. Pages 125-139 in M.E. Soulé (ed.). Viable Populations for Conservation. Cambridge University Press, Cambridge, England.

Gopher Tortoise Council. 2009. http://www.gophertortoisecouncil.org/about.php. Accessed 2 June 2009.

Green Horizon Land Trust. 2009. http://www.greenhorizon.org. Website accessed 17 June 2009.
Haltom, W.L. 1931. Alabama reptiles. Alabama Geological Survey and Natural History Museum, Paper No. 11:1-145.

Hammer, S. 2000. Meristem growth dynamics and branching patterns in the Cladoniaceae. American Journal of Botany 87(1):33-47.

Hanna, D. 2009. personal communication. Highlands County Planning Department. March 2009.

Hardin, E.D. and A.M. Schrift. 2006. Florida statewide endangered and threatened plant conservation program E-9-13 final report 2004-2005. Florida Department of Forestry, Tallahassee, Florida.

Harper, R. 1911. A new plum from the Lake Region of Florida. Torreya 11:64-67.

Harper, R.M. 1927. Natural resources of southern Florida. Florida State Geological Survey Annual Report 18:27-206.

Hartnett, D.C., and Richardson, D.R. 1989. Population biology of *Bonamia grandiflora* (Convolvulaceae): Effects of fire on plant and seed bank dynamics. American Journal of Botany 76(3):361-369.

Hawkes, C.V. 1995. Comments on draft account. July 1995 *in* U.S. Fish and Wildlife Service (1999).

Hawkes, C.V. and E.S. Menges. 1995. Density and seed production of a Florida endemic, Polygonella basiramia, in relation to time since fire and open sand. American Midland naturalist 133:138-148.

Hawkes, C.V., and E.S. Menges. 1996. The relationship between open space and fire for species in a xeric Florida shrubland. Bulletin Torrey Botany Club 123(2):81-92

Hawkes, C.V. 1998. Comments on draft species account. January 21 *in* U.S. Fish and Wildlife Service (1999).

Hawkes, C.V., and E.S. Menges. 2003. Effects of lichens on seedling emergence in xeric Florida shrubland. Southeastern Naturalist 2:223-234.

Hawkes, C.V. 2003. Nitrogen cycling mediated by biological soil crusts and arbuscular mycorrhizal fungi. Ecology 84:1553-1562.

Hawkes, C.V. 2004. Effects of biological soil crusts on seed germination of four endangered herbs in a xeric Florida shrubland during drought. Plant Ecology 170:121-134.

Heartland 2060 Regional Vision statement *in* Draft April 2008. Central Florida Regional Planning Council, Heartland 2060 fact sheet, April 2008.

Herndon, A. 1996. Life history of *Liatris ohlingerae* (Asteracea), an endangered plant endemic to the Lake Wales Ridge, Florida. Final report, project number NG91-016, Florida Game and Fresh Water Fish Commission; Tallahassee, Florida.

Hewitt, R.E., and E.S. Menges. In press. Allelopathic effects of *Ceratiola ericoides* (Empetraceae) on germination and survival of six Florida scrub species. Plant Ecology. *in* U.S. Fish and Wildlife Service (2008e).

Highlands County 1990. Highlands County, Florida Comprehensive Plan of 1990. website: . http://www.hcbcc.net/PDFfiles/compplancompleteamended.pdf. Accessed 17 June 2009.

Highlands County 2008. Future Land Use Map. Website: http://www.hcbcc.net/FuturLandUse.html. Accessed 17 June 2009.

Highlands County. 2009. Natural Resources Advisory Commission (NRAC) agenda. April 29, 2009 Regular Meeting (http://www.hcbcc.net/PDFfiles/NRACagenda.pdf). Accessed June 17, 2009.

Highlands County Soil and Water Conservation District web site. http://www.highlandsswcd.org/everything/lake_summaries/re%20beach.htm. Accessed 23 December 2008.

Hill, K.E. 1999. Responses of released populations of the sand skink, *Neoseps reynoldsi*, to scrub habitat translocation in central Florida. M.S. Thesis, University of South Florida, Tampa, Florida.

Historic Bok Sanctuary. 2006. Endangered and threatened native flora conservation grants program. Interim report to the Florida Plant Conservation Program of the Florida Department of Agriculture and Consumer Services. Contract 011298.

Horton, J.H. 1960. A monograph of *Delopyrum* Small, *Dentoceras* Small, *Polygonella* Michx., and *Thysanella* Gray (Polygonaceae). Unpublished PhD dissertation, University of North Carolina, Chapel Hill, North Carolina.

Howell, W., B. Malloy, and G. Brock. 2003. Land management review team findings: 1997-2003. Office of Environmental Service, Division of State Lands, Department of Environmental Protection, Tallahassee, Florida.

Huck, R.B., W.S. Judd, W.M. Whitten, J.D. Skean Jr., R.P. Wunderlin, K.R. Delany. 1989. A new *Dicerandra* (Labiatae) from the Lake Wales Ridge of Florida, with a cladistic analysis and discussion of endemism. Systematic Botany 14(2):197-213.

Huck, R.B. 2009. Email to Dave Bender. Florida Museum of Natural History. Gainesville, Florida. August 7, 2009.

Hunter, M.E., and E.S. Menges. 2002. Allelopathic effects and root distribution of *Ceratiola ericoides* (Empretaceae) on seven rosemary scrub species. American Journal of Botany 89:1113-1118.

Hutchinson, J.T. 2003. Invasive Plants of Archbold Biological Station and Highlands County, Florida. Land Management Program at Archbold Biological Station, Lake Placid Florida. Website: (http://www.archboldstation.org/ABS/landmanage/ExoticsGrant03/ExoticsMain/aaInvasives_index). Accessed July, 2008.

Jackson, D.R. and E.G. Milstrey. 1989. The fauna of gopher tortoise burrows. Pages 86-98 in J.E. Diemer et al., eds. Proc. gopher tortoise relocation symposium. Fla. Game and Fresh Water Fish Commission, Nongame Wildlife Program Technical Report No. 5

Johnson, A.F. 1982. Some demographic characteristics of the Florida rosemary *Ceratiola ericoides* Michx. American Midland Naturalist 108:170-174.

Johnson, A.F., W.G. Abrahamson, and K.D. McCrea. 1986. Comparison of biomass recovery after fire of a seeder (*Ceratiola ericoides*) and a sprouted (*Quercus inopina*) species from south-central Florida. American Midland Naturalist 116:423-428.

Johnson, A.F., and W.G. Abrahamson. 1990. A note on the fire responses of species in rosemary scrubs on the southern Lake Wales Ridge. Florida Scientist 53:138-143.

Johnson, A. 1982. Some demographic characteristics of the Florida rosemary *Ceratiola ericoides* Michx. American Midland Naturalist 10:170-174.

Johnson, F.A., T. Beech, R.M. Dorazio, M. Epstein, J. Lyon. 2006. Abundance and detection probabilities of Florida scrub-jays at Merritt Island National Wildlife Refuge using spatially replicated counts. U.S. Fish and Wildlife Service, University of Florida, Gainesville.

Judd, W.S. 1980. Status report of Hypericum cumulicola. U.S. Fish and Wildlife Service, Jacksonville, Florida.

Kane S.R. 2003. Historical and current distribution status of *Lupinus aridorum* McFarlin ex Beckner. Unpublished M.S. Thesis. University of Central Florida, Orlando, Florida.

Kane, R and M. Dickman. 2005. Water Resources Data Florida Water Year 2005 Volume 3A. Southwest Florida surface water. USGS 10500 University Center Drive Suite 215, Tampa FL. 374 p

Kautz, R., R. Kawula, T. Hoctor, J. Comiskey, D. Jansen, D. Jennings, J. Kasbohm, F. Mazzotti, R. McBride, L. Richardson, and K. Root. 2006. How much is enough? Landscape-scale conservation for the Florida panther. Biological Conservation 130:118-133

Kersey, Jr., Harry A. 1987. *The Seminole and Miccosukee Tribes: A Critical Bibliography*. Bibliographical Series for the Newbury Library D' Arcy McNickle Center for the History of the American Indian.

Klein, M.L. 1993. Waterbird Behavior Responses to Human Disturbances. Wildlife Society Bulletin 21: pp. 31-39.

Knisley, C.B., and J.M. Hill. 1992. Status survey of the rare Florida scrub tiger beetle, *Cicindela highlandensis*. Manuscript report prepared for U. S. Fish and Wildlife Service, Jacksonville, Florida *in* U.S. Fish and Wildlife Service (2008k)

Knisley, C.B., and J.M. Hill. 1996. The Florida Highlands tiger beetle, *Cicindela highlandensis*: habitat requirements, remaining range, life history, and management. Final report, Florida nongame wildlife program grant (NG91-012). Submitted to Florida Game and Fresh Water Fish Commission, Bureau of Nongame Wildlife, Richmond, Virginia.

Knisley, C.B. 2005. Status survey of the Highlands tiger beetle, *Cicindela highlandensis*, 2005. Final draft report to the U.S. Fish and Wildlife Service.

Kral, R. 1983. A report on some rare, threatened, or endangered forest-related vascular plants of the South. U.S. Department of Agriculture, Forest Service Technical Publication R8-TP-2; Atlanta, Georgia.

Laessle, A.M. 1968. Relationships of sand pine scrub to former shore lines. Quarterly Journal of the Florida Academy of Science 30(4):269-286.

Lake Wales Ridge Ecosystem Working Group (LWREWG). 1998. Florida's Ancient Islands: The Lake Wales Ridge. 16 pp.

Lake Wales Ridge Ecosystem Working Group (LWREWG). 2008. Florida's Ancient Islands: A Visitor's Guide to the Lake Wales Ridge.

Landers, J.L., and D.W. Speake. 1980. Management needs of sandhill reptiles in southern Georgia. Proceedings of the annual conference of the southeastern association of fish and wildlife agencies 34:515-529.

LandScope Florida. Endemic Invertebrate Animals List. Website: http://www.landscope.org/. Accessed June 2009.

Langeland, K.A., and Burks, K.C. (eds.). 1998. Identification and Biology of Non-Native Plants in Florida's Natural Areas. University of Florida. 165p.

Lawler, H.E. 1977. The status of *Drymarchon corais couperi* (Holbrook), the eastern indigo snake, in the southeastern U.S.A. Herpetological Review 8(3):76-79.

Laycock, George. 1965. The Sign of the Flying Goose: A Guide to the National Wildlife Refuges. The Natural History Press, Garden City, New York. 299 pp.

Layne, J.N., and T.M. Steiner. 1996. Eastern indigo snake (*Drymarchon corais couperi*): summary of research conducted on Archbold Biological Station. Report prepared under Order 43910-6-0134 to the U.S. Fish and Wildlife Service; Jackson Mississippi.

Legare, M.L., D.R. Breninger, and M.R Bolt. 1998-2002. Indigo snake radiotracking data collected from Brevard County, Florida. Dynamac Corporation.

Lenze, David G. 2002. Florida: Long-term Economic Forecast 2002, Volume 2 – State and Counties. Bureau of Economic and Business Research, University of Florida Gainesville, Florida. 503 pp.

Leonard, Jerry. 2008. Wildlife Watching in the U.S.: The Economic Impacts on National and State Economies in 2006 – Addendum to the 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Report 2006-1. Wildlife and Sport Fish Restoration Programs. U.S. Fish and Wildlife Service. Arlington, VA.

Lewis, M.N. 2007. Life history and reproductive biology of *Clitoria fragrans* relative to fire history on the Avon Park Air Force Range. Master's Thesis, University of Central Florida, Orlando, FL. 44 pp.

Li, J.H., D.P. Johnson, P. Dijkstra, B.A. Hungate, C.R. Hinkle and B.G. Drake. 2007. Elevated CO_2 mitigates the adverse effects of drought on daytime net ecosystem CO_2 exchange and photosynthesis in Florida scrub-oak ecosystem. Photsynthetcia 25(1): 51-58.

Loding, H.P. 1922. A preliminary catalog of Alabama reptiles and amphibians. Alabama Geological Survey and Natural History Museum, Paper No. 5:1-59.

Main, K. N. and E. S. Menges. 1997. *Archbold Biological Station Fire Management Plan.* Archbold Biological Station. Lake Placid Florida. 103 pgs.

Main, K. N. 1999. *Vegetative Coverages for the Carter Creek and Flamingo Villas Units of the Lake Wales Ridge National Wildlife Refuge*, Archbold Experiment Station. Lake Placid, Florida.

Malatesta, A. 2007. Peer review comments to U.S. Fish and Wildlife Service, Vero Beach, FL. June 13 *in* U.S. Fish and Wildlife Service (2007b).

Martin, T. 1998. Florida's Ancient Islands. The Lake Wales Ridge Ecosystem Working Group. 1999 copy write, Archbold Biological Station, Lake Placid, Florida.

McCartan, L. 1992. Evolution of landforms on the Florida platform with special emphasis on the Lake Wales Ridge. Abstract, History and Ecology of the Florida Scrub: 1992 conference commemorating the 50th anniversary of Archbold Biological Station. Archbold Biological Station, Lake Placid, Florida.

McConnell, K. and E.S. Menges. 2002. Effects of fire and treatments on the Florida endemic scrub buckwheat (*Eriogonum longifolium* Nutt. var. *gnaphalifolium* Gand.). Natural Areas Journal 22(3):194-201.

McCoy, E.D., Mushinsky H. 1992. Rarity of Organisms in the Sand Pine Scrub Habitat of Florida. Conservation Biology, Vol. 6, No. 4 pp. 537-548

McDaniel, J. 1974. Habitat of the black bear in Florida. Proceedings of Eastern Workshop on Black Bear Research and Management 2:157-162

Menges, E.S. 1992. Habitat preferences and response to disturbance for *Dicerandra frutescens*, a Lake Wales Ridge (Florida) endemic plant. Bulletin of the Torrey Botanical Club 119:308-313.

Menges, E.S., and Kohfeldt, N. 1995. Life history strategies of Florida scrub plants in relation to fire. Bulletin of the Torrey Botanical Club 122:282-297.

Menges , E.S. 1995. FWS Multi-Species Recovery Team meeting. December 6-8, 1995 *in* U.S. Fish and Wildlife Service 1999.

Menges, E.S., and D.R. Gordon. 1996. Three levels of monitoring intensity for rare plant species. Natural Areas Journal 16:227-237.

Menges, E.S., D. Gordon, R. Dolan. 1996. Demography, breeding system, and genetics of Nolina brittoniana. Final report to the Florida Division of Forestry; Tallahassee, Florida.

Menges, E. S. 1997. Meeting discussion, 23 January 1997 *in* U.S. Fish and Wildlife Service (1999).

Menges, E.S., and C.V. Hawkes. 1998. Interactive effects of fire and microhabitat on plants of Florida scrub. Ecological Applications 8(4):935-946.

Menges, E.S., et.al. unpublished data. 1998. *In* Florida's Ancient Islands of Lake Wales Ridge, Lake Wales Ridge Ecosystem Working Group webpage http://www.archbold-station.org/fai/species4.html. Accessed January 2009.

Menges, E.S. 1999. Ecology and conservation of Florida scrub. Pp. 7-22. In: Anderson, R.C., J.S. Fralish, and J. Baskin (eds.). The savanna, barren, and rock outcrop communities of North America. Cambridge University Press, Cambridge, UK. 470 pp.

Menges E.S., P.J., McIntyre, M.S. Finer, E. Gross, and R. Yahr. 1999. Microhabitat of the narrow Florida scrub endemic *Dicerandra christmanii*, with comparisons to its congener *D. frutescens*. Journal of the Torrey Botanical Society 126: 24–31.

Menges, E.S., and C.W. Weekley. 1999. Final report on continued ecological monitoring and experimental research on four endemic scrub plants. Report to the Division of Forestry, Florida Department of Agriculture. Archbold Biological Station. Lake Placid, Florida.

Menges, E.S., R.W. Dolan, R. Yahr, and D.R. Gordon. 2001. Comparative genetics of seven plants endemic to Florida's Lake Wales Ridge. Castanea 66:98-114.

Menges, E.S., and P.F. Quintana-Ascencio. 2004. Population viability with fire in *Eryngium cuneifolium*: deciphering a decade of demographic data. Ecological Monographs 74:79-99.

Menges, E.S., P.F. Quintana Ascencio, C.W. Weekley, O.G. Gaoue. 2006. Population Viability Analysis and Fire Return Intervals for an Endemic Florida Scrub Mint. Biological Conservation 127:115-127.

Menges E.S. 2007. Integrating demography and fire management: an example from Florida scrub. Australian Journal of Botany 55:262-272.

Menges, E.S., C.W. Weekley, S.I. Hamze, and R.L. Pickert. 2007. Soil preferences for listed plants on the Lake Wales Ridge in Highlands County, Florida. Florida Scientist 70:24-39.

Menges, E.S., C.W. Weekley, and M.A. Rickey. 2008a. Sandhill restoration studies and experimental introduction of *Ziziphus celata* at Lake Wales Ridge National Wildlife Refuge. Annual Report to Florida Fish and Wildlife Conservation Commission, Gainesville, FL

Menges, E.S., A. Craddock, J. Salo, R. Zinthefer, and C.W. Weekly. 2008b. Gap ecology in Florida scrub: species occurrence, diversity, and gap properties. Journal of Vegetation Science 19:503-514.

Menges, E.S., C.W. Weekley, G.L. Clarke, and S.A. Smith. 2008c. Restoration of degraded sites in high quality Florida scrub. Final report to U.S. Fish and Wildlife Service, Vero Beach, FL. 24 pp.

Menges, E.S., C.A. Weekley, S. A. Smith. 2008d. Archbold Biological Station, Report to: Endangered and Threatened Plant Conservation Grants Program. Florida Department of Agriculture and Consumer Services, Division of Plant Industry. July 2008.

Menges, E.S. 2008e. Personal observation of unpublished data collected by P.F. Quintana-Ascencio, E.S. Menges, and C.W. Weekly, data through February 2008 *in* U.S. Fish and Wildlife Service (2008e).

Menges E.S. 2008a. Archbold Biological Station. Personal communication to U.S. Fish and Wildlife Service via Email 2 June 2008.

Menges, E.S. 2008b. Personal communication. Senior research Biologist, Archbold Biological Station. June 2. *in* U.S. Fish and Wildlife Service (2008h).

Menges, E.S. 2008c. Personal communication. Senior research Biologist, Archbold Biological Station. June 2. *in* U.S. Fish and Wildlife Service (2008h)

Menges, E.S. 2008d. Personal communication. Senior research Biologist, Archbold Biological Station. June 2. *in* U.S. Fish and Wildlife Service (2008h)

Menges, E.S. 2008e. Personal communication. Senior research Biologist, Archbold Biological Station. June 2. *in* U.S. Fish and Wildlife Service (2008h)

Menges, E.S., and D.R. Gordon. 2010. Should Mechanical Treatments and Herbicides be used as Fire Surrogates to Manage Florida's Uplands? A Review. Florida Scientist 73(2): 147-174.

Milanich, Jerald T., and Donna L. Ruhl. 1986. *Fort Center and the Belle Glade Culture, Florida*. Pictures of Record, Weston, Connecticut.

Milanich, Jerald T. (editor). 1993. *Florida Historical Contexts*. Division of Historical Resources, Tallahassee.

Milanich, Jerald T. 1994. *Archaeology of Precolumbian Florida*. University Press of Florida, Gainesville.

Miller, L. 1989. Bonamia grandiflora: road survey, Lake George and Seminole Ranger Districts, Ocala National Forest, July and August 1989. Manuscript report, Lake George Ranger District, Ocala National Forest; Silver Springs, Florida.

Minno, M.C., J.F. Butler, and D.W. Hall. 2005. Florida butterfly caterpillars and their host plants. University Press of Florida, Gainesville, FL. 341 pp.

Moler, P.E. 1985a. Distribution of the eastern indigo snake, *Drymarchon corais couperi*, in Florida. Herpetological Review 16(2):37-38.

Moler, P.E. 1985b. Home range and seasonal activity of the eastern indigo snake, *Drymarchon corais couperi*, in northern Florida. Final performance report, Study E-1-06, III-A-5. Florida Game and Fresh Water Fish Commission; Tallahassee, Florida.

Moore, B.J. 1968. The macrolichen flora of Florida. The Bryologist 71(3):161-266.

Morrison, S. 2007. Personal Communication *in* U.S. Fish and Wildlife Service (2008f)

Morton J.M. 1995. Management of Human Disturbance and its Effect on Waterfowl. Pages F59-F86 *in* W.R. Whitman, T. Strange, L. Widjeskog, R. Whittemore, P. Kehoe, and L. Roberts (eds). Waterfowl Habitat Restoration, Enhancement and Management in the Atlantic Flyway. Third Ed. Environmental Management Committee, Atlantic Flyway Council Technical Section, and Delaware Division of Fish and Wildlife. Dover, DE. 1114 pp.

Muller, J.W., E.D. Hardin, D.R. Jackson, S.E. Gatesood, and N. Caire. 1989. Summary report on the vascular plants, animals and plant communities endemic to Florida. Nongame wildlife program technical report number 7. Florida Game and Fresh Water Fish Commission; Tallahassee, Florida.

Mushinsky, H.R., and E.D. McCoy. 1999. Studies of the sand skink (*Neoseps reynoldsi*) in Central Florida. Final report to the Disney Wildlife Conservation Fund. University of South Florida, Tampa, Florida.

Mushinsky, H.R., E.D. McCoy, K. Gianopulos, K. Penney, and C. Meyer. 2001. Biology of the threatened sand skink on restored scrub habitat and its responses to land management practices. Final report to the Disney Wildlife Conservation Fund. University of South Florida, Tampa, Florida.

Mushinsky, H. 2007a. Peer review comments to U.S. Fish and Wildlife Service, Vero Beach, Florida. June 1 *in* U.S. Fish and Wildlife Service (2007b).

Mushinsky, H. 2007b. Personal communication. Biologist. Notes from skink workshop with U.S. Fish and Wildlife Service in Ocala, Florida, handwritten notes dated May 16 *in* U.S. Fish and Wildlife Service (2007b).

Myers, R.L. 1985. Fire and the dynamic relationship between Florida sandhill and sandpine vegetation. Bulletin of the Torrey Botanical Club. 112:241-252.

Myers, R.L. 1990. Scrub and high pine. Pages 150-193 *in* R.L. Myers and J.J. Ewel, eds. Ecosystems of Florida. University Presses of Florida; Gainesville, Florida.

Nash, G.V. 1895. Notes on some Florida plants. Bulletin of the Torrey Botanical Club 22(4):141-161.

National Oceanic and Atmospheric Administration. 2002. Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1971-2000 for Florida. Climatography of the United States, Bulletin No. 81.

NatureServe. 2007. NatureServe Explorer: An online encyclopedia of life [web application]. Version 6.2. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer. Accessed January 30, 2008.

Navratil, G. 1999. A study of selected land management practices on the sand pine scrub habitat of Florida: A measure of the effects of land management on the sand skink, Neoseps reynoldsi. M.S. Thesis. University of South Florida, Tampa, Florida.

Noss, R. F., Peters, R. 1995. Endangered Ecosystems: A Status Report on America's Vanishing Habitat and Wildlife. Defenders of Wildlife publication, 1995. Washington, D.C.

North Wind Inc. 2006. Lake Wales Ridge National Wildlife Refuge Exotic Species Mapping, Summary of GIS Data. On file at U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge Complex; Titusville, Florida.

Oetting, J, and T. Hoctor. 2007. CLIP Critical Lands & Waters Identification Project Phase I Report to the Century Commission for a Sustainable Florida, Tallahassee, FL. 45pp. http://www.centurycommission.org/current_projects.asp.

Ogden, J.C. and B.W. Patty. 1981. The Recent Status of the Wood Stork in Florida and Georgia. Georgia Dept. Nat. Res. Game and Fish Div. Tech. Bull. WL 5:97-101.

Orzell, S.L. 2008. Personal communication *in* U.S. Fish and Wildlife Service (2008c). Avon Park Air Force Range. 14 April 2008.

Pace-Aldana, D. Gordon, and J Slapcinsky. 2006. Monitoring of scrub plum (*Prunus geniculata*) on the Lake Wales Ridge, in Annual research report 2006 – a compilation of research conducted or supported by The Nature Conservancy in Florida.

Pace-Aldana, B. 2008. Electronic mail. Conservation Biologist with The Nature Conservancy. April 21 in U.S. Fish and Wildlife Service (2008h).

Partners In Flight (PIF). 2009. Executive Summary of the Peninsular Florida physiographic area. Website: http://www.partnersinflight.org/bcps/pl_02sum.htm accessed 23 September 2009.

Pearson, D.L., and F. Cassola. 1992. World-wide species richness patterns of tiger beetles (Coleoptera: Cicinedelidae): indicator taxon for biodiversity and conservation studies. Conservation Biology 6:376-391.

Pease, M.L., R.K. Rose and M.J. Butler. 2005. Effects of human disturbances on the behavior of wintering ducks. *Wildlife Society Bulletin* 33(1): 103-112.

Penney, K.M. 2001. Factors affecting translocation success and estimates of dispersal and movement patterns of the sand skink Neoseps reynoldsi on restored scrub. M.S. Thesis. University of South Florida, Tampa, Florida.

Penney, K.M., H.R. Mushinsky, and E.D. McCoy. 2001. Translocation success of the threatened sand skink. Proceedings from the Florida Scrub Symposium, Orlando, Florida.

Percival, H.F., D.B. McDonald, and M.J. Mazurek. 1995. Status and distribution of the Florida scrub jay (*Aphelocoma c. coerulescens*) on Cape Canaveral, Florida. Final report, research work order 136. Technical Report No. 51. Florida Fish and Wildlife Research Unit, Gainesville, Florida.

Petru, M., and E.S. Menges. 2003. Seedling establishment in natural and experimental Florida scrub gaps. Journal of the Torrey Botanical Society 130:89-100.

Polk County Environmental Lands Program. 2009. http://www.polk-county.net. Accessed June 17, 2009.

Polk County 2030 Transportation Improvement Plan. 2009. Polk County Transportation Planning Organization: Ridge Scenic Highway. (http://polktpo.s3.amazonaws.com/downloads/631/Chapter_10_Ridge_Scenic_Highway.pdf). Accessed 17 June 2009.

Quintana-Ascencio, P. 1995. FWS Multi-Species Recovery Team Meeting in U.S. Fish and Wildlife Service (1999). December 6-8, 1995.

Quintana-Ascencio, P.F., and E.S. Menges. 1996. Inferring metapopulation dynamics from patch-level incidence of Florida scrub plants. Conservation Biology 10:1210-1219.

Quintana-Ascencio, P.F., and M. Morales Hernandez. 1997. Fire-mediated effects of shrubs, lichens and herbs on the demography of *Hypericum cumulicola* in patchy Florida scrub. Oecologia 112:267-271.

Quintana-Ascencio, P.F., and E.S. Menges. 2000. Competitive abilities of three narrowly endemic plant species in experimental neighborhoods along a fire gradient. American Journal of Botany 87:690-699.

Quintana-Ascencio, P.F., E.S. Menges, and C.W. Weekley. 2003. A fire-explicit population viability analysis of *Hypericum cumulicola* in Florida rosemary scrub. Conservation Biology 17:433-449.

Quintana-Ascencio, P.F., C.W. Weekley, and E.S. Menges. 2007. Comparative demography of a rare species in Florida scrub and road habitats. Biological Conservation 137:263-270.

Quintana-Ascencio, P.F., E.S. Menges, C.W. Weekly, M. Kelrick, and B. Pace-Aldana. 2008. Demographic delays cause biennial population cycles in the annual *Warea carteri*. Manuscript in preparation for Population Ecology.

Reese, G.A. and S. Orzell. 1995. A natural areas inventory of Lake County, Florida: Summary report. Final report to the Florida Natural Areas Inventory; Tallahassee, Florida.

Richardson, D. 1985. Evidence for allelopathy in sand pine scrub. Oral presentation to: Florida Native Plant Society, May 3, 1985. Based on unpublished thesis, University of South Florida; Tampa Florida.

Rickey, M.A., E.S. Menges, and C.W. Weekley. 2006. Effects of mechanical treatments and fire on Florida scrub vegetation. Quarterly status report #3 - report to U.S. Fish and Wildlife Service, Vero Beach Office. Archbold Biological Station, Lake Placid, FL.

Riffell, S.K., J. Gutzwiller, and S.H. Anderson. 1996. Does repeated human intrusion cause cumulative declines in avian richness and abundance? Ecological Applications 6(2): 492-505.

Robertson, K. 2008. Unpublished information from presentation: Carbon Sequestration and Carbon Credits: The Future with Regard to Fire. Tall Timbers Research Station Fire Summit presentation. January 16, 2008.

Robbins, L.E. and R.L. Myers. 1989. Seasonal effects of prescribed burning in Florida: a review. The Nature Conservancy, Tallahassee, Florida.

Robbins, L. E. and R .L. Myers. 1992. *Seasonal Effects of Prescribed Burning: A Review.* Tall Timbers Research Inc. Tallahassee, Florida.

Rochow, T.F. 1985. Hydrologic and vegetational changes resulting from underground pumping the Cypress Gardens wellfield, Pasco County, FL. Florida Science 48:65-80.

Romano, G. 1997. Letter. February 13, 1997 *in* U.S. Fish and Wildlife Service 1999.

Romano, G.B. 1999. Reproductive biology and population molecular genetics of the scrub morning glory *Bonamia grandiflora*. PhD. Dissertation, University of Florida, Gainesville, Florida.

Satterthwaite, W.H., E.S. Menges, and P.F. Quintana-Ascencio. 2002. Assessing scrub buckwheat viability in relation to fire using multiple modeling techniques. Ecological Applications 12(6):1672-1687.

Schafer, J.L., E.S. Menges, P.F. Quintana-Ascencio, and C.W. Weekley. In revision *in* U.S. Fish and Wildlife Service (2008g). Effects of time-since-fire and microhabitat on the density and distribution of the endemic *Paronychia chartacea* ssp. *chartacea* in Florida scrub and along roadsides. American Midland Naturalist.

Schafer, J.L. 2008a. Personal communication *in* U.S. Fish and Wildlife Service (2008g). University of Florida. Email of 4 May 2008.

Schafer, J.L. 2008b. Personal communication *in* U.S. Fish and Wildlife Service (2008g). University of Florida. Email of 4 June 2008.

Schmalzer, P. A. and C. R. Hinkle. 1991. Dynamics of Vegetation and Soils of Oak/Saw Palmetto Scrub After Fire. NASA Tech. Mem. 103817. Kennedy Space Center, Florida. 146p

Schultz, G.E., L.G. Chafin, and S.T. Krupenevich. 1999. Rare plant species and high quality natural communities of twenty-six CARL sites in the Lake Wales Ridge Ecosystem. Florida Natural Areas Inventory, Tallahassee, Florida.

Scott, C. 2004. Endangered and Threatened Animals of Florida and their Habitats. University of Texas Press, Austin Texas. 317pp.

Simberloff, D., D.C. Schmitz, and T.C. Brown. 1997. Strangers in Paradise: Impact and Management of Nonindigenous Species in Florida. Island Press. 467pp.

Sinclair, W.C., and R.C. Reichenbaugh. 1981. Hydrology of the Winter Haven Chain of Lakes, Polk County, Florida: U.S. Geological Survey Open-File Report 81-212,

Smith, C.R. 1977. Food resource partitioning of burrowing sand pine scrub reptiles. Herpetological Review 8(3):17.

Smith, C.R. 1987. Ecology of juvenile and gravid eastern indigo snakes in north Florida. Unpublished M.S. thesis, Auburn University; Auburn Alabama.

Smith, C.R. 1982. Food resource partitioning of fossorial Florida reptiles. Pages 173-178 *in* N.J. Scott, ed. Herpetological communities: A symposium of the Society for the Study of Amphibians and Reptiles and the Herpetologist's League, August, 1977. U.S. Fish and Wildlife Service, Wildlife Research Report No.13.

Soil Survey Staff. 1989. Soil Survey of Polk County, Florida. US Department of Agriculture, Soil Conservation Service.

South Florida Water Management District. 2005. Lake Marion & Reedy Creek Management Areas Five-year General Management Plan (2005-2010). Land Stewardship Division, West Palm Beach, Florida.

South Florida Water Management District. 2009. 2009 South Florida Environmental Report. West Palm Beach, Florida

Southwest Florida Water Management District (SWFWMD). 2006. 2004 land use/cover features categorized according to the Florida Land Use and Cover Classification System (FLUCCS). Southwest Florida Water Management District. Brooksville, Florida. http://www.swfwmd.state.fl.us/data/gis/libraries/physical_dense/lu04.htm

Southwest Florida Water Management District (SWFWMD). 2009. Strategic Plan 2010-2014. Brooksville, Florida.

Speake, D.W., J.A. McGlincy, and T.R. Colvin. 1978. Ecology and management of the eastern indigo snake in Georgia: A progress report. Pages 64-73 in R.R. Odum and L. Landers, eds. Proceedings of rare and endangered wildlife symposium, Georgia Department of Natural Resources, Game and Fish Division, Technical Bulletin WL 4.

Speake, D.W. 1993. Indigo snake recovery plan revision. Final report to the U.S. Fish and Wildlife Service; Jacksonville, Florida.

Spechler, R.M. and S.E. Kroening. 2007. Hydrology of Polk County Florida, Scientific Investigation Report 2006-5320. DOI USGS Reston VA. 114p.

Steiner, T.M., O.L. Bass, Jr., and J.A. Kushlan. 1983. Status of the eastern indigo snake in southern Florida National Parks and vicinity. South Florida Research Center Report SFRC-83/01, Everglades National Park; Homestead, Florida.

Stith, B.M., J.W. Fitzpatrick, G.E. Woolfenden, and B. Pranty. 1996. Classification and conservation of metapopulations: a case study of the Florida scrub jay. Pages 187-215 in D.R. McCullough, ed., Metapopulations and wildlife conservation. Island Press; Washington, D.C.

Stout, I.J. 1982. Descriptions of 84 stands of Florida sand pine scrub vegetation. Unpublished report prepared for U.S. Fish and Wildlife Service; Jacksonville, Florida.

Stout, I.J., S.J. Woiak, and A.M. Bard. 2001. Population dynamics of the scrub lupine and some management implications. In D.P. Zattau, ed., Proceedings of the Florida scrub symposium 2001. U.S. Fish and Wildlife Service, Jacksonville, Florida.

Stout, I.J., and M. Lewis. 2004. Monitor rare and endangered plants at Avon Park Air Force Base, Florida. Quarterly report October 1-December 31 to Avon park Air Force Range, FL. 4 pp.

Stout, I.J. 2004. Interim report January 9- July 20, 2004. Management of scrub lupine at Fenton Road, Orange County. Grant Agreement 401813F050. On file U.S. Fish and Wildlife Service, Jacksonville, Florida in U.S. Fish and Wildlife Service (2008f)

Stout, I.J., 2005. Personal Communication *in* U.S. Fish and Wildlife Service (2008f)

Stout, I.J., and M.N. Lewis. 2006. Monitor rare and endangered plants at Avon park Air Force Base, FL. Biannual report to Avon Park Air Force Range, FL. 6+pp.

Stout, I.J. 2007. Personal Communication *in* U.S. Fish and Wildlife Service (2008f)

Stout, I.J. 2008a. Personal communication *in* U.S. Fish and Wildlife Service (2008c). University of Central Florida. Email of 22 April, 2008.

Stout, I.J. 2008b. Personal communication *in* U.S. Fish and Wildlife Service (2008c). University of Central Florida. Email of 1 July 2008.

Stout, I.J. 2009. Personal communication in 11 March 2009 Email to D. Bender, U.S. Fish and Wildlife Service's Botanist, Ecological Services Vero Beach Field Office.

Stout, I.J. 2010. Personal communication in 28 May 2010 Email to W. Miller, U.S. Fish and Wildlife Service Biologist.

Stout, I.J. In press. Scrub lupine (*Lupinus aridorum*) (McFarlin ex Beckner) Isley. Manuscript submitted to the Florida Committee on Rare and Endangered Plants and Animals, second edition, plant volume. On file at U.S. Fish and Wildlife Service, South Florida Ecosystem Office; Vero Beach, Florida *in* U.S. Fish and Wildlife Service (1999).

Sturtevant, William C. (editor). 1987. *A Seminole Source*. Garland Publishing.

Sullivan, L. 2008. Personal communication *in* U.S. Fish and Wildlife Service (2008g). Washington University. 4 June 2008.

Sutton, P.E. 1996. A mark and recapture study of the Florida sand skink, *Neoseps reynoldsi*, and a comparison of sand skink sampling methods. M.S. Thesis. University of South Florida, Tampa, Florida.

Swain, H.M., T. Martin, and F.E. Lohrer. 2000. Florida's Ancient Islands, Endangered Species webpage. Endangered, Threatened, or Rare Species of the Upland Habitats of the Lake Wales Ridge Table *through* The Lake Wales Ridge Ecosystem Working Group and Archbold Biological Station. Accessed March 2009. http://www.archbold-station.org/fai/species4.html

Swain, H. 2007. Comments on draft 5-year review form as official peer reviewer. Email to U.S. Fish and Wildlife Service, Vero Beach, Florida, dated August 24, 2007. Archbold Biological Station. Venus, FL.

Telford, S.R., Jr. 1959. A study of the sand skink, *Neoseps reynoldsi* Stejneger. Copeia 2:110-119.

Thaxton, J.E. and T.M. Hingtgen. 1996. Effects of suburbanization and habitat fragmentation on Florida scrub-jay dispersal. Florida Field Naturalist 24(2):25-60.

The Nature Conservancy (TNC). 1999. Conservation plan for *Lupinus aridorum*. Florida Department of Agriculture and Consumer Affairs, Division of Forestry, Contract 4759.

The Nature Conservancy (TNC). 2006. Annual research report 2006 – a compilation of research conducted or supported by The Nature Conservancy in Florida.

The Nature Conservancy (TNC). 2006a. Jay watch annual report 2006. The Nature Conservancy, Babson Park, Florida

The Nature Conservancy (TNC). 2007a. Jay Watch annual report 2007. The Nature Conservancy. Babson Park, Florida.

The Nature Conservancy (TNC). 2008. Jay Watch annual report 2008. The Nature Conservancy. Babson Park, Florida.

The Nature Conservancy (TNC). 2009a. Lake Wales Ridge Conservation Project Management Workbook: A Tool for Developing Strategies, Taking Action, and Measuring Success. The Nature Conservancy, Babson Park, Florida.

The Nature Conservancy (TNC). 2009b. Florida Scrub-Jay Fire Strike Team Website: http://www.nature.org/initiatives/fire/work/art15394.html. Accessed 21 September 2009.

Toland, B.R. 1999. Current status and conservation recommendations for the Florida scrub-jay in Brevard County. Report to the Brevard County Board of County Commissioners. Brevard County Natural Resources Management Office, Viera, Florida.

Turner, W.R., D.S. Wilcove, and H.M. Swain. 2006. State of the scrub: conservation progress, management responsibilities, and land acquisition priorities for imperiled species of Florida's Lake Wales Ridge. Archbold Biological Station, Lake Placid, Florida. 44p.

University of Florida Digital Image Library Center Scans of US Department of Agriculture black and white photographs (Eloise Quad). Website (http://www.uflib.ufl.edu/digital/collections/flap).

University of Florida. 2008. 2007 Florida County Retail Price and Wage Indices. Bureau of Economic and Business Research, Gainesville, Florida.

University of Florida. 2009. 2008 Florida Price Level Index. Bureau of Economic and Business Research, Gainesville, Florida.

U.S. Department of Agriculture Natural Resources Conservation Service. 2009. Web Soil Survey for Highlands and Polk Counties, FL. Website accessed July 2009. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx.

U.S. Department of Energy. 1999. Carbon Sequestration Research and Development. Washington, D.C.

U.S. Department of Energy. 2007. Carbon Sequestration Technology Roadmap and Program Plan. Ensuring the Future of Fossil Energy Systems through the Successful Deployment of Carbon Capture and Storage Technologies. Office of Fossil Energy, National Energy Technology Laboratory. pp. 48.

U.S. Census Bureau. 2005-2007. U.S. Census Bureau, 2005-2007 American Community Survey. http://factfinder.census.gov/servlet. Accessed 17 June 2009.

U.S. Census Bureau. 2008. 2008 Population Estimates in Florida. U.S. Census Bureau Population Estimates Program. http://factfinder.census.gov/servlet/GCTTable. Accessed 17 June 2009.

U.S. Environmental Protection Agency [USEPA]. 2009. Air Quality Monitoring Information 2007 Status and Trends. Website: http://www.epa.gov/airtrends/factbook.html. Accessed January 2009.

U.S. Fish and Wildlife Service [Service]. 1990. Recovery Plan for Eleven Florida Scrub Plants. U.S. Fish and Wildlife Service, Atlanta, Georgia. 64 pp.

U.S. Fish and Wildlife Service [Service]. 1991. Preliminary Project Proposal for Establishment of the Lake Wales Ridge National Wildlife Refuge, Highlands and Polk Counties, Florida. Atlanta, GA. July 1991.

U.S. Fish and Wildlife Service [Service]. 1993. Final Land Protection Plan for the Proposed Establishment of Lake Wales Ridge National Wildlife Refuge Highlands and Polk Counties, Florida. U.S. Department of the Interior, U.S. Fish and Wildlife Service, Southeast Regional Office, Atlanta, Georgia. 28pp.

U.S. Fish and Wildlife Service [Service]. 1994. Project Development Planning Report for the Establishment of Lake Wales Ridge National Wildlife Refuge, Highlands and Polk Counties, Florida.

U.S. Fish and Wildlife Service [Service]. 1996a. Recovery plan for nineteen central Florida scrub and high pineland plants (revised). U.S. Fish and Wildlife Service; Atlanta, Georgia.

U.S. Fish and Wildlife Service [Service]. 1996b. Revised Recovery Plan for the U.S. Breeding Population of the Wood Stork. U.S. Fish and Wildlife Service, Atlanta, Georgia. 41 pp.

U.S. Fish and Wildlife Service [Service]. 1998. South Florida Ecosystem Team's Ecosystem Plan. U.S. Fish and Wildlife Service Ecological Services South Florida Field Office, Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 1999. South Florida Multi-Species Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 2,178 pp.

U.S. Fish and Wildlife Service [Service]. 2005. Lake Wales Ridge NWR Wildlife and Habitat Management Review. Unpublished Report. 59pp.

U.S. Fish and Wildlife Service [Service]. 2006. Excel spreadsheet containing questionnaire responses received from conservation land managers. On file, Jacksonville Field Office, Florida.

U.S. Fish and Wildlife Service [Service]. 2007a. Florida Scrub-Jay (*Aphelocoma coerulescens*) 5-Year Review: Summary and Evaluation. Southeastern Region. Jacksonville Ecological Services Field Office. Jacksonville, Florida.

U.S. Fish and Wildlife Service [Service]. 2007b. Bluetail Mole Skink (*Eumeces egregius lividus*), Sand Skink (*Neoseps reynoldsi*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeastern Region, South Florida Ecological Services Office, Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2007c. Wood Stork (*Mycteria americana*) 5-Year Review: Summary and Evaluation. Southeastern Region. Jacksonville Ecological Services Field Office. Jacksonville, Florida.

U.S. Fish and Wildlife Service [Service]. 2008a. Florida bonamia (*Bonamia floridana*) 5-Year Review: Summary and Evaluation. Southeast Region, Jacksonville Ecological Services Field Office; Jacksonville, Florida.

U.S. Fish and Wildlife Service [Service]. 2008b. Florida perforate cladonia (*Cladonia perforata*) 5-Year Review: Summary and Evaluation. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2008c. Pigeon wings (*Clitoria fragrans*) 5-Year Review: Summary and Evaluation. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2008d. Scrub Buckwheat (*Eriogonum longifolium var. gnaphalifolium*) 5-Year Review: Summary and Evaluation. Southeast Region, Jacksonville Ecological Services Field Office; Jacksonville, Florida.

U.S. Fish and Wildlife Service [Service]. 2008e. Highlands scrub hypericum (*Hypericum cumulicola*) 5-Year Review: Summary and Evaluation. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2008f. Scrub Lupine (*Lupinus aridorum*) 5-Year Review: Summary and Evaluation. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2008g. Papery whitlow-wort (*Paronychia chartacea*) 5-Year Review: Summary and Evaluation. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2008h. Carter's mustard (*Warea carteri*) 5-Year Review: Summary and Evaluation. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2008i. Florida Panther Recovery Plan (*Puma concolor coryi*), Third Revision. U.S. Fish and Wildlife Service. Atlanta, Georgia. 217 pp.

U.S. Fish and Wildlife Service [Service]. 2008j. Species Assessment and Listing Priority Assignment Form for *Cicindela highlandensis*. South Florida Ecological Services Office, Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2009a. Scrub plum (*Prunus geniculata*) 5-Year Review: Summary and Evaluation – in review. Southeast Region, Jacksonville Ecological Services Field Office; Jacksonville, Florida.

U.S. Fish and Wildlife Service [Service]. 2009b. Florida ziziphus (*Ziziphus celata*) 5-Year Status Review. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service [Service]. 2009c. Lake Wales Ridge National Wildlife Refuge Boundary Data. U.S. Fish and Wildlife Division of Realty, Atlanta, Georgia. (http://www.fws.gov/data/r4gis/boundary/Meta/lkwbnd.html).

U.S. Fish and Wildlife Service [Service] New Employee Handbook.

U.S. Forest Service. 1977. Cavity-Nesting Birds of North American Forests. U.S. Forest Service, U.S. Department of Agriculture. Agriculture Handbook No. 511. November 1977.

U.S. Forest Service. 2005. 2005 annual monitoring and evaluation report, national forests in Florida. Tallahassee, Florida.

U. S. Soil Conservation Service. 1980. Twenty-six ecological communities of Florida. U.S. Department of Agriculture, Gainesville, Florida.

U. S. Soil Conservation Service. 1990. Soil Survey of Polk County, Florida. Gainesville, Florida.

Visit Florida. 2008. Visit Florida Research Department, Tallahassee, Florida. Website: http://media.visitflorida.org

Von Haartman, Lars. 1968. The evolution of resident versus migratory habits in birds: some considerations. Ornis Fenn. 45(1):1-7.

Walking With Alligators website. 2009. Website: http://www.gator-woman.com/ridge.html. 2008. Accessed June 2009.

Ward, D.B. 1979. *Bonamia grandiflora*. Pages 71-72. *in* D.B. Ward and R.K Godfrey (eds.), Rare and endangered biota of Florida, vol. 5: Plants. University Presses; Gainesville, Florida.

Ward, D.B., and R.K. Godfrey. 1979. Pygmy fringe-tree. *in* Ward, D.B., editor. Rare and endangered biota of Florida. Plants. vol 5. University of Florida Presses; Gainesville, Florida.

Watts, W.A. and B.C.S. Hanson. 1988. Environments of Florida in the Late Wisconsin and Holocene. Pages 307-323 in B. A. Purdy, ed *Wet Site Archaeology*. The Telford Press, Cadwell New Jersey.

Webb, R.H. and H.G. Wilshire. 1983. Environmental effects of off-road vehicles: impacts and management in arid regions. Springer-Verlag, New York.

Webber, H.J. 1935. The Florida scrub, a fire-fighting association. American Journal of Botany 22(3):344-361.

Weekley, C.W. 1996. *Bonamia grandiflora* monitoring report #1. Florida Division of Forestry, statewide endangered and threatened plant conservation program. Tallahassee, Florida.

Weekley, C. 1996. Telephone conversation. 10 December 1996 *in* U.S. Fish and Wildlife Service (1999).

Weekley, C.W. 1998. *Bonamia grandiflora* monitoring report #2. Florida Division of Forestry, statewide endangered and threatened plant conservation program. Tallahassee, Florida.

Weekly, C. 1998. Comments on technical/agency draft multi-species recovery plan for South Florida. January 28, 1998 *in* U.S. Fish and Wildlife Service (1999).

Weekley, C.W. and E.S. Menges. 2001. Demography, floral biology and breeding system of scrub plum (*Prunus geniculata*), a federally listed endangered plant. Annual report to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Weekley, C.W., and T.M. Race. 2001. The breeding system of *Ziziphus celata* Judd and D.W. Hall (Rhamnaceae), a rare endemic plant of the Lake Wales Ridge, Florida, USA: implications for recovery. Biological Conservation 100: 207-213.

Weekley, C.W., S.I. Hamze, R.L. Pickert, and E.S. Menges. 2001. GPS/GIS mapping of federally-listed scrub plants of the Lake Wales Ridge in Highlands County, Florida. Final report to the U.S. Fish and Wildlife Service, Jacksonville Office.

Weekley, C.W, T. L. Kubisiak, and T.M. Race. 2002. Genetic impoverishment and cross-incompatibility in remnant genotypes of *Ziziphus celata* (Rhamnaceae), a rare shrub endemic to the Lake Wales Ridge, FL. Biodiversity and Conservation 11:2027–2046.

Weekley, C.W. and E.S. Menges. 2002. Demography, floral biology and breeding system of scrub plum (*Prunus geniculata*), a federally listed endangered plant. Annual report to the U.S. Fish and Wildlife Service, Jacksonville, Florida.

Weekley, C.W., and E.S. Menges. 2003. Species and vegetation responses to prescribed fire in a long-unburned, endemic-rich Lake Wales Ridge scrub. Journal of the Torrey Botanical Society 130(4)::265-282.

Weekley, C.W., and E.S. Menges. 2006. Florida Ziziphus Strategic Plan. Archbold Biological Station, Lake Placid, FL.

Weekley, C.W. and E.S. Menges. 2007. Reproductive biology of scrub plum (*Prunus geniculata*), a Lake Wales Ridge Endangered Shrub. Interim report, U.S. Fish and Wildlife Service, Jacksonville, Florida

Weekley, C.W., E.S. Menges, E.F. Niclen, and D.N. Zaya. 2007a. The reproductive biology and seed ecology of scrub plum (*Prunus geniculata*), a Lake Wales Ridge endangered shrub. Final report grant agreement 401516G075. Fish and Wildlife Service, Jacksonville, Florida.

Weekley, C.W., E.S. Menges, and G.L. Clarke. 2007. Effects of mechanical treatments and fire on Florida scrub vegetation. Annual Report #2 to U.S. Fish and Wildlife Service, Vero Beach, Florida. 4 October 2007. 60 pp.

Weekley, C.W., and E.S. Menges. 2008a. Experimental introductions of Florida ziziphus on Florida's Lake Wales Ridge, USA *in* Soorae, P.S. (ed.) (2008) Global Re-introduction Perspectives: re-introduction case-studies from around the globe. IUCN/SSC Re-introduction Specialist Group, Abu Dhabi, UAE. vii + 284 pp.

Weekley, C.W. and E.S. Menges. 2008b. Further demographic research on Lake Wales Ridge endemic plants. Report to Endangered and Threatened Plant Conservation Grants Program, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Tallahassee, Florida.

Weekley, C.W., and E.S. Menges. 2008c. Continuation of research on the federally-listed Lake Wales Ridge endemic Florida ziziphus (*Ziziphus celata*). Final report to the Plant Conservation Program of the Florida Division of Forestry. Tallahassee, FL.

Weekley, C.W., E.S. Menges, and R.L Pickert. 2008. An ecological map of Florida's Lake Wales Ridge: A new boundary delineation and an assessment of post-Columbian habitat loss. Florida Scientist 71:45-64.

Weekley, C.W. 2008a. Personal communication *in* U.S. Fish and Wildlife Service (2008a). Archbold Biological Station. Lake Placid, Florida

Weekley, C.W. 2008b. Personal communication *in* U.S. Fish and Wildlife Service (2008c). Archbold Biological Station. 20 May 2008

Weekley, C.W. 2008c. Personal observation *in* U.S. Fish and Wildlife Service (2008c). Archbold Biological Station. 2 June 2008.

Weekley, C.W. 2008d. Email to Dave Bender. Archbold Biological Station. Lake Placid, Florida. August 22, 2008.

Weekley, C.W. 2008e. Email to Dave Bender. Archbold Biological Station. Lake Placid, Florida. November 14, 2008.

Weekley, C.W., and E.S. Menges. 2009. Interim Report on Continuation of Research on the Federally-Listed Lake Wales Ridge Endemic Florida Ziziphus (*Ziziphus celata*). Archbold Biological Station, Lake Placid, Florida.

Weekley, C.W. 2009. Personal communication. Archbold Biological Station. 22 June 2009.

Weisman, Brent R. 1999. *Unconquered People: Florida's Seminole and Miccosukee Indians*. University Press of Florida, Gainesville.

Weller, S.G. 1994. The relationship of rarity to plant reproductive biology. In: Bowles, M.L., Whelan. C.J. (Eds.), Restoration of Endangered Species. Cambridge University Press. Cambridge. pp. 90-1 17.

Wheeler, Ryan J., James J. Miller, Ray M. McGee, Donna Ruhl, Brenda Swan, and Melissa Memory. 2003. Archaic Period Canoes from Newnans Lake, Florida. *American Antiquity* 68(3): 533-551.

White, W.A. 1970. The geomorphology of the Florida Peninsula: Tallahassee, Florida Bureau of Geology Bulletin 51, 164 p.

Whitney, E. 2004. Priceless Florida- Natural Ecosystems and Native Species. pp 67-83.

Wood, D. A. 1993. Official List of Endangered and Potentially Endangered Fauna and Flora in Florida. Florida Game and Fresh Water fish Commission.

Woolfenden, G.E. and J.W. Fitzpatrick. 1990. Florida scrub jays: A synopsis after 18 years of study. Pages 241-266 in P.B. Stacey and W.B. Koenig, eds. Cooperative breeding in birds: long term studies of ecology and behavior. Cambridge University Press, Cambridge.

Woolfenden, G.E. and J.W. Fitzpatrick. 1991. Florida scrub jay ecology and conservation. Pages 542-565 in: Perrine, C.M., J.D. Lebreton, and G.J.M. Hirons (eds.). Bird population studies: relevance to conservation and management. Oxford University Press; Oxford, United Kingdom.

Woolfenden, G.E. and J.W. Fitzpatrick. 1996a. Florida scrub jay. Pages 267-280 in J.A. Rodgers, H.W. Kale, and H.T. Smith, eds. Rare and Endangered Biota of Florida, Volume V. Birds. University Press of Florida; Gainesville, Florida.

Woolfenden, G.E. and J.W. Fitzpatrick. 1996b. Florida scrub-jay. Pages 1-27 in A. Poole and F. Gill, eds. The birds of North America, No.228. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union; Washington, D.C.

Wunderlin, R., D. Richardson, and B. Hanson. 1980. Status report on *Bonamia grandiflora*. Unpublished report prepared for U.S. Fish and Wildlife Service; Jacksonville, Florida.

Wunderlin, R.P., D. Richardson, and B. Hansen. 1980. Status report on *Clitoria fragrans*. Unpublished report, U.S. Fish and Wildlife Service; Jacksonville, Florida

Wunderlin, R.P., D. Richardson, and B. Hansen. 1981. Status report on *Chionanthus pygmaeus*. Unpublished report for: U.S. Fish and Wildlife Service; Atlanta, Georgia.

Wunderlin, R.P. 1984. Endangered and threatened plant survey, *Lupinus aridorum*. Unpublished status report prepared under contract no. 14-16-0004-82-013. U.S. Fish and Wildlife Service; Jacksonville, Florida.

Yahr, R. 1997. Recolonization and reintroduction of *Cladonia perforata* Evans, an endangered lichen at Eglin Air Force Base, Florida. Final report to Florida Division of Forestry contract #3339. Archbold Biological Station, Lake Placid, FL.

Yahr, R. 2000. Ecology and post-fire recovery of *Cladonia perforata*, an endangered Florida-scrub lichen. Final report. U.S. Fish and Wildlife Cooperative Agreement #1448-0004096-9199. Archbold Biological Station, Lake Placid, FL.

Yahr, R. 2003. *Cladonia perforata*. *In*: IUCN 2006. 2006 IUCN Red List of Threatened Species. www.iucnredlist.org.

Yahr, R., and P.T. DePriest. 2005. Lichens: Phylum Ascomycota. *In*: Plant Conservation: a Natural History Approach (G.A. Krupnick and W.J. Kress, *eds.*). The University of Chicago Press, Chicago, IL.

Zwick, P.D. and M.H. Carr. 2006. Florida 2060: a population distribution scenario for the state of Florida. A research project prepared for 1000 Friends of Florida by the GeoPlan Center at the University of Florida, Gainesville. Available on the internet at http://www.1000friendsofflorida.org/planning/2060.asp.

Appendix III. Relevant Legal Mandates and Executive Orders

STATUTE	DESCRIPTION
Administrative Procedures Act (1946)	Outlines administrative procedures to be followed by federal agencies with respect to identification of information to be made public; publication of material in the Federal Register; maintenance of records; attendance and notification requirements for specific meetings and hearings; issuance of licenses; and review of agency actions.
American Antiquities Act of 1906	Provides penalties for unauthorized collection, excavation, or destruction of historic or prehistoric ruins, monuments, or objects of antiquity on lands owned or controlled by the United States. The Act authorizes the President to designate as national monuments objects or areas of historic or scientific interest on lands owned or controlled by the Unites States.
American Indian Religious Freedom Act of 1978	Protects the inherent right of Native Americans to believe, express, and exercise their traditional religions, including access to important sites, use and possession of sacred objects, and the freedom to worship through ceremonial and traditional rites.
Americans With Disabilities Act of 1990	Intended to prevent discrimination of and make American society more accessible to people with disabilities. The Act requires reasonable accommodations to be made in employment, public services, public accommodations, and telecommunications for persons with disabilities.
Anadromous Fish Conservation Act of 1965, as amended	Authorizes the Secretaries of Interior and Commerce to enter into cooperative agreements with states and other non-federal interests for conservation, development, and enhancement of anadromous fish and contribute up to 50 percent as the federal share of the cost of carrying out such agreements. Reclamation construction programs for water resource projects needed solely for such fish are also authorized.
Archaeological Resources Protection Act of 1979, as amended.	This Act strengthens and expands the protective provisions of the Antiquities Act of 1906 regarding archaeological resources. It also revised the permitting process for archaeological research.
Architectural Barriers Act of 1968	Requires that buildings and facilities designed, constructed, or altered with federal funds, or leased by a federal agency, must comply with standards for physical accessibility.
Bald and Golden Eagle Protection Act of 1940, as amended	Prohibits the possession, sale or transport of any bald or golden eagle, alive or dead, or part, nest, or egg except as permitted by the Secretary of the Interior for scientific or exhibition purposes, or for the religious purposes of Indians.

STATUTE	DESCRIPTION
Bankhead-Jones Farm Tenant Act of 1937	Directs the Secretary of Agriculture to develop a program of land conservation and utilization in order to correct maladjustments in land use and thus assist in such things as control of soil erosion, reforestation, conservation of natural resources and protection of fish and wildlife. Some early refuges and hatcheries were established under authority of this Act.
Cave Resources Protection Act of 1988	Established requirements for the management and protection of caves and their resources on federal lands, including allowing the land managing agencies to withhold the location of caves from the public, and requiring permits for any removal or collecting activities in caves on federal lands.
Clean Air Act of 1970	Regulates air emissions from area, stationary, and mobile sources. This Act and its amendments charge federal land managers with direct responsibility to protect the "air quality and related values" of land under their control. These values include fish, wildlife, and their habitats.
Clean Water Act of 1974, as amended	This Act and its amendments have as its objective the restoration and maintenance of the chemical, physical, and biological integrity of the Nation's waters. Section 401 of the Act requires that federally permitted activities comply with the Clean Water Act standards, state water quality laws, and any other appropriate state laws. Section 404 charges the U.S. Army Corps of Engineers with regulating discharge of dredge or fill materials into waters of the United States, including wetlands.
Coastal Barrier Resources Act of 1982 (CBRA)	Identifies undeveloped coastal barriers along the Atlantic and Gulf Coasts and included them in the John H. Chafee Coastal Barrier Resources System (CBRS). The objectives of the act are to minimize loss of human life, reduce wasteful federal expenditures, and minimize the damage to natural resources by restricting most federal expenditures that encourage development within the CBRS.
Coastal Barrier Improvement Act of 1990	Reauthorized the Coastal Barrier Resources Act (CBRA), expanded the CBRS to include undeveloped coastal barriers along the Great Lakes and in the Caribbean, and established "Otherwise Protected Areas (OPAs)." The Service is responsible for maintaining official maps, consulting with federal agencies that propose spending federal funds within the CBRS and OPAs, and making recommendations to Congress about proposed boundary revisions.
Coastal Wetlands Planning, Protection, and Restoration (1990)	Authorizes the Director of the Fish and Wildlife Service to participate in the development of a Louisiana coastal wetlands restoration program, participate in the development and oversight of a coastal wetlands conservation program, and lead in the implementation and administration of a national coastal wetlands grant program.

STATUTE	DESCRIPTION
Coastal Zone Management Act of 1972, as amended	Established a voluntary national program within the Department of Commerce to encourage coastal states to develop and implement coastal zone management plans and requires that "any federal activity within or outside of the coastal zone that affects any land or water use or natural resource of the coastal zone" shall be "consistent to the maximum extent practicable with the enforceable policies" of a state's coastal zone management plan. The law includes an Enhancement Grants Program for protecting, restoring, or enhancing existing coastal wetlands or creating new coastal wetlands. It also established the National Estuarine Research Reserve System, guidelines for estuarine research, and financial assistance for land acquisition.
Emergency Wetlands Resources Act of 1986	This Act authorized the purchase of wetlands from Land and Water Conservation Fund moneys, removing a prior prohibition on such acquisitions. The Act requires the Secretary to establish a National Wetlands Priority Conservation Plan, required the states to include wetlands in their Comprehensive Outdoor Recreation Plans, and transfers to the Migratory Bird Conservation Fund amounts equal to import duties on arms and ammunition. It also established entrance fees at national wildlife refuges.
Endangered Species Act of 1973, as amended	Provides for the conservation of threatened and endangered species of fish, wildlife, and plants by federal action and by encouraging the establishment of state programs. It provides for the determination and listing of threatened and endangered species and the designation of critical habitats. Section 7 requires refuge managers to perform internal consultation before initiating projects that affect or may affect endangered species.
Environmental Education Act of 1990	This Act established the Office of Environmental Education within the U.S. Environmental Protection Agency to develop and administer a federal environmental education program in consultation with other federal natural resource management agencies, including the Fish and Wildlife Service.
Estuary Protection Act of 1968	Authorized the Secretary of the Interior, in cooperation with other federal agencies and the states, to study and inventory estuaries of the United States, including land and water of the Great Lakes, and to determine whether such areas should be acquired for protection. The Secretary is also required to encourage state and local governments to consider the importance of estuaries in their planning activities relative to federal natural resource grants. In approving any state grants for acquisition of estuaries, the Secretary was required to establish conditions to ensure the permanent protection of estuaries.

STATUTE	DESCRIPTION
Estuaries and Clean Waters Act of 2000	This law creates a federal interagency council that includes the Director of the Fish and Wildlife Service, the Secretary of the Army for Civil Works, the Secretary of Agriculture, the Administrator of the Environmental Protection Agency and the Administrator for the National Oceanic and Atmospheric Administration. The council is charged with developing a national estuary habitat restoration strategy and providing grants to entities to restore and protect estuary habitat to promote the strategy.
Food Security Act of 1985, as amended (Farm Bill)	The Act contains several provisions that contribute to wetland conservation. The Swampbuster provisions state that farmers who convert wetlands for the purpose of planting after enactment of the law are ineligible for most farmer program subsidies. It also established the Wetland Reserve Program to restore and protect wetlands through easements and restoration of the functions and values of wetlands on such easement areas.
Farmland Protection Policy Act of 1981, as amended	The purpose of this law is to minimize the extent to which federal programs contribute to the unnecessary conversion of farmland to nonagricultural uses. Federal programs include construction projects and the management of federal lands.
Federal Advisory Committee Act (1972), as amended	Governs the establishment of and procedures for committees that provide advice to the federal government. Advisory committees may be established only if they will serve a necessary, nonduplicative function. Committees must be strictly advisory unless otherwise specified and meetings must be open to the public.
Federal Coal Leasing Amendment Act of 1976	Provided that nothing in the Mining Act, the Mineral Leasing Act, or the Mineral Leasing Act for Acquired Lands authorized mining coal on refuges.
Federal-Aid Highways Act of 1968	Established requirements for approval of federal highways through national wildlife refuges and other designated areas to preserve the natural beauty of such areas. The Secretary of Transportation is directed to consult with the Secretary of the Interior and other federal agencies before approving any program or project requiring the use of land under their jurisdiction.
Federal Noxious Weed Act of 1990, as amended	The Secretary of Agriculture was given the authority to designate plants as noxious weeds and to cooperate with other federal, State and local agencies, farmers' associations, and private individuals in measures to control, eradicate, prevent, or retard the spread of such weeds. The Act requires each Federal land-managing agency, including the Fish and Wildlife Service, to designate an office or person to coordinate a program to control such plants on the agency's land and implement cooperative agreements with the states, including integrated management systems to control undesirable plants.

STATUTE	DESCRIPTION
Fish and Wildlife Act of 1956	Establishes a comprehensive national fish, shellfish, and wildlife resources policy with emphasis on the commercial fishing industry but also includes the inherent right of every citizen and resident to fish for pleasure, enjoyment, and betterment and to maintain and increase public opportunities for recreational use of fish and wildlife resources. Among other things, it authorizes the Secretary of the Interior to take such steps as may be required for the development, advancement, management, conservation, and protection of fish and wildlife resources including, but not limited to, research, development of existing facilities, and acquisition by purchase or exchange of land and water or interests therein.
Fish and Wildlife Conservation Act of 1980, as amended	Requires the Service to monitor non-gamebird species, identify species of management concern, and implement conservation measures to preclude the need for listing under the Endangered Species Act.
Fish and Wildlife Coordination Act of 1958	Promotes equal consideration and coordination of wildlife conservation with other water resource development programs by requiring consultation with the Fish and Wildlife Service and the state fish and wildlife agencies where the "waters of a stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted…or otherwise controlled or modified" by any agency under federal permit or license.
Improvement Act of 1978	This act was passed to improve the administration of fish and wildlife programs and amends several earlier laws, including the Refuge Recreation Act, the National Wildlife Refuge System Administration Act, and the Fish and Wildlife Act of 1956. It authorizes the Secretary to accept gifts and bequests of real and personal property on behalf of the United States. It also authorizes the use of volunteers on Service projects and appropriations to carry out volunteer programs.
Fishery (Magnuson) Conservation and Management Act of 1976	Established Regional Fishery Management Councils comprised of federal and state officials, including the Fish and Wildlife Service. It provides for regulation of foreign fishing and vessel fishing permits.
Freedom of Information Act, 1966	Requires all federal agencies to make available to the public for inspection and copying administrative staff manuals and staff instructions; official, published and unpublished policy statements; final orders deciding case adjudication; and other documents. Special exemptions have been reserved for nine categories of privileged material. The Act requires the party seeking the information to pay reasonable search and duplication costs.
Geothermal Steam Act of 1970, as amended	Authorizes and governs the lease of geothermal steam and related resources on public lands. Section 15 c of the Act prohibits issuing geothermal leases on virtually all Service-administrative lands.

STATUTE	DESCRIPTION
Lacey Act of 1900, as amended	Originally designed to help states protect their native game animals and to safeguard U.S. crop production from harmful foreign species, this Act prohibits interstate and international transport and commerce of fish, wildlife or plants taken in violation of domestic or foreign laws. It regulates the introduction to America of foreign species.
Land and Water Conservation Fund Act of 1948	This Act provides funding through receipts from the sale of surplus federal land, appropriations from oil and gas receipts from the outer continental shelf, and other sources for land acquisition under several authorities. Appropriations from the fund may be used for matching grants to states for outdoor recreation projects and for land acquisition by various federal agencies, including the Fish and Wildlife Service.
Marine Mammal Protection Act of 1972, as amended	The 1972 Marine Mammal Protection Act established a federal responsibility to conserve marine mammals with management vested in the Department of the Interior for sea otter, walrus, polar bear, dugong, and manatee. The Department of Commerce is responsible for cetaceans and pinnipeds, other than the walrus. With certain specified exceptions, the Act establishes a moratorium on the taking and importation of marine mammals, as well as products taken from them.
Migratory Bird Conservation Act of 1929	Established a Migratory Bird Conservation Commission to approve areas recommended by the Secretary of the Interior for acquisition with Migratory Bird Conservation Funds. The role of the commission was expanded by the North American Wetland Conservation Act to include approving wetlands acquisition, restoration, and enhancement proposals recommended by the North American Wetlands Conservation Council.
Migratory Bird Hunting and Conservation Stamp Act of 1934	Also commonly referred to as the “Duck Stamp Act,” requires waterfowl hunters 16 years of age or older to possess a valid federal hunting stamp. Receipts from the sale of the stamp are deposited into the Migratory Bird Conservation Fund for the acquisition of migratory bird refuges.
Migratory Bird Treaty Act of 1918, as amended	This Act implements various treaties and conventions between the United States and Canada, Japan, Mexico, and the former Soviet Union for the protection of migratory birds. Except as allowed by special regulations, this Act makes it unlawful to pursue, hunt, kill, capture, possess, buy, sell, purchase, barter, export or import any migratory bird, part, nest, egg, or product.
Mineral Leasing Act for Acquired Lands (1947), as amended	Authorizes and governs mineral leasing on acquired public lands.

STATUTE	DESCRIPTION
Minerals Leasing Act of 1920, as amended	Authorizes and governs leasing of public lands for development of deposits of coal, oil, gas, and other hydrocarbons; sulphur; phosphate; potassium; and sodium. Section 185 of this title contains provisions relating to granting rights-of-way over federal lands for pipelines.
Mining Act of 1872, as amended	Authorizes and governs prospecting and mining for the so-called "hardrock" minerals (i.e., gold and silver) on public lands.
National and Community Service Act of 1990	Authorizes several programs to engage citizens of the U.S. in full- and/or part-time projects designed to combat illiteracy and poverty, provide job skills, enhance educational skills, and fulfill environmental needs. Among other things, this law establishes the American Conservation and Youth Service Corps to engage young adults in approved human and natural resource projects, which will benefit the public or are carried out on federal or Indian lands.
National Environmental Policy Act of 1969	Requires analysis, public comment, and reporting for environmental impacts of federal actions. It stipulates the factors to be considered in environmental impact statements, and requires that federal agencies employ an interdisciplinary approach in related decision-making and develop means to ensure that unqualified environmental values are given appropriate consideration, along with economic and technical considerations.
National Historic Preservation Act of 1966, as amended	It establishes a National Register of Historic Places and a program of matching grants for preservation of significant historical features. Federal agencies are directed to take into account the effects of their actions on items or sites listed or eligible for listing in the National Register.
National Trails System Act (1968), as amended	Established the National Trails System to protect the recreational, scenic, and historic values of some important trails. National recreation trails may be established by the Secretaries of Interior or Agriculture on land wholly or partly within their jurisdiction, with the consent of the involved state(s), and other land managing agencies, if any. National scenic and national historic trails may only be designated by Congress. Several national trails cross units of the National Wildlife Refuge System.
National Wildlife Refuge System Administration Act of 1966	Prior to 1966, there was no single federal law that governed the administration of the various national wildlife refuges that had been established. This Act defines the National Wildlife Refuge System and authorizes the Secretary of the Interior to permit any use of a refuge provided such use is compatible with the major purposes(s) for which the refuge was established.

STATUTE	DESCRIPTION
National Wildlife Refuge System Improvement Act of 1997	This Act amends the National Wildlife Refuge System Administration Act of 1966. This Act defines the mission of the National Wildlife Refuge System, establishes the legitimacy and appropriateness of six priority wildlife-dependent public uses, establishes a formal process for determining compatible uses of Refuge System lands, identifies the Secretary of the Interior as responsible for managing and protecting the Refuge System, and requires the development of a comprehensive conservation plan for all refuges outside of Alaska.
Native American Graves Protection and Repatriation Act of 1990	Requires federal agencies and museums to inventory, determine ownership of, and repatriate certain cultural items and human remains under their control or possession. The Act also addresses the repatriation of cultural items inadvertently discovered by construction activities on lands managed by the agency.
Neotropical Migratory Bird Conservation Act of 2000	Establishes a matching grant program to fund projects that promote the conservation of neotropical migratory birds in the united States, Latin America, and the Caribbean.
North American Wetlands Conservation Act of 1989	Provides funding and administrative direction for implementation of the North American Waterfowl Management Plan and the Tripartite Agreement on wetlands between Canada, the United States, and Mexico. The North American Wetlands Conservation Council was created to recommend projects to be funded under the Act to the Migratory Bird Conservation Commission. Available funds may be expended for up to 50 percent of the United States' share cost of wetlands conservation projects in Canada, Mexico, or the United States (or 100 percent of the cost of projects on federal lands).
Refuge Recreation Act of 1962, as amended	This Act authorizes the Secretary of the Interior to administer refuges, hatcheries, and other conservation areas for recreational use, when such uses do not interfere with the area's primary purposes. It authorizes construction and maintenance of recreational facilities and the acquisition of land for incidental fish and wildlife-oriented recreational development or protection of natural resources. It also authorizes the charging of fees for public uses.
Partnerships for Wildlife Act of 1992	Establishes a Wildlife Conservation and Appreciation Fund to receive appropriated funds and donations from the National Fish and Wildlife Foundation and other private sources to assist the state fish and game agencies in carrying out their responsibilities for conservation of non-game species. The funding formula is no more than 1/3 federal funds, at least 1/3 foundation funds, and at least 1/3 state funds.

STATUTE	DESCRIPTION
Refuge Revenue Sharing Act of 1935, as amended	Provided for payments to counties in lieu of taxes from areas administered by the Fish and Wildlife Service. Counties are required to pass payments along to other units of local government within the county, which suffer losses in tax revenues due to the establishment of Service areas.
Rehabilitation Act of 1973	Requires nondiscrimination in the employment practices of federal agencies of the executive branch and contractors. It also requires all federally assisted programs, services, and activities to be available to people with disabilities.
Rivers and Harbors Appropriations Act of 1899, as amended	Requires the authorization by the U.S. Army Corps of Engineers prior to any work in, on, over, or under a navigable water of the United States. The Fish and Wildlife Coordination Act provides authority for the Service to review and comment on the effects on fish and wildlife activities proposed to be undertaken or permitted by the Corps of Engineers. Service concerns include contaminated sediments associated with dredge or fill projects in navigable waters.
Sikes Act (1960), as amended	Provides for the cooperation by the Departments of Interior and Defense with state agencies in planning, development, and maintenance of fish and wildlife resources and outdoor recreation facilities on military reservations throughout the United States. It requires the Secretary of each military department to use trained professionals to manage the wildlife and fishery resource under his jurisdiction, and requires that federal and state fish and wildlife agencies be given priority in management of fish and wildlife activities on military reservations.
Transfer of Certain Real Property for Wildlife Conservation Purposes Act of 1948	This Act provides that upon determination by the Administrator of the General Services Administration, real property no longer needed by a federal agency can be transferred, without reimbursement, to the Secretary of the Interior if the land has particular value for migratory birds, or to a state agency for other wildlife conservation purposes.
Transportation Equity Act for the 21st Century (1998)	Established the Refuge Roads Program, requires transportation planning that includes public involvement, and provides funding for approved public use roads and trails and associated parking lots, comfort stations, and bicycle/pedestrian facilities.
Uniform Relocation and Assistance and Real Property Acquisition Policies Act (1970), as amended	Provides for uniform and equitable treatment of persons who sell their homes, businesses, or farms to the Service. The Act requires that any purchase offer be no less than the fair market value of the property.

STATUTE	DESCRIPTION
Water Resources Planning Act of 1965	Established Water Resources Council to be composed of Cabinet representatives including the Secretary of the Interior. The Council reviews river basin plans with respect to agricultural, urban, energy, industrial, recreational and fish and wildlife needs. The act also established a grant program to assist States in participating in the development of related comprehensive water and land use plans.
Wild and Scenic Rivers Act of 1968, as amended	This Act selects certain rivers of the nation possessing remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values; preserves them in a free-flowing condition; and protects their local environments.
Wilderness Act of 1964, as amended	This Act directs the Secretary of the Interior to review every roadless area of 5,000 acres or more and every roadless island regardless of size within the National Wildlife Refuge System and to recommend suitability of each such area. The Act permits certain activities within designated wilderness areas that do not alter natural processes. Wilderness values are preserved through a "minimum tool" management approach, which requires refuge managers to use the least intrusive methods, equipment, and facilities necessary for administering the areas.
Youth Conservation Corps Act of 1970	Established a permanent Youth Conservation Corps (YCC) program within the Departments of Interior and Agriculture. Within the Service, YCC participants perform many tasks on refuges, fish hatcheries, and research stations.

EXECUTIVE ORDERS	DESCRIPTIONS
EO 11593, Protection and Enhancement of the Cultural Environment (1971)	States that if the Service proposes any development activities that may affect the archaeological or historic sites, the Service will consult with Federal and State Historic Preservation Officers to comply with Section 106 of the National Historic Preservation Act of 1966, as amended.
EO 11644, Use of Off-road Vehicles on Public Land (1972)	Established policies and procedures to ensure that the use of off-road vehicles on public lands will be controlled and directed so as to protect the resources of those lands, to promote the safety of all users of those lands, and to minimize conflicts among the various uses of those lands.
EO 11988, Floodplain Management (1977)	The purpose of this Executive Order is to prevent federal agencies from contributing to the "adverse impacts associated with occupancy and modification of floodplains" and the "direct or indirect support of floodplain development." In the course of fulfilling their respective authorities, federal agencies "shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains."
EO 11989 (1977), Amends Section 2 of EO 11644	Directs agencies to close areas negatively impacted by off-road vehicles.
EO 11990, Protection of Wetlands (1977)	Federal agencies are directed to provide leadership and take action to minimize the destruction, loss of degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands.
EO 12372, Intergovernmental Review of Federal Programs (1982)	Seeks to foster intergovernmental partnerships by requiring federal agencies to use the state process to determine and address concerns of state and local elected officials with proposed federal assistance and development programs.
EO 12898, Environmental Justice (1994)	Requires federal agencies to identify and address disproportionately high and adverse effects of its programs, policies, and activities on minority and low-income populations.

EXECUTIVE ORDERS	DESCRIPTIONS
EO 12906, Coordinating Geographical Data Acquisition and Access (1994), Amended by EO 13286 (2003). Amendment of EOs and other actions in connection with transfer of certain functions to Secretary of DHS.	Recommended that the executive branch develop, in cooperation with state, local, and tribal governments, and the private sector, a coordinated National Spatial Data Infrastructure to support public and private sector applications of geospatial data. Of particular importance to comprehensive conservation planning is the National Vegetation Classification System (NVCS), which is the adopted standard for vegetation mapping. Using NVCS facilitates the compilation of regional and national summaries, which in turn, can provide an ecosystem context for individual refuges.
EO 12962, Recreational Fisheries (1995)	Federal agencies are directed to improve the quantity, function, sustainable productivity, and distribution of U.S. aquatic resources for increased recreational fishing opportunities in cooperation with states and tribes.
EO 13007, Native American Religious Practices (1996)	Provides for access to, and ceremonial use of, Indian sacred sites on federal lands used by Indian religious practitioners and direction to avoid adversely affecting the physical integrity of such sites.
EO 13061, Federal Support of Community Efforts Along American Heritage Rivers (1997)	Established the American Heritage Rivers initiative for the purpose of natural resource and environmental protection, economic revitalization, and historic and cultural preservation. The Act directs Federal agencies to preserve, protect, and restore rivers and their associated resources important to our history, culture, and natural heritage.
EO 13084, Consultation and Coordination With Indian Tribal Governments (2000)	Provides a mechanism for establishing regular and meaningful consultation and collaboration with tribal officials in the development of federal policies that have tribal implications.
EO 13112, Invasive Species (1999)	Federal agencies are directed to prevent the introduction of invasive species, detect and respond rapidly to and control populations of such species in a cost effective and environmentally sound manner, accurately monitor invasive species, provide for restoration of native species and habitat conditions, conduct research to prevent introductions and to control invasive species, and promote public education on invasive species and the means to address them. This EO replaces and rescinds EO 11987, Exotic Organisms (1977).

EXECUTIVE ORDERS	DESCRIPTIONS
EO 13186, Responsibilities of Federal Agencies to Protect Migratory Birds. (2001)	Instructs federal agencies to conserve migratory birds by several means, including the incorporation of strategies and recommendations found in Partners in Flight Bird Conservation plans, the North American Waterfowl Plan, the North American Waterbird Conservation Plan, and the United States Shorebird Conservation Plan, into agency management plans and guidance documents.
EO 13443, Facilitation of Hunting Heritage and Wildlife Conservation (2007)	Directs federal agencies to facilitate the expansion and enhancement of hunting opportunities and the management of game species and their habitats.

Appendix IV. Public Involvement

SUMMARY OF PUBLIC SCOPING COMMENTS

The issues, ideas, concerns and comments raised by stakeholders during the public scoping meeting were varied. Comments were submitted addressing:

- Establish management agreements and memoranda of understandings with partners for prescribed burning and scrub management;
- Provide for and acquire sufficient resources for prescribed fire;
- Support regional fire strike team efforts;
- Provide detailed surveys of trust resources on each management unit;
- Understand the threats of global climate change;
- Control exotic and nuisance species;
- Acquire in-holdings within the refuge acquisition boundary and use different means to purchase lands including brokering through existing or new partnerships;
- Develop conservation easements/agreements with refuge neighbors to ensure further protection of habitats directly influencing refuge lands;
- Pursue agreements with local, state, federal, and non-governmental organization land management agencies to provide land management authority;
- Participate and be actively involved in regional planning efforts;
- Provide guided tours of the refuge to increase public knowledge of the importance of the Lake Wales Ridge Ecosystem and refuge resources;
- Continue management activities to remove litter and debris from the refuge;
- Work with partners to participate in regional environmental education opportunities including coordinated development of regional school curriculum;
- Work with partners to develop educational materials for distribution to communities throughout the Lake Wales Ridge system;
- Increase law enforcement communication with FWC;
- Increase management of trespassing and ATV use;
- Maintain a federal presence on the Lake Wales Ridge and keep federal ownership as a refuge, providing prominence for the ridge which brings support for partner efforts.

The Intergovernmental Coordination Team identified a variety of issues and developed a list of recommended priority issues to be addressed by the CCP, as follows:

- Develop new or rework existing partnership with regional fire Strike Teams;
- Attain currency with prescribed burn campaign;
- Develop prescribed fire and wildfire memoranda of understanding with state agencies and partners including FDOF, FWC, and TNC;
- Develop intergovernmental team for prescribe burn planning;
- Support Service funding to other agencies for fire management actions both on the refuge and on non-service, naturally managed ridge lands;
- Establish a refuge contact person for fire management;
- Investigate potential of working through the LWREWG to develop prescribed burning and management plans;
- Hire private contractors for prescribed burning;

- Provide dedicated refuge personnel for fire and invasive species management;
- Through partnerships, implement plant monitoring, restoration/recovery, reintroduction, and burn frequency research;
- Develop a common species occurrence list for each property in addition to maintaining current endangered, threatened, and rare species list;
- Actively control for the introduction/reintroduction of exotic vegetation in openings created from treatments;
- Develop fire regime based on a multi-species management approach to ensure that habitat production for key species (i.e. Florida ziziphus (*Ziziphus celata*) and Florida scrub-jay (*Aphelocoma coerulescens*)) is optimized;
- Inventory, research, and map exotic vegetation utilizing the expertise of partners;
- Develop management and burn plans specific to listed and rare plants;
- Establish a refuge contact person for fire management;
- Develop a plan for desired future conditions of various habitats and track progress through a 5-year review;
- Actively coordinate vegetation and fire effects monitoring with FDOF,FWC, USFWS Ecological Services, ABS, and universities, including University of Central Florida and University of South Florida;
- Prioritize and acquire lands within the refuge acquisition boundary in addition to the refuge's current four units;
- Active participation in Highlands County habitat purchase campaigns promoting acquisition within the acquisition boundary;
- Provide law enforcement personnel or refuge ranger to curtail illegal trespass/all-terrain vehicle use.
- Develop a friends group to enable the establishment of a trust fund to support management efforts on the refuge;
- Need for a dedicated staff and budget for this refuge;
- Provide the ability for volunteer groups and partners to independently lead controlled access events on the refuge, managed through the special use permit program. Emphasize events that involve a work element – targeted invasive control, pre-fire weed reduction, planting projects.

SUMMARY OF PUBLIC COMMENTS OF THE DRAFT CCP/EA AND SERVICE RESPONCES

All comments that were received on the Draft Comprehensive Conservation Plan and Environmental Assessment (Draft CCP/EA) for Lake Wales Ridge National Wildlife Refuge are summarized in this section. Public comments on this Draft CCP/EA were accepted from April 30 to June 01, 2010, while comments from the State of Florida were submitted through the State Clearinghouse on July 26, 2010. A notice of availability of the Draft CCP/EA was published in the *Federal Register* on April 30, 2010, requesting public review and comment. In addition, over 200 flyers were mailed to mailing list members and a news release was provided to local media outlets announcing the availability and desire to seek public comment. The Draft CCP/EA was made available via the internet, CD, and/or paper copy upon request. A total of eight organizations, and government agencies including The Nature Conservancy, Archbold Biological Station, The University of Central Florida, Florida Department of Environmental Protection, Florida Division of Forestry, and the South Florida Water Management District submitted comments on the Draft CCP/EA. Under the State Clearinghouse review, the proposed activities were found to be consistent with the Florida Coastal Zone Management Program.

Under NEPA, the Service must respond to substantive comments. For purposes of this CCP, a substantive comment is one that was submitted during the public review and comment period which is within the scope of the proposed action (and the other alternatives outlined in the EA), is specific to the proposed action, has a direct relationship to the proposed action, and includes reasons for the Service to consider it. (For example, a substantive comment might be that the document referenced 500 individuals of a particular species, but that current research found 600. In such a case, the Service would likely update the plan to reflect the 600, citing the current research. While a comment that would not be considered substantive would be: "We love the refuge."

The page numbers referenced relate to the original page numbers in the Draft CCP/EA released for public review and comment.

AFFILIATION OF COMMENTERS

Eight organizations and governmental agencies submitted comments, as listed.

Commenter	Affiliation and Location
Reed Bowman	Archbold Biological Station, Lake Placid, Florida
Tom Butler	Florida Department of Environmental Protection, Tallahassee, Florida
James Golden	South Florida Water Management District, West Palm Beach, Florida
Steve Morrison	The Nature Conservancy, Bartow, Florida
Jack Stout	University of Central Florida, Orlando, Florida
Forrest Watson	Florida Department of Agriculture and Consumer Services, Division of Forestry, Tallahassee, Florida
	Florida Department of State
	Florida Department of Transportation

SUMMARY OF CONCERNS AND THE SERVICE'S RESPONSES

The comments submitted during the public review and comment period were evaluated, summarized, and grouped into several categories: Wildlife and Habitat Management; Resource Protection; Visitor Services; Refuge Administration; and Other. Comments on like topics were grouped together. The Service's responses to the comments are provided, by category.

Wildlife and Habitat Management

Habitat and Cover Class

Comment: A comment concerning the understanding that Atlantic white cedar (*Chamaecyparis thyoides*) was not a floral component of Lake Wales Ridge bayhead habitats as reported in the Plan.

Service Response: Comment noted. Atlantic white cedar was removed as a species associated with Ridge bayhead systems and was removed from the list of species we would anticipate on the refuge.

Comment: Page 94 – Wiregrass is not normally found where scrub lupines grow. I would use corkscrew threeawn, *Aristida gyrans*.

Service Response: Comment noted. The CCP was updated, changing wiregrass (*Aristida beyrichiana*) to corkscrew threeawn (*Aristida gyrans*) and author citation was added.

Comment: Pg 187: No titi on the ridge…

Service Response: Comment noted. We removed titi - (*Cyrilla racemiflora),* a shrub or small tree that commonly grows in dense thickets in wet places, particularly pocosins, bogs, wet pine flatwoods and swamps (Floriadata 2010) from our lists of species known to or potentially occurring on the refuge.

Species Including Rare, Threatened, and Endangered Species

Comment: I noticed the scientific name in of scrub lupine was not consistent in the document. I go with *L. aridorum* because it was listed as a species rather than a subspecies by your organization.

Service Response: According to the most recent Scrub Lupine 5-year Review: Summary and Evaluation authored by the Service's Jacksonville Ecological Services Field Office (Service, 2008f) the scientific name used by the Service is *Lupinus aridorum* as identified by the commenter. We updated all occurrences of *L. westianus* var. *aridorum* to *L. aridorum* throughout the CCP.

Comment: A comment concerning the use of the term 'reintroduction' for the population of *Ziziphus celata* on Carter Creek. Specifically: ziziphus "reintroduction" (if it wasn't known to be there, isn't it an introduction?)

Service Response: Comment noted. The Service recognizes the term reintroduction as establishment of a species into unoccupied, suitable habitat within its historic range (Service 1999), whereas introduction is the establishment of a species outside of its historic range and is commonly associated with the spread and proliferation of exotic, non-native species. These terms, however are frequently interchanged and hybridized as is the case in this CCP to mean an establishment of an extant species not historically known on a particular area of land (the refuge) which contains suitable habitat and lies within the historic range of the species. Since 2002, experimental establishment of Florida ziziphus has been conducted on publically owned sites where habitat conditions could support Florida ziziphus populations, including the refuge's Carter Creek Unit. Per Service definition, this establishment is a reintroduction as the Carter Creek unit contains both suitable habitat (sandhill) and is within the historic range of Florida ziziphus (in Highlands County). The Service recognizes the intermixing of these distinct terms and has updated the CCP, changing 'introduction' to 'reintroduction' unless part of a direct citation where the term used by the author remains unchanged.

Comment: Current literature show the Florida sand skink as *Plestiodon reynoldsi*.

Service Response: According to the most recent Service 5-year Review: Summary and Evaluation conducted by the South Florida Ecological Services Office, the scientific name for sand skink as *Neoseps reynoldsi* (Service 2007b). We recognize that the scientific community recommends this change; however, the Service has not accepted a change in genus for the species.

Comment: Rufous-sided towhee is now Eastern Towhee and the scientific name is misspelled.

Service Response: Comment noted. The CCP was updated with this information.

Comment: Page 76 – The fringe tree is left out of Table 14 for Lake McLeod.

Service Response: Comment noted. We updated Table 14, adding pygmy fringe-tree to the list of rare plants known to occur or potentially occurring on the Lake McLeod Unit.

Comment: FSJ section – Jay Watch results…report states mean group size is 3.63 at Flamingo Villas (2.85 adults and 1.29 juveniles); however this adds up to a mean group size of 4.14. Fix the discrepancy but also note that stable populations are characterized by a mean group size of 3.0 adults, excluding young of the year.

Service Response: Comment noted. We updated the CCP, recalculating the average number of adults to 2.34 from the correctly identified total average group size (3.63) minus the juvenile per group (1.29). In addition, we noted that stable populations are characterized by a group size of 3.0 excluding young of the year as suggested and cited by the author/commenter.

Comment: Page 81 – Fringe trees no longer occur on the east side of the refuge at Lake McLeod. When I trespassed on the property in 1992 at least one plant was present, but when I returned in 1997 I found evidence that it had been dug up and removed. Less than 6 fringe trees occur across the road on the lake side today.

Service Response: Comment noted. The CCP was updated to reflect the known occurrence of pygmy fringe-tree on the lake side (west side) of the Lake McLeod Unit.

Comment: Page 93 – I must take my words back on the issue of scrub lupines and rosemary. They can indeed survive in the drip line of the foliage of rosemary and even flower and yield seeds.

Service Response: Comment noted. The sentence and citation were deleted from the final CCP version.

Comment: 446 and vicinity – I think the species name for the fence lizard is incorrect.

Service Response: Comment noted. We updated the table to reflect the proper species name for the fence lizard – *undulates*.

Comment: 446 and vicinity – The sand skink is missing from the table.

Service Response: Comment noted. We updated the table and added the sand skink (*Neoseps reynoldsi*).

Comment: 446 and vicinity – Looks like the velvet ants have different common names but the same scientific names.

Service Response: The scientific name for the Lake Wales Ridge Velvet ant is *Dasymutilla archboldi* according to Scott 2004. The CCP has been updated to correct this oversight and a citation of the author has been added. Nocturnal scrub velvet ant is properly identified as *Photomorphus archboldi*.

Comment: 446 and vicinity – I may be misinformed but I thought the Rosemary Grasshopper was restricted to north Florida scrubs and sandhills.

Service Response: According to the Florida Entomological Society (FES) website: http://www.flaentsoc.org/arthropdiversity/rosemary_grasshopper.htm, the Florida range for rosemary grasshopper includes central and southeastern Florida. Specifically, 'this species is only found in association with rosemary in central and southeastern Florida.' The Service acknowledges that there is a lack of evidence that rosemary grasshopper exists on the refuge. Baseline condition analysis including species inventories will be conducted as part of this CCP, which will broaden our knowledge of species composition and abundance. Appendix I (Refuge Biota) of the Draft CCP/EA includes species known to occur or potentially occur on the refuge based on the occurrence of similar species or the existence of suitable habitat found on the refuge. We, therefore, did not remove the rosemary grasshopper from the refuge biota list and added the FES website listed above as a citation in Appendix II.

Fire Management

Comment: General comments in support of the following:

- Two stages of fire management, restoration, and maintenance with differing fire return intervals
- The concept of "pre-fire exclusion conditions"
- Using vegetation height to determine burn scheduling in scrub, rather than a set number of years

Service Response: Comments noted. The Service has made a sincere and concerted effort to integrate contemporary science and local knowledge of fire into its fire management program. Our plan is to restore refuge habitats to pre-fire exclusion conditions for the benefit of rare, threatened, and endangered species. We plan to do this primarily through the implementation of prescribed fire on 2- to 5-year fire return intervals to restore habitat to pre-fire exclusion conditions, monitor ecological response, and adapt intervals as maintenance levels are achieved. Monitoring species and habitat level responses are key components in the assessment of management effectiveness.

Comment: Page 167 – one objective is to restore pre-fire exclusion conditions through an aggressive fire regime of fires every 2 to 5 years until the latter conditions are restored. This is too aggressive and will result in the extirpation of FSJs in occupied habitat and the loss of many plants that depend on the longer-term fire return intervals.

Service Response: The plan to utilize an aggressive prescribed fire rotation of 2 to 5 years will occur where habitats require restorative management to return to pre-fire exclusion conditions. Habitats exhibiting conditions presently suitable for and utilized by Florida scrub-jay would not require this aggressive fire return interval as these systems are closer or already exhibit restored resources. As an example, a 5- to 20-year rotation would be targeted in restored scrubby flatwoods to maintain desired conditions suitable for Florida scrub-jay. In addition, habitat conditions in areas that have had suppressed fire conditions often have limited and discontinuous fuels. These fuel conditions lead to a mosaic of fire behavior, often leaving patches of burned and unburned habitat within a burn unit. The mosaic of burned and unburned areas would leave patches of habitats within the burn unit, allowing FSJ and listed plants to persist in the area. The refuge will adapt management based on ecological indicators including affects to scrub-jay and habitat conditions whether in a restoration or maintenance phase to ensure existing rare, threatened, and endangered species benefit from restoration and/or maintenance management.

Comment: The Florida Division of Forestry will continue to provide support for a total fire management program for the lake Wales Ridge NWR as is outlined in the Draft CCP/EA.

Service Response: Comment noted. The CCP calls for continued and/or development of new partnerships to help manage trust resources on the refuge including the desire to continue our long-term partnership with the State of Florida Department of Agriculture and Consumer Services Division of Forestry for unwanted wildland fire and prescribed fire support.

Mechanical Treatment

Comment: It is unclear whether mechanical treatment will receive the same level of monitoring that you propose for prescribed fire. Monitoring of mechanical treatment is recommended in Menges and Gordon's recent summary of mechanical treatment studies (attached). This seems particularly apropos since the effects of mech. treatments on skinks has not been adequately studied. Also, as recommended in the above report, it should be clarified that mech. treatment will be used to facilitate the use of fire as a one-time restoration technique, not as a surrogate (with the exception of areas where fire must be discontinued due to risk analysis). And finally, of particular concern to skinks is the practice of burning the mulch created by broadcast gyro-tracking of scrub. This can create severe fires with long residence time, the heat from which may penetrate the soil to greater depths than normal prescribed fires.

Service Response: The careful and judicious application of mechanical treatments in select areas using the most appropriate tools is included as a habitat management strategy in this CCP. Tools include heavy equipment such as gyro-tracking and hand held equipment such as chainsaw and herbicide and/or a combination of tools and approaches. We recognize that inappropriate use of mechanical control, notably the use of heavy equipment such as gyro-tracking can negatively impact resources we are working to restore and protect. These tools do have a place in resource management on the refuge however, if used in a judicious and careful manner - particularly where the use of prescribed fire must be excluded due to urban interface threats or where fire has been excluded and habitats have succeeded from a desired habitat condition. In these cases, integration of mechanical control is often necessary and in the case of discontinued use do to risk analysis, may be the only management method available to restore target habitats.

Application of mechanical control in habitats requiring restoration: Heavy equipment including gyro-tracking will be considered as an initial treatment technique to prescribed burning in unrestored settings where fuel loads are heavy. These settings are not preferred habitat for skinks in this condition but would be restored as early successional pyrogenic habitats through this process and as such eventually serving as preferred skink habitat. Once pre-fire exclusion conditions have been met through this integrated approach, continued use of heavy equipment for mechanical control would not be necessary to maintain the restored system. Where fire must be discontinued, controlling vegetation through heavy equipment use (e.g., gyro-tracking) may be a more appropriate tool to restore habitats to desired conditions. The Service concurs that a one-time application of heavy equipment mechanical control on sites targeted for restoration where prescribed fire can be utilized is appropriate and helps to lessen the impact associated with repeated use of heavy equipment on refuge resources.

Application of mechanical control in restored habitats: Differing strategies of mechanical control will be implemented depending on conditions and appropriateness. The refuge does not plan to gyro-track or use other types of heavy equipment in restored habitats where the application of prescribed fire can be used as the primary treatment method to maintain appropriate habitat conditions. In these settings, crews utilizing handtools will be the preferred method of mechanical control when

mechanical control is necessary. For instance, mechanical treatment of undesired fuels through hand cutting using chainsaw and herbicide will be used at Carter Creek to maintain suitable habitat conditions for the Florida ziziphus reintroduction project.

Monitoring: The CCP includes projects that analyze species response to restoration activities including the impacts from mechanical control in order to adapt management to benefit species and habitats. Restoring and maintaining habitats to pre fire exclusion conditions will provide open sand gaps and food resources benefitting skink populations. Working with the partners, we will conduct demographic monitoring of refuge skink populations (Project 6, Chapter V) to provide baseline information on refuge skink populations. In addition under Project 7, Chapter V, we will analyze habitat response to differing methods of mechanical disturbance to determine the most appropriate type of mechanical control to use.

Monitoring the effects of mechanical control on refuge resources is an important component of this plan and is discussed both as a separate project and as an integrated element of fire effects monitoring. Project 7 of Chapter V seeks to evaluate habitat response from mechanical disturbance to determine the most appropriate mechanical methods to use depending on site conditions. Findings will help us adapt management as necessary to protect species and meet restoration targets. In addition, monitoring habitat responses from differing treatment efforts including the use of mechanical control as a site prep feature is a component of fire effects monitoring (Project 11, Chapter V). The Plan also identifies the need to coordinate monitoring and research discoveries and apply new and innovative methods with partners so that Ridge resources are restored and maintained on a landscape level. Monitoring results will be used to guide and adapt management during the present restoration and future maintenance phases.

Comment: Page 145 – include recent paper by Menges and Gordon Florida Scientist 2009 on relative success of fire/mechanical treatment options.

Service Response: Comment noted. We updated the CCP to accommodate this review of the appropriateness of mechanical treatments and herbicides as fire surrogates to manage Florida's uplands and cited the author(s).

Inventorying, Monitoring, and Research

Comment: Page 59 – My research at Lake McLeod began in March 1997 and has continued to date. Study plots are surveyed monthly to document survival, size, germination, and flowering of scrub lupines. The initial work was funded from the Merritt island NWR. A report on the first year of work was submitted to the refuge.

Service Response: Comment noted. The CCP was changed to reflect this oversight and a citation to the author was provided in Appendix II.

Refuge Hydrology and Water Resources

Comment: A comment concerning the review of groundwater resources, particularly the reference to the refuge water table potentially being as much as 100 feet (30.5m) below the surface of higher sand and scrub habitats (Page 30, para 3) and that this seemed very high.

Service Response: Comment noted. The CCP discusses the refuge's lack of baseline information regarding ground and surface water resources. In addition, we don't have a complete and clear understanding of offsite inputs and how they may be impacting both ground and surface water

systems. The CCP was updated to acknowledge the lack of baseline information concerning groundwater resources on the refuge. Project 13 of Chapter V develops introduces a project to inventory ground and surface water resource and restore wetland habitats on the refuge - particularly on the Flamingo Villas Unit where impacts to rare, threatened, and endangered species of historic ditching and off-site inputs are unknown.

Comment: Page 29 – there is a little discussion on surface water quality and there is no reference to the DEP's numerous water quality programs including the TMDL program that assesses the entire area the refuge is within. Maybe they could add a sentence or two to reference that to provide a more comprehensive view of surface water quality and put in the web site http://www.dep.state.fl.us/water/tmdl/.

Service Response: Comment noted. The CCP has been updated to include a more comprehensive review of surface water quality monitoring and reporting performed by FDEP and the website was cited.

Comment: Page 26 — why use summary data for rainfall from Ona, Florida? Ona is not on the Lake Wales Ridge and many good data sources exist on the LWR, Archbold Biological Station, for one.

Service Response: Comment noted. We updated the document, deleting the reference to Ona, Florida, and updating the discussion of climate with NOAA climatography data for temperature and precipitation normals from the Avon Park 2W Station. In addition, the NOAA reference was cited in Appendix II.

Comment: In the section of the report entitled "Regional Conservation Plans and Initiatives" (pages 19-24), please add a reference to Northern Everglades and Estuaries Protection Program (NEEPP) and the Lake Okeechobee Watershed Protection Plan. The NEEPP promotes a comprehensive, interconnected watershed approach to protecting Lake Okeechobee and the Caloosahatchee and St. Lucie Rivers and estuaries and recognizes the importance and connectivity of the entire Everglades ecosystem from the Kissimmee chain of lakes south to Florida bay. The primary goal of the legislation is to restore the timing and distribution of water to the natural system.

Service Response: The plan has been updated to include a discussion of the NEEPP and the Lake Okeechobee Watershed Protection Plan.

Comment: The conservation plan should be consistent with the necessary nutrient load reductions identified in Section 373.4595, *Florida Statutes*, including the Lake Okeechobee Watershed Construction Project Phase II Technical Plan, the established Total Maximum Daily Load (TMDL) for Lake Okeechobee and NEEPP. Existing water quality in the Lake Okeechobee watershed is significantly influenced by the various land use and land management practices within the individual sub-watersheds and drainage basins of the watershed. The Lake Okeechobee watershed is subject to NEEPP, Lake Okeechobee Watershed Comprehensive Everglades Restoration Plan, Lake Okeechobee Watershed Construction Project Phase II Technical Plan, and the established phosphorus TMDL for Lake Okeechobee.

It is important that land management activities, such as removal of exotics, conducted within those units located within the NEEPP area or within basins that drain into the NEEPP area, be performed in a manner consistent with NEEPP legislation. Activities should not adversely impact nutrient loadings in the basins within the Lake Okeechobee watershed and should be consistent with established TMDLs. (See discussion on page 321 of the plan under Unavoidable Impacts and Mitigation Measures.)

Service Response: The Service recognizes its place and significance in the NEEPP area, specifically Flamingo Villas, Carter Creek, and Snell Creek units are all part of the NEEPP area and eventually drain to Lake Okeechobee via the Kissimmee River basin. In order to control exotic infestations, mechanical and herbicide treatments will be necessary. Every effort will be made to ensure refuge management is consistent with nutrient load reductions under Florida Statute, including management of pest species. To accomplish this, pest species management will be consistent with all applicable rules and regulations governing the use.

Use of site specific herbicides to control pest species in natural areas is a proven tool and is consistent with standard methodologies currently employed by natural area mangers throughout Florida. Application methods and materials (i.e., herbicides and mechanical treatment) will include those already widely used and accepted throughout Florida to control invasive species. There may be very short term impacts to non-target resources, including surface waters where exotic infestation is heaviest. In order to minimize non-target damage, the refuge will strictly adhere to the Material Safety Data Sheets (MSDS), Pesticide Labels, and will utilize both refuge staff and contractors who hold a Florida Natural Areas Pesticide License certified contractors for herbicide application. In addition, the refuge will utilize best management practices where appropriate and necessary to protect watershed and water resources both on and off the refuge. To further protect non-target species and habitats from the unwanted effects of pest plant control, the CCP calls for the development of an Integrated Pest Management Plan (IPMP) as a step-down from the CCP. The IPMP will provide specific analysis on the occurance, density, and best methods to treat pest species, including products and methodologies and interrelationships with surface and groundwater systems.

In terms of water resource management, the refuge does not have a clear understanding of both on and off site water resources. In order to develop a complete picture of refuge water resource relationships, Project 13 of Chapter V discusses the need to inventory and monitor refuge wetland habitats to further our understanding of wetland, groundwater and basin interactions. In addition, Projects 26-33, Chapter V, identify staff compliments to increase our ability to manage refuge water resources and integrate water resource management and discovery through established and new partnerships.

Thorough the proper application of herbicides, better understanding of refuge water resources, development of step down plans designed to provide details of pesticide use and methodologies, and through the addition of staff, the refuge is poised to deliver natural resource management consistent with local and regional initiatives including NEEPP.

Climate Change

Comment: In the brief review on climate (page 26), some discussion of the predictions of climate change for the region would be appropriate.

Service Response: In the Refuge Overview Chapter (Chapter II) we discuss what is known of refuge resources. Predictions of climate change do not fit in this Chapter but are addressed elsewhere in the document. Specifically, Goal E of Chapter IV (pg 182) addresses strategies to increase our knowledge and understanding on the impacts of climate change. Further, developing an understanding of the role climate change plays on the refuge and Ridge landscape was analyzed as a key topic in the Draft CCP/EA and as an effect common to all alternatives under the Environmental Consequences Section of the EA. In addition, Project 18 of Chapter V introduces a project to commission a comprehensive study to better understand the impacts of climate change on the Lake Wales Ridge ecosystem and the effects climate change may have on changing patterns of suitable habitat for rare, threatened, and endangered species.

Resource Protection

Management Agreements

Comment: For the Lake Wales Ridge NWR management units located adjacent to SFWMD-owned lands or within boundaries of existing or proposed Everglades' restoration projects, coordinate with SFWMD ecosystem restoration and land management staff regarding the compatibility of the proposed activities with SFWMD activities and objectives, including the use of applicable Best Management Practices. See below for comments on specific management units.

a. The Snell Creek unit is located adjacent to Lake Marion Creek and Reedy Creek Management Area. It includes private in-holdings on the south side of the unit. If acquisition of this area is not likely to occur in the near future, it would be beneficial to install a boundary fence and a fire line to separate the refuge from the in-holdings. This would enable SFWMD land managers to provide regular prescribed burn and coverage on the refuge property by allowing fires from SFWMD property to burn through the refuge property to the southern boundary.

Service Response: Comment noted. Establishing management agreements and other mechanisms to partner management of refuge interests is a key component of this CCP. Specifically, Projects 19 and 21 of Chapter V discuss the development of management agreements with partner agencies including the SFWMD. In addition, Chapter IV Objective F.2: Management Agreements evaluates the need to establish management agreements with partners and refuge neighbors, including through lease agreements, memorandum of understanding, and easements to benefit rare, threatened and endangered species. The CCP also specifically targets that within three years of its date, the refuge will work with partners to investigate the development of a management agreement with the State of Florida to manage the resources of the Snell Creek Unit. The management agreement would identify specific management options including the need to provide infrastructure to better manage these public interests. In terms of priority acquisitions, the CCP's land acquisition strategy for the Snell Creek Unit (Chapter IV, Objective F.1, and Figure 10.4) identifies the two Snell Creek Unit in-holdings as very high and high priority sites for acquisition given their undeveloped or minimally developed settings and connectivity to adjacent natural areas already in public ownership.

b. While the Lake Placid Unit is not located within SFWMD boundaries, it is adjacent to Fisheating Creek Basin where a Feasibility Study is currently underway to refine water quality and storage for the Fisheating Creek watershed and to identify projects that can help meet those targets. TMDL development is currently scheduled for 2011.

Service Response: The Service has not acquired and does not manage lands within the Placid Lakes Unit. The Unit is one of twelve units within the refuge's approved acquisition boundary (See Figure 3 for location and Table 1 for ownership patterns) but acquisition within the unit has not been a priority for the refuge. If acquisition does occur, the Service will abide by any TMDL requirements developed by the SFWMD.

Cultural Resources

Comment: The Florida Department of State (DOS) has reviewed the document and concurs that additional cultural resource surveys will be necessary prior to any new construction or excavation on refuge lands. DOS staff looks forward to further consultation as individual projects arise. Please see the enclosed DOS letter for additional information.

Service Response: Comment noted. The Service will contact and consult with DOS during the planning process of any construction projects and will conduct all resource surveys that are necessary.

Refuge Administration

Staffing

Comment: Page 200 lists the new staff, but it is not clear if they will be housed at new facilities on the Lake Wales Ridge NWR or at Pelican Island NWR…the latter is not acceptable because it is still 60 miles away and the ability to respond to wildlife and any items of immediate need will be sorely limited.

Service Response: The Service understands the logistical challenges associated with administering refuge management from the Pelican Island NWR in Vero Beach, Florida, and fire management from Merritt Island NWR. To this end, the CCP calls for a staff compliment of five full-time employees including a fire/forestry technician, botanist/biologist, private lands biologist, biological science technician, assistant manager, shared law enforcement officer, and a shared refuge ranger (Projects 27-33, Chapter V). Permanent positions would be placed in close proximity to the refuge. To accomplish this, the CCP identifies a project (Project 24, Chapter V) to provide through dedicated funding the ability to enter into agreements for use of dedicated space necessary to administer, operate, and manage day-to-day and long-term functions of the refuge.

Partnerships

Comment: So much of the success of this CCP depends on the implementation of an on-site fire program (page 40, 2nd paragraph). The CP still depends on strengthening the cooperative agreements with partners, such as TNC, but TNC is actively trying to divest itself of fire strike teams. In the absence of the ability to form such partnerships, how will the Service provide the capacity to implement the aggressive burn program put forth in this plan?

Service Response: The Service recognizes the need to provide fire management services both within the Service as well as through partnerships for the successful implementation of restoration goals. We have developed an integrated approach to fire management on the refuge through this CCP. Particularly, the refuge will continue to utilize the Merritt Island NWR fire management program to implement the majority of prescribed fire needs including planned treatment efforts. Fire effects monitoring, routine day-to-day operations, and facilitation of plan objectives and strategies will be conducted by additional, on-site staff identified though this CCP (Objective K.1, Chapter IV and Projects 29-33, Chapter V). Monitoring efforts will be coordinated with partners including members of the LWREWG and the Merritt Island NWR fire management program. In addition, we will continue to cooperate through formal agreements with the Florida Division of Forestry to provide for initial and extended attack of unwanted wildland fires and will continue to honor existing MOUs with partners and renegotiate as needed.

Project Delivery

Comment: For the proposed List of Projects in Table 25 on pages 222-224, assign priorities and, where applicable, note specific management units where the projects should occur.

Service Response: Comment noted. Projects are not in priority rank as they are all priorities to the refuge to accomplish the goals, objectives, and strategies set forth in this CCP. Chapter V outlines discussions of each project and, unless otherwise noted (for instance, Project 14 – Restore Lake

McLeod Unit) shall be implemented on all refuge managed units. The Proposed Project section of Chapter V was updated to include these important considerations.

Comment: The Florida Department of Transportation's (FDOT) District One staff has concluded its review of the proposed plan and notes that no significant impacts will result to the State Highway System if the plan is implemented. If the proposed plan does result in impacts to FDOT roadways, however, all necessary permits need to be obtained from the Local Operation Center prior to construction activities occurring within state road right-of-way. If any existing trees or shrubs on state right-of-way are impacted by construction activities from this project, please contact the local municipality to inquire their desire to relocate materials on FDOT right-of-way.

Service Response: Comment noted. The Service will consult with FDOT and local municipalities prior to any tree or shrub removal activity or construction activities within state road right-of-way

Other

Comment: I have spent about 5 hours on your document and can only imagine how long it took to prepare. I have been working with Florida communities since 1973 (arrived fall 1972) and have seen real progress in building our knowledge of this strange place. This is a really good job

Service Response: Comment noted.

Comment: Overall, this is a lengthy and detailed description of the history and plans for the Lake Wales Ridge NWR. It is extremely verbose and redundant, entire sections are repeated over and over and this greatly adds to the length and indigestibility of the final product. It would greatly benefit from a severe copy edit; however, my comments are geared more towards content.

Service Response: Comment noted.

Comment: Overall: very thorough, well documented. Land management recommendations are nuanced and appropriate.

Service Response: Comment noted.

Alternatives

Comment: The Service's Draft CCP/EA for the Lake Wales Ridge NWR appears to be consistent with the state management goals for the Florida Forever Lake Wales Ridge Ecosystem, which includes federal properties. The Service, choosing among several options for management, is going with Alternative B, emphasizing rare, threatened, and endangered species, as opposed to a "current management" alternative, or an alternative aimed at creating more wildlife and habitat diversity.

Service Response: Comment noted. The Lake Wales Ridge NWR CCP Core Team made of Service and State of Florida natural resource professionals formulated three alternatives to address the priority issues, concerns, and problems identified by the Service and the public during public scoping. Alternatives are different approaches or combinations of management objectives and strategies designed to achieve the refuges purpose and vision. The team selected Alternative B as the preferred action as it targets habitat management for rare, threatened, and endangered species thus meeting the refuge's primary purpose.

Comment: The biggest feature I saw of Alternative B is the emphasis on controlled burn to reduce fuel loads and to try to recreate historical habitat, particularly for the endangered *Florida ziziphus*. The existing management plan acknowledges some burning, but Alternative B spells it out in greater detail and goes into the need to recreate habitat as opposed to just reducing fuel load.

Service Response: Comment noted. Alternative B was selected as the preferred alternative as it emphasized the continued management for and recovery of rare, threatened, and endangered species. A cornerstone component of this CCP was the emphasis to restore habitats to pre-fire exclusion conditions through the routine implementation of a prescribed fire program. In addition, we sought to provide as thorough and detailed an explanation of the many aspects of planned refuge prescribed fire management as we could, including: expected response of habitat; implementation methods including mechanical treatment efforts; inventory, monitoring and research needs of species; protection of rare, threatened, and endangered species; developing and maintaining partnerships with the Lake Wales Ridge resource management community; and the need to provide dedicated staff and funding.

Comment: Other key elements of Alternative B are maintain the fencing at Carter Creek unit of the refuge, increasing law enforcement to discourage illegal vehicle drivers, and restoring scrubby flatwoods at Cater Creek and Flamingo Villas. These are goals laid out in the Florida Forever report in the Management Prospectus of the Lake Wales Ridge Ecosystem, as "Conditions affecting intensity of management."

Service Response: Comment noted. Controlling illicit activities on the refuge is an important element of this CCP and plays a consequential role in protecting rare, threatened, and endangered species – particularly plants like Garrett's mint found in one location on the Flamingo Villas Unit and scrub lupine found on the Lake McLeod Unit. Increasing our law enforcement capacity and partnering with other agencies to provide additional law enforcement support are planned ways to discourage illicit uses including from off-road vehicle drivers.

Restoration through the implementation of a routine prescribed fire program is the principle method to restore and maintain scrubby flatwoods. The 101.3 acres (41.7 ha) of scrubby flatwoods found on the refuge are host to a wide range of rare, threatened, and endangered species including the Florida scrub-jay. Restoration and maintenance of scrubby flatwoods at Flamingo Villas are expected to increase existing populations of Florida scrub-jay, while habitat restoration is expected to provide opportunities for Florida scrub-jay on the Carter Creek Unit where they have not been identified since 2005.

We sought management congruency with a host of natural resource plans including Florida Forever. Regional conservation plans and initiatives reviewed and discussed in preparation for this plan can be found in Chapter II, page 20.

Comment: We support Alternative "B."

Service Response: Comment noted. Alternative B – management for rare, threatened, and endangered species was selected as the preferred alternative and was used to develop the goals objectives and strategies outlined in this CCP.

Typographical Errors and Updates

Comment: The following paragraph on 9 should read as follows: FWC, FDACS, and FDEP manage state lands and waters. FWC directly manages 1.4 million acres (0.57 million ha) and participates with other public land mangers on 2.9 million acres (1.2 million ha) and 220,000 acres (0.89 million

ha) of private lands for recreation and conservation purposes. FDEP manages 150 state parks covering nearly 0.6 million acres (0.24 million ha) and 57 coastal and aquatic managed areas, totaling over 5 million acres (2 million ha) of submerged lands and coastal uplands.

Service Response: Comment noted. The CCP was updated with this information.

Comment: Page 52, 3rd para., *Gopherus polyphemus* is repeated, plus two plants are included in a list of herps…suspect cut and paste errors.

Service Response. Comment noted, the second reference to *Gopherus polyphemus* was deleted. The reference to the two plants included in a list of herps was not found in the document.

Comment: Page 7, first full paragraph, should add the Florida Department of Agriculture and Consumer Services (FDACS).

Service Response: Comment noted. The CCP has been updated with this information.

Comment: The top paragraph on page 9 should read: Management of state fish and wildlife resources is administered by FWC, FDACS, and FDEP for the long-term well-being and benefit of people. FWC protects and manages more than 575 species of wildlife, more than 200 native species of freshwater fish, and more than 500 native species of saltwater fish; while balancing these species' needs with the needs of more than 18 million residents (U.S. Census Bureau 2007) and the over 85 million annual visitors (FDOT 2008) who share the land and water with Florida's wildlife.

Service Response: Comment noted. The CCP was updated to include FDACS.

Comment: Title page: Conservation misspelled title.

Service Response: The title page has been updated, correcting for the misspelling of Conservation

Appendix V. Appropriate Use Determinations

Lake Wales Ridge National Wildlife Refuge Appropriate Use Determinations

An appropriate use determination is the initial decision process a refuge manager follows when first considering whether or not to allow a proposed use on a refuge. The refuge manager must find that a use is appropriate before undertaking a compatibility review of the use. This process clarifies and expands on the compatibility determination process by describing when refuge managers should deny a proposed use without determining compatibility. If a proposed use is not appropriate, it will not be allowed and a compatibility determination will not be undertaken.

Except for the uses noted below, the refuge manager must decide if a new or existing use is an appropriate refuge use. If an existing use is not appropriate, the refuge manager will eliminate or modify the use as expeditiously as practicable. If a new use is not appropriate, the refuge manager will deny the use without determining compatibility. Uses that have been administratively determined to be appropriate are listed.

- Six wildlife-dependent recreational uses - As defined by the National Wildlife Refuge System Improvement Act of 1997, the six wildlife-dependent recreational uses (i.e., hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation) are determined to be generally appropriate for refuges. However, a particular refuge may have none, some, or all of these uses and the refuge manager must still determine if these uses are compatible.

- Take of fish and wildlife under state regulations - States have regulations concerning the take of wildlife that includes hunting, fishing, and trapping. The Service considers take of wildlife under such regulations appropriate. However, the refuge manager must determine if the activity is compatible before allowing it on a refuge.

Statutory Authorities for this policy:

National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, 16 U.S.C. 668dd-668ee. This law provides the authority for establishing policies and regulations governing refuge uses, including the authority to prohibit certain harmful activities. The Act does not authorize any particular use, but rather authorizes the Secretary of the Interior to allow uses only when they are compatible and "under such regulations as he may prescribe." This law specifically identifies certain public uses that, when compatible, are legitimate and appropriate uses within the Refuge System. The law states ". . . it is the policy of the United States that . . .compatible wildlife-dependent recreation is a legitimate and appropriate general public use of the System . . .compatible wildlife-dependent recreational uses are the priority general public uses of the System and shall receive priority consideration in refuge planning and management; and . . . when the Secretary determines that a proposed wildlife-dependent recreational use is a compatible use within a refuge, that activity should be facilitated . . . the Secretary shall . . . ensure that priority general public uses of the System receive enhanced consideration over other general public uses in planning and management within the System . . . ." The law also states "in administering the System, the Secretary is authorized to take the following actions: . . . issue regulations to carry out this Act." This policy implements the standards set in the Act by providing enhanced consideration of priority general public uses and ensuring other public uses do not interfere with our ability to provide quality, wildlife-dependent recreational uses.

Refuge Recreation Act of 1962, 16 U.S.C. 460k. The Act authorizes the Secretary of the Interior to administer refuges, hatcheries, and other conservation areas for recreational use, when such uses do not interfere with the area's primary purposes. It authorizes construction and maintenance of recreational facilities and the acquisition of land for incidental fish and wildlife oriented recreational development or protection of natural resources. It also authorizes the charging of fees for public uses.

Other Statutes that Establish Refuges, including the Alaska National Interest Lands Conservation Act of 1980 (ANILCA) (16 U.S.C. 410hh - 410hh-5, 460 mm - 460mm-4, 539-539e, and 3101 - 3233; 43 U.S.C. 1631 et seq.).

Executive Orders. The Service must comply with Executive Order 11644 when allowing use of off-highway vehicles on refuges. This order requires the Service to designate areas as open or closed to off-highway vehicles in order to protect refuge resources, promote safety, and minimize conflict among the various refuge users; monitor the effects of these uses once they are allowed; and amend or rescind any area designation as necessary based on the information gathered. Furthermore, Executive Order 11989 requires the Service to close areas to off-highway vehicles when it is determined that the use causes or will cause considerable adverse effects on the soil, vegetation, wildlife, habitat, or cultural or historic resources. Statutes, such as ANILCA, take precedence over executive orders.

Definitions:

Appropriate Use
A proposed or existing use on a refuge that meets at least one of the listed four conditions.

1) The use is a wildlife-dependent recreational use as identified in the Improvement Act.
2) The use contributes to fulfilling the refuge purpose(s), the Refuge System mission, or goals or objectives described in a refuge management plan approved after October 9, 1997, the date the Improvement Act was signed into law.
3) The use involves the take of fish and wildlife under state regulations.
4) The use has been found to be appropriate as specified in section 1.11.

*Native American***.** American Indians in the conterminous United States and Alaska Natives (including Aleuts, Eskimos, and Indians) who are members of federally recognized tribes.

Priority General Public Use. A compatible wildlife-dependent recreational use of a refuge involving hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation.

Quality. The criteria used to determine a quality recreational experience include those listed.

- Promotes safety of participants, other visitors, and facilities.
- Promotes compliance with applicable laws and regulations and responsible behavior.
- Minimizes or eliminates conflicts with fish and wildlife population or habitat goals or objectives in a plan approved after 1997.
- Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation.
- Minimizes conflicts with neighboring landowners.
- Promotes accessibility and availability to a broad spectrum of the American people.
- Promotes resource stewardship and conservation.
- Promotes public understanding and increases public appreciation of America's natural resources and the Service's role in managing and protecting these resources.

- Provides reliable/reasonable opportunities to experience wildlife.
- Uses facilities that are accessible and blend into the natural setting.
- Uses visitor satisfaction to help define and evaluate programs.

Wildlife-Dependent Recreational Use. As defined by the Improvement Act, a use of a refuge involving hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Lake Wales Ridge National Wildlife Refuge

Use: Research

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	X	
(b) Does the use comply with applicable laws and regulations (Federal, State, Tribal, and local)?	X	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	X	
(d) Is the use consistent with public safety?	X	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	X	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	X	
(g) Is the use manageable within available budget and staff?	X	
(h) Will this be manageable in the future within existing resources?	X	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	X	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	X	

Where we do not have jurisdiction over the use ["no" to (a)], there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ["no" to (b), (c), or (d)] may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. **Yes** X **No** ___

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ___ **Appropriate** X

Refuge Manager: _____ Date: 9/1/2010

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.
If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.
If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor: _____ Date: 9/13/2010

A compatibility determination is required before the use may be allowed.

Appendix VI. Compatibility Determinations

LAKE WALES RIDGE NATIONAL WILDLIFE REFUGE
COMPATIBILITY DETERMINATIONS

Introduction: The U.S. Fish and Wildlife Service has reviewed several uses for compatibility during the process of developing the Comprehensive Conservation Plan (CCP) for Lake Wales Ridge National Wildlife Refuge (NWR). The descriptions and anticipated impacts of the uses are addressed separately; however, the "Uses" through "Public Review and Comment" sections, the "Literature Cited" section, and the "Approval of Compatibility Determination" section apply to each use. If one of these uses is considered outside of the CCP for Lake Wales Ridge NWR, then those sections become part of that compatibility determination.

Uses: Several uses were evaluated to determine their compatibility with the mission of the National Wildlife Refuge System and the purposes of the refuge: wildlife observation and photography, environmental education and interpretation, and research.

Refuge Name: Lake Wales Ridge National Wildlife Refuge

Date Established: Lake Wales Ridge National Wildlife Refuge was established on April 22, 1994.

Establishing and Acquisition Authorities:
Endangered Species Act of 1973 (16 U.S.C. 1534, Endangered Species Act)
National Wildlife Refuge System Administration Act of 1966 [16 U.S.C. 668dd (a)(2), National Wildlife Refuge System Administration Act]

Refuge Purposes: The primary purpose of the Lake Wales Ridge NWR is to "…to conserve (A) fish or wildlife which are listed as endangered species… or (B) plants…" (Endangered Species Act,1973). The primary purpose applies to the entire refuge. A secondary purpose has also been applied to the refuge: "…conservation, management, and restoration of the fish, wildlife, and plant resources and their habitats for the benefit of present and future generations of Americans" (National Wildlife Refuge System Improvement Act of 1997).

National Wildlife Refuge System Mission: The mission of the Refuge System, as defined by the National Wildlife Refuge System Improvement Act of 1997, is:

> *... to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.*

Other Applicable Laws, Regulations, and Policies:
Antiquities Act of 1906 (34 Stat. 225)
Migratory Bird Treaty Act of 1918 (15 U.S.C. 703-711; 40 Stat. 755)
Migratory Bird Conservation Act of 1929 (16 U.S.C. 715r; 45 Stat. 1222)
Migratory Bird Hunting Stamp Act of 1934 (16 U.S.C. 718-178h; 48 Stat. 451)
Criminal Code Provisions of 1940 (18 U.S.C. 41)
Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d; 54 Stat. 250)
Refuge Trespass Act of June 25, 1948 (18 U.S.C. 41; 62 Stat. 686)
Fish and Wildlife Act of 1956 (16 U.S.C. 742a-742j; 70 Stat.1119)

Refuge Recreation Act of 1962 (16 U.S.C. 460k-460k-4; 76 Stat. 653)
Wilderness Act (16 U.S.C. 1131; 78 Stat. 890)
Land and Water Conservation Fund Act of 1965
National Historic Preservation Act of 1966, as amended (16 U.S.C. 470, et seq.; 80 Stat. 915)
National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668dd, 668ee; 80 Stat. 927)
National Environmental Policy Act of 1969, NEPA (42 U.S.C. 4321, et seq; 83 Stat. 852)
Use of Off-Road Vehicles on Public Lands (Executive Order 11644, as amended by Executive Order 10989)
Endangered Species Act of 1973 (16 U.S.C. 1531 et seq; 87 Stat. 884)
Refuge Revenue Sharing Act of 1935, as amended in 1978 (16 U.S.C. 715s; 92 Stat. 1319)
National Wildlife Refuge Regulations for the Most Recent Fiscal Year (50 CFR Subchapter C; 43 CFR 3101.3-3)
Emergency Wetlands Resources Act of 1986 (S.B. 740)
North American Wetlands Conservation Act of 1990
Food Security Act (Farm Bill) of 1990 as amended (HR 2100)
The Property Clause of the U.S. Constitution Article IV 3, Clause 2
The Commerce Clause of the U.S. Constitution Article 1, Section 8
The National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57, USC668dd)
Executive Order 12996, Management and General Public Use of the National Wildlife Refuge System. March 25, 1996
Title 50, Code of Federal Regulations, Parts 25-33
Archaeological Resources Protection Act of 1979
Native American Graves Protection and Repatriation Act of 1990

Public Review and Comment:
Public scoping for the CCP commenced on June 20, 2008, and included a notice in the *Federal Register* (73 FR 35149). The *Federal Register* notice was followed by the release of additional information about the planning process and the public scoping period via an August 2008 informational flyer; a September 2008 news release and subsequent articles in local newspapers including the *Lakeland Ledger* (September 19, 2008), the *Heartland SunTimes* (September 17-23, 2008), and *Highlands Today* (September 25, 2008); and postings on the Fish and Wildlife Service's Internet website (http://www.fws.gov/lakewalesridge/).

A comprehensive mailing list of interested parties was developed and updated on a regular basis. Utilizing this list, over 200 flyers were initially mailed in August, 2008 inviting participation in the planning process through a variety of means including attending a September 25, 2008 public scoping meeting; sending letters to Merritt Island NWR Complex, PO Box 2683 Titusville, FL 32781; faxes to 321-861-1276; telephone calls to 321-861-0667; e-mail messages to LakeWalesRidgeCCP@fws.gov; and personal visits to the Merritt Island NWR Complex Visitor's Center. The flyer also announced the time and location of the public meeting, provided refuge facts and described the purposes of the refuge.

The September 25, 2008 public meeting was attended by a total of 23 people representing the general public, neighboring landowners, local conservation organizations, area conservation land managers, and educational institutions. The meeting attendees submitted comments on a wide variety of issues, concerns, and ideas for future management of the refuge.

A notice of availability of the Draft CCP/EA was published in the *Federal Register* (75 FR 22832) on April 30, 2010 requesting public review and comment. In addition, two separate mailings of over 200 postcards were sent to mailing list members in January 2010 and May 2010. In May 2010, the Draft CCP/EA was made available via the internet (http://www.fws.gov/southeast/planning/CCP/LakeWalesRidgeDraftSinglePageDocument.html), CD

and/or paper copy upon request. Public comments were accepted from April 30 to June 01, 2010, while comments from the State of Florida through the State Clearinghouse beginning May 17, 2010 were received on July 26, 2010. A total of eight organizations, and government agencies including The Nature Conservancy, Archbold Biological Station, The University of Central Florida, Florida Department of Environmental Protection, Florida Division of Forestry, Florida Department of Transportation, Florida Department of State, and the South Florida Water Management District submitted comments on the Draft CCP/EA. Under the State Clearinghouse review, received electronically on July 26, 2010, the proposed activities were found to be consistent with the Florida Coastal Zone Management Program. Appendix IV summarizes comments received during public review and comment period and the Service's responses to those comments.

Description of Use: *Research*

Research is the planned, organized, and systematic gathering of data to discover or verify facts. In principle, research conducted on the refuge by universities, co-op units, non-profit organizations, and other research entities furthers refuge management and serves the purposes, vision, and goals of the refuge. The refuge hosts research from a variety of research institutions, including various universities and private research groups. All research activities, whether conducted by governmental agencies, public research entities, universities, private research groups, or any other entity, shall be required to obtain special use permits from the refuge. Approved refuge special use permits will contain conditions under which researchers must operate to help minimize negative impacts to refuge resources. All research activities will be overseen by the refuge wildlife biologist/botanist, refuge manager, or refuge staff member as assigned by the refuge manager or designee. Projects that are fish and wildlife management-oriented, which will provide needed information to refuge operation and management, will receive priority consideration and may even be solicited.

Availability of Resources: The Lake Wales Ridge NWR is presently administered through the Pelican Island NWR Complex and has no on-site housing opportunities for researchers, students, and/or volunteers. Other than the administration of associated special use permits, no refuge resources are generally required for this use.

Anticipated Impacts of the Use: Generally, adverse impacts from research are minimal. An anticipated method of accessing research sites throughout the refuge may include all-terrain vehicles (ATVs) or similar vehicles. A critical and objective evaluation of the potential effects that ATVs could have on wildlife and habitat is based on the most current information available and best professional judgment. Although ATVs have the potential to impact refuge resources, the focus is to minimize their negative effects. This is based on the impacts at the existing and projected level of use. Improperly used ATVs can have very serious and long-term consequences due to destruction of habitat and disturbance to wildlife (Webb and Wilshire 1983, Defenders of Wildlife 2002). Occasionally, slight or temporary wildlife or habitat disturbances may occur (e.g., minor trampling of vegetation may occur when researchers access monitoring plots). However, these impacts are not considerable, nor are they permanent. Also, a small number of individual plants or animals might be collected for further scientific study, but these collections are anticipated to have minimal impact on the populations from which they came. All collections will adhere to the Service's specimen collection policy (Director's Order 109, dated March 28, 2005).

Determination (check one below):

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: All research conducted on the refuge must further the purposes of the refuge and the mission of the National Wildlife Refuge System. All research will adhere to established refuge policy on research and policy on collecting specimens (Directors Order Number 109). To ensure that research activities are compatible, the refuge requires that a special use permit be obtained before any research activity may occur. Research proposals and/or research special use permit applications must be submitted in advance of the activity to allow for review by refuge staff to ensure minimal impacts to the resources, staff, and programs of the refuge. Each special use permit may contain conditions under which the research will be conducted. Each special use permit holder will submit annual reports or updates to the refuge on research activities, progress, funding, and other information. Further, each special use permit holder will provide copies of findings, final reports, publications, and/or other documentation at the end of each project. The refuge will deny permits for research proposals that are determined to not serve the purposes of the refuge and mission of the National Wildlife Refuge System. The refuge will also deny permits for research proposals that are determined to negatively impact resources or that materially interfere with or detract from the purposes of the refuge. All research activities are subject to the conditions of their permits.

Justification: Research activities provide benefits to the refuge and to the natural resources supported by the refuge. Research conducted on the refuge can lead to new discoveries, new facts, verified information, and increased knowledge and understanding of resource management, as well as track current trends in fish and wildlife habitat and populations to enable better management decisions. Research has the potential to further the purposes and goals of the refuge and the mission of the National Wildlife Refuge System.

NEPA Compliance for Refuge Use Description:

_____ Categorical Exclusion without Environmental Action Statement
_____ Categorical Exclusion and Environmental Action Statement
__X__ Environmental Assessment and Finding of No Significant Impact
_____ Environmental Impact Statement and Record of Decision

Mandatory 10-year Re-evaluation Date: 09/23/2020

Description of Use: *Environmental Education and Interpretation*

Environmental education and interpretation consist primarily of youth and adult education and interpretation of the natural resources of the refuge. Activities include on-site refuge-led or refuge approved environmental education programs; teacher workshops; and interpretation of wildlife, habitat, other natural features, and/or management activities occurring in the refuge. These activities seek to increase the public's knowledge and understanding of wildlife and their habitats and to contribute to wildlife conservation and support of the refuge. Environmental education and interpretation were identified in the National Wildlife Refuge System Improvement Act of 1997 as priority public activities, provided they are appropriate and compatible with the purposes for which the refuge was established.

The Lake Wales Ridge NWR is presently closed to public access and will remain closed over the 15-year life of the CCP; however, the CCP identifies an expansion of the refuge's role in providing public awareness for the increasingly threatened Lake Wales and Winter Haven ridge scrub habitats. The refuge will provide limited and controlled opportunities and participate in environmental education

programs through Lake Wales Ridge Ecosystem Working Group (LWREWG), including participation in Discovering Florida Scrub - an existing curriculum-based environmental education program developed by Archbold Biological Station, the State of Florida, and local partners. The refuge will participate in environmental education opportunities that provide a diverse range of refuge approved, onsite, staff-led or staff approved-led education programs that explore various habitats on the refuge (e.g., scrub, wetlands, flatwoods, and sandhill), leading to a better understanding of the value of these habitats to rare, threatened, and endangered species; the human influence on the ecosystem; and the importance of these resources to society. The proposed updates in the refuge's interpretation program strive to increase public awareness and understanding of the refuge's natural features, habitat diversity, wildlife, human history, and refuge management activities through the participation in the LWREWG. The CCP calls for minor changes such as: adding new signs, maintaining and expanding partnerships through the LWREWG to enable a consistent partnership message, providing for an annual refuge awareness day, providing a refuge brochure, updating the refuge webpage with new information, and providing partner links to broaden the appreciation of the ridge ecosystem.

Environmental education and interpretation programs may be conducted by the Service or by a Service approved member. Any non-Service environmental education and interpretation activities must be reviewed and approved by the Service through a special use permit issued by the refuge. These permits will contain conditions to minimize impacts and ensure compatibility.

Availability of Resources: The refuge has no dedicated budget or staff. Annual refuge operation and maintenance funds provided for the Pelican Island NWR Complex will be used to support wildlife the Lake Wales Ridge NWR visitor services program including environmental education and interpretation opportunities during planned programs and events, or as requested through a special use permit on a case-by-case basis. In this way, minimal operating funds will be necessary to provide for planned environmental education and interpretation opportunities. The refuge presently has no infrastructure to support environmental education interpretation opportunities, however, temporary dedicated areas may be provided during planned events, which may require minimal site preparation/maintenance by refuge staff and/or refuge approved partners or volunteers.

Funding is not currently available to fully support the planned environmental education and interpretation opportunities identified in the CCP. To support the program, the refuge, in cooperation with other partners, will pursue additional funding opportunities as they become available. The CCP outlines proposed staffing and projects to support visitor services during the 15-year life of the plan. Interns, volunteers, partners, and members of the Merritt Island Wildlife Association (MIWA) also provide staffing to support these uses.

Anticipated Impacts of the Use: The CCP seeks to expand environmental education and interpretation opportunities, primarily through the facilitation of existing curriculum-based programs; through interpretive opportunities led by Service or Service approved members; and through other Service-led/Service approved activities, including an annual refuge awareness day. Even the most well intentioned visitor guided by Service or Service approved members utilizing existing refuge maintained fire lines and refuge access trails may trample vegetation and, according to Riffell, et al. (1996), may displace birds and can cause localized declines in the richness and abundance of wildlife species. The refuge has maintained a closed status due in large part to the threat of trampling rare, threatened, and endangered plants, some of which are protected nowhere else but on refuge lands. To reduce the threat of trampling plants as a result of planned environmental education and interpretation opportunities, refuge environmental educational and interpretive opportunities will be designed to allow only Service-led or Service approved programs with access on a case-by-case basis through a refuge special use permit. Disturbance promulgated by refuge specific, limited programs, managed through and with direct oversight by refuge or refuge-approved members will be considered short-term and

discrete disturbances due to the low anticipated frequency of use; the utility of existing infrastructure, such as fire lines and unimproved access roads; and the ability to move sites to new areas if the habitat shows signs of impact. It is anticipated that by utilizing existing resources and guiding all aspects of use, vegetation trampling, alteration of structure and species composition, and temporal wildlife impacts to species will be minimal. The minimal impact associated with conducting limited environmental educational and interpretation programs is acceptable.

Determination (check one below):

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: While the anticipated impacts are expected to be minimal, stipulations are required to ensure that wildlife resources are adequately protected. The refuge shall remain closed over the 15-year life of the CCP, apart from refuge approved environmental education and interpretation programs and events provided by refuge-led or refuge approved entities. Limiting programs and activities to refuge-led or refuge approved entities provides the highest level of management control over programs and activities, while minimizing natural resource disturbance. This enables the refuge to protect resources, while simultaneously building understanding and appreciation for the refuge and the naturally managed areas of the Lake Wales and Winter Haven Ridges. As use through the structured refuge approved activities increases, minimal wildlife disturbances are unavoidable. Through interpretive materials, including, but not limited to refuge brochures, proper wildlife etiquette will be emphasized. In addition, wildlife etiquette will be built in to environmental education curriculum that further minimizes disturbance threats. Education is critical for making visitors aware that their actions can have negative impacts on plants and wildlife. The environmental education program and interpretation activities will avoid sensitive sites and vulnerable wildlife and plant populations. Environmental education and interpretive programs and activities will be held and conducted at or near disturbed areas, including, but not limited to fire lines and unimproved access roads where impacts can be minimized. Annual evaluations will be conducted to assess if objectives are being met and that the natural resources are not being adversely impacted. Other than Service programs, any other environmental education or interpretation activity or program conducted on Service properties will be required to obtain a special use permit. These permits will contain conditions to help ensure that impacts are minimized to ensure compatibility. Evaluations of special use permitted programs and activities will be conducted annually to assess if objectives are being met, as well as to ensure that natural resources are not being adversely impacted.

Justification: Environmental education and interpretation represent two priority wildlife dependent recreational activities under the National Wildlife Refuge System Improvement Act. Environmental education and interpretation are key components of the Service's initiative to connect children with nature and are used to encourage all citizens to act responsibly in protecting natural resources. In addition, they are tools the refuge can use to build understanding, appreciation, and support for the refuge, ridge system, and the National Wildlife Refuge System. As long as stipulations to ensure compatibility are followed, the programs should remain compatible with the purposes of the refuge. At such time that unacceptable species impacts are detected the refuge will modify or eliminate the activity to minimize or eliminate the impacts. Both programs allow the education of the public on the missions of the Service, the Refuge System, and the purposes of the refuge. They highlight the areas that are most closely aligned with the refuge's management philosophy proposed under the CCP. Considering the minimal anticipated impacts through the implementation of the environmental education and interpretation programs and the benefits that should arise through public education, participation, and involvement, the program is deemed compatible.

NEPA Compliance for Refuge Use Description:

_____ Categorical Exclusion without Environmental Action Statement
_____ Categorical Exclusion and Environmental Action Statement
__X__ Environmental Assessment and Finding of No Significant Impact
_____ Environmental Impact Statement and Record of Decision

Mandatory 15-year Re-evaluation Date: 09/23/2025

Description of Use: *Wildlife Observation and Photography*

Wildlife observation and photography are considered simultaneously in this compatibility determination. Wildlife observation and photography have been identified in the National Wildlife Refuge System Improvement Act of 1997 as priority wildlife-dependent recreational uses provided they are compatible with the purposes of the refuge. This compatibility determination applies only to personal photography and not to other forms of photography (e.g., commercial photography and filming). The refuge shall remain closed over the 15-year life of the CCP, apart from refuge approved environmental education and interpretation programs and events. Opportunities for wildlife observation and photography will be provided during Service approved events led by refuge staff or refuge approved entities through the special use permit process. Wildlife observation and photography activities will be an incidental part of environmental education and interpretation programs.

Availability of Resources: The refuge has no dedicated budget or staff. Annual refuge operation funds provided for the Pelican Island NWR Complex will be used to support wildlife observation and photography opportunities during environmental education and interpretation programs and events or as requested through a special use permit on a case-by-case basis. In this way, minimal operating funds will be necessary to provide for planned wildlife observation and photography opportunities. The refuge presently has no infrastructure to support wildlife observation and photography opportunities, however, temporary dedicated viewing areas may be provided during planned events, which may require minimal site preparation/maintenance by refuge staff and/or refuge approved partners or volunteers.

Funding is not currently available to fully support the planned wildlife observation and photography opportunities identified in the CCP. To support the program, the refuge, in cooperation with other partners, will pursue additional funding opportunities as they become available. The CCP outlines proposed staffing and projects to support Visitor Services during the 15-year life of the plan. Interns, volunteers, partners, and members of the Merritt Island Wildlife Association (MIWA) also provide staffing to support these uses.

Anticipated Impacts of the Use: The purpose of this section is to critically and objectively evaluate the potential effect that wildlife observation and photography could have on wildlife and habitat based on available information and best professional judgment. Each activity has the potential to have impacts, but the focus is to minimize impacts to levels within acceptable limits. This is based on the impacts at the existing and projected level of use.

The refuge will remain closed over the 15-year life of the CCP, apart from refuge-led or refuge approved events and opportunities. Given this level of refuge oversight and control, resource impacts associated with planned wildlife observation and photography opportunities are anticipated to be minimal. However, even the most controlled wildlife observation and photography programs designed in-part to limit wildlife disturbance have the potential for disturbing wildlife species. In general, activities that occur outside of vehicles tend to increase the disturbance potential for most wildlife species (Klein 1993; Gabrielson and Smith 1995; Burger 1981; Pease et al. 2005) as compared to similar activities conducted within vehicles. The majority of wildlife observation and photography opportunities in the CCP will be conducted out-of-vehicle due to the lack of improved roads and anticipated damage vehicles may cause traversing the sandy, undulating terrain. As a consequence, refuge-led or refuge approved and led visitors will typically access refuge habitats on-foot via fire lines and/or unimproved roads. Although this type of access could potentially disturb wildlife, it is expected to be minimal as a result of the limited and controlled character of such events and opportunities. Among wetland habitats, out-of-vehicle approaches can reduce wildlife foraging times and can cause water birds to avoid foraging habitats adjacent to the out-of-vehicle disturbance (Klein 1993). One possible reason for this result is that vehicle activity is usually brief, while walking requires a longer period of time to cover the same distance. Similarly, walking on wildlife observation trails tends to displace birds and can cause localized declines in the richness and abundance of wildlife species (Riffell et al. 1996). Wildlife photographers tend to have the largest disturbance impacts (Klein 1993; Morton 1995; Dobb 1998). While wildlife observers frequently stop their vehicles to view wildlife, wildlife photographers are much more likely to leave their vehicles and approach wildlife on foot (Klein 1993). Even a slow approach by wildlife photographers tends to have behavioral consequences to wildlife (Klein 1993). Other impacts include the potential for photographers to remain close to wildlife for extended periods of time (Dobb 1998) and the tendency of casual photographers with low power lenses to get much closer to their subject than other activities would require (Morton 1995).

Determination (check one below):

_____ Use is Not Compatible

__X__ Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility: By design, wildlife observation and photography should have minimal species and habitat impacts. Nonetheless, as use increase, species impacts are more likely to occur. Evaluation of the sites and programs will be conducted annually to determine if objectives are being met, if habitat impacts are minimized, and if wildlife populations are not being adversely affected. If evidence of unacceptable impacts begins to appear, it may be necessary to change the activity or the program, relocate the activity or program, or eliminate the program.

Stipulations that may be employed include those listed.

- Providing limited, refuge approved, refuge-led and/or refuge approved wildlife observation and photography opportunities during refuge events and/or through special use permit will lessen species impacts.
- Providing access on fire-lines and/or unimproved roads will lessen species impacts.
- Vegetation that effectively conceals visitors and provides cover for birds can help minimize impacts of people in busy areas.
- Establishing buffer zones that minimize disturbance around sensitive areas and establishing no-entry zones during refuge approved events and opportunities will help minimize impacts.

- Rerouting, modifying, or eliminating activities which have demonstrated direct species impacts should be employed.
- Education is critical for making visitors aware that their actions can have negative impacts on plants and wildlife.

Justification: Wildlife observation and photography are priority public uses of the National Wildlife Refuge System. Providing quality, appropriate, and compatible opportunities for these activities help fulfill the provisions of the National Wildlife Refuge System Improvement Act. Wildlife observation and photography will provide excellent forums for promoting increased awareness, understanding, and support of refuge resources relative to wildlife/human interactions. The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. Under a controlled level of limited visitation, these wildlife-dependent uses will not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the refuge.

NEPA Compliance for Refuge Use Description:

_____ Categorical Exclusion without Environmental Action Statement
_____ Categorical Exclusion and Environmental Action Statement
__X__ Environmental Assessment and Finding of No Significant Impact
_____ Environmental Impact Statement and Record of Decision

Mandatory 15-year Re-evaluation Date: 09/23/2025

Literature Cited:

Burger, J. 1981. The effects of human activity on birds at a coastal bay. *Biological Conservation* 21:231-241.

Defenders of Wildlife. 2002. Out of Control: The Impacts of Off-Road Vehicles and Roads on Wildlife and Habitat in Florida's National Forests. August 2002.

Dobb, E. 1998. Reality Check: The Debate behind the Lens. Audubon: Jan-Feb.

Gabrielson, G.W. and E.N. Smith. 1995. Physiological responses of wildlife to disturbance. Pages 95-107 in R.L. Knight and K.J. Gutzwiller, eds., *Wildlife and Recreation: Coexistence through Management and Research*. Island Press, Washington, D.C. 372 pp.

Klein, M.L. 1993. Waterbird Behavior Responses to Human Disturbances. Wildlife Society Bulletin 21: pp. 31-39.

Morton J.M. 1995. Management of Human Disturbance and its Effect on Waterfowl. Pages F59-F86 *in* W.R. Whitman, T. Strange, L. Widjeskog, R. Whittemore, P. Kehoe, and L. Roberts (eds). Waterfowl Habitat Restoration, Enhancement and Management in the Atlantic Flyway. Third Ed. Environmental Management Committee, Atlantic Flyway Council Technical Section, and Delaware Division of Fish and Wildlife. Dover, DE. 1114 pp.

Pease, M.L., R.K. Rose and M.J. Butler. 2005. Effects of human disturbances on the behavior of wintering ducks. *Wildlife Society Bulletin* 33(1): 103-112.

Riffell, S.K., J. Gutzwiller, and S.H. Anderson. 1996. Does repeated human intrusion cause cumulative declines in avian richness and abundance? Ecological Applications 6(2): 492-505.

Webb, R.H. and H.G. Wilshire. 1983. Environmental effects of off-road vehicles: impacts and management in arid regions. Springer-Verlag, New York.

Approval of Compatibility Determinations

The signature of approval is for all compatibility determinations considered within the Comprehensive Conservation Plan for Lake Wales Ridge NWR. If one of the descriptive uses is considered for compatibility outside of the comprehensive conservation plan, the approval signature becomes part of that determination.

Refuge Manager:
Lake Wales Ridge NWR: _____ 9/1/2010
(Signature/Date)

Project Leader,
Merritt Island NWR Complex: Layne T. Hunt 9/1/2010
(Signature/Date)

Regional Compatibility
Coordinator: Pamela Hart 9/15/10
(Signature/Date)

for Refuge Supervisor: Holly T. Dabouchault 9/21/10
(Signature/Date)

Regional Chief, National
Wildlife Refuge System,
Southeast Region: Mike T. Pruitt Sept 28, 2010
(Signature/Date)

Appendix VII. Intra-Service Section 7 Biological Evaluation

SOUTHEAST REGION
INTRA-SERVICE SECTION 7 BIOLOGICAL EVALUATION FORM

Originating Person: Charles Pelizza, Refuge Manager, Pelican Island National Wildlife, Archie Carr National Wildlife Refuge, and Lake Wales Ridge National Wildlife Refuge

Telephone Number: 772-562-3909 X 244 **E-Mail:** charlie_pelizza@fws.gov

Date: January 28, 2010

PROJECT NAME: Lake Wales Ridge National Wildlife Refuge Comprehensive Conservation Plan

I. Service Program:
___ Ecological Services
___ Federal Aid
___ Clean Vessel Act
___ Coastal Wetlands
___ Endangered Species Section 6
___ Partners for Fish and Wildlife
___ Sport Fish Restoration
___ Wildlife Restoration
___ Fisheries
_X_ Refuges/Wildlife

II. State/Agency:
n/a

III. Station Name:
Lake Wales Ridge National Wildlife Refuge, FL

IV. Description of Proposed Action:
The proposed action consists of approving and then implementing a Comprehensive Conservation Plan (CCP) for Lake Wales Ridge National Wildlife Refuge in Highlands and Polk Counties, Florida, as required under the National Wildlife Refuge System Improvement Act of 1997. The CCP provides overall management guidance on the refuge over a 15 year period in the form of a vision, goals, objectives and strategies related to fish and wildlife management, habitat management, resource protection, visitor use, and refuge administration.

The purpose of a CCP is to describe the desired future conditions of a refuge and provide long-range guidance and management direction to accomplish the purposes of the refuge, to contribute to the mission of the Refuge System, and to meet other relevant mandates. The CCP details the proposed action to improve refuge management in the following area: wildlife and habitat management, resource protection, visitor services, and refuge administration. The proposed action (Alternative B) focuses refuge management actions on the needs of rare, threatened, and endangered species.

Wildlife and Habitat Management
The primary focus over the 15-year life of the CCP will be recovering the landscape from the historical suppression of fire over the previous 50 years. It is anticipated that by the end of the 15-year life of this CCP, the vegetation will have recovered to pre-fire exclusion conditions. After recovery, management activities should be directed towards maintaining the landscape. This rehabilitation phase will include the application of more frequent fire in the initial stages, with associated monitoring. As fuel loads are reduced and as habitat qualities increase, the refuge will adapt management and fire return intervals in accordance with information from research and experts, the results of species and habitat response monitoring, and best professional judgment.

The refuge will expand management activities to better protect federally and state listed species, migratory and native birds, and native wildlife and habitat diversity; expand management activities to better control exotic, invasive, and nuisance species; and develop management activities to address the impacts of climate change on refuge resources. Again, the CCP's focus is to restore habitats to pre-fire exclusion conditions to benefit rare, threatened, and endangered species, which may take the entire 15-year life of the CCP for some habitats. Once pre-fire exclusion conditions are attained, fire return intervals shall be adapted based on habitat and species response. Expanded surveys will help the refuge better understand the diverse wildlife using the refuge. Management activities will be adapted as necessary and the refuge shall identify any rare or listed species in need of additional protection and management. Communication with partners under the plan increases, including the Service's South Florida and North Florida Ecological Services Field Offices for opportunities in species recovery funding and to share information and adapt management where necessary based on new inputs from science and recovery management.

Rare, Threatened, and Endangered Plants. The refuge will expand management activities and continue to work through partnerships to contribute to the recovery efforts of rare, threatened, and endangered plants, both on the refuge and throughout the Lake Wales and Winter Haven ridges, emphasizing recovery management for Florida ziziphus; Garrett's mint; scrub lupine; and a host of rare, threatened, and endangered plants found on the refuge. The refuge will continue to rely on existing partnerships to provide species' statuses and trends and the statuses of recovery performance from refuge units. Through partnerships, the refuge plans to inventory and monitor listed plants and provide for systematic updates of in-house and shared data sets. The refuge will coordinate fire management, mechanical treatments, and monitoring efforts with the partners to ensure that management direction provides for the preservation of Florida ziziphus, Garrett's mint, and scrub lupine, in addition to other rare, threatened, and endangered species populations on the refuge. When necessary, management will adapt to provide for the recovery needs of a suite of rare, threatened, and endangered plants known to occur on the refuge. Through partnerships and in support of recovery efforts, the refuge will promote research opportunities and act as a living laboratory for inventory, monitoring, and research projects concerning rare, threatened, and endangered plants, including the impacts of climate change on changing patterns of suitable habitat for rare, threatened, and endangered species.

Florida Scrub-jay. The refuge continues to encourage Florida scrub-jay population expansion to support a sustainable metapopulation of Florida scrub-jays on the Lake Wales Ridge. The refuge will improve Florida scrub-jay habitat though the implementation of routine prescribed fire designed to restore habitat to pre-fire exclusion conditions with suitable shrub cover and height, bare patch cover, and overstory pine cover in scrubby flatwoods of the Flamingo Villas and Carter Creek units. The Service will continue partnerships with The Nature Conservancy's (TNC) Jay Watch and Archbold Biological Station (ABS) for support of scrub-jay monitoring efforts. Additional research opportunities on Florida scrub-jay populations and status will be encouraged. Through partnerships, the refuge will

investigate the distribution of suitable and potential Florida scrub-jay habitats on the refuge and evaluate the potential to translocate Florida scrub-jays to the refuge.

Skinks. Through the implementation of a routine prescribed fire program to provide pre-fire exclusion conditions, open scrub and sandhill habitats will be managed to provide resource opportunities for existing bluetail mole and sand skink populations and for the recruitment of new skink populations. Through partnerships, monitoring efforts designed to provide for a consistent survey of skink population presence and absence is planned for development. In addition, through partnerships, fire impacts on skink populations, including the impacts of fire intensity, will be monitored to adapt management techniques, where necessary. Management agreements with neighbors will be investigated to increase protection of off-refuge skink source populations.

Gopher Tortoise and Eastern Indigo Snake. Through partnerships, monitoring of gopher tortoise and eastern indigo snake populations will be encouraged. Refuge habitats suitable for gopher tortoise will be evaluated though partnerships to investigate conditions for established populations and recruitment opportunities. Where appropriate and through the use of prescribed fire, canopy cover shall be reduced to provide conditions for established populations and recruitment opportunities.

Bald Eagle and Wood Stork. The refuge will work with partners to minimize impacts and expand management activities in relation to bald eagles and wood storks. Where bald eagles are discovered, the refuge will institute protection measures to buffer nests from management actions, including prescribed fire and exotic control treatments. Surveys in suitable habitats will help determine the presence or absence of wood storks. The refuge will increase research opportunities with partners to understand the refuge's role in managing population, status, and trends.

Other Birds. The refuge will work with partners to increase management activities for migratory and non migratory birds, including shorebirds, wading and water birds, raptors, waterfowl, and non migratory birds by maintaining closed areas and restoring wetland habitat values and functions through the use of prescribed fire, exotic control, and wetland restoration.

Climate Change. The refuge will institute management activities to address the impacts of climate change on refuge resources. The refuge will coordinate with researchers and partners to identify climate change research needs for the refuge, investigating the impacts of climate change from changing patterns of suitable habitat on rare, threatened, and endangered species. Further, through partnerships, the refuge shall provide a living laboratory for the investigation of the relationship of prescribed fire effects on carbon sequestration and greenhouse gas production.

Exotic, Invasive and Nuisance Species. Control of exotic, invasive, and nuisance species activities shall be expanded under an Integrated Pest Management Plan (IPMP), focused on treatments to control those exotic, invasive, and nuisance species impacting high priority habitats serving rare, threatened, and endangered species. Volunteers and partners will continue to conduct opportunistic exotic plant control activities. The refuge plans to regularly identify new infestations of Florida Exotic Pest Plant Council (FLEPPC) Category I and II invasive plants and with the assistance of trained volunteers will regularly update an exotic plant database utilizing GIS technologies (FLEPPC 2009). In addition, the refuge will pursue Service and State of Florida contract funding and in-kind treatment support through the Service's Region 4 Invasive Species Strike Team and FDEP's Bureau of Invasive Plant Management. Feral hog control efforts will increase and the refuge will work directly with partners and neighbors to manage and control source populations of feral hogs.

Habitat Management. Habitat management activities will be expanded for sandhill, yellow sand scrub, scrubby flatwoods, rosemary scrub, cutthroat seeps, depression marshes and associated wetlands, and bayhead habitats. Throughout the life of the CCP, habitat restoration will be a key focus of management actions in an effort to establish pre-fire exclusion conditions. The refuge will provide a routine prescribed fire program and implement prescribed fire at frequencies to restore habitat, typically at short (2- to 5-year) return intervals. Once pre-fire exclusion conditions have been met, the refuge will provide for fire return intervals and rotations depending on response of species and habitat conditions. Prescribed fire activities shall be coordinated with the partners, including pre and post fire monitoring designed to identify the response of rare, threatened, and endangered species. The refuge will protect research sites when managing by mechanical means where appropriate. Existing fire plow lines will continue to be used and maintained to define geographically identified fire units. New fire line or unit development will be coordinated with the partners and will provide for the management needs of rare, threatened, and endangered species and the habitats they occupy. Applying adaptive management strategies will provide additional opportunities to utilize mechanical treatments that are best suited for recovery and restoration efforts.

Fire Management. As mentioned, over the 15-year life of the CCP, management efforts will be implemented to first restore habitat conditions to pre-fire exclusion conditions through the implementation of prescribed fire targeting fire management units containing pyrogenic habitat types, including but not limited to sandhill, yellow sand scrub and scrubby flatwoods, on two to five year rotations. The refuge will lengthen fire rotations to achieve a mosaic and heterogeneity of habitat structure and function once pre-fire exclusion conditions are met. During the restoration period, thought to extend through the life of the CCP, fire management will adapt based on habitat and species response utilizing the results of fire effects monitoring. Working with the partners, the refuge will identify fire effects, optimal fire frequencies and intensities, and interval conditions, and through adaptive management, adapt fire treatments as necessary to provide for the pyrogenic needs of the rare, threatened, and endangered species of the refuge.

Corridor Development. The refuge will work with the partners, including Florida Department of Transportation, to encourage wildlife corridor development between Flamingo Villas and Carter Creek units, including encouraging the construction of wildlife underpasses for State Highway 98 and Kennilworth Blvd and increasing public awareness and understanding of the need for connected habitats through outreach. Working with partners, the refuge will continue to support the network of protected lands serving as wildlife corridors for Florida panther, Florida black bear, and other wide ranging species.

Resource Protection

Land Acquisition, Land Swaps, and Management Consolidation. The Service will continue to pursue completion of the acquisition boundary from willing sellers. Prioritized active acquisition efforts will focus on the unprotected, undeveloped inholdings of the Flamingo Villas, Lake McLeod, and Snell Creek Units, and the area south of the Carter Creek Management Unit. The refuge will evaluate a variety of land protection and conservation measures (including land swaps) to protect high quality properties. The refuge will work with partners to identify and protect sites that serve rare, threatened, and endangered species. It will consider coordinating land management and consolidate those areas publicly held by multiple partners under management of one entity (e.g., through management agreements and land swaps). The refuge will investigate the ability to enter into management agreements and other options with the partners to enable partner management of Service properties in accord with the CCP, subsequent step-down plans, and Service policies and as approved by refuge managers. Management to protect important habitat and wildlife corridors will increase. The refuge will work with partners and private landowners to identify and map potential wildlife movement

corridors for rare, threatened and endangered species to connect refuge lands to other conservation areas and develop conservation easements on strategically located privately owned lands serving a corridor function.

Cultural Resources. The refuge will continue to respond to any cultural resources issues as they arise. The refuge will actively work with the partners to survey all of the refuge's management units for the presence of archeological and historical resources. Management will be adapted to protect any discovered cultural resources.

Law Enforcement. Under this CCP, a Pelican Island NWR Complex law enforcement officer will be shared with Pelican Island, Archie Carr, and Lake Wales Ridge NWRs, to conduct routine patrols. Patrols shall be scheduled to enforce refuge regulations on Service lands, particularly emphasizing illicit use, including trespass by off-road vehicles.

Visitor Services

Welcome and Orientation, Signage and Access. The refuge will remain closed to visitor use, except for limited and controlled guided tours by Service staff or Service approved volunteers and partners on a case-by-case basis to provide opportunities for environmental education and interpretation and wildlife observation and photography. The refuge will increase protection for refuge managed lands through the implementation of additional boundary signage and identify refuge managed lands through the use of information signs providing refuge contact information.

Outreach. The refuge plans to develop and conduct an annual refuge day where guided tours, information, and refuge awareness through community outreach is provided. The refuge plans to provide updated messages focusing on rare, threatened, and endangered species; the role of the refuge in the landscape; and minimization of human impacts. Further, the refuge will work with the partners to incorporate applicable messages into their visitor activities and signage. Information about the refuge will be improved. The refuge will work with the partners to actively maintain and update associated websites, including providing cross links between refuge and partner sites. The refuge will coordinate with the partners to distribute an overall map of all the visitor facilities available in the area and the Service will continue to update the Service brochure for the refuge.

Environmental Education and Interpretation. Working with the partners including the Lake Wales Ridge Ecosystem Working Group (LWREWG), the refuge will increase environmental education and interpretation opportunities, focusing key messages on rare, threatened, and endangered species. The refuge will continue working with the LWREWG to promote educational opportunities designed to relay the importance and uniqueness of the refuge and its resources to local school groups, and visitors to and residents of the Lake Wales and Winter Haven Ridges. The refuge will identify and support public use opportunities within the system of natural areas that comprise the Lake Wales and Winter Haven Ridge ecosystems through interpretive elements such as the refuge's webpage and brochures.

Volunteers and Partnerships. The refuge will continue to coordinate volunteer activities utilizing the Ridge Rangers and it will increase the number of active refuge volunteers and focus their efforts on projects to benefit rare, threatened, and endangered species. The refuge's volunteers will be coordinated by refuge staff, and the refuge will coordinate with the partners to continue to provide a volunteer cadre for protected lands throughout the ridge system. The refuge will continue to draw support from the Merritt Island Wildlife Association, building support from the Friends of the Carr Refuge and the Pelican Island Preservation Society, and plans to seek agreements with other organizations to expand opportunities to assist the refuge in meeting its

goals and objectives. The refuge plans to work with these groups to focus efforts and activities to benefit rare, threatened, and endangered species.

Litter and Debris. The refuge will work with the partners to control existing litter and to deter future dumping of litter and debris on the refuge. Through the assistance of refuge partners and volunteers, trash and debris cleanups will continue. The Service will continue to maintain fences and informational signage, designed to inform the public of the refuge's status; provide contact information; and protect refuge resources from illicit uses, such as off-road vehicles.

Refuge Administration

The refuge plans to continue to share facilities, equipment, utilities, and staff with Pelican Island and Archie Carr NWRs, and Merritt Island NWR will continue to provide fire program staff, but the refuge will have its own budget and its own full-time staff members potentially located at partner facilities in close proximity to Lake Wales Ridge NWR resource interests.

Staffing. Staff will be increased and a refuge law enforcement officer, identified in the approved Archie Carr NWR CCP will be shared amongst Pelican Island, Archie Carr, and Lake Wales Ridge NWRs. The refuge will share seven full-time employees (FTEs) with Pelican Island and Archie Carr NWRs. These positions are: refuge manager; wildlife refuge specialist; park ranger; biologist (term); biological science technician (term); laborer (temporary); and equipment operator (term). Fire program and refuge administrative responsibilities will continue to be provided by Merritt Island NWR.

Five additional staff will be added at Lake Wales NWR for on-site management of the refuge. These positions are: wildlife refuge specialist (assistant refuge manager); private lands biologist; botanist/biologist; biological science technician; and fire/forestry technician. See Figure 11 for an organizational chart of the proposed staffing level.

Operations and Administration. The refuge will seek a presence in the Lake Wales and Winter Haven Ridge systems in order to provide for refuge management, operations and maintenance, and administration. The limited facilities will be managed by Lake Wales Ridge NWR staff. Service fire presence and initial attack support either on or posing a threat to refuge interests will be provided through a full-time fire/forestry technician and fire equipment housed on partner facilities. Existing Refuge Complex staff will be housed at the South Florida Field Office of Ecological Services, Vero Beach. Refuge specific staff will potentially be housed at partner facilities to administer day-to-day management of the refuge. The refuge plans to enter into memoranda of understanding or other appropriate agreements with the partners for equipment storage, operational functions, and refuge administrative needs. Further, the refuge plans to move all equipment to Service or partner facilities.

Partnerships. The refuge plans to enhance and increase partnership efforts to support management and recovery of rare, threatened, and endangered species. Working with the volunteers and partners, the refuge plans to develop an organized training program to better educate volunteers on rare, threatened, and endangered species relative to their specific work element(s). The refuge will continue to work with the governmental and non-governmental partners through the LWREWG. Beyond the Working Group, the refuge will also continue to work directly with both the South Florida and North Florida Field Offices of Ecological Services for funding and recovery direction. The refuge will also build additional support through the Merritt Island Wildlife Association, Pelican Island Preservation Society, and Friends of the Carr Refuge.

V. Pertinent Species and Habitat:

A. Include species/habitat occurrence map:

No species occurrence maps are provided. However, general species occurrence maps are included in the South Florida Multi-Species Recovery Plan (Service 1999).

The proposed project area is located on the Lake Wales Ridge NWR in Highlands and Polk Counties along the Lake Wales and Winter Haven Ridges of south Central Florida. Prominent refuge habitats include basin marsh/depression marsh, bayhead, mesic flatwoods, mesic and xeric hammock, sand pine scrub, scrubby flatwoods, yellow sand scrub, and turkey oak/wiregrass sandhill.

B. Federally Listed Species:

The Refuge currently provides habitat for 24 federally threatened, endangered, and candidate species, as listed.

Table V.B. Status of federally listed species occurring on the Lake Wales Ridge NWR

SPECIES	CRITICAL HABITAT	STATUS
Flora		
Britton's beargrass (*Nolina brittoniana*)	none	endangered
Carter's warea (Carter's mustard) (*Warea carteri*)	none	endangered
Florida blazing star (*Liatris ohlingerae*)	none	endangered
Florida bonamia (*Bonamia grandiflora*)	none	Threatened
Florida perforate cladonia (*Cladonia perforata*)	none	Endangered
Florida ziziphus (*Ziziphus celata*)	none	Endangered
Garrett's mint (*Dicerandra christmanii*)	none	Endangered
Highlands scrub hypericum (*Hypericum cumulicola*)	none	Endangered
Lewton's polygala (*Polygala lewtonii*)	none	Endangered
Paper-like nailwort (Papery whitlow-wort) (*Paronychia chartacea* var. *chartacea*)	none	Threatened

SPECIES	CRITICAL HABITAT	STATUS
Pigeon-wing (*Clitoria fragrans*)	none	Threatened
Pygmy fringe-tree (*Chionanthus pygmaeus*)	none	Endangered
Sandlace (*Polygonella myrophylla*)	none	endangered
Scrub buckwheat (*Eriogonum longifolium* var. *gnaphalifolium*)	none	threatened
Scrub plum (*Prunus geniculata*)	none	endangered
Scrub lupine (*Lupinus aridorum*)	none	endangered
Wireweed (*Polygonella basiramia*)	none	endangered
Fauna		
American alligator (*Alligator mississippiensis*)	none	threatened (s/a)
Bluetail mole skink (*Eumeces egregius lividus*)	none	threatened
Eastern indigo snake (*Drymarchon corais couperi*)	none	threatened
Florida scrub-jay (*Aphelocoma coerulescens*)	none	threatened
Florida panther* (*Puma concolor coryi*)	none	endangered
Highlands tiger beetle (*Cicindela highlandensis*)	none	candidate
Sand skink (*Neoseps reynoldsi*)	none	endangered
Wood stork (*Mycteria americana*)	none	endangered

**Unconfirmed*

VI. Location:

A. Ecoregion Number and Name:
Ecosystem 53, South Florida

B. County and State:
Highlands and Polk Counties, Florida

C. Section, township, and range (or latitude and longitude):

Flamingo Villas Unit:	27.4425 N	81.3917 W
Carter Creek Unit:	27.5166 N	81.4079 W
Lake McLeod Unit:	27.9631 N	81.7402 W
Snell Creek Unit:	28.1303 N	81.5444 W

D. Distance (miles) and direction to nearest town:
The refuge manages four units: Flamingo Villas, Carter Creek, Lake McLeod, and Snell Creek that occur along an approximately 60 mile area of the Lake Wales and Winter Haven Ridges of south Central Florida. Towns within close proximity to refuge managed lands include Sebring – approximately four miles northwest of the Flamingo Villas Unit and two miles southwest of the Carter Creek unit; Eagle Lake – approximately one mile northwest of the Lake McLeod Unit; and Haines City – approximately five mile southwest of the Snell Creek Unit.

E. Species/habitat occurrence:

Flora

Seventeen (17) federally listed plant species are known to occur on the refuge, locations for which occur throughout the four refuge management units but are typically associated with scrub lands. A reintroduced population of Florida ziziphus occurs over an approximately 60-acre area of the northwest portion of the Carter Creek Unit. Garrett's mint occurs within yellow sand scrub habitat of the Flamingo Villas Unit and this unit supports the only known protected population of Garrett's mint. Scrub lupine and Florida cladonia occur within the sand pine scrub habitat of the Lake McLeod Unit. Thirteen other listed plants occur on the refuge units, as identified in Table VI.E.1.

Garrett's Mint. Garrett's mint is a small, fragrant suffrutescent shrub that inhabits the scrub of central peninsular Florida. It had originally been classified as *D. frutescens* and was protected under an earlier listing. Of the many protected areas throughout the Lake Wales Ridge, *D. christmanii* is only known to occur on the refuge's Flamingo Villas Unit (Schultz et al. 1999, Turner et al. 2006, Menges et al. 2007).

Florida Ziziphus. Florida ziziphus is a scrub that is endemic to the Lake Wales Ridge in Central Florida and was believed extinct until 1987. Florida ziziphus is found on the refuge's Carter Creek Unit where 82 individuals survive from a 2002 introduced population (Weekley and Menges 2006, 2008; Service 2009).

Scrub Lupine. Scrub lupine is known from two distinct areas. In western Orange County (Orlando area) it is found on the southern Mount Dora Ridge from the Apopka-Plymouth area south, past Lake Buena Vista. In South Florida, it is found in north-central Polk County on the Winter Haven Ridge near Audurndale and Winter Haven (Service 1999). Scrub lupine is an herb endemic to Orange and Polk counties and is known to occur on the refuge's Lake McLeod Management Unit (Schultz et al. 1999, Kane 2003) where it occurs as a pioneer species in sand pine scrub that until recently was

routinely disturbed through the illegal use of off-road vehicles. The unit has been recently (2005) fenced which has limited unpermitted public use and particularly the use of off-road vehicles. The species is an unusual central Florida scrub plant because it is absent from the Lake Wales Ridge. Like many other scrub species, however, it is threatened by loss of habitat due to land conversion for agriculture and residential construction.

Rare Plant Suite. Apart from Garrett's mint, Florida ziziphus, and scrub lupine, a suite of listed plants can be found on the refuge in varying densities and locations (Table VI.E.1).

Table VI.E.1. Federal and state status of federally listed flora known to occur on the Lake Wales Ridge NWR by unit

Scientific Name	Common Name	Agency Status in Florida		Occurrence			
		Federal	State	FV	CC	LM	SC
Bonamia grandiflora	Florida bonamia	T	E	X		X	X
Chionanthus pygmaeus	Pygmy fringe-tree	E	E	X	X		X
Cladonia perforata	Florida perforate cladonia	E	E			X	
Clitoria fragrans	Pigeon-wing	T	E	X	X		
Dicerandra christmanii	Garrett's mint	E	E	X			
Eriogonum longifolium var. *gnaphalifolium*	Scrub buckwheat	T	E	X	X		
Hypericum cumulicola	Highlands scrub hypericum	E	E		X		
Liatris ohlingerae	Florida blazing star	E	E	X	X		
Lupinus aridorum	Scrub lupine	E	E			X	

Scientific Name	Common Name	Agency Status in Florida		Occurrence			
		Federal	State	FV	CC	LM	SC
Nolina brittoniana	Britton's beargrass	E	E		X	X	
Paronychia chartacea spp. *chartacea*	Paper-like nailwort (Papery whitlow-wort)	T	E	X	X	X	
Polygala lewtonii	Lewton's polygala	E	E		X		
Polygonella basiramia	Wireweed	E	E	X	X	X	
Polygonella myrophylla	Sandlace	E	E	X	X	X	
Prunus geniculata	Scrub plum	E	E	X	X	X	X
Warea carteri	Carter's warea (Carter's mustard)	E	E	X	X		X
Ziziphus celata	Florida ziziphus	E	E		±		

Key: E = endangered; T = threatened; ± = Re-introduced, LM = Lake McLeod, CC = Carter Creek, FV = Flamingo Villas, SC = Snell Creek

Fauna

Seven (7) federally listed faunal species (including one federally listed candidate species) are known to occur over the four refuge units. Sand skink occurs on each refuge unit while the Highlands tiger beetle occurs on three units. Radio telemetry data have recorded the occurrence of Florida panther within approximately one-tenth of a mile from the refuge's Flamingo Villas Unit. Bluetail mole skink has been identified on the Lake McLeod Unit as referenced by Shultz et al. (1999). Signs of eastern indigo snake have been observed at the Flamingo Villas Unit. Table VI.E.2 identifies the federally listed faunal species known to occur on the refuge by refuge management unit.

Table VI.E.2. Federal and state status of federally listed fauna known to occur on the Lake Wales Ridge NWR by unit

Scientific Names	Common Names	Agency Status in Florida		Occurrence			
		Federal	State	FV	CC	LM	SC
Cicindela highlandensis	Highlands tiger beetle	C	N	X	X		X
Alligator mississippiensis	American alligator	T(S/A)	SSC	X			
Drymarchon corais couperi	Eastern indigo snake	T	T	X			
Eumeces egregius lividus	Bluetail mole skink	T	T			X	
Neoseps reynoldsi	Sand skink	E	E	X	X	X	X
Aphelocoma coerulescens	Florida scrub-jay	T	T	X	X		
Mycteria Americana	Wood stork	E	E	X			
Puma concolor coryi	Florida panther	E	E	X*			

Key: E = endangered, T = threatened, T(S/A) = listed due to similarity in appearance of a threatened species (American crocodile), C = candidate (FWS), SSC = species of special concern (State),X = present, X = unconfirmed, LM = Lake McLeod, CC = Carter Creek, FV = Flamingo Villas, SC = Snell Creek*

American Alligator. The refuge supports populations of American alligators, however, their occurrence is thought to be rare. American alligators are known to utilize Red Beach Lake and drainage ditches of the Flamingo Villas Unit and are presumed to exist in Lake McLeod. They may also utilize wetland habitats associated with Carter Creek and Snell Creek units, although occurrence information for these units is lacking.

Bluetail Mole Skink. The bluetail mole skink occurs in suitable habitat on the Lake Wales Ridge in Highlands, Polk, and Osceola counties in Central Florida and populations are known to occur on the refuge's Lake McLeod Unit east of Gerber-Dairy road (Schultz et al. 1999).

Eastern Indigo Snake. The refuge supports habitat for populations of eastern indigo snake. Signs of eastern indigo snake have been observed on the Flamingo Villas Unit, however, due to large home ranges (48-114 acres) and the use of a variety of habitat types (Legare et al. 1998-2002), it is difficult to determine presence at a site or monitor population status on the refuge.

Florida Panther**.** Based on 1998 Service telemetry data, Florida panther presence was documented within one-tenth of a mile of the refuge's Flamingo Villas Unit, roughly one-half a mile from the Carter Creek Unit, and roughly one mile from the Snell Creek Unit. In addition, motion triggered cameras used to identify feral hog presence at the Flamingo Villas Unit photographed a large cat in January 2007; however, the species was not confirmed. The refuge has not conducted research or monitoring specific to Florida panther on refuge units.

Florida Scrub-Jay. In 2002, TNC working closely with ABS, developed the Jay Watch monitoring program by engaging volunteer citizens and scientists to annually survey scrub-jays, consistently using standardized protocols to detect population trends along the Lake Wales Ridge (TNC 2007). The refuge relies on Jay Watch for survey efforts on refuge units, specifically at Flamingo Villas and Carter Creek. According to 2008 survey results, seven groups totaling 29 birds (20 adults and 9 juveniles) were identified on the Flamingo Villas Unit in 2008 (TNC 2008). Group size averaged 3.63 birds (2.34 adults) and 1.29 juveniles per group (TNC 2008). The 2007 survey results identified eight groups with an average group size of 3.13 birds and 0.88 juveniles occupied the Flamingo Villas Unit in 2007. Total number of groups at Flamingo Villas ranges from zero groups in 2002 to 11 identified in 2004, while average group size ranges from zero in 2002 to a high of 4.13 groups in 2006, and juveniles per group ranged from zero in 2002 to 1.29 in 2005 (TNC 2007). A single scrub jay was identified in both the 2004 and 2005 reporting periods on the Carter Creek Unit, but none have been reported by the survey since.

Highlands Tiger Beetle. Turner et al. (2006) and Schultz et al. (1999) report the occurrence of Highlands tiger beetle at the Flamingo Villas Unit, and Shultz et al. (1999) reports occurrence within Carter Creek's State managed Lake Wales Ridge Wildlife and Environmental Area, north of Arbuckle Creek Road. Turner et al. (2006) reports occurrence within the refuge managed Carter Creek Unit. In addition, staff has observed signs at the Snell Creek Unit. The species is thought to occur on all refuge management units due to its range of distribution over scrub and sandhill habitats.

Sand Skink. Sand skinks are endemic to the sandy ridges of Central Florida, occurring on the Lake Wales, Winter Haven, and Mount Dora Ridges in Highlands, Lake, Marion, Orange, Osceola, Polk, and Putnam Counties (Service 1999). Schultz et al. (1999), and Turner et al. (2006) reported the occurrence of sand skinks on the refuge's Flamingo Villas Unit and Service staff (2009) have reported sand skink occurrence at the Flamingo Villas, Lake McLeod, and Snell Creek units, although population estimates are lacking.

Wood Stork. Wood storks are not known to breed on the refuge and foraging opportunities are limited. They may utilize various wetland features within the refuge, including littoral habitats of lake shores and flooded ephemeral ponds and wetlands.

VII. Determination of Effects:

A. Explanation of effects

The impacts to listed species occurring on the refuge (listed in Table V.A) are anticipated to be beneficial over the long term. The Draft CCP/EA for Lake Wales Ridge NWR includes a table that summarizes the environmental consequences of plan implementation (Table 28 in the EA).

Table VII.A. Impacts of plan implementation to listed species occurring on the Lake Wales Ridge NWR

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
Florida Ziziphus	Positive. Increased inventory, monitoring, and research. Increased protection of introduced/reintroduced populations at the Carter Creek Management Unit and law enforcement. Increased prescribed fire activity specific to sandhill community structure and function. Increased partnerships. Adaptive management strategies based on species and habitat response to management actions including the use of prescribed fire.
Garrett's Mint	Positive. Planned prescribed fire frequency provides maintenance and establishment of gaps, and reduces shading by competing vegetation. Increased maintenance of fences to limit disturbance from illicit uses. Increased ability to provide for prescribed fire on a regular basis. Adaptive management strategies based on species and habitat response to management actions including the use of prescribed fire.
Scrub Lupine	Positive. Continued research specific to scrub lupine. Increased habitat quality through management. Increased ability to perform prescribed fire on a routine basis. Focused efforts on minimizing threats to and optimizing habitat conditions for rare, threatened, and endangered species. Adaptive management strategies based on species and habitat response to management actions including the use of prescribed fire.
Rare Plant Suite	Positive. Increased baseline data through monitoring, inventory and research. Focused efforts on minimizing threats to and optimizing habitat conditions for rare, threatened, and endangered species. Adaptive management strategies based on species and habitat response to management actions including the use of prescribed fire.
Florida Scrub-Jay	Positive. Continued support for partner monitoring efforts. Supported development of baseline data on suitable and potential habitats. Enhanced habitat quality.

SPECIES/ CRITICAL HABITAT	IMPACTS TO SPECIES/CRITICAL HABITAT
Skinks (Bluetail mole and Sand)	Positive. Expanded partnerships and supported expansion of inventory, monitoring and research efforts to include all refuge managed units. Enhanced habitat quality, providing recruitment opportunities.
Eastern Indigo Snake	Positive. Enhanced habitat quality through implementation of prescribed fire on a routine basis. Efforts to coordinate corridor development to decrease potential roadkill. Increased outreach and information for refuge neighbors.
Wood Stork	Positive. Identified colonies and use if determined. Increased partnerships and supported partner conducted surveys. Adaptive management to protect colonies if discovered. Enhanced wetland habitat.
American Alligator	Positive. Enhanced wetland habitat. Increased protection.
Florida Panther	Neutral to Positive. Enhanced habitat value. Increased partnerships. Increased inventory, monitoring and research designed to better understand refuge's role in managing for the needs of wide-ranging species. Increased protection.
Highlands Tiger Beetle	Positive. Increased partnerships. Increased baseline data through monitoring, inventory and research of rare species. Focused efforts on minimizing threats to and optimizing habitat conditions for rare, threatened, and endangered species.

B. Explanation of actions to be implemented to reduce adverse effects:

The implementation of all goals, objectives, and strategies outlined in the CCP will follow the refuge's best management practices and will pursue avoidance and minimization of impacts to federally listed and endangered species, to the extent possible and practicable. Whenever and wherever prudent, the avoidance and minimization measures outlined in Table V.B will be incorporated into the implementation of the CCP to minimize the effect to federally listed threatened or endangered species.

Table VII.B. Explanation of actions to be implemented to reduce adverse effects to Listed Species

SPECIES/ CRITICAL HABITAT	ACTIONS TO MITIGATE/MINIMIZE IMPACTS
	Exotic Plant Control and Removal Activities Throughout Florida, refuges regularly and commonly use herbicides in both wetland and upland systems to combat the spread and proliferation of pest plants. The Lake Wales Ridge NWR seeks to control all FLEPPC Category I and II plants on both upland and wetland communities using a variety of approved herbicides at label rates including but not limited to glyphosate, metsulfuron methyl, imazapyr, and triclopyr amine and ester depending on habitat (wetland or upland application). Associated surfactants are also incorporated in herbicide solutions depending on species targets and application methods. Nontarget damage is minimized as a result of the careful and planned application of herbicides approved for the intended use. Residual effects of herbicide application in natural areas may be expressed by short half-lives or toxicity to fauna, effects of which will be minimized to the maximum extent practicable based on the method of application (targeted application) and use of products at or below label rates. In order to effectively and efficiently provide a pest plant control program to combat infestation from pest plants, the refuge has located (North Wind Inc., 2006) pest plants found on the refuge and will continue to update inventories over the life of this plan utilizing GIS technology and by updating pest plant location inventories at regular intervals. Identifying locations of pest plants provides greater reliability on ground application and minimizes the need to broadcast application of herbicides, thereby reducing nontarget damage to federally threatened and endangered species. Additionally, the refuge will develop an Integrated Pest Management Plan (IPMP) through the step down planning process to provide specific refuge management direction and actions designed to minimize impacts of pesticide use. The IPMP will be consulted on separately. The refuge provides orientation information regarding federally threatened and endangered species found on the refuge to all new employees, volunteers, and contractors involved in controlling and removing pest plants. All control products are approved by Service Pesticide Use Proposal Process, and applied according to label rates. The refuge will make all efforts possible and practicable to limit long-term wildlife impacts from management activities. Measures to limit wildlife impacts during control and removal of pest plants include preliminary assessments by qualified individuals to avoid burrows, nests, and obvious signs of wildlife activity.
	Fire Management Activities Fire management is a tool employed for the benefit of wildlife, including improving habitat, controlling wildfires, and controlling or removing exotic plants. The refuge will make all efforts possible and practicable to limit long-term wildlife impacts of fire management activities. Efforts to minimize undesired impacts to rare, threatened, and endangered species

SPECIES/ CRITICAL HABITAT	ACTIONS TO MITIGATE/MINIMIZE IMPACTS
	include but are not limited to implementation of best management practices, prescribed burn plan consultation with appropriate Ecological Services Field Stations, and coordination with partner agencies. The primary focus over the 15-year life of the CCP will be recovering the landscape from the historical suppression of fire over the previous 50 years. Over the life of this CCP, the refuge will target management activities to restore habitat for the recovery and continued viability of rare, threatened and endangered species in an effort to return habitats to a pre-fire exclusion state. The historical lack of fire promotes unsuitable habitat structure and function for many of the rare, threatened and endangered species for which the refuge was envisioned to protect. The refuge will provide a routine prescribed fire program, instituting initial prescribed fire intervals targeting two to five years in fire management units designed to return habitats to pre-fire exclusion conditions. Working with partners, the refuge will monitor fire effects during the restoration phase to assess habitat and rare, threatened, and endangered species response. Fire management will adapt based on species and habitat response. Once pre-fire exclusion conditions have been met, the refuge will institute fire return intervals to provide for the maintenance of habitat structure and function in an effort to provide suitable habitat conditions for rare, threatened, and endangered species. The refuge will provide opportunities and conduct fire effects monitoring including establishment of photo points strategically located on the refuge. For on the ground support, the refuge will recruit assistance through partnerships to assist in fire effects monitoring, data collection, and reporting
	Research Activities Baseline information on most species and habitats on the refuge is lacking. Working with the partners, the refuge plans to provide for inventorying, monitoring and research of habitats and species assemblages, occurrence, and trends over the life of the Plan, including collecting and analyzing data used to support management efforts for the recovery of rare, threatened, and endangered species. All research on the refuge must obtain all applicable permits, including a refuge special use permit before commencement of research activities on the refuge. During the application of permits, conditions may be imposed to eliminate or minimize any impacts that may be anticipated from the research proposal. The refuge provides orientation information regarding federally threatened and endangered species found n the refuge to all researchers.
	Increased Visitation In order to minimize unintended impacts from well-intentioned visitors to rare, threatened and, endangered plants, and to best manage the restoration of habitats to pre-fire exclusion conditions, the refuge will remain closed to visitor use through the life of the Plan. The refuge understands it plays an important role in the system of protected lands managed throughout the Lake Wales and Winter Haven Ridges. In order

SPECIES/ CRITICAL HABITAT	ACTIONS TO MITIGATE/MINIMIZE IMPACTS
	help promote the importance of and develop interest in the Lake Wales Ridge and Winter Haven Ridge ecosystems, the refuge plans to provide limited visitation through Service lead or Service approved guided tours and other special events on a case-by-case basis through the special use and/or other refuge approved processes. Working with partners, the refuge will make all efforts possible and practicable to limit wildlife impacts related to increased visitation. Measures to limit wildlife impacts related to increased visitation include providing Service-approved guided tours led by refuge staff or refuge approved volunteers through the Special Use Permit process on a case-by-case basis. Tours will be either independent of, or in concert with partner outreach events with key messages focused on the importance of the refuge to rare, threatened, and endangered species; the habitats they occupy; and the minimization of human impacts. The refuge will integrate key messages with partner messages, focusing on the importance of the ridge ecosystem to the many rare plants and animals. The refuge also plans to participate in partner sponsored outreach events to increase public understanding and appreciation for the Lake Wales Ridge and the refuge. The refuge will review available materials from the partners and develop, as needed, refuge informational materials to present key messages that can be provided at partner outreach events and sites. To bolster community support for the refuge and Lake Wales and Winter Haven Ridge systems, the refuge will host an annual refuge event where environmental education and interpretation will be focused on the unique resources of the refuge and where wildlife observation and photography opportunities will be made available under limited and controlled conditions. Increasing volunteer participation will be needed to support visitor service opportunities, including approved visits. The refuge will participate with the state and other land managers in conducting events, programs, news releases, and interpretive materials that will educate the public on the Lake Wales Ridge and Winter Haven Ridge. In order to control illicit uses, the refuge will increase law enforcement presence, maintain and erect new boundary fencing, and plans to provide additional boundary signage strategically posted where illicit public use has historically taken place throughout the refuge units.
	Earthmoving Activities Over the life of the CCP, the refuge will embark on an effort to restore habitats to pre-fire exclusion conditions for the benefit of rare, threatened, and endangered species. Earthmoving activities are anticipated to include existing and potentially new fire line management, tree planting activities designed to restore habitat value, mechanical control of habitats where appropriate and applicable, and as a result of pest plant removal and control efforts. Earthmoving activities on the refuge will obtain all applicable permits before commencement. During the application of permits, conditions may be imposed to minimize impacts that may be

SPECIES/ CRITICAL HABITAT	ACTIONS TO MITIGATE/MINIMIZE IMPACTS
	anticipated from proposed earthmoving activities. Major earthmoving activities in listed species' habitat would be expected to require future Section 7 consultations. The refuge provides orientation information regarding federally threatened and endangered species found on the refuge to all new employees, volunteers, and contractors involved in earthmoving activities. The refuge will make all efforts possible and practicable to limit long-term wildlife impacts of earthmoving activities. During earthmoving activities associated with exotic plant control, habitat restoration, and fire line development and maintenance, measures to limit wildlife impacts include preliminary assessments by qualified individuals to avoid burrows, nests, research plots employed to study rare, threatened and endangered species, and other obvious signs of wildlife activity and occurrence.
	Construction Activities Over the life of the CCP, the refuge will investigate the ability to base operational, maintenance, and administrative capacities on partner managed lands to further minimize direct impacts to the refuge. If co-location is unavailable, the refuge will seek to provide infrastructure on refuge owned and managed lands. All construction activities on the refuge will obtain all applicable permits before commencement. During the application for permits, conditions may be imposed to eliminate or minimize any impacts that may be anticipated from proposed construction. Future construction activities would be expected to require future consultations once specific sites and structure footprints have been identified (e.g., another Section 7 would be required for the siting and building of refuge maintenance and operational storage structures). The refuge will make all efforts possible and practicable to limit long-term impacts of management activities.

Table **VIII. Effect determination and response requested:**

SPECIES/ CRITICAL HABITAT	DETERMINATION[1]			[1]RESPONSE REQUESTED
	NE	NA	AA	
FLORA				
Britton's beargrass (*Nolina brittoniana*)		X		Concurrence
Carter's warea (Carter's mustard) (*Warea carteri*)		X		Concurrence
Florida blazing star (*Liatris ohlingerae*)		X		Concurrence
Florida bonamia (*Bonamia grandiflora*)		X		Concurrence
Florida perforate cladonia (*Cladonia perforata*)		X		Concurrence
Florida ziziphus (*Ziziphus celata*)		X		Concurrence
Garrett's mint (*Dicerandra christmanii*)		X		Concurrence

SPECIES/ CRITICAL HABITAT	DETERMINATION[1]			[1]RESPONSE REQUESTED
	NE	NA	AA	
Highlands scrub hypericum (*Hypericum cumulicola*)		X		Concurrence
Paper-like nailwort (Papery whitlow-wort) (*Paronychia chartacea spp. chartacea*)		X		Concurrence
Pigeon-wing (*Clitoria fragrans*)		X		Concurrence
Pygmy fringe-tree (*Chionanthus pygmaeus*)		X		Concurrence
Lewton's polygala (*Polygala lewtonii*)		X		Concurrence
Sandlace (*Polygonella myrophylla*)		X		Concurrence
Scrub buckwheat (*Eriogonum longifolium var. gnaphalifolium*)		X		Concurrence
Scrub lupine (*Lupinus aridorum*)		X		Concurrence

SPECIES/ CRITICAL HABITAT	DETERMINATION[1]			[1]RESPONSE REQUESTED
	NE	NA	AA	
Scrub plum (*Prunus geniculata*)		X		Concurrence
Wireweed (*Polygonella basiramia*)		X		Concurrence
FAUNA				
Bluetail mole skink (*Eumeces egregius lividus*)		X		Concurrence
Eastern indigo snake (*Drymarchon corais couperi*)		X		Concurrence
Florida panther (*Puma concolor coryi*)		X		Concurrence
Florida scrub-jay (*Aphelocoma coerulescens*)		X		Concurrence
Highlands tiger beetle (*Cicindela highlandensis*)		X		Concurrence

SPECIES/ CRITICAL HABITAT	DETERMINATION[1]			[1]RESPONSE REQUESTED
	NE	NA	AA	
Sand skink (*Neoseps reynoldsi*)		X		Concurrence
Wood stork (*Mycteria americana*)		X		Concurrence

[1]DETERMINATION/ RESPONSE REQUESTED:

NE = no effect/no adverse modification. This determination is appropriate if the proposed action and its interrelated and interdependent actions will not, either positively or negatively, affect any listed, proposed, candidate species or designated/proposed critical habitat. Response Requested is optional but "Concurrence" is recommended for a complete Administrative Record.

NA = not likely to adversely affect. This determination is appropriate when the proposed action is not likely to adversely impact any listed, proposed, candidate species or designated/proposed critical habitat or there may be beneficial effects to these resources. In other words, effects to the species or critical habitat are expected to be beneficial, discountable, or insignificant. Beneficial effects are contemporaneous positive effects without any adverse effects to the species or habitat. Insignificant effects relate to the size of the impact (and should never reach the scale where take occurs), while discountable effects are those that are extremely unlikely to occur. Based on best judgment, a person would not: (1) be able to meaningfully measure, detect, or evaluate insignificant effects; or (2) expect discountable effects to occur. Response Requested is "Concurrence". If the Ecological Services Office concurs in writing with the Project Leader's determination of "NA", the intra-Service section 7 consultation process is completed.

AA = likely to adversely affect. This determination is appropriate when the proposed action is likely to adversely impact any listed, proposed, candidate species or designated/proposed critical habitat as a direct or indirect result of the proposed action or its interrelated or interdependent actions, and the effect is not discountable or insignificant. In the event the overall effect of the proposed action is beneficial to the listed species or critical habitat, but may also cause some adverse effect on individuals of the listed species or segments of the critical habitat, then the determination should be "AA". Response Requested for listed species and designated critical habitat is "Formal Consultation". Response requested for proposed and candidate species and proposed critical habitat is "Conference".

IX. Reference and Literature Cited

Florida Exotic Pest Plant Council [FLEPPC]. 2009. List of Florida's Invasive Plant Species. Florida Exotic Pest Plant Council. Internet: http://www.fleppc.org/list/List-WW-F09-final.pdf

Kane S.R. 2003. Historical and current distribution status of *Lupinus aridorum* McFarlin ex Beckner. Unpublished M.S. Thesis. University of Central Florida, Orlando, Florida.

Legare, M.L., D.R. Breninger, and M.R Bolt. 1998-2002. Indigo snake radiotracking data collected from Brevard County, Florida. Dynamac Corporation. Titusville, Florida?

Menges, E.S., C.W. Weekley, S.I. Hamze, and R.L. Pickert. 2007. Soil preferences for listed plants on the Lake Wales Ridge in Highlands County, Florida. Florida Scientist 70:24-39.

North Wind Inc. 2006. Lake Wales Ridge National Wildlife Refuge Exotic Species Mapping, Summary of GIS Data. On file at U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge Complex; Titusville, Florida.

Schultz, G.E., L.G. Chafin, and S.T. Krupenevich. 1999. Rare plant species and high quality natural communities of twenty-six CARL sites in the Lake Wales Ridge Ecosystem. Florida Natural Areas Inventory, Tallahassee, Florida.

The Nature Conservancy [TNC]. 2007. Jay Watch annual report 2007. The Nature Conservancy. Babson Park, Florida.

The Nature Conservancy [TNC]. 2008. Jay Watch annual report 2008. The Nature Conservancy. Babson Park, Florida.

Turner, W.R., D.S. Wilcove, and H.M. Swain. 2006. State of the scrub: conservation progress, management responsibilities, and land acquisition priorities for imperiled species of Florida's Lake Wales Ridge. Archbold Biological Station, Lake Placid, Florida.

U.S. Fish and Wildlife Service. 1999. South Florida Multi-Species Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 2,178 pp.

U.S. Fish and Wildlife Service. 2009. Florida ziziphus (*Ziziphus celata*) 5-Year Review: Summary and Evaluation. Southeast Region, South Florida Ecological Services Field Office; Vero Beach, Florida. http://ecos.fws.gov/docs/five_year_review/doc2587.pdf

Weekley, C.W., and E.S. Menges. 2006. Florida Ziziphus Strategic Plan. Archbold Biological Station, Lake Placid, Florida.

Weekley, C.W., and E.S. Menges. 2008. Continuation of research on the federally-listed Lake Wales Ridge endemic Florida ziziphus (*Ziziphus celata*). Final report to the Plant Conservation Program of the Florida Division of Forestry. Tallahassee, Florida.

Signature (originating station) — Date: 1/28/10

Refuge Manager
Title

IX. Reviewing Ecological Services Office Evaluation:

A. Concurrence X Nonconcurrence _____

B. Formal consultation required _____

C. Conference required _____

D. Informal conference required _____

E. Remarks (attach additional pages as needed):

Signature — Date: 2/5/2010

Super. Fish & Wildlife Biol.
Title

South Florida Ecological Services
Vero Beach, FL
Office

Appendix VIII. Wilderness Review

The Wilderness Act of 1964 outlines criteria for the designation of federally owned lands as wilderness areas. A wilderness area is defined as underdeveloped Federal lands retaining primeval character with no permanent evidence of the works of humans. Such wilderness areas are managed to preserve this natural character. Further, a wilderness area:

- generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable;
- has outstanding opportunities for solitude or a primitive and unconfined type of recreation;
- has at least 5,000 contiguous, roadless acres (2,023 ha) of land or is of sufficient size as to make practicable its preservation and use in an unimpeded condition; or is a roadless island, regardless of size;
- does not substantially exhibit effects of logging, farming, grazing, or other extensive development or alteration of the landscape, to its wilderness character could be restored through appropriate management at the time of review; and
- may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Wilderness Act, 16 U.S.C. 1 1 21(2)(c)

Except as specifically provided for in this chapter, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this chapter and, except as necessary to meet minimum requirements for the administration of the area for the purpose of this chapter (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.

Wilderness Act, 16 U.S.C. 1 1 21(4)(c)

National Wilderness Preservation System

The 1964 Wilderness Act established the National Wilderness Preservation System. In order to assure that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness. For this purpose there is hereby established a National Wilderness Preservation System to be composed of federally owned areas designated by Congress as "wilderness areas," and these shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness; and no Federal lands shall be designated as "wilderness areas" except as provided for in this chapter or by a subsequent Act.

Wilderness Act, 16 U.S.C. 1 1 21(2)(a)

Wilderness Area Criteria

The Wilderness Act outlines criteria for the designation of federally owned lands as wilderness areas. A wilderness area is defined as underdeveloped federal lands retaining primeval character with no permanent evidence of the works of humans. Such wilderness areas are managed to preserve this natural character. Further, a wilderness area:

(1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value.

Wilderness Act, 16 U.S.C. 1 1 21(2)(c)

Except as specifically provided for in this chapter, and subject to existing private rights, there shall be no commercial enterprise and no permanent road within any wilderness area designated by this chapter and, except as necessary to meet minimum requirements for the administration of the area for the purpose of this chapter (including measures required in emergencies involving the health and safety of persons within the area), there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area.

Wilderness Act, 16 U.S.C. 1 1 21(4)(c)

Wilderness Inventory for Lake Wales Ridge National Wildlife Refuge

No units of the refuge meet the minimum Wilderness Area size criteria of 5,000 acres, nor does the refuge contain any islands. The only management unit of any size is Flamingo Villas, which is currently 1,039.1 acres (420.5 ha) plus one acre (0.4 ha) of state owned lands the refuge manages for a total of 1,040.1 acres (420.9 ha) owned/managed by the refuge. But, Flamingo Villas is bounded by two state highways and one U.S. highway, has numerous internal roadways, is split by a railroad, and has a high voltage power line running through it. The next largest unit is Carter Creek, which is 627.5 acres (253.9 ha) in size. This unit is bounded by a county highway, local roads, and development, as well as has a power line running through it. The other two units - Lake McLeod at 38 acres (15.4 ha) and Snell Creek at 139.3 acres (56.4 ha) - are also bounded by roadways and have internal roadways. All of the management units have had previous human disturbance.

In review of the federally owned lands and waters within the boundary of Lake Wales Ridge NWR, no areas were found suitable for designation as Wilderness. The lands and waters of the refuge:

- do not meet the wilderness minimum size requirement of 5,000 contiguous roadless acres;
- do not contain any units of sufficient size for preservation as wilderness;
- have been altered by historic and ongoing human activities;
- do not include outstanding opportunities for solitude or for primitive recreation; and
- are fragmented by roadways and human development.

Therefore, no units of Lake Wales Ridge NWR are suitable for designation as Wilderness at this time. The lands within Lake Wales Ridge NWR were reviewed for their suitability in meeting the criteria for wilderness, as defined by the Wilderness Act of 1964. The refuge is made up of four, disconnected tracts totaling just 1,843.4 acres (746 ha) acres and spanning about 64 miles through two counties. No units of the refuge meet the minimum Wilderness Area size criteria of 5,000 acres, nor does the refuge contain any islands. In addition, all of the management units have had previous human disturbance.

As mentioned, the largest management unit is Flamingo Villas, currently about 1,038.6 acres (419.9 ha) and the aggregate total of refuge owned/managed lands that presently make up the refuge is1,843.4 acres (746 ha). All refuge management units have existing or are influenced by adjacent development. Flamingo Villas is bounded by two state highways, one U.S. highway, has numerous internal roadways, is split by a railroad, and a high voltage power line traverses the unit. The Carter Creek Unit is bound by a county highway to the north with local roads and power lines in close proximity to the management boundary. The Lake McLeod Unit is surrounded by mixed use urban and agricultural development and the Snell Creek Unit is bounded in part by a paved 2-lane highway with internal roads running through it.

Commercial and residential development exists throughout the Lake Wales Ridge landscape with cities, major towns, shopping centers, agricultural uses, neighborhoods, and community centers occurring throughout the ridge and at times, directly abutting Service lands. Together, the small size and fragmented nature of the refuge and the presence of public roads with associated commercial, agricultural, and residential development preclude the opportunity for a Wilderness experience at Lake Wales Ridge NWR.

Therefore, no units of Lake Wales Ridge NWR are suitable for designation as Wilderness at this time.

Appendix IX. Refuge Biota

Refuge biota listed below includes suites of bird, mammal, reptile, amphibian, fish, insect, and plant species that are known to occur or potentially may occur based the occurrence of similar species or the existence of suitable habitat found on the refuge. In addition, rare, threatened, and endangered species are listed with refuge unit occurrence provided for each species listed. Finally, a list of non-native species is provided.

Refuge Birds

Common Name	Scientific Name
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Carduelis tristis*
American Kestrel	*Falco sparverius*
American Robin	*Turdus migratorius*
American Swallow-tailed Kite	*Elanoides forficatus*
Anhinga	*Anhinga anhinga*
Bachman's Sparrow	*Aimophila aestivalis*
Barn Swallow	*Hirundo rustica*
Barred Owl	*Strix varia*
Black Vulture	*Coragyps atratus*
Black-and-white Warbler	*Mniotilta varia*
Black-crowned Night-Heron	*Nycticorax nycticorax*
Blue Jay	*Cyanocitta cristata*
Blue-Gray Gnatcatcher	*Polioptila caerulea*
Boat-tailed Grackle	*Quiscalus major*
Brown Thrasher	*Toxostoma rufum*
Brown-headed Cowbird	*Molothrus ater*
Brown-headed Nuthatch	*Sitta pusilla*
Cape May Warbler	*Dendroica caerulescens*
Carolina Wren	*Thryothorus ludovicianus*

Common Name	Scientific Name
Cattle Egret	*Bubulcus ibis*
Cedar Waxwing	*Bombycilla cedorum*
Chipping Sparrow	*Spizella passerine*
Chuck-will's widow	*Caprimulgus carolinensis*
Common Grackle	*Quiscalus quiscula*
Common Ground-Dove	*Columbina passerine*
Common Nighthawk	*Chaetura pelagica*
Common Snipe	*Gallinago gallinago*
Common Yellowthroat	*Geothlypis trichas*
Cooper's Hawk	*Accipiter striatus*
Double-crested Cormorant	*Phalacrocorax auritus*
Downy Woodpecker	*Picoides pubescens*
Eastern Bluebird	*Sialia sialis*
Eastern Kingbird	*Tyrannus tyrannus*
Eastern Meadowlark	*Sturnella magna*
Eastern Phoebe	*Sayornis phoebe*
Eastern Towhee	*Pipilo erythrophthalmus*
Fish Crow	*Corvus assisfragus*
Florida Burrowing Owl	*Athene cunicularia floridana*
Glossy Ibis	*Plegadis falinellus*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray Catbird	*Dumetella carolinensis*
Great Blue Heron	*Ardea Herodias*
Great Egret	*Egretta alba*
Great-crested Flycatcher	*Myiarchus crinitus*
Great-horned Owl	*Bubo virginianus*
Green-backed Heron	*Burorides striatus*

Common Name	Scientific Name
Ground Dove	*Columbiana passerina*
Hairy Woodpecker	*Picoides villosus*
Hermit Thrush	*Catharus fuscenscens*
House Wren	*Troglodytes aedon*
Indigo Bunting	*Passerina cyanea*
Killdeer	*Charadrius vociferous*
King Rail	*Rallus elegans*
Least Bittern	*Ixobrychrus exilis*
Limpkin	*Aramus guaauna*
Little Blue Heron	*Egretta caerulea*
Loggerhead Shrike	*Lanius ludovicianus*
Marsh Wren	*Cistothorus palustris*
Mottled Duck	*Anas fulvigula*
Mourning Dove	*Zenaida macroura*
Northern Bobwhite	*Colinus virginianus*
Northern Cardinal	*Cardinalis cardinalis*
Northern Flicker	*Colaptes auratus*
Northern Mockingbird	*Mimus polygottos*
Northern Parula	*Parula Americana*
Osprey	*Pandion haliaetus*
Ovenbird	*Seiurus aurocapillus*
Palm Warbler	*Dendroica palmarum*
Pied-billed Grebe	*Podilymbus podiceps*
Pileated Woodpecker	*Dryocopus pileatus*
Pine Warbler	*Dendroica pinus*
Prairie Warbler	*Dendroica discolor*
Purple Martin	*Progne subis*

Common Name	Scientific Name
Red-bellied Woodpecker	*Melanerpes carolinus*
Red-eyed Vireo	*Vireo olivaceus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-shouldered Hawk	*Buteo lineatus*
Red-winged Blackbird	*Agelaius phoeniceus*
Ring-billed Gull	*Larus delewarensis*
Ruby-Crowned Kinglet	*Regulus calendula*
Savannah Sparrow	*Passerculus sandwichensis*
Screech Owl	*Megascops asio*
Snowy Egret	*Egretta thula*
Southeastern Kestrel	*Falco sparverius paulus*
Swamp Sparrow	*Melospiza Georgiana*
Tri-colored Heron	*Egretta tricolor*
Turkey	*Meleagris gallopavo*
Turkey Vulture	*Cathartes aura*
Whip-poor-will	*Caprimulgus vociferous*
White Ibis	*Eudocimus albus*
White-eyed Vireo	*Vireo griseus*
White-winged Dove	*Zenaida asiatica*
Wood Duck	*Aix sponsa*
Yellow Rail	*Coturnicops noveboracensis*
Yellow-crowned Night-Heron	*Nycticorax violaceus*
Yellow-rumped Warbler	*Dendroica coronata*
Yellow-throated Warbler	*Dendroica dominica*

Refuge Mammals, Reptiles, Amphibians, and Fishes

Common Name	Scientific Name
MAMMALS	
Big Brown Bat	*Eptesicus fuscus*
Black Bear (Florida)	*Ursus americanus*
Bobcat	*Lynx (Felix) rufus*
Cotton Mouse	*Peromyscus gossypinus*
Cotton Rat	*Sigmodon hispidus*
Eastern Cottontail	*Sylvilagus floridanus*
Eastern Mole	*Scalopus aquaticus*
Eastern Spotted Skunk	*Spilogale putorius*
Evening Bat	*Nycticeius humeralis*
Florida Mouse	*Podomys floridanus*
Golden Mouse	*Ochrotomys nuttalli*
Gray Fox	*Urocyon cinereoargenteus*
Gray Squirrel	*Sciurus carolinensis*
Least Shrew	*Cryptotis parva*
Long-tailed Weasel	*Mustela frenata*
Marsh Rabbit	*Sylvilagus palustris*
Marsh Rice Rat	*Oryzomys palustris*
Oldfield Mouse	*Peromyscus polionotus*
Raccoon	*Procyon lotor*
Rafinesque's Big-eared Bat	*Corynorhinus rafinesquii*
River Otter	*Lontra Canadensis*
Round-tailed Muskrat	*Neofiber alleni*
Seminole Bat	*Lasiurus seminolus*
Short-tailed Shrew	*Blarina carolinensis*
Southeastern Shrew	*Sorex longirostris*
Southern Mink	*Mustela vison*
Spotted Skunk	*Spilogale putorius*
Striped Skunk	*Mephitis mephitis*
Virginia Opossum	*Didelphis virginiana*
White-tailed Deer	*Odocoileus virginianus*

Common Name	Scientific Name
Yellow Bat	*Lasiurus interimedius*
REPTILES	
Brown Water Snake	*Nerodia taxispilota*
Chicken Turtle	*Deirochelys reticularia*
Coachwhip	*Masticophis flagellum flagellum*
Common Musk Turtle	*Sternotherus adoratus*
Coral Snake	*Micrurus fulvius*
Corn Snake	*Elaphe guttata*
Crowned Snake	*Tantilla relicta*
Dusky Pigmy Rattlesnake	*Sistrurus miliarius*
Eastern Coachwhip	*Masticophis flagellum*
Eastern Diamondback Rattlesnake	*Crotalus adamanteus*
Eastern Garter Snake	*Thamnophis sirtalis*
Eastern Glass Lizard	*Ophisaurus ventralis*
Eastern Hognose Snake	*Heterodon platirhinos*
Fence Lizard	*Sceloporus undulatus*
Florida Box Turtle	*Terrapene carolina*
Florida Brown Snake	*Storeria dekayi*
Florida Pine Snake	*Pituophis melanoleucus*
Florida Scarlet Snake	*Cemophora coccinea*
Florida Scrub Lizard	*Sceloporus woodi*
Florida Softshell	*Apalone ferox*
Florida Water Snake	*Nerodia fasciata*
Florida Worm Lizard	*Rhineura floridana*
Gopher Tortoise	*Gopherus polyphemus*
Ground Skink	*Scincella lateralis*
Hognose Snake	*Heterodon platirhinos*
Northern Green Anole	*Anolis carolinensis*
Peninsula Cooter	*Pseudemys peninsularis*
Peninsular Crowned Snake	*Tantilla relicta*
Peninsular Ribbon Snake	*Thamnophis sauritus*
Red Rat Snake	*Elaphe guttata*

Common Name	Scientific Name
Rough Green Snake	*Opheodrys aestivus*
Sand Skink	*Neoseps reynoldsi*
Scarlet Kingsnake	*Lampropeltis triangulum*
Short-tailed Snake	*Stilosoma extenuatum*
Six-lined Racerunner	*Cnemidophorus sexlineatus*
Snapping Turtle	*Chelydra serpentine*
Southeastern Five-lined Skink	*Eumeces inexpectatus*
Southern Black Racer	*Coluber constrictor priapus*
Southern Ringneck Snake	*Diadophis punctatus*
Striped Crayfish Snake	*Regina alleni*
Striped Mud Turtle	*Kinosternon baurii*
Worm Lizard	*Amphisbaena alba*
Yellow Rat Snake	*Elaphe obsole*
AMPHIBIANS	
Barking Treefrog	*Hyla gratiosa*
Dwarf Salamander	*Eurycea quadridigitata*
Eastern Lesser Siren	*Siren intermedia*
Eastern Narrow-Mouthed Toad	*Gastrophryne carolinensis*
Eastern Spadefoot Toad	*Scaphiopus holbrooki*
Flatwoods Salamander	*Ambystoma cingulatum*
Florida (Southern) Chorus Frog	*Pseudacris nigrita*
Florida (Southern) Cricket Frog	*Acris gryllus*
Florida Leopard Frog	*Rana sphenocephala*
Green Treefrog	*Hyla cinerea*
Little Grass Frog	*Pseudacris ocularis*
Mole Salamander	*Ambystoma talpoideum*
Narrowmouth Toad	*Gastrophryne carolinensis*
Oak Toad	*Bufo quercicus*
Ornate Treefrog	*Pseudacris ornate*
Peninsula Newt	*Notophthalmus viridescens*
Pig Frog	*Rana grylio*
Pinewoods Treefrog	*Hyla femoralis*

Common Name	Scientific Name
Southern Dusky Salamander	*Desmognathus auriculatus*
Southern Mud Salamander	*Pseudotriton montanus*
Southern Toad	*Bufo terrestris*
Squirrel Treefrog	*Hyla squirella*
Striped Newt	*Notophthalmus perstriatus*
Tiger Salamander	*Ambystoma tigrinum*
FISH	
Bluegill	*Ameiurus nebulosus*
Brown Bullhead	*Gambusia holbrooki*
Eastern Mosquitofish	*Elassoma evergladei*
Everglades Pygmy Sunfish	*Lepisosteus platyrhincus*
Florida Gar	*Micropterus salmoides*
Largemouth Bass	*Heterandria formosa*
Least Killifish	*Etheostoma fusiforme*
Swamp Darter	*Lepomis gulosus*
Warmouth	*Lepomis macrochirus*

Refuge Insects and Gastropods

Common Name	Scientific Name
ANTS, BEES, WASPS, and SPIDERS	
Carpenter Ant	*Camponotus Sp.*
Chiggers	*Trombicula species*
Cone Ant	*Dorymyrmex sp.*
Crab Spider	*Thomisidae Sp.*
Daddy-Long-Legs Spider	*Pholcus phalangioides*
Deer Tick	*Blacklegged Tick*
Eastern Yellow Jacket	*Vespula maculifrons*
Florida Carpenter Ant	*Camponotus atriceps*
Fungus Ant	*Trachymyrmex septentrionalis*

Common Name	Scientific Name
Giant Scrub Plasterer Bee	*Caupolicana floridana*
Harvester Ant	*Pogonomyrmex badius*
Lake Wales Ridge Velvet Ant	*Dasymutilla archboldi*
Nocturnal Scrub Velvet Ant	*Photomorphus archboldi*
Paper Wasp	*Polistes sp.*
Pygmy Florida Velvet Ant	*Dasymutilla mickeli*
Red Fire Ant	*Solenopsis invicta*
Red Widow Spider	*Latrodectus bishopi*
Rosemary Wolf Spider	*Lycosa ericeticola*
Scrub Wolf Spider	*Geolycosa* spp.
Sugar Ant	*Camponotus consobrinus*
Wood Tick	*Dermacentor species*
GRASSHOPPERS and FLIES	
Arogos Skipper	*Atrytone arogos*
Bee Fly	*Bombyliidae sp.*
Berry's Skipper	*Euphyes berryi*
Broad Cercus Scrub Grasshopper	*Melanoplus forcipatus*
Flat-Footed Fly	*Ceuthophilus sp.*
Fruit Fly	*Drosophilidae*
Fungus Gnat	*Sciaridae*
Horse Fly	*Tabanus atratus*
House Fly	*Musca domestica*
House Mosquito	*Culex pipiens*
Humpback Fly	*Phoridae*
Rosemary Grasshopper	*Schistocerca ceratiola*
BUTTERFLIES, MOTHS, DRAGONFLIES, AND CADDISFLIES	
Cosmet Moths	*Cosmopterix sp.*

Common Name	Scientific Name
Emerald Moth	*Nemouria outina*
Floridian Triaenode Caddisfly	*Triaenodes florida*
Gelechiid Moths	*Dichomeris sp.*
House Moth	*Callima anthrax*
Loammi Skipper	*Atrytonopsis loammi*
Love Bug	*Plecia nearctica*
Maidencane Cruiser	*Didymops floridensis*
Monarch	*Danaus plexippus*
Rosemary Grasshopper	*Schistocerca certiola*
Sandhill Clubtail	*Gomphus cavillaris*
Tawny Sanddragon	*Progomphus alachuensis*
Tequesta Grasshopper	*Melanoplus tequestae*
BEETLES	
Blue Tortoise Beetle	*Hemisphaerota cyanea*
Gopher Tortoise Copris Beetle	*Copris gopheri*
Ladybug	*Adalia bipunctata*
Ox Beetle	*Strategus sp.*
Patent Leather Beetle	*Passalus cornutus*
Scarab Beetle	*Scarabaeidae sp.*
Scrub Palmetto Flower Scarab Beetle	*Trigonopeltastes floridana*
Scrub Scarab Beetle	*Geopsammodius relictillus*
Scrub Tiger Beetle	*Cicindela scabrosa*
OTHER INSECTS	
Camel Cricket	*Ceuthophilus sp.*
Gopher Cricket	*Gryllus sp.*
Leaf Roller Weevil	*Attelabos analis*
Leafhopper	*Cicadellidae*

Common Name	Scientific Name
Painted Ground Cricket	*Pictonemobius arenicola*
Palm Weevil	*Rhyncophora cruentata*
Pygmy Mole Cricket	*Neotridactylus apicialis*
Scrub Firefly	*Lucidota luteicollis*
Scrub Milipede	*Floridobolus penneri*
GASTROPODS	
Ridge Scrubsnail	*Praticolella bakeri*
Snail Slug	*Veronicella floridana*

Refuge Flora

Common Name	Scientific Name
Adam's Needle	*Yucca filamentosa*
American Beauty-Berry	*Callicarpa Americana*
American Nailwort	*Paronychia americana*
Atlantic St. John's Wort	*Hypericum gentianoides*
Beyrich Threeawn	*Aristida beyrichiana*
Blazing Star	*Liatris tenuifolia*
Bracken Fern	*Pteridium aquilinum*
Brown-Haired Snoutbean	*Rhynchosia cinerea*
Butterfly-weed	*Asclepias tuberosa*
Cabbage Palm	*Sabal palmetto*
Calusa Grape	*Vitis shuttleworthii*
Capillary Hairsedge	*Bulbostylis ciliatifolia*
Carolina Holly	*Ilex ambigua*
Carolina Stripeseed	*Piriqueta caroliniana*
Catbrier	*Smilax auriculata*
Chapman's Gayfeather	*Liatris chapmanii*
Chapman's Goldenrod	*Solidago chapmanii*
Chapman's Oak	*Quercus chapmanii*
Clammy Weed	*Polanisia tenuifolia*
Coastal Plain Staggerbush	*Lyonia fruticosa*
Coastal-plain honeycomb-head	*Balduina angustifolia*
Common Beggar-ticks	*Bidens alba*
Common Ragweed	*Ambrosia artemisiifolia*
Condensed Dicranum Moss	*Dicranum condensatum*
Corkscrew Threeawn	*Aristida gyrans*
Cudweed	*Gnaphalium pensylvanicum*

Common Name	Scientific Name
Cup Lichen	*Cladonia leporina*
Darrow's Blueberry	*Vaccinium darrowii*
Dixie Reindeer Lichen	*Cladonia subtenuis*
Dog Fennel	*Eupatorium capillifolium*
Dogtongue Wild Buckwheat	*Eriogonum tomentosum*
Dwarf Horseweed	*Conyza canadensis*
Dwarf Huckleberry	*Gaylusscacia dumosa*
Elliott's Bluestem	*Andropogon gyrans*
Evan's Reindeer Lichen	*Cladonia evansii*
Feay's Palafox	*Palafoxia feayi*
Feay's Prairie-Clover	*Dalea feayi*
Fetterbush	*Lyonia lucida*
Fireweed	*Erechtites hieracifolius*
Flag Paw-Paw	*Asimina obovata*
Flat-Top Bluet	*Houstonia procumbens*
Flat-Topped Goldenrod	*Euthamia tenuifolia*
Florida Alicia	*Chapmannia floridana*
Florida Bluestem	*Andropogon floridanus*
Florida Bully	*Bumelia reclinata*
Florida Greeneyes	*Berlandiera subacaulis*
Florida Milk-Pea	*Galactia regularis*
Florida Milkweed	*Asclepias feayi*
Florida Needle Grass	*Piptochaetium avenacioides*
Florida Rosemary	*Ceratiola ericoides*
Florida Scrub Frostweed	*Helianthemum nashii*
Florida Scrub Roseling	*Cuthbertia ornata*
Florida Sensitive-Briar	*Mimosa quadrivalvis*

Common Name	Scientific Name
Florida Toadflax	*Linaria floridana*
Forked Bluecurls	*Trichostema dichotomum*
Garberia	*Garberia heterophylla*
Golden Aster	*Pityopsis graminifolia*
Florida Gopher Apple	*Licania floridana*
Gopher Apple	*Licania michauxii*
Greater Florida Spurge	*Euphorbia floridana*
Hairy Dawnflower	*Stylisma villosa*
Hawk's Beard	*Hieracium megacephalon*
Hemlock Witchgrass	*Dichanthelium sabulorum*
Hog Plum	*Ximenia americana*
Inkberry	*Ilex glabra*
Jeweled Blue-eyed Grass	*Sisyrinchium xerophyllum*
Jointweet	*Polygala polygama*
Largeflower False Rosemary	*Conradina grandiflora*
Largeflower Jointweed	*Polygonella robusta*
Licorice Weed	*Scoparia dulcis*
Little Chalky Bluestem	*Andropogon virginicus*
Longleaf Pine	*Pinus palustris*
Lopsided Indiangrass	*Sorghastrum secundum*
Michaux's Hawthorn	*Crataegus mixchauii*
Munson's Grape	*Vitis munsoniana*
Muscadine Grape	*Vitis rotundifolia*
Myrtle Oak	*Quercus myrtifolia*
Nailwort	*Paronychia herniarioides*
Nodding Weed	*Lechea deckertii*
Pale Meadow Beauty	*Rhexia mariana*

Common Name	Scientific Name
Papery Whitlow Wort	*Paronychia chartacea*
Partridge Pea	*Chamaecrista fasciculata*
Pennsylvania Cudweed	*Gnaphalium pensylvanicum*
Piedmont Seymeria	*Seymeria pectinata*
Pineland Scaly-Pink	*Stipulicida setacea*
Pinewoods Milkweed	*Asclepias humistrata*
Poorland Flatsedge	*Cyperus retrorsus*
Powder Puff Lichen	*Cladina subtenuius*
Prickly-Pear Cactus	*Opuntia humifusa*
Rabbit Tobacco	*Pterocaulon pycnostachyum*
Reindeer Lichen	*Cladonia perforata*
Red Bay	*Persia borbonia*
Reindeer Moss	*Cladonia prostate*
Resurrection Fern	*Polypodium polypodioides*
Roundleaf Bluet	*Houstonia procumbens*
Rusty Lyonia	*Lyonia ferruginea*
Sand Blackberry	*Rubus cuneifolius*
Sand Pine	*Pinus clausa*
Sand Spikemoss	*Selaginella arenicola*
Sandspur	*Krameria lanceolata*
Sandy-Field Beaksedge	*Rhynchospora megalocarpa*
Savannah Milkweed	*Asclepias pedicellata*
Saw Palmetto	*Serenoa repens*
Scrub Hickory	*Carya floridiana*
Scrub Live Oak	*Quercus geminate*
Scrub Oak	*Quercus inopina*
Scrub Palmetto	*Sabal etonia*

Common Name	Scientific Name
Scurf Hoary-Pea	*Tephrosia chrysophylla*
Shiny Blueberry	*Vaccinium myrsinites*
Shortspike Bluestem	*Andropogon brachystachyus*
Scrub Bay	*Persea humilis*
Silver Buckthorn	*Bumelia tenax*
Sky-Blue Lupine	*Lupinus diffusus*
Slash Pine	*Pinus elliottii*
Small Ball-Moss	*Tillandsia recurvata*
Spanish Moss	*Tillandsia usneoides*
Spiderwort	*Tradescantia roseolens*
Spotless Balm	*Dicerandra immaculate*
Stinging Nettle	*Cnidoscolus stimulosus*
Sweet Bay	*Magnolia virginiana*
Texas signalgrass	*Panicum texanum*
Tomentose Milkweed	*Asclepias tomentosa*
Tough Bumelia	*Bumelia lacuum*
Silver Buckthorn (Tough Bully)	*Sideroxylon tenax*
Tracy's Bluestem	*Andropogon tracyi*
Trailing Milkvine	*Matelea pubiflora*
Turkey Oak	*Quercus laevis*
Upland Queen's Delight	*Stillingia sylvatica*
Viriginia Snakeroot	*Aristolochia serpentaria*
Ware's Hairsedge	*Bulbostylis warei*
Wavy-Leaf Noseburn	*Tragia urens*
Wax Myrtle	*Myrica cerifera*
Whitemouth Day-Flower	*Commelina erecta*
Wild Coffee	*Psychotria nervosa*

Common Name	Scientific Name
Wild Pine	*Tillandsia setacea*
Wiregrass	*Aristida beyrichiana*

State and Federally Listed Rare, Threatened, and Endangered Species of Lake Wales Ridge NWR

Scientific Names	Common Names	Agency Status in Florida		Location			
		FWS	FWC	FV	CC	LM	SC
Invertebrates							
Cicindela highlandensis	**Highlands tiger beetle**	C	N	X	X		X
Amphibians and Reptiles							
Alligator mississippiensis	**American alligator**	T(S/A)	SSC	X			
Drymarchon corais couperi	**Eastern indigo snake**	T	T	X			
Eumeces egregius lividus	**Bluetail mole skink**	T	T			X	
Rana capito	**Florida gopher frog**	N	SSC	X			
Sceloporus woodi	**Florida scrub lizard**	N	N	X	X	X	X
Gopherus polyphemus	**Gopher tortoise**	N	T	X	X	X	
Neoseps reynoldsi	**Sand skink**	E	E	X		X	X
Stilosoma extenuatum	**Short-tailed snake**	N	T				
Birds							
Aphelocoma coerulescens	**Florida scrub-jay**	T	T	X	X		
Haliaeetus leucocephalus	**Bald eagle**	N	T	X	X		
Mycteria americana	**Wood stork**	E	E	X			

Scientific Names	Common Names	Agency Status in Florida		Location			
		FWS	FWC	FV	CC	LM	SC
Polyborus plancus audubonii	**Crested caracara**	T	T				
Grus canadensis pratensis	**Sandhill crane**	N	T				
Falco peregrinus	**Peregrine falcon**	N	E				
Picoides borealis	**Red-cockaded woodpecker**	E	T				
Mammals							
Podomys floridanus	**Florida mouse**	N	SCC	X			
Puma concolor coryi	**Florida panther**	E	E	X*			
Ursus americanus floridanus	**Florida black bear**	N	T	X			
Eumops floridanus	**Florida bonneted bat**	C	E				
Flora							
Asclepias curtissii	**Curtiss' milkweed**	N	E	X	X	X	X
Bonamia grandiflora	**Florida bonamia**	T	E	X		X	X
Calamintha ashei	**Ashe's Calamint**	N	T				
*Chionanthus pygmaeus***	**Pygmy fringe-tree**	E	E	X	X		X
Cladonia perforata	**Florida perforate cladonia**	E	E			X	
Clitoria fragrans	**Pigeon-wing**	T	E	X	X		
Conradina brevifolia	**Short-Leaved Rosemary**	E	E				
Crotalaria avonensis	**Avon Park Harebells**	E	E				
Dicerandra frutescens	**Scrub Mint**	E	E				
Dicerandra christmanii	**Garrett's mint**	E	E	X			

Scientific Names	Common Names	Agency Status in Florida		Location			
		FWS	FWC	FV	CC	LM	SC
Drosera intermedia	**Spoon-Leaved Sundew**	N	T				
Eltroplectris calcarata	**Spurred Neottia**	E	E				
Eriogonum longifolium var. gnaphalifolium	**Scrub buckwheat**	T	E	X	X		
Eryngium cuneifolium	**Snakeroot**	E	E				
Hypericum cumulicola	**Highlands scrub hypericum**	E	E		X		
Lechea cernua	**Nodding pinweed**	N	T			X	
Liatris ohlingerae	**Florida blazing star**	E	E	X			
Lupinus aridorum	**Scrub lupine**	E	E			X	
Nolina brittoniana	**Britton's beargrass**	E	E		X	X	
Panicum abscissum	**Cutthroat grass**	N	E	X	X		
Paronychia chartacea spp. chartacea	**Paper-like nailwort (Papery Whitlow-wort**	T	E	X		X	
Persea humilis	**Scrub bay**	N	N	X		X	X
Polygala lewtonii	**Lewton's polygala**	E	E		X		
Polygonella basiramia	**Wireweed**	E	E			X	
Polygonella myrophylla	**Sandlace**	E	E	X		X	
Prunus geniculata	**Scrub plum**	E	E	X	X	X	X
Pteroglossaspis ecristata	**Giant Orchid**	N	T				
Schizachyrium niveum	**Scrub Bluestem**	N	E				
Stylisma abdita	**Scrub stylisma**	N	E			X	
Warea amplexifolia	**Wide-Leaf Warea**	E	E				

Scientific Names	Common Names	Agency Status in Florida		Location			
		FWS	FWC	FV	CC	LM	SC
Warea carteri	**Carter's warea (Carter's mustard)**	E	E	X	X		X
Ziziphus celata	**Florida ziziphus**	E	E		±		

Key: E = endangered, T = threatened, T(S/A) = listed due to similarity in appearance of a threatened species (American crocodile), C = candidate (FWS), SSC = species of special concern (FWC), N = Not listed or not being considered, X= unconfirmed*

Non-native Species Occurring on the refuge

Common Name	Scientific Name
PLANTS	
Australian Pine	*Casiarina equisetifolia*
Brazilian Pepper	*Schinus terebinthifolius*
Caesar-Weed	*Urena lobata*
Chinaberry	*Melia azedarach*
Cogon Grass	*Imperata cylindrica*
Common Dandelion	*Taraxacum officinale*
Golden Flamboyant	*Peltophorum pterocarpum*
Lantana	*Lantana camara*
Madagascar Periwinkle	*Catharanthus roseus*
Melaleuca	*Melaleuca quinquenervia*
Mimosa	*Albizia julibrissin*
Old World Climbing Fern	*Lygodium microphyllum*
Pacara Earpod Tree	*Enterolobium contortisiliquum*
Para Grass	*Brachiaria mutica*
Red Natalgrass	*Rhynchelytrum repens*
Rough Hairy Indigo	*Indigofera hirsute*

Common Name	Scientific Name
Sweet Orange	*Citrus sinensis*
Tropical Mexican Clover	*Richardia brasiliensis*
Wild Balsam Apple	*Momoridica charantia*
FISHES	
Brown Hoplo	*Hoplosternum littorale*
Walking Catfish	*Clarias batrachus*
AMPHIBIANS	
Cuban Treefrog	*Osteopilus septentrionalis*
MAMMALS	
Coyote	*Canis latrans*
Feral Hog	*Sus scrofa*
Jaguarundi	*Herpailurus yaguarondi*
Nine-banded Armadillo	*Dasypus novemcinctus*

Appendix X. Budget Requests

Refuge budget requests are contained in the Service's Refuge Operating Needs System (RONS) and Service Asset and Maintenance Management System (SAMMS) database. RONS and SAMMS lists are constantly updated and include priority projects. Contact the refuge for the most current RONS and SAMMS lists. Please refer to Chapter V, Plan Implementation, for key budget requests which are linked to applicable objectives, and Table 25 which identifies staff, first year costs, and recurring costs for the outlined projects.

Appendix XI. List of Preparers

Fred Adrian, *Administrative Forester*, Merritt Island NWR Complex, USFWS

Dave Bender, *Botanist,* South Florida Field Office, Ecological Services, USFWS

Boyd Blihovde, *Fire Management Specialist*, Merritt Island NWR Complex, USFWS

George Dennis, *PhD., Fish and Wildlife Biologist*, South Florida Field Office, Ecological Services, USFWS

Cheri M. Ehrhardt, *AICP, Natural Resource Planner*, USFWS

Layne Hamilton, Project leader, Merritt Island NWR Complex, USFWS

Ron Hight, *Former Project Leader*, Merritt Island NWR Complex, USFWS

Mike Jennings, *Fish and Wildlife Biologist*, North Florida Field Office Ecological Services, USFWS

Kristen Kneifl, *Wildlife Biologist*, Pelican Island NWR Complex, USFWS

Ralph Lloyd, *Deputy Project Leader*, Merritt Island NWR Complex, USFWS

Mike McMillian, *Wildlife Biologist III*, Lake Wales Ridge Wildlife and Environmental Area, Florida Fish and Wildlife Conservation Commission

Bill Miller, *Fish and Wildlife Biologist/Natural Resource Planner*, USFWS

Charles Pelizza, *Refuge Manager*, Pelican Island NWR Complex, USFWS

Glen Stratton, *Fire Management Officer*, District 5, Merritt Island NWR Complex, USFWS

Joanna Webb, *Senior Refuge Ranger*, Pelican Island NWR Complex, USFWS

Dorn Whitmore, *Wildlife Management Specialist*, Merritt Island NWR Complex, USFWS

Nick Wirwa, *Wildlife Management Specialist*, Pelican Island NWR Complex, USFWS

Barry Wood, *Information Technology Specialist GIS Specialist*, South Florida Field Office, Ecological Services, USFWS

Appendix XII. Consultation and Coordination

OVERVIEW

The Lake Wales Ridge NWR comprehensive conservation planning process involved a wide variety of participants, including federal, state, and local governments; universities and other researchers; and private non-profit groups; as well as a wide variety of local residents, local businesses, and concerned citizens. The list of participants, beyond those individuals and organizations providing comments during the public review process, includes the Core CCP Planning Team, the Wildlife and Habitat Management Review Team, the Visitor Services Review Team, the Wilderness Review Team, and the Intergovernmental Coordination Planning Team.

CORE CCP PLANNING TEAM

The Core Planning Team included representatives from the Service and State of Florida. The team met as a whole to review the issues, determine priority issues, and identify potential solutions and approaches

U.S. Fish and Wildlife Service

- Fred Adrian, Administrative Forester, Merritt Island NWR Complex
- Dave Bender, Fish and Wildlife Botanist, South Florida Field Office, Ecological Services
- Boyd Blihovde, Fire Management Specialist, Merritt Island NWR Complex
- George Dennis, PhD., Fish and Wildlife Biologist, South Florida Field Office, Ecological Services
- Cheri Ehrhardt, AICP, Natural Resource Planner
- Ron Hight, Former Project Leader, Merritt Island NWR Complex
- Mike Jennings, Fish and Wildlife Biologist, North Florida Field Office, Ecological Services
- Kristen Kneifl, Wildlife Biologist, Pelican Island, Archie Carr, and Lake Wales Ridge NWRs, Merritt Island NWR Complex
- Ralph Lloyd, Deputy Project Leader, Merritt Island NWR Complex
- William Miller, Fish and Wildlife Biologist/Natural Resource Planner
- Charles Pelizza, Wildlife Refuge Manager, Pelican Island, Archie Carr, and Lake Wales Ridge NWRs, Merritt Island NWR Complex
- Glen Stratton, Fire Management Officer, District 5, Merritt Island NWR Complex
- Joanna Webb, Park Ranger, Pelican Island, Archie Carr, and Lake Wales Ridge NWRs, Merritt Island NWR Complex
- Dorn Whitmore, Wildlife Management Specialist, Merritt Island NWR Complex
- Nick Wirwa, Wildlife Management Specialist, Pelican Island, Archie Carr, and Lake Wales Ridge NWRs, Merritt Island NWR Complex
- Barry Wood, Information Technology Specialist (GIS), South Florida Field Office, Ecological Services

Florida Fish and Wildlife Conservation Commission

- Mike McMillian, Wildlife Biologist III, Lake Wales Ridge Wildlife and Environmental Area

WILDLIFE AND HABITAT MANAGEMENT AND VISITOR SERVICES REVIEW TEAM

A Wildlife and Habitat Management Review was conducted May 23-26, 2005 at ABS in Lake Placid, Florida. The Wildlife and Habitat Management Review Team included a core group of Service staff with invited participants. A total of 24 persons were invited to take part in the Lake Wales Ridge

NWR Wildlife and Habitat Management Review, including representatives from the Service's divisions of Refuges, Ecological Services, Migratory Birds, and Fisheries. Outside of the Service, invitees included representatives from the University of Central Florida, ABS, TNC, and Polk County government. The mixture of scientists and managers ensured a high-quality and impartial review of refuge resources and issues. The Lake Wales Ridge NWR Visitor Services Review was conducted as part of the Wildlife and Habitat Management Review on May 23-26, 2005. Attendees included:

U.S. Fish and Wildlife Service

- Fred Adrian, Administrative Forester, Merritt Island NWR Complex
- Boyd Blihovde, Fire Management Specialist, Merritt Island NWR Complex
- Dave Brownlie, Regional Fire Ecologist, Southeastern Region
- Cheri Ehrhardt, AICP, Natural Resource Planner
- Marc Epstein, Supervisory Biologist, Merritt Island NWR Complex
- Ron Hight, Former Project Leader, Merritt Island NWR, Former Refuge Manager Lake Wales Ridge NWR
- Marilyn Knight, Fish and Wildlife Biologist, South Florida Field Office, Ecological Services
- Dave Martin, Former Fish and Wildlife Biologist, South Florida Field Office, Ecological Services
- Larry Richardson, Wildlife Biologist, Florida Panther NWR
- Glen Stratton, Fire Management Officer, District 5, Merritt Island NWR Complex
- Susan Trokey, Realty Specialist, Southeast Region
- Dorn Whitmore, Assistant Refuge Manager, Merritt Island NWR Complex

Experts and Partners

- Ryan Kordek, Principal Transportation Planner, Polk County
- Eric Menges, Plant Ecologist, Archbold Biological Station
- Kevin Main, Land Manager, Archbold Biological Station
- Steve Morrison, Preserve Manager, The Nature Conservancy
- Jack Stout, Professor, Ecology and Conservation Biology, University of Central Florida
- Carl Weekley, Plant Ecologist, Archbold Biological Station

WILDERNESS REVIEW TEAM

The Wilderness Review Team involved the Merritt Island NWR Complex project leader, key visitor service and fire management staff from the Merritt Island NWR Complex, and natural resource planners. The Review was completed on May 1, 2008.

U.S. Fish and Wildlife Service

- Boyd Blihovde, Prescribed Fire Specialist, Merritt Island NWR Complex
- Cheri M. Ehrhardt, AICP, Natural Resource Planner
- Ron Hight, Former Project Leader, Merritt Island NWR Complex
- William Miller, Fish and Wildlife Biologist/Natural Resource Planner
- Dorn Whitmore, Wildlife Management Specialist, Merritt Island NWR Complex

INTERGOVERNMENTAL COORDINATION PLANNING TEAM

The Intergovernmental Coordination Planning Team included representatives of local, state, and federal government field staff representatives involved with resources at the local level. Individuals representing federal, state and local governmental interests including the Fish and Wildlife Service,

Avon Park Air Force Range, Natural Resources Conservation Service (U.S. Department of Agriculture), Florida Fish and Wildlife Conservation Commission, Florida Park Service, Florida Division of Forestry, Southwest Florida Water Management District, Polk County Natural Resources Division, Highlands County Planning Department, and Highlands County Soil and Water Conservation District met on September 25, 2008, to discuss issues. Additional public partners were invited to participate on the Intergovernmental Coordination Team including representatives from the South Florida Water Management District and the Seminole Tribe of Florida; however, these members were unfortunately unable to attend the September 25, 2008 meeting. Input was provided through direct correspondence with those that could not attend.

U.S. Fish and Wildlife Service

- Boyd Blihovde, Prescribed Fire Specialist, Merritt Island NWR Complex
- Cheri M. Ehrhardt, AICP, Natural Resource Planner
- Dave Bender, Fish and Wildlife Botanist, South Florida Field Office, Ecological Services
- Dorn Whitmore, Wildlife Management Specialist, Merritt Island NWR Complex
- George Dennis, PhD., Fish and Wildlife Biologist, South Florida Field Office, Ecological Services
- Mike Jennings, Fish and Wildlife Biologist, North Florida Field Office, Ecological Services
- Nick Wirwa, Acting Refuge Manager, Pelican Island NWR Complex
- Ron Hight, Former Project Leader, Merritt Island NWR Complex
- William Miller, Fish and Wildlife Biologist/Natural Resource Planner

Seminole Tribe of Florida

- Sarah Webber, Wildlife Biologist, Environmental Resource Management Department, Seminole Tribe of Florida

U.S. Avon Park Air Force Range

- Mark Fredlake, Wildlife Biologist, ES Program U.S. Avon Park Air Force Range
- Kurt Olsen, Forester, U.S. Avon Park Air Force Range
- Amy Clifton, Biologist, Archbold Biological Station representing U.S. Avon Park Air Force Range

U.S. Department of Agriculture, National Resources Conservation Service

- Carlos Torres, District Conservationist, Natural Resources Conservation Service, Florida Area 4

State of Florida

- Mike McMillian, Wildlife Biologist III, Lake Wales Ridge Wildlife and Environmental Area, Florida Fish and Wildlife Conservation Commission
- Terry Hingtgen, Environmental Scientist III, District IV, Florida Park Service
- Dave Butcher, Resource Manager, Lake Wales Ridge State Forest, Florida Division of Forestry
- Erik Egensteiner, Park Biologist, Lake Kissimmee State Park
- Stephanie Green, Senior Land Management Specialist, Land Resources Division, SWFWMD
- Peter Anderson, Park Manager, Highlands Hammock and Lake June in Winter Scrub State Park
- Jeff McLemore, Senior Environmental Analyst, South Florida Water Management District

Highlands County

- Janice McCarthy, Senior Planner, Highlands County Planning Department
- Corine Burgess, Natural Resources Specialist II, Highlands County Natural Resources Department
- Erin McCarta, Lake Management Assistant Technician, Highlands County Natural Resources Department

Polk County

- Gaye Sharpe, Environmental Lands Coordinator, Polk County Natural Resources Division

Appendix XIII. Finding of No Significant Impact

INTRODUCTION

The U.S. Fish and Wildlife Service (Service) proposes to protect and manage certain fish and wildlife resources in Highlands and Polk Counties, Florida, through the Lake Wales Ridge National Wildlife Refuge (NWR). An Environmental Assessment (EA) was prepared to inform the public of the possible environmental consequences of implementing the Comprehensive Conservation Plan (CCP) for Lake Wales Ridge NWR. A description of the alternatives, the rationale for selecting the preferred alternative, the environmental effects of the preferred alternative, the potential adverse effects of the action, and a declaration concerning the factors determining the significance of effects, in compliance with the National Environmental Policy Act of 1969, are outlined below. The supporting information can be found in the EA, Section B of the Draft CCP.

ALTERNATIVES

In developing the CCP for Lake Wales Ridge NWR, the Service evaluated three alternatives with different focuses for future management, as listed.

Alternative A – Current Management (No Action Alternative)
Alternative B – Rare, Threatened, and Endangered Species (Preferred Alternative)
Alternative C – Wildlife and Habitat Diversity

The different management focuses of the action alternatives represent different philosophies and approaches to refuge management, messages delivered, priority setting, and decision making.

The Service adopted Alternative B, the "Preferred Alternative," as the CCP for guiding the direction of the Lake Wales Ridge NWR for the next 15 years. The overriding concern reflected in this CCP is that rare, threatened, and endangered species assumes first priority in refuge management.

Alternative A – (No Action) Continuation of Current Management

Alternative A continues refuge management activities and programs at levels similar to past management and provides a baseline for comparison of the action alternatives. Management emphasis would continue to focus on maintaining existing habitats for rare, threatened, and endangered species through partnerships and management agreements. Primary management activities would continue to include providing infrequent and limited habitat management through the application of prescribed fire; rare, threatened, and endangered species monitoring through partnerships; litter and debris control; and through the control of exotic, invasive, and nuisance species. Alternative A represents the anticipated conditions of the refuge for the next 15 years assuming current funding, staffing, policies, programs, and activities continue. The other two alternatives are compared to this alternative in order to evaluate differences in future conditions compared to baseline management.

This alternative reflects actions that include managing habitats for rare, threatened, and endangered species. Many federal and state listed species are found on the refuge; however, monitoring and specific management of most species would be limited due to staffing constraints. Habitat management actions are intended to benefit rare, threatened, and endangered species, but there is limited active management of other species and habitats due to the refuge's unstaffed and unfunded

conditions. As a result, the refuge would continue to rely almost entirely on the actions and assistance of partners and volunteers to conduct a wide array of resource management activities, including monitoring of key refuge resources.

Management coordination would occur primarily between the refuge and the Lake Wales Ridge Ecosystem Working Group (LWREWG) – a consortium of federal, State, local, and non-governmental land management organizations where natural area management information is shared in an effort to increase the understanding and awareness of the Lake Wales Ridge ecosystem.

Land acquisition would continue based on a willing seller approach within the refuge's approved acquisition boundary, and where opportunities arise, through the LWREWG or other initiatives on a case-by-case basis. Management agreements between the refuge and partner agencies/organizations would be a primary focus resulting from the refuge's unstaffed and unfunded condition. In this capacity, the refuge would actively seek management agreements in all areas of resource management with partners.

The refuge would remain closed and access for management purposes would be conducted solely through the refuge's special use permit process. On a case-by-case basis, extremely limited access for environmental education and interpretation opportunities might occur. The refuge would actively support key Lake Wales Ridge ecosystem partner managed lands that are open to public use by identifying and updating links to partner websites on the refuge's official website.

The refuge would remain unstaffed and administered through the Pelican Island NWR Complex. Volunteer activities would continue to be supported through the Merritt Island Wildlife Association and the Pelican Island NWR Complex staff. Partnerships through the LWREWG and the Service's South and North Florida Ecological Services field offices would continue. The refuge would continue to opportunistically seek funding for habitat management, monitoring, and other program areas through alternative sources.

Alternative B – (Preferred Alternative) Rare, Threatened, and Endangered Species

This alternative expands on Alternative A with a greater amount of active habitat management focusing primarily on the restoration and enhancement of existing habitats to benefit the needs of rare, threatened, and endangered species. Twenty-three federally listed species (17 plants and 6 animals) and one federal candidate species are known to occur on the roughly 1,844-acre refuge - some of which are protected nowhere else but on refuge lands. In addition, this endemic-rich refuge is home to at least 33 State listed species including 11 species (5 plants and 6 animals) that are not listed federally.

One key to this alternative is a focused effort to expand management activities through the implementation of a frequent, routine prescribed fire program to restore pyrogenic habitats to pre-fire exclusion conditions. This focused approach would provide for the restoration of a mosaic of suitable habitats, including xeric scrub lands, sandhills, open sand patches, and ephemeral wetlands necessary to maintain and expand populations of the refuge's rare, threatened, and endangered species. This restorative process may exceed the 15-year life of the CCP for some habitats. Once pre-fire exclusion conditions are attained, fire return intervals would be adapted based on rare, threatened, and endangered species and habitat responses provided through fire effects monitoring. As habitats are restored, the refuge would investigate potential expansion of rare, threatened, or endangered species introduction/reintroduction projects, coordinating and collaborating with partners through the LWREWG to identify best management opportunities.

This alternative would expand the monitoring efforts of Alternative A to provide additional, active efforts to monitor rare, threatened, and endangered species. Monitoring efforts would be increased with the assistance of additional staff, trained volunteers, and academic research. Greater effort would be made to recruit academic research to the refuge to study and monitor rare, threatened, and endangered species. Under this alternative, the refuge would increase efforts to control invasive and nuisance species; assume a leadership role in identifying the impacts of climate change on rare, threatened, and endangered species; and increase coordination with researchers and partners to investigate rare, threatened, and endangered species response to changing patterns of suitable habitats.

This alternative proposes to continue pursuing completion of the acquisition boundary from willing sellers, prioritizing acquisition efforts on unprotected, undeveloped inholdings where threats of habitat loss and constraints to habitat management are greatest. The refuge would evaluate a variety of land protection and conservation measures (including land swaps) to protect high-quality properties.

Expanding public awareness and support for the refuge and partner managed lands of the Lake Wales Ridge ecosystem is an important component of this alternative. The refuge plans to implement a range of visitor service opportunities controlled through an approval process. The refuge would remain closed to visitor use. Increased public awareness and appreciation for the refuge and the Lake Wales Ridge ecosystem, environmental education and interpretation, and wildlife observation and photography opportunities are also proposed. The refuge would implement guided tours provided by Service staff or Service partners on a case-by-case basis and permitted through the refuge's special use permit process. In addition, the refuge would develop and conduct an annual refuge day where guided tours, information, and refuge awareness through community outreach would be provided. In addition, updated messages on both the refuge's website and brochure would be provided, focusing on the needs of rare, threatened, and endangered species. Further, the refuge would work with the partners to incorporate these messages on partner distributed information.

The refuge would increase involvement with the governmental and non-governmental partners through the LWREWG and would be positioned to increase Service presence with other partner organizations when opportunities arise. Coordination with both South and North Florida Ecological Services field offices for funding and recovery direction would be expanded to optimize listed species management, and opportunities to build additional support through the Merritt Island Wildlife Association, Pelican Island Preservation Society, and Friends of the Carr Refuge would increase.

The refuge would gain staff to fulfill the goals, objectives, and strategies identified in the CCP and staff would be situated to manage all day-to-day operations. The Lake Wales Ridge NWR is presently administered remotely and has no dedicated staff or budget. The refuge is located approximately 100 to 130 miles from fire management support (the Merritt Island NWR Complex) and approximately 80 to 100 miles from its Pelican Island NWR Complex management team. This situation considerably challenges all day-to-day operations and management necessary to provide for the needs of rare, threatened, and endangered species and the habitats they occupy. This alternative proposes a five member staff, including a wildlife refuge specialist (assistant refuge manager), a private lands biologist, a botanist/biologist, a biological science technician, and a fire/forestry technician to manage refuge programs and provide a Service presence presently currently lacking in the Lake Wales Ridge system of naturally managed lands. The proposed staff would be located in close proximity to refuge lands in order to manage day-to-day operations of the refuge. To support operations and maintenance, the refuge would enter into memoranda of understanding (MOUs) or other agreements with partners and/or secure independent spaces for equipment storage, operational functions, and refuge administrative needs. This alternative proposes to bolster refuge management by investigating opportunities to enter into management agreements and other options with partner land management agencies and organizations thereby enabling partner management of Service properties in accordance with the CCP,

subsequent step-down plans, and Service policies. The refuge would continue to share facilities, equipment, utilities, and staff with Pelican Island and Archie Carr NWRs and Merritt Island NWR would continue to provide fire program staff.

Alternative C – Wildlife and Habitat Diversity

This alternative seeks to serve the needs of key rare, threatened, and endangered species on the refuge, but within the larger context of wildlife and habitat diversity. Under this alternative, focused efforts utilizing prescribed fire to restore habitats to pre-fire exclusion conditions would be proposed, targeting the needs of a wide array of native wildlife and habitats to benefit the larger Lake Wales Ridge and central Florida landscape. The refuge would continue to support recovery efforts of key listed species and expand efforts to provide opportunities targeting the needs of neotropical migratory birds, resident birds, wading and water birds, shorebirds, raptors, cavity-dependent species, and other resident species. Habitats where pines dominate the overstory would be managed to provide more pine stems per acre to promote habitat for cavity-dependent birds. Understory, shrub, and canopy vegetation would be managed to provide for a diversity of wildlife, and snag development would be encouraged to provide cavities and perch sites and to promote insect development. Where appropriate, burn frequencies would be reduced to provide for the production of saw palmetto for use as forage by wildlife, including Florida black bear. The refuge would investigate management opportunities with the Atlantic Coast Joint Venture and would support management of migratory birds. Through partnerships, wading and water bird surveys would be conducted to better understand the refuge's management role at the landscape level. Management to protect important habitat and wildlife corridors would increase under this alternative and invasive and nuisance species control efforts would expand.

This alternative would expand monitoring efforts of Alternative A to provide additional, active efforts to monitor neotropical migratory and resident birds in addition to other resident species. Monitoring efforts would be increased with the assistance of additional staff, trained volunteers, and academic research. The refuge would take a leadership role in identifying the impacts of climate change on refuge resources, coordinating with researchers and partners to investigate species response to changing patterns of suitable habitats.

Under this alternative, the refuge would remain closed to visitor use except for limited and guided environmental education and interpretation, wildlife observation and photography opportunities by Service staff or Service approved volunteers and partners. Education, interpretation, and outreach messages would focus on the importance of the refuge in the landscape and wildlife and habitat diversity and would include listed species as a key topic of this element. Further, the refuge would work with the partners to incorporate applicable messages into their visitor activities and signage. The refuge would develop and conduct an annual refuge day to promote refuge awareness. This alternative seeks to expand partnerships and would work with the partners including the LWREWG environmental education subcommittee to expand environmental education and interpretation opportunities to refuge lands.

Similar to Alternative B, the refuge would gain staff to fulfill the outlined management direction and staff would be located locally to manage all day-to-day operations of the refuge. Direct management of the refuge would be conducted through the addition of four staff positions, including a Wildlife Refuge Specialist (Assistant Refuge Manager), a Private Lands Biologist, a Botanist/Biologist, and a Fire/Forestry Technician. To support operations and maintenance, the refuge would enter into memoranda of understanding (MOUs) or other agreements with the partners and/or secure independent spaces for equipment storage, operational functions, and refuge administrative needs. This alternative also proposes to bolster refuge management by investigating opportunities to enter

into management agreements and other options with partner land management agencies and organizations, thereby enabling partner management of Service properties in accordance with the CCP, subsequent step-down plans, and Service policies. The refuge would continue to share facilities, equipment, utilities, and staff with Pelican Island and Archie Carr NWRs and Merritt Island NWR would continue to provide fire program staff.

SELECTION RATIONALE

Alternative B was selected for implementation because it directs the development of programs to best achieve the refuge's purpose and goals; emphasizes rare, threatened, and endangered species; collects habitat and wildlife data; and ensures long term achievement of refuge and Service objectives. At the same time, these management actions provide balanced levels of compatible public use opportunities consistent with existing laws, Service policies, and sound biological principles. It provides the best mix of program elements to achieve desired long term conditions.

Under this alternative, all lands under the management and direction of the refuge will be protected, maintained, and enhanced to best achieve national, ecosystem, and refuge specific goals and objectives within anticipated funding and staffing levels. In addition, the action positively addresses priority issues and concerns expressed by the public.

ENVIRONMENTAL EFFECTS

Implementation of the Service's management action is expected to result in environmental, social, and economic effects as outlined in the Draft CCP/EA. Habitat management, population management, and land conservation activities on Lake Wales Ridge NWR would result in increased management and protection of wildlife populations; rare, threatened, and endangered species and the habitats they occupy; cultural resources; and enhanced visitor services. These effects are detailed as listed.

Implementing the preferred alternative is anticipated to result in increased protection for rare, threatened, and endangered species on the refuge. Increased information on a variety of species, suites of species, and habitats will enhance decision-making for the refuge. Further benefits will be realized from increased efforts to restore habitats to pre-fire exclusion conditions through the implementation of a routine prescribed fire management program and the control of exotic, invasive, and nuisance species. The refuge will coordinate with the partners to address concerns related to the impacts from water quality, quantity, and from impacts related to stressors including climate change and landscape level impacts to species and habitats associated with land development and changing land use patterns. Resource protection will be enhanced, including through increased law enforcement presence and enhanced boundary protection. Protection of cultural resources will be enhanced and improved coordination with the partners will enhance all refuge resource areas. The refuge will remain closed except for refuge led/approved guided tours and events to achieve restoration objectives. To achieve this, the refuge will work with governmental and non-governmental partners, area communities, the Lake Wales Ridge Ecosystem Working Group, and local businesses in addition to pursuing the addition of staff to address management concerns.

POTENTIAL ADVERSE EFFECTS AND MITIGATION MEASURES

Water Quality from Soil Disturbance and Use of Herbicide Use

Soil disturbance and siltation due to wetland management activities is expected to be minor and of short duration. To further reduce potential impacts, the refuge would use best management practices to minimize the erosion of soils into water bodies.

Long-term herbicide use for exotic plant control could result in a slight decrease in water quality in areas prone to exotic plant infestations. Through the proper application of herbicides and adjuvants appropriate to site specific conditions, herbicidal control of exotic and nuisance plants seeks to benefit the environmental health and integrity of the refuge. Appropriately used herbicides and adjuvants may have a minimal, short term impact on water quality in the immediate vicinity of the application where unexpected rain events or high winds may move recently applied, highly mobile herbicides. The use of site appropriate herbicides is a proven, standard methodology to control and manage exotic and nuisance plant infestations presently degrading native plant and wildlife habitats throughout Florida and proper application following label requirements greatly reduces risks to water quality. Every effort would be employed to ensure proper and appropriate application of herbicides to control noxious weeds throughout the refuge.

Wildlife Disturbance

Disturbance to wildlife is an unavoidable consequence of any public use program, regardless of the activity involved. And, the preferred action includes only limited and highly controlled public use activities on the refuge. While some activities may be less disturbing than others, all of the public use activities outlined under the preferred action would be planned to avoid unacceptable levels of impact.

Known and anticipated levels of disturbance from the preferred action are not anticipated to be significant. Nevertheless, the refuge would manage public use activities to minimize impacts and to ensure appropriateness and compatibility. Wildlife observation may result in minimal disturbance to wildlife, however, any planned use would be limited and controlled and provided through a refuge approved guide due to the closed nature of the refuge. If the refuge determines that impacts from the proposed visitor uses are above acceptable levels, those uses would be modified, discontinued, restricted, or rerouted to other less sensitive areas and/or to partner properties to minimize impacts.

Vegetation Disturbance

Negative impacts could result from the maintenance of fire lines and unimproved roads for Service and researcher access that require maintenance of vegetation along their lengths. Every effort would be made to ensure disturbance to rare plants and wildlife is reduced or eliminated through fire plan implementation efforts, including rerouting lines to limit disturbance to rare species.

User Group Conflicts

Although the refuge is closed, illicit public use has provided management challenges for the refuge. These challenges are provided for in all action alternatives. Due to the closed nature of the refuge, conflicts between different user groups are not anticipated. However, if conflicts occur with permitted special uses, such as for research or refuge led environmental education/interpretation opportunities, the refuge would adjust its programs, as needed, to eliminate or minimize any resulting issues. The refuge would use methods that have proven to be effective in reducing or eliminating permitted special use conflicts. These methods include establishing separate use areas, different use periods,

and limits on the numbers of special use permits in order to provide safe, quality, appropriate, and compatible, permitted special use opportunities.

Effects on Adjacent Landowners

Implementation of the preferred action is not expected to negatively affect owners of private lands adjacent to the refuge. Positive impacts that would be expected include higher property values, less intrusion of invasive exotic plants, and increased opportunities for viewing more diverse wildlife.

However, some negative impacts may occur. To help minimize these potential impacts on adjacent landowners, the refuge would work with the partners to provide informational signs that clearly mark refuge and partner boundaries; use law enforcement; and provide increased educational and outreach efforts. Prescribed burning could negatively impact adjacent landowners, but the refuge would minimize effects by informing the public well in advance of any burns. Prescribed burning on refuge lands would benefit adjacent landowners by decreasing fuel loads and minimizing the risk of catastrophic wildfire.

Land Ownership and Site Development

Land acquisition efforts by the Service could lead to changes in land use and recreational use patterns. However, most of the non-Service and non-partner owned lands within the refuge's approved acquisition boundary that are targeted for acquisition are currently undeveloped. As any lands are acquired as additions to the refuge, they would be maintained in a natural state, managed for native wildlife populations in accordance with goals, objectives, and strategies developed in the CCP and in subsequent step-down management plans. Additional lands acquired for the refuge would be evaluated for appropriate and compatible wildlife-dependent public uses.

Potential development of any refuge structures, including fence construction and maintenance or other improvements (e.g., boundary and informational signs), could lead to minor short-term discrete negative impacts on plants, soils, and some wildlife species. When building structures, efforts would be made to use recycled products and environmentally sensitive treated lumber. All construction activities would comply with the requirements of Section 404 of the Clean Water Act; the National Historic Preservation Act; Executive Order 11988, Floodplain Management; and other applicable regulatory requirements.

COORDINATION

The management action has been thoroughly coordinated with all interested and/or affected parties. Parties contacted include those listed.

All affected landowners
Congressional representatives
Governor of Florida
Seminole Tribe of Florida
Florida Fish and Wildlife Conservation Commission
Florida State Historic Preservation Officer
Florida Department of Environmental Protection
South Florida Water Management District
Southwest Florida Water Management District
Avon Park Air Force Range
Natural Resources Conservation Service

Florida Department of Agriculture and Consumer Services
Polk County
Highlands County
Central Florida Regional Planning Council
Local community officials
Interested citizens
Conservation organizations
Area media

FINDINGS

It is my determination that the management action does not constitute a major federal action significantly affecting the quality of the human environment under the meaning of Section 102(2)(c) of the National Environmental Policy Act of 1969 (as amended). As such, an environmental impact statement is not required. This determination is based on the listed factors (40 C.F.R. 1508.27), as addressed in the Environmental Assessment of the Draft Comprehensive Conservation Plan for Lake Wales Ridge National Wildlife Refuge.

1. Both beneficial and adverse effects have been considered and this action will not have a significant effect on the human environment. (Environmental Assessment, pages 299-326).

2. The actions will not have a significant effect on public health and safety. (Environmental Assessment, pages 299, 301-302, 323-324).

3. The project will not significantly affect any unique characteristics of the geographic area such as proximity to historical or cultural resources, wild and scenic rivers, or ecologically critical areas. (Environmental Assessment, pages 299-300, 317, 323-324).

4. The effects on the quality of the human environment are not likely to be highly controversial. (Environmental Assessment, pages 299-302, 304-320, 323-325).

5. The actions do not involve highly uncertain, unique, or unknown environmental risks to the human environment. (Environmental Assessment, pages 299-326).

6. The actions will not establish a precedent for future actions with significant effects nor do they represent a decision in principle about a future consideration. (Environmental Assessment, pages 299-326).

7. There will be no cumulatively significant impacts on the environment. Cumulative impacts have been analyzed with consideration of other similar activities on adjacent lands, in past action, and in foreseeable future actions. (Environmental Assessment, pages 323-324).

8. The actions will not significantly affect any site listed in, or eligible for listing in, the National Register of Historic Places, nor will they cause loss or destruction of significant scientific, cultural, or historic resources. (Environmental Assessment, pages 299-300, 317, 323-325).

9. The actions are not likely to adversely affect threatened or endangered species, or their habitats. (Environmental Assessment, pages 304-316, 321, 323-324).

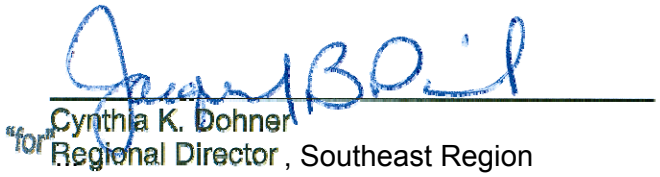
10. The actions will not lead to a violation of federal, state, or local laws imposed for the protection of the environment. (Environmental Assessment, pages 299-326).

SUPPORTING REFERENCES

U.S. Fish and Wildlife Service. 2010. Draft Comprehensive Conservation Plan and Environmental Assessment for Lake Wales Ridge National Wildlife Refuge, Polk and Highlands Counties, Florida. U.S. Department of the Interior, Fish and Wildlife Service, Southeast Region. 466pp.

DOCUMENT AVAILABILITY

The Environmental Assessment was Section B of the Draft Comprehensive Conservation Plan for Lake Wales Ridge National Wildlife Refuge. The Draft CCP/EA was made available for public review and comment on April 30, 2010. Additional copies are available by writing: Project Leader, Lake Wales Ridge NWR, 1339 20th Street, Vero Beach, Florida 32960.



Cynthia K. Dohner
"for" Regional Director, Southeast Region

SEP 23 2010
Date