Merritt Island National Wildlife Refuge

Comprehensive Conservation Plan

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

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COMPREHENSIVE CONSERVATION PLAN

MERRITT ISLAND NATIONAL WILDLIFE REFUGE

Brevard and Volusia Counties, Florida

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

Southeast Region
Atlanta, Georgia

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Executive Summary

The U.S. Fish and Wildlife Service developed this Comprehensive Conservation Plan (CCP) and Final Environmental Assessment (EA) to guide the management of Merritt Island National Wildlife Refuge in Brevard and Volusia Counties, Florida. The plan outlines the refuge's programs and corresponding resource needs for the next 15 years, as mandated by the National Wildlife Refuge System Improvement Act of 1997.

As part of the planning process, the Service conducted a biological review of the refuge's wildlife and habitat management program and a visitor services review of the refuge's public use program. The Service also held a series of eight public scoping and stakeholder meetings to solicit a wide range of public opinions on the issues the plan should address. The comments and feedback from these stakeholder and public scoping meetings, as well as those from the biological and visitor services reviews, were considered and incorporated in the preparation of the Draft Comprehensive Conservation Plan and Environmental Assessment (Draft CCP/EA). This Draft CCP/EA was completed and made available for public review and comment for a period of 60 days, from December 27, 2006 to February 26, 2007.

The Service developed and analyzed four alternatives. Alternative A was a proposal to maintain the status quo, or no change from current management of the refuge. Under this alternative, the refuge would continue to maintain 550 Florida scrub-jay family groups across 15,000 acres; 11–13 nesting pairs of bald eagles; and 6.4 miles of sea turtle nesting beaches. Visitor services and facilities would be continued at levels similar to those conducted in the past. No active management currently or in the future would address resource protection issues. Coordination and partnerships with various agencies would not reach their potential.

Alternative B proposed to expand refuge management for the needs of threatened and endangered species. Under this alternative, the refuge would aggressively manage for Florida scrub-jays, restoring and maintaining 19,000–20,000 acres in optimal condition to support 900 family groups. Habitat management activities would be implemented to expand the number of nesting pairs of bald eagles to 20, with increased protection of nest sites and development of artificial nesting platforms. Visitor access would be limited and certain hunt areas would be reduced. The visitor experience would be focused on the visitor center with fewer field opportunities. Resource protection would be focused only on those habitats supporting threatened and endangered species. Coordination would take on a more adversarial approach to protect key species.

Alternative C was a proposal to focus refuge management on the needs of migratory birds. Under this alternative, current management activities for threatened and endangered species would remain the same or would be decreased. The refuge would manage intensively for waterfowl, increasing the size of the managed wetland impoundments to over 16,000 acres and annually support targets of 250 breeding pairs of mottled ducks; 60,000 scaup; 25,000 dabbling ducks; and 38,000 other diving ducks. The refuge would also intensively manage for shorebirds, increasing to over 5,000 acres the areas of impounded wetlands set aside for their use. Waterfowl hunting would be eliminated on the refuge. Estuarine waters would be closed to boating activity. Coordination would take on a more adversarial approach over impoundment management and reduced public use.

Alternative D proposed a more landscape view of the refuge and its resources, focusing refuge management on wildlife and habitat diversity. The refuge would support 500–650 Florida scrub-jay family groups with 350–500 territories in optimal condition across 15,000–16,000 acres. With active management, the refuge would support 11–15 nesting pairs of bald eagles; maintain 6.3 miles of sea

turtle nesting beaches; and maintain 100 acres of habitat for the southeastern beach mouse. Manatee-focused management would be reestablished on the refuge. Several impoundments would be managed for wood storks. The refuge would manage 15,000–16,000 acres of impounded wetlands for waterfowl. More than 2,500 acres of wetlands would be managed for shorebirds and another 1,500 acres would focus on wading birds. An increased effort to control exotic plants and animals would be made. Coastal islands would be restored. Environmental education would be increased, with greater emphasis on diversity of habitats and global warming. Coordination and partnerships would be enhanced.

The Service selected Alternative D for implementation because it directs the development of programs to best achieve the refuge's purpose and goals; emphasizes a landscape approach to land management; collects habitat and wildlife data; and ensures long-term achievement of refuge and Service objectives. At the same time, its 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 the desired long-term conditions within the anticipated funding and staffing levels, and positively addresses significant issues and concerns expressed by the public.

I. Background

INTRODUCTION

The U.S. Fish and Wildlife Service (Service) developed this Comprehensive Conservation Plan (CCP) to provide a foundation for the management and use of Merritt Island National Wildlife Refuge in Brevard and Volusia Counties, Florida. The CCP is intended to serve as a working guide for the refuge's management programs and actions over the next 15 years.

The CCP was developed in compliance with the National Wildlife Refuge System Improvement Act of 1997 and Part 602 (National Wildlife Refuge System Planning) of the Fish and Wildlife Service Manual. The actions described in this CCP also meet the requirements of the National Environmental Policy Act (NEPA) of 1969. Compliance with NEPA was achieved through the involvement of the public and the development of an environmental assessment (EA), which describes the alternatives considered and an analysis of the environmental consequences of the alternatives.

The CCP was prepared by a planning team composed of representatives from the refuge, the Florida Fish and Wildlife Conservation Commission, and the Service's Ecological Services Division (see Appendix H, Consultation and Coordination). In developing this CCP, the planning team and refuge staff incorporated the input of state agencies, other federal agencies, non-governmental organizations, local citizens, and the general public through a series of stakeholder and public scoping meetings. This public involvement and the planning process itself are described in Chapter III, Plan Development.

The CCP represents Alternative D, the Service's preferred action alternative, and is being put forward after considering three other alternatives, as described in the EA and summarized in the Executive Summary. The preferred alternative is the Service's recommended course of action for the management of the refuge and is described in this CCP. While the CCP provides general guidance, subsequent step-down plans will provide more detailed management direction and actions.

PURPOSE AND NEED FOR THE PLAN

The purpose of this CCP is to identify the role Merritt Island National Wildlife Refuge will play in support of the mission of the National Wildlife Refuge System, and to provide long-term guidance to the refuge's management programs and activities for the next 15 years. The CCP is needed to:

- provide a clear statement of direction for the future management of the refuge;
- provide refuge neighbors, visitors, and local, state, and federal government officials with an understanding of the Fish and Wildlife Service's management actions on and around the refuge;
- ensure that the Service's management actions, including land protection and recreational and educational programs, are consistent with the mandates of the National Wildlife Refuge System Improvement Act of 1997;
- ensure that the management of the refuge is consistent with federal and state laws; and
- provide a basis for the development of budget requests for the refuge's operational, maintenance, and capital improvement needs.

Perhaps the greatest need of the Service is to communicate with the public and include public participation in its efforts to carry out the mission of the National Wildlife Refuge System. Many agencies, organizations, institutions, businesses, and private citizens have developed relationships with the Service to advance the goals of the Refuge System.

U.S. FISH AND WILDLIFE SERVICE

The U.S. Fish and Wildlife Service is the primary federal agency responsible for the conservation, protection, and enhancement of the Nation's fish and wildlife populations and their habitats. Although the Service shares some conservation responsibilities with other federal, state, tribal, local, and private entities, it has specific trustee obligations for migratory birds, threatened and endangered species, anadromous fish, and certain marine mammals. As part of its mission, the Service administers the National Wildlife Refuge System, a national network of lands and waters established for the management and protection of these resources.

NATIONAL WILDLIFE REFUGE SYSTEM

To date, the National Wildlife Refuge System is comprised of more than 540 national wildlife refuges and over 3,000 small waterfowl breeding and nesting sites covering nearly 100 million acres, the world's largest collection of lands and waters specifically managed for fish and wildlife. The majority of these lands, 77 million acres, is in Alaska. The remaining acres are spread across the other 49 states and several island U.S. territories. The mission of the Refuge System 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 Improvement Act of 1997

The wildlife and habitat vision for national wildlife refuges stresses that wildlife come first; that ecosystems, biodiversity, and wilderness are vital concepts in refuge management; that refuges must be healthy; that the growth of refuges and the Refuge System must be strategic; and that the Refuge System serves as a model for habitat management with broad participation from others. This broad participation includes local, state, and federal government partners; organizations; the local business communities; individuals; and volunteers. Volunteers continue to be a major contributor to the success of the Refuge System and in 1999, some 36,000 of them contributed more than 1.3 million hours on refuges nationwide, representing an economic value of more than $20 million.

The National Wildlife Refuge System Improvement Act of 1997 established, for the first time, a clear legislative mission of wildlife conservation for the National Wildlife Refuge System. Activities were initiated in 1997 to implement the direction of this new legislation, including an effort to complete 15-year comprehensive conservation plans for all refuges. These plans, which are conducted with full public involvement, help guide the future management of refuges, including providing management direction for the refuges' natural resources and recreational and educational programs. The 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 fish and wildlife first;
- fulfill the requirement of developing a comprehensive conservation plan for each unit of the Refuge System and fully involve the public in the preparation of these plans;

- maintain the biological integrity, diversity, and environmental health of the Refuge System; and
- recognize that wildlife-dependent recreational activities, including hunting, fishing, observing wildlife, photographing wildlife, and participating in environmental education and interpretation, are legitimate and priority public uses of national wildlife refuges.

The National Wildlife Refuge System hosts more than 37 million annual visitors. Economists found that these refuge visitors contribute more than $400 million annually to local economies. In 2001 on conservation lands throughout the nation, approximately 37.8 million people participated in wildlife-related activities, most to observe wildlife in their natural habitats. These visitors represent nearly 40 percent of the country's adults who spent $108 billion on wildlife-related pursuits in 2001, according to the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of Interior, Fish and Wildlife Service, and U.S. Department of Commerce, U.S. Census Bureau 2001). As visitation continues to grow on conservation lands and waters in general and specifically on refuges, adjacent local communities are realizing economic benefits.

LEGAL POLICY CONTEXT

Administration of national wildlife refuges is guided by the mission and goals of the National Wildlife 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. Management options are guided by a refuge's establishing authorities, Public Law 104, Stat. 2957 (§108, H.R. 3338), and the National Wildlife Refuge System Improvement Act of 1997 (see Appendix C for more information on legal and policy guidance for the operation of national wildlife refuges). Key guidance and direction can be found in:

- National Wildlife Refuge System Administration Act of 1966;
- Refuge Recreation Act of 1962;
- Title 50 of the Code of Federal Regulations;
- U.S. Fish and Wildlife Service Manual; and
- National Wildlife Refuge System Improvement Act of 1997.

Since refuges must be managed for wildlife first, lands and waters within the National Wildlife Refuge System are closed to public uses unless specifically and legally opened under specified conditions providing for compatibility with the refuges' purpose(s). All programs and uses of a refuge must be evaluated based on mandates set forth in the National Wildlife Refuge System Improvement Act, including those that:

- contribute to ecosystem goals, as well as to refuge purpose(s) 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 compatible wildlife-dependent visitor uses as those uses which benefit the conservation of fish and wildlife resources and which contribute to the enjoyment of the public (these uses include hunting, fishing, observing wildlife, photographing wildlife, and participating in environmental education and interpretation); and
- ensure that visitor activities are compatible with refuge purpose(s).

NATIONAL CONSERVATION PLANS AND INITIATIVES

In addition to the above laws and policies, numerous national landscape-level conservation plans and initiatives also impact the management of the refuge's resources, including those listed as follows:

- U.S. Department of the Interior, Fish and Wildlife Service Strategic Plan
- Wildlife Fire and Air Quality National Strategic Plan
- U.S. Fish and Wildlife Service, Fulfilling the Promise: The National Wildlife Refuge System
- North American Bird Conservation Initiative
- North American Waterfowl Management Plan
- North American Colonial Waterbird Conservation Plan
- Southeastern U.S. Region Waterbird Conservation Plan
- U.S. Shorebird Conservation Plan
- U.S. Shorebird Conservation Plan: Southeastern Coastal Plains-Caribbean Region
- Western Hemisphere Shorebird Reserve Network
- Partners in Flight Bird Conservation Plans
- Atlantic Coast Joint Venture Management Plan
- Atlantic Coast Joint Venture Waterfowl Implementation Plan
- North Florida Ecosystem Unit Management Plan for Fish and Wildlife Service Trust Resources
- Fish and Wildlife Service Florida Manatee Recovery Plan
- Fish and Wildlife Service Florida Scrub-jay Recovery Plan (in preparation)
- Fish and Wildlife Service Recovery Plan for Anastasia Island Beach Mouse and Southeastern Beach Mouse
- Fish and Wildlife Service Recovery Plan for Leatherback Turtles (*Dermochelys coriacea*) in the Caribbean, Atlantic, and Gulf of Mexico
- Fish and Wildlife Service Recovery Plan for the U.S. Population of the Atlantic Green Turtle (*Chelonia mydas*)
- Fish and Wildlife Service Recovery Plan for the U.S. Population of Loggerhead Sea Turtle (*Caretta caretta*)
- Recovery Plan for Marine Turtles. National Marine Fisheries Service
- Fish and Wildlife Service Southeastern States Bald Eagle Recovery Plan
- Fish and Wildlife Service Eastern Indigo Snake Recovery Plan
- Fish and Wildlife Service Revised Recovery Plan for the U.S. Breeding Population of the Wood Stork
- Fish and Wildlife Service Atlantic Coast Piping Plover Recovery Plan

RELATIONSHIP TO STATE PARTNERS

The Fish and Wildlife Service is committed to encouraging and maintaining partnerships with others to improve the environmental health of ecosystems and the National Wildlife Refuge System. Partnerships are recognized by the Service as vital to fulfill its mission and help share advocacy for fish and wildlife resources. Some of the current partners include federal and state agencies, environmental organizations, outdoor sporting groups, industry, local governments, and private landowners. A provision of the National Wildlife Refuge System Improvement Act of 1997, and subsequent agency policy, is that the Service shall ensure timely and effective cooperation and collaboration with other federal agencies and state fish and wildlife agencies during the course of acquiring and managing refuges.

Merritt Island National Wildlife Refuge's state agency partners include the Florida Fish and Wildlife Conservation Commission; Florida Department of Environmental Protection; Florida Division of Forestry; Florida Inland Navigation District; and St. Johns River Water Management District.

Management of the state's fish and wildlife is administered by the Florida Fish and Wildlife Conservation Commission (http://www.floridaconservation.org/) and the Florida Department of Environmental Protection (http://www.dep.state.fl.us/). These two agencies are charged with enforcement responsibilities relating to migratory birds, trust species, and fisheries, as well as with management of the state's natural resources. Both agencies manage state lands and waters. The Fish and Wildlife Conservation Commission manages 4.3 million acres of public lands and 220,000 acres of private lands for recreation and conservation purposes. The Department of Environmental Protection manages 150 state parks covering nearly 600,000 acres and 57 coastal and aquatic managed areas, totaling over 5 million acres of submerged lands and coastal uplands. In addition, the St. Johns River Water Management District manages more than 260,000 acres in the Upper St. Johns River Basin, with further acquisitions planned.

The various agencies within the state government have participated in a mix of refuge projects, including the planning process to develop a 15-year CCP for the refuge. The State of Florida's participation and contribution throughout this comprehensive planning process have been valuable. Many of the state agencies are continuing their work with the Service to provide for ongoing opportunities and open dialogue to improve the ecological sustainment of fish and wildlife in Florida. An integral part of the comprehensive planning process is the integration of common mission objectives, where appropriate.

II. Refuge Environment

INTRODUCTION

Merritt Island National Wildlife Refuge, located along Florida's east central coast about 60 miles east of the city of Orlando in Brevard and Volusia Counties, was established by agreement as an overlay of the National Aeronautics and Space Administration's John F. Kennedy Space Center (Figure 1). The refuge covers a total of more than 140,000 acres and lies within one of the most productive estuaries in the country, the Indian River Lagoon, which has more species of plants and animals than any other estuary in North America (South Florida Water Management District 2005).

The refuge faces the Atlantic Ocean and includes three major water bodies that are all part of the Indian River lagoon system: the Indian River Lagoon itself, Mosquito Lagoon, and the Banana River. A growing human population, along with ongoing development and other human activities, currently threatens the fragile but highly productive waters of the Indian River Lagoon system and the refuge.

The refuge derives its name from Merritt Island, which, along with Cape Canaveral, is a barrier island complex that formed during the Pleistocene and Holocene periods. The complex is one of the last extensive undeveloped barrier islands on the eastern coast of Florida. The lagoon's location, combined with its large size and other physical characteristics, make it one of the most diverse estuaries in North America. As a result, a wide array of habitats exist on the refuge, including the beach and dune system; estuarine waters; forested and nonforested wetlands; impounded wetlands; and upland shrublands and forests. These diverse habitats support more than 1,000 species of plants and more than 500 species of fish and wildlife, including a variety of waterfowl, shorebirds, and neotropical migratory birds, as well as 93 federal- and state-listed species. Ten federally listed threatened and endangered species regularly occur on the refuge.

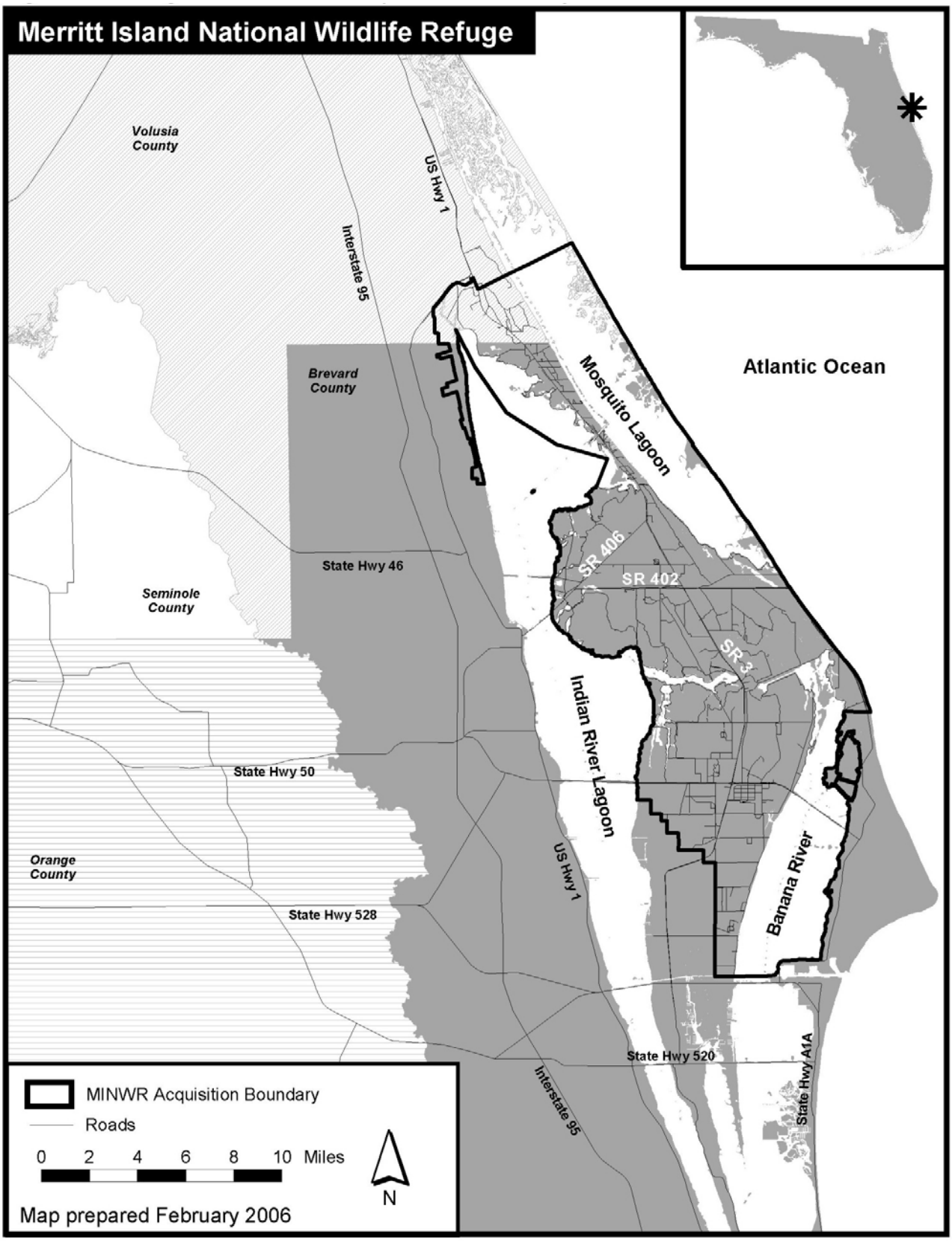
Merritt Island National Wildlife Refuge was established on August 28, 1963, as the 286th refuge of the National Wildlife Refuge System. According to the agreement with NASA, the lands and waters of the Kennedy Space Center are primarily to serve the space program and secondarily to serve as a wildlife refuge or park.

The refuge's primary habitat management activities involve applying prescribed fire, using mechanical treatments in upland scrub, employing chemical control of exotic plants, and managing water levels in impounded wetlands. Low-intensity prescribed burning activities help to enhance and maintain vegetative communities that are dependent upon or positively influenced by fire, for the benefit of wildlife; to promote nutrient cycling; and to reduce an unnatural buildup of fuels that could otherwise create hazardous, high-intensity wildfires. Among 76 impounded wetlands of the refuge, water levels in 33 are seasonally manipulated to benefit migratory waterfowl, wading birds, shorebirds, and other wildlife. The other wetlands are managed for fisheries and restoration. Additional upland management activities include the periodic thinning of pine flatwoods to enhance nesting habitat for bald eagles, as well as the control of exotic, invasive, and nuisance species.

REFUGE HISTORY AND PURPOSES

By 1962, the National Aeronautics and Space Administration had purchased most of the northern portion of the barrier island known as Merritt Island in order to launch rockets into space. Located adjacent to the U.S. Air Force's Cape Canaveral Air Force Station, the new site was named the John F. Kennedy Space Center. Sufficient lands to serve as safety and security buffer zones in order to

Figure 1. Refuge location and acquisition boundary



launch the heavy lift booster rockets for manned space exploration were acquired through fee title purchases, condemnation, and negotiation with the State of Florida for state lands and waters. On August 28, 1963, the Fish and Wildlife Service entered into a cooperative agreement with NASA to establish the Merritt Island National Wildlife Refuge, where space operations have priority. In this initial interagency agreement, NASA transferred management authority to the refuge for only a portion of the Kennedy Space Center's lands and waters. This agreement authority was expanded in the latter 1960s and by 1972 it included all nonoperational areas of the space center. A new updated agreement between NASA and the Service was signed by both parties in May 2002. The most recent agreement reflects the changes in operations of the two agencies and the coordination procedures that have occurred over time.

On April 2, 1975, Congress established the Canaveral National Seashore. This act transferred management responsibility of Playalinda Beach and approximately 1,000 acres north of the Gomez Grant Line to the National Park Service. At the same time, approximately 34,345 acres in and around Mosquito Lagoon were designated as a joint management area between Park Service and the Fish and Wildlife Service. Natural resource management of much of the joint jurisdiction area remained under refuge management, while the Park Service assumed management of all cultural resources in this overlap area. Generally, the Seashore manages those areas in the refuge/Seashore overlap east of the beach or sand road and the refuge manages the remainder of that overlap.

Due to its nature as an overlay of the Kennedy Space Center and its unique location and resources, the refuge has two traditional purposes, as well as an additional purpose stemming from legislation that created a unit of the National Park Service. Recognizing the high migratory bird benefits served by the lands and waters of the refuge, the Service administratively designated Merritt Island Refuge in 1963 under the provisions of the Migratory Bird Conservation Act, outlining a primary purpose of these lands and waters:

> *"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."*
>
> 16 USC §715d (Migratory Bird Conservation Act)

Further reading of the Migratory Bird Conservation Act also recognizes benefits to other species, including those designated threatened or endangered:

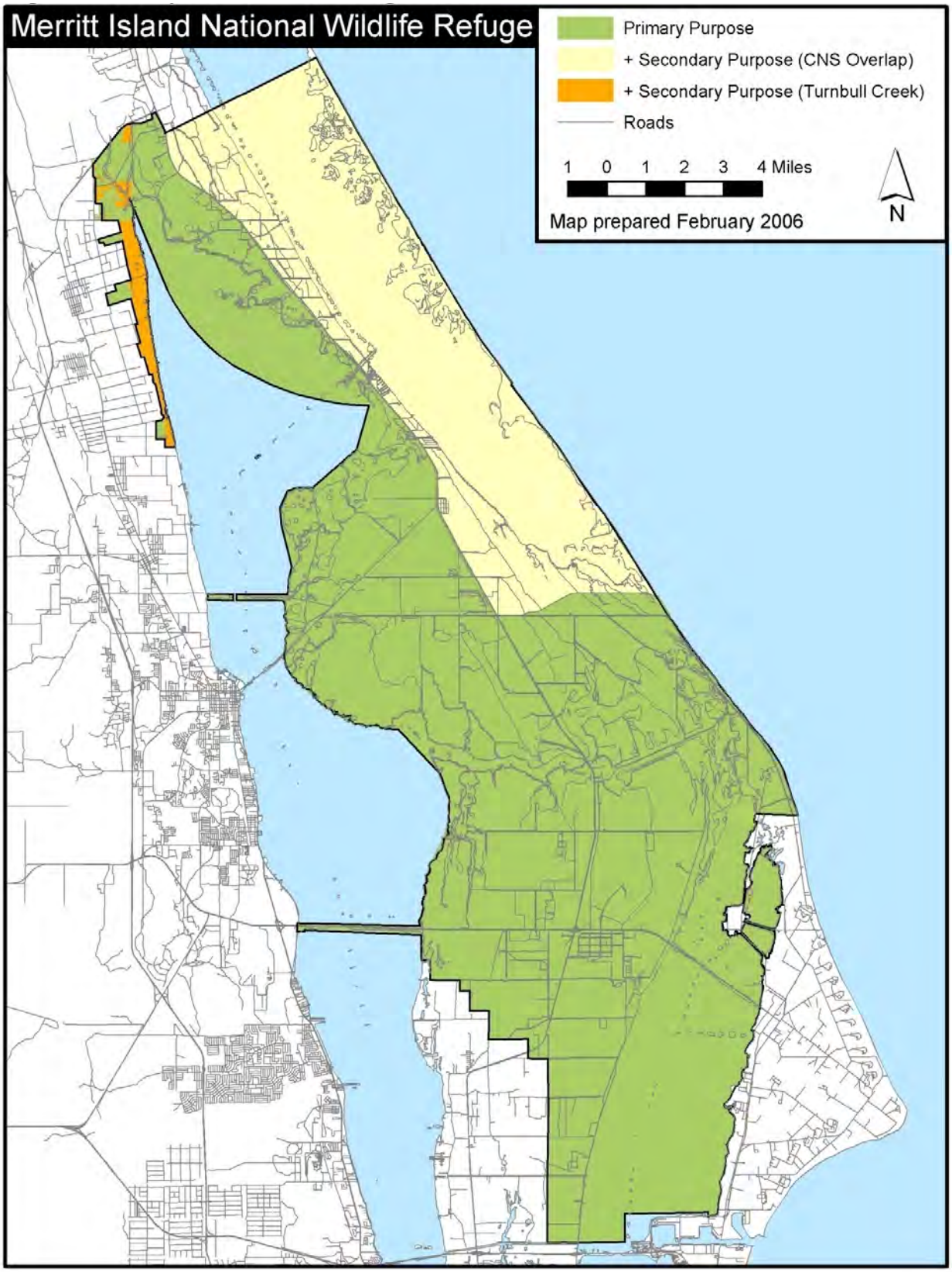
> *"... to conserve and protect migratory birds ... and other species of wildlife that are listed ... as endangered species or threatened species and to restore or develop adequate wildlife habitat."*
>
> 16 USC §715i (Migratory Bird Conservation Act)

The refuge's primary purpose applies to all lands and waters managed by the refuge, regardless of when they were added to the refuge (see Figure 2). Since the refuge has management agreements with NASA and the State of Florida, the lands and waters under those management agreements are also subject to the conditions of those agreements.

In 1995, under the authority of the North American Wetlands Conservation Act, the refuge and its partners began purchasing additional lands and waters in the northwest corner of the refuge, the Turnbull Creek area:

> *"(1) to protect, enhance, restore, and manage an appropriate distribution and diversity of wetland ecosystems and other habitats for migratory birds and other fish and wildlife in North America; (2) to maintain current or improved distributions of migratory bird populations; and*

Figure 2. Primary and secondary purpose areas, Merritt Island National Wildlife Refuge



(3) to sustain an abundance of waterfowl and other migratory birds consistent with the goals of the North American Waterfowl Management Plan and the international obligations contained in the migratory bird treaties and conventions and other agreements with Canada, Mexico, and other countries."

16 USC §4401(2)(b) (North American Wetlands Conservation Act)

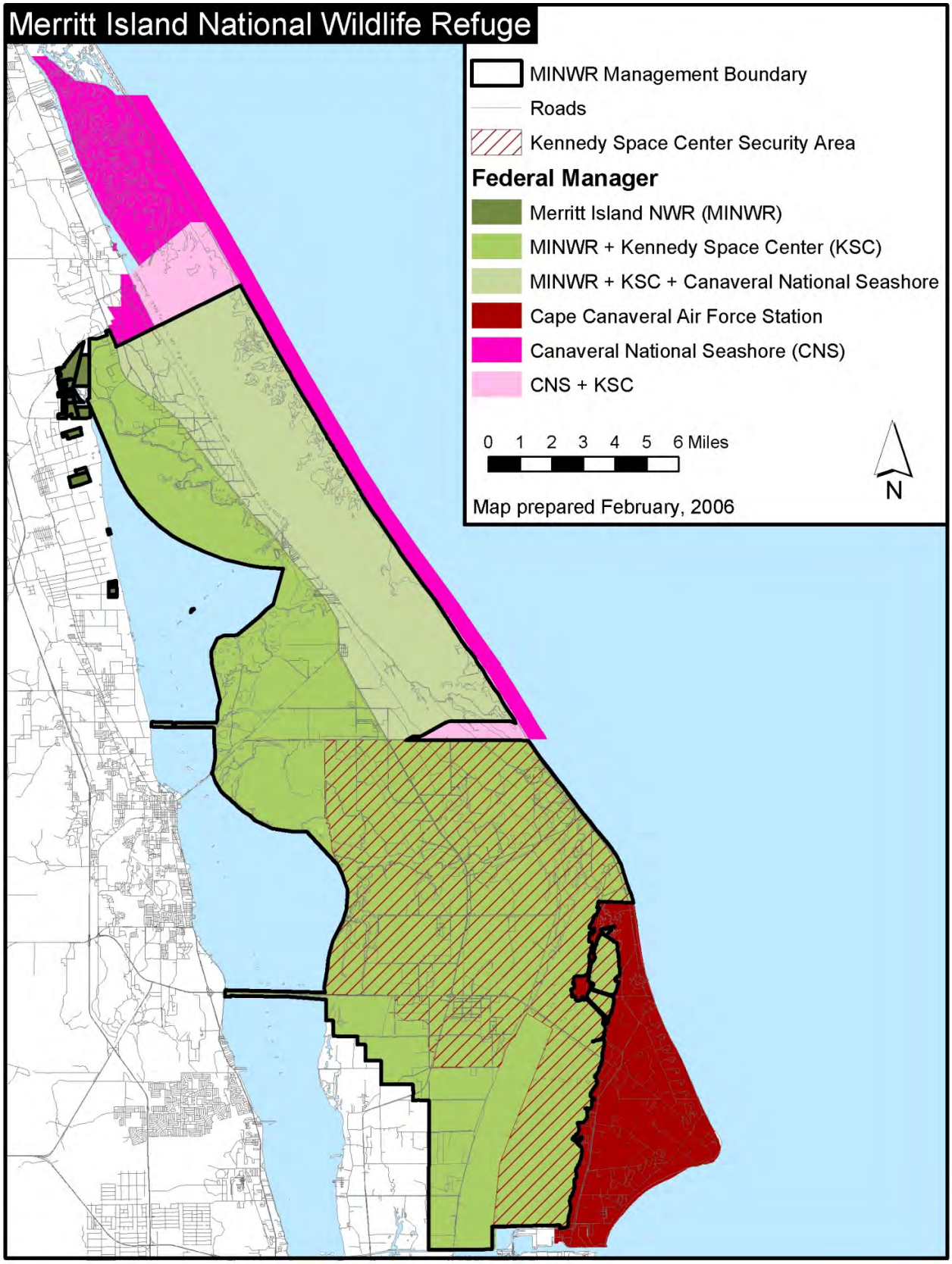
This secondary purpose applies only to those lands and waters of the Turnbull Creek area of the refuge (Figure 2), whether owned by the Service or managed under some sort of agreement as part of the refuge. However, the primary purpose also applies to the lands and waters of the Turnbull Creek area. Again, since the refuge has management agreements with the State of Florida for lands and waters in the Turnbull Creek area, those lands and waters are also subject to the conditions of those agreements.

Congruent to the discussion of the traditional purposes of the refuge is the congressional enabling legislation in 1975 that established Canaveral National Seashore as a unit of the National Park Service. Congress established a national seashore partially on new lands and waters and partially as an overlay of NASA's Kennedy Space Center on lands and waters that were already being managed as part of Merritt Island National Wildlife Refuge. In the legislation, Congress outlined that the majority of the overlay portion of the Seashore would be managed as a refuge. The overlay area encompasses approximately 34,345 acres and includes southern Mosquito Lagoon. Figure 3 shows the complex land ownership and management picture for this area. The Seashore was established "... to preserve and protect the outstanding natural, scenic, scientific, ecologic, and historic values ... and to provide for public outdoor recreation use and enjoyment of the same ... the Secretary shall retain such lands in their natural and primitive condition, shall prohibit vehicular traffic on the beach except for administrative purposes, and shall develop only those facilities which he deems essential for public health and safety" [16 USC 459(j)]. This language applies much as a wilderness designation might apply, making this a secondary purpose for the 34,345 acres in the overlap area.

SPECIAL DESIGNATIONS OF THE REFUGE

The refuge holds several special designations. The State of Florida has designated numerous national parks, a national memorial, national wildlife refuges, state parks and recreation areas, state preserves and reserves, and other waters as Outstanding Florida Waters for their exceptional ecological values and water quality. The Merritt Island Refuge was designated an Outstanding Florida Water in 1979. In 1997, the refuge was designated under the Magnuson-Stevens Act as Essential Fish Habitat to conserve and enhance the habitats necessary for fish to carry out their life cycles. In 1994, Brevard County designated the refuge an Honorary Historic Landmark. Managed by the Florida Fish and Wildlife Conservation Commission, the Great Florida Birding Trail is a collection of sites throughout Florida that serve as excellent birdwatching sites and/or bird education opportunities. Due to the refuge's importance to resident and migratory birds, the refuge was designated in 2000 as one of three gateways to the eastern section of the Great Florida Birding Trail, which generally extends from the Florida-Georgia border in Nassau County to south of Fort Pierce and from the Atlantic Ocean to west of Ocala. Also in 2000, the refuge was listed as a candidate Marine Protected Area for its protection of estuarine waters. Since the Marine Protected Area system is currently being designed, this designation holds the potential to benefit and/or constrain refuge management activities. Further, the State of Florida has also expressed concern regarding the impacts to management of such a designation. The Service is working with the Department of the Interior, the President's Marine Protected Area advisory council, the state, and other agencies regarding the designation of marine protected areas. In 2001, the American Bird Conservancy recognized 500 sites worldwide as Globally Important Bird Areas, including 183 national wildlife refuges, such as Merritt Island National Wildlife Refuge.

Figure 3. Federal agency boundaries in planning area



ECOSYSTEM CONTEXT

Comprising one of the 52 ecosystems around the country, the Fish and Wildlife Service's North Florida Ecosystem includes portions of southern Georgia and most of northern and central Florida (Figure 4), spanning 33 Florida counties and 19 Georgia counties. The North Florida Ecosystem includes several important areas with protective designations, including Ocala National Forest and Okefenokee and Merritt Island national wildlife refuges. In total, thirteen national wildlife refuges and one national fish hatchery occur in the North Florida Ecosystem.

Various other local, state, and federal conservation areas are also located within the North Florida Ecosystem. The North Florida Ecosystem 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, sawgrass prairies, sloughs, and tree islands of the North Florida Ecosystem 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 North Florida Ecosystem is the loss of habitat through direct destruction and fragmentation, as well as through impacts from human activities. The predominant stresses for the North Florida Ecosystem are population growth; tourism; agriculture; silviculture; mining; water channelization; urbanization; aquifer depletion; fire suppression; exotic species; nonpoint source pollution; and point source pollution (U.S. Fish and Wildlife Service 1996). The actions of the North Florida Ecosystem Team 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.

To address these threats, the management issues, and the needs of the trust resources, the North Florida Ecosystem Team pursues a mix of objectives under five goals:

- Goal 1: Protect, conserve, and enhance migratory birds and their habitats in the North Florida Ecosystem;
- Goal 2: Protect, conserve, recover, and restore fish, aquatic species, and their habitats in the North Florida Ecosystem;
- Goal 3: Protect, conserve, and enhance wetlands in the North Florida Ecosystem;
- Goal 4: Protect, conserve, enhance, and recover listed and candidate threatened and endangered species and their habitats; and
- Goal 5: Protect and manage units of the National Wildlife Refuge System and the National Fish Hatchery System (U.S. Fish and Wildlife Service 1996).

REGIONAL CONSERVATION PLANS AND INITIATIVES

To address these and other threats and management issues, several regional-level conservation plans and initiatives also impact the refuge's resource management activities, including those listed below (Figure 5 outlines the conservation lands around the refuge):

- Indian River Lagoon Surface Water Improvement and Management Plan, SJRWMD
- Indian River Lagoon Comprehensive Conservation and Management Plan, SJRWMD

Figure 4. North Florida Ecosystem

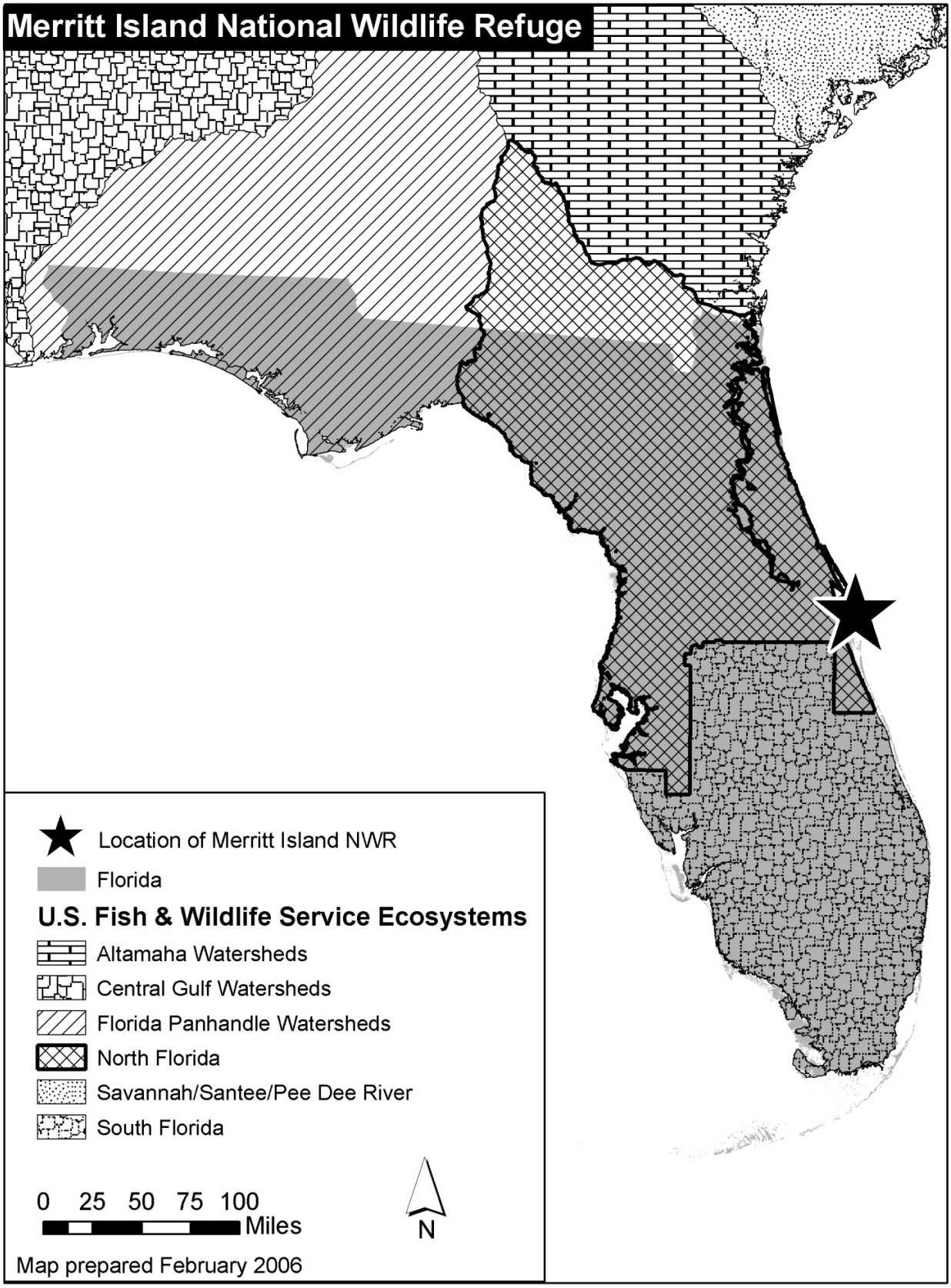
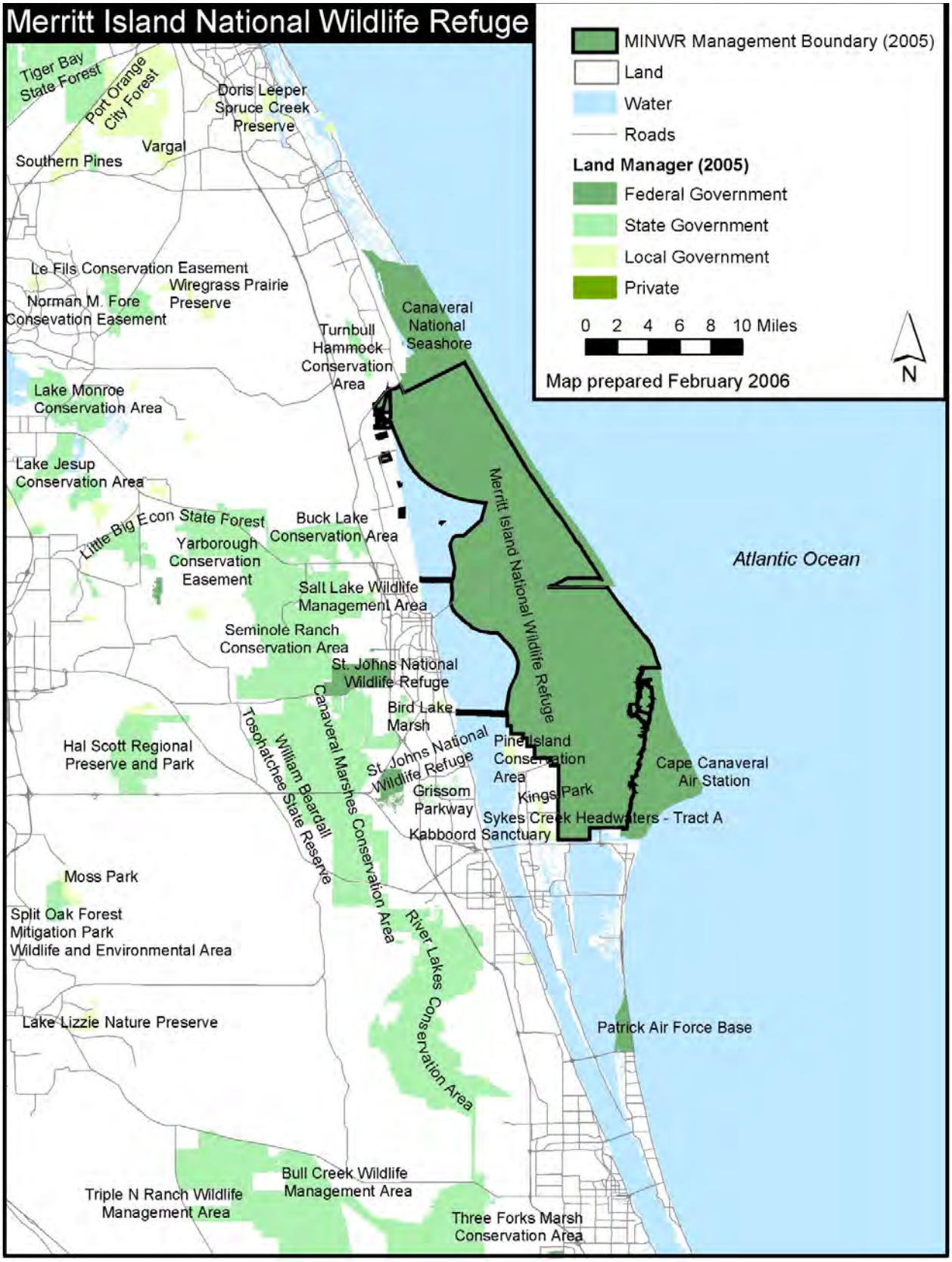


Figure 5. Area conservation lands



- Indian River Lagoon North Feasibility Study, Comprehensive Everglades Restoration Plan, U.S. Army Corps of Engineers and SJRWMD
- Mosquito Lagoon Aquatic Preserve Management Plan, Florida Department of Environmental Protection
- Banana River Aquatic Preserve Management Plan, Florida Department of Environmental Protection
- NASA's Facilities Master Plan for John F. Kennedy Space Center
- Cape Canaveral Spaceport Master Plan
- Future land use plans of Brevard and Volusia Counties
- City of Titusville Future Land Use Plan
- State of Florida Greenway Plan
- South Atlantic Marine Fisheries Council Fisheries Management Plan
- South Atlantic Marine Fisheries Council Ecosystem-Based Fisheries Management Plan
- General Management Plan, Canaveral National Seashore, National Park Service
- Resource Management Plan, Canaveral National Seashore, National Park Service
- Florida's Wildlife Legacy Initiative – Comprehensive Wildlife Conservation Strategy: Planning for the Future for Florida's Wildlife, Florida Fish and Wildlife Conservation Commission
- 45th Space Wing Integrated Natural Resources Management Plan, Cape Canaveral Air Force Station, U.S. Air Force

ECOLOGICAL THREATS AND PROBLEMS

Merritt Island National Wildlife Refuge is in a key location, not only to serve and support the biological diversity of the Indian River Lagoon and central Florida, but also to serve continental migratory bird populations along the Atlantic Flyway. Human impacts and underlying threats to biological diversity on and off the refuge include:

- the direct loss of habitat due to development and other human activities;
- the simplification and degradation of remaining habitats, including habitat alteration and fragmentation;
- the loss and decline of species and biological diversity;
- the effects of constructing navigation and water diversion facilities;
- the introduction and spread of exotic, nuisance, and invasive species;
- the lack of environmental regulation and enforcement;
- the cumulative effects of land and water resource development projects;
- the ongoing wildlife disturbance due to development and other human activities;
- the impacts of nonpoint sources of pollution and water quality degradation; and
- the impacts of sea level rise and global warming.

As a result of these threats, some species endemic to the northern Indian River Lagoon have become extinct, endangered, or threatened. The refuge supports 10 federally threatened or endangered species that regularly occur on the refuge. Further, the refuge also supports an additional 47 species listed by the State of Florida as either threatened, endangered, of special concern, or commercially exploited. Of those species that have a state or federal designation, 46 are listed by the Florida Committee on Rare and Endangered Plants and Animals; 53 are listed by the Florida Natural Areas Inventory; and 26 are on the Audubon Society's Watch List (see Appendix D for a complete listing of these species). [Nationally, 1,262 species are federally listed with 986 listed as endangered (including 388 animals and 598 plants) and 276 listed as threatened (including 129 animals and 147 plants). Further, 257 species are listed as candidates for federal listing.]

The refuge serves to protect, maintain, and enhance the high productivity and biological diversity within this system. Increasing human population growth and impact have altered many ecological characteristics of Indian River Lagoon. The refuge faces ongoing threats from contaminated air, soil, and water; from erosion and sedimentation; and from cumulative habitat impacts from land and water resource development activities adjacent to and on the refuge (e.g., NASA's operations facilities). Rapid population growth and development have resulted in long-term negative impacts to Merritt Island National Wildlife Refuge, including increased boat traffic in the shallow waters of the lagoon, increased use and development of natural resources in the area, local habitat fragmentation, and the introduction and spread of exotic species.

Due to elevation, topographic relief, and proximity of the refuge to the ocean, impacts on the refuge stemming from global warming and climate change may manifest themselves through rising sea level and increased tropical cyclones. Rising sea level could result in wetter hydrologic regimes and saltwater intrusion. The extent and nature of the refuge's impoundments and marshes could be altered. More frequent and more intense tropical cyclones could cause alteration to the beach profiles and affect the flora and fauna that presently use these habitats.

The refuge has a history of working with its partners on the management of a wide variety of issues. This cooperation can be extended to collect data, develop modeling, and determine possible management activities that would relate to the effects of climate change. It is certainly true that more scientifically valid data are needed to effectively determine what management actions might be appropriate to combat the possible effects of global warming.

Due to the current state of knowledge about the nature and extent of global warming and climate change impacts to the refuge, the focus will be to monitor and collect data relevant to changes in habitats and wildlife over the life of this plan. One action the refuge can take is to incorporate more information on possible changes brought about as a result of global warming in outreach to the public. In addition, the refuge can work cooperatively with partners to develop prudent adaptive management strategies that work in concert with changes brought about due to global warming.

Native terrestrial habitats that once dominated uplands include hardwood hammocks, which are very important for mammals and migratory birds. Urbanization and agricultural operations (e.g., large citrus groves) now dominate land uses in the upland areas along the entire Indian River Lagoon. Historically, citrus and other agricultural operations, such as cattle pastures, dominated the area's landscape, but these are quickly being replaced by urban and suburban sprawl. Stormwater inputs, saltwater exchange through fortified ocean inlets, pollution, habitat destruction, and continual land and water use practices are constant threats to fish and wildlife resources in this area. By the year 2015, Florida is expected to have more than 20 million residents, while the four-county area around the refuge is anticipated to reach nearly 3 million (Lenze 2002).

The reduction of ecological function and connection are major concerns, especially in areas where the modification of inland waterways has caused declines in fisheries and aquatic resource productivity. Beaches, seagrass beds, salt marshes, mangrove islands, and hammocks are subject to further loss or elimination. Some known environmental modification includes the construction of causeways (e.g., impacting seagrasses); the construction and maintenance of the Intracoastal Waterway (e.g., changing hydrological functions and salinity); the development of beaches and shorelines (e.g., impoundments, impacting fragile coastal habitats for migratory birds, small mammals, and nesting sea turtles); and fishing activities (e.g., increasing recreational and commercial uses) in transitional and aquatic communities and habitats. Causeway construction, canal dredging, and commercial agricultural operations have contributed to the long-term loss and

elimination of aquatic resources and habitats. In addition, declining water quality due to increased sediment and nutrient runoff is likely to adversely impact seagrass communities, resulting in declines in fish and mollusk (fisheries and aquatic resource) production.

Estuarine wetlands (native salt marsh and mangrove swamps) on the refuge were impounded to meet mosquito control needs. Refuge wetland management objectives include reconnecting impoundments and restoring natural-like flow and biological interchange, while maintaining mosquito control and migratory bird habitats.

Invasive exotic plants have displaced many native species in upland and wetland communities. Brazilian pepper and Australian pine are two invasive species that are widespread throughout the refuge. Citrus trees for agricultural harvest cover other large areas. As adjacent urbanization and suburbanization continue to increase, the refuge is likely to experience an increased threat from feral animals, free-roaming pets, recreational boating, elevated nutrient loading, and pollution, as well as from the increased demand for public use activities that are not directly linked to fish and wildlife goals. Additionally, new recreational technologies are likely to be developed that may not be compatible with fish and wildlife management.

Increased disturbance of fish spawning areas and nesting and roosting birds, and impacts to water quality and habitat are likely to lower the refuge's biological integrity. Management overlap of refuge lands and waters is shared by multiple agencies and a continual challenge is to coordinate conservation management with the more than 100 agencies and organizations which share the responsibility of managing the Indian River Lagoon watershed (Indian River Lagoon National Estuary Program 1996).

The lack of Service ownership of most of the refuge presents a difficult management challenge. The Service owns ± 925.7 acres; manages ± 320.04 acres under a lease or management agreement with the State of Florida; and manages nearly 135,000 acres through a management agreement with NASA (including over 4,000 acres in operational areas at Kennedy Space Center for specific responsibilities, including removing nuisance wildlife from these areas).

State and federal assessments of the coastal zone to vulnerability from current and future sea level rise reflect coastal changes, particularly to coastal barrier island systems. Leatherman and Kershaw (2001) reported an approximate rate of 2 mm/year, which was estimated to accelerate over time to 20–30 cm by 2100 along the Florida Atlantic coast (Ron Schaub, Dynamac, Inc., personal communication). The average rate of sea level rise at Mayport, Florida, is 2.43 mm/yr with a standard error of 0.18 mm/yr based on monthly mean sea level data from 1928 to 1999 (National Oceanic and Atmospheric Administration 2001). Impacts to the refuge could include beach and dune habitat changes that would pose threats to several federally listed sea turtles and the southeastern beach mouse. Loss of dune systems and lowered dune profile could increase sea turtle disorientation from lighting at NASA's and the U.S. Air Force's launch facilities. The refuge's beach has been changing with a mix of points of accretion and erosion since the 1800s with no observed long-term trend (Ron Schaub, Dynamac, Inc., personal communication). However, increased sea level would exacerbate beach erosion and may reconfigure the beach and shoreline contour (e.g., the beach could experience increased overwash and the formation of an inlet in Mosquito Lagoon). Additionally, impacts could include inundation of low-lying areas along the Mosquito Lagoon, Indian River Lagoon, and the Banana River, including marshes, impoundment dikes, marsh islands, and spoil islands. The changes could include habitat transitions from upland to coastal wetlands. Saltwater intrusion into aquifers and increased flooding potential (increasing the potential for impacts from disasters) are also important considerations, particularly in beach areas that have been developed (Leatherman and Kershaw 2001). Coastal wetland ecologists have suggested that the coastal marshes may be impacted if they cannot maintain the detrital-building process and the marsh elevation due to sea

level rise (accretion deficit; Reed and Cahoon 1993). They suggest that some marsh management practices (e. g., burning or migratory bird management) would inhibit marsh accretion in a system that has a narrow tidal range, low sediment accretion rate, and a low tolerance for accelerated sea level rise (Cahoon et al. 2004). The rise in sea level could effectively cause the transition of high marsh systems to lower marshes and the migration of high marshes into the fringing upland ecotones. Marsh expansion may have beneficial impacts; however, the increase in salt marsh may also increase the production potential of the salt marsh mosquito.

PHYSICAL RESOURCES

The climate, geology and topography, soils, air quality, and hydrology and water quality form the foundation of the physical environment of the refuge.

CLIMATE

General Climatic Conditions

The main factors influencing the climate at Merritt Island National Wildlife Refuge are latitude and the proximity of large bodies of water. Generally, the climate can be described as subtropical with short, mild winters and hot, humid summers, with no appreciable spring or fall seasons. Summer weather patterns usually begin in April and prevail for nine months.

Temperature

Summer temperatures (measured in degrees Fahrenheit) range from the low 70s at dawn to the upper 80s and low 90s during the afternoon. November may have some cool days, but winter weather typically starts in December and lasts through March. Average temperatures during the winter range from lows in the 50s to highs near 75º. Temperature extremes range from a low of 19º to a high of 100º (Patrick Air Force Base 2004).

Atmospheric Moisture

As one would expect with the large bodies of water in and around the refuge, the relative humidity (RH) is typically high. The mean dawn RH is between 88 and 95 percent throughout the year, while readings in the mid-afternoon are between 55 and 67 percent. Very low RH can occur with the passage of cold fronts in the winter. Readings in the 30 to 40 percent range are common and a RH as low as 26 percent has been recorded. On the other end of the spectrum, an RH of 100 percent is not uncommon with fog occurring 90 days per year on average.

Precipitation

The refuge's average annual precipitation, as recorded at the Shuttle Landing Facility, is 49 inches (Patrick Air Force Base 2004). Rainfall typically occurs during two time periods separated by dry seasons. Between late May and early October, weather patterns are dominated by the effects of the Bermuda High. This system causes southeast winds that bring moist warm air onshore, leading to the formation of thunderstorms. These are short duration, high intensity localized storms. The refuge averages 83 thunderstorm days per year, with 60 percent of the annual precipitation occurring during these months.

From November to February, the weather patterns are influenced by cold continental air masses. Rainfall during this period comes from the effects of frontal passage, with rainfalls more widespread and less intense than in the summer. The transitional periods between these two wet seasons tend to be dry. Although uncommon, snow does occur on the refuge. The Shuttle Landing Facility has reported snow in both December and January, but the accumulations were less than 0.05 inches.

Annual precipitation amounts can vary widely. In 1998, the annual rainfall was only 34.1 inches. The total accumulation of rainfall for the months of April, May, and June was only 1.03 inches, as compared to the expected amount of 10.42 inches. Conversely, in the year 2001 the refuge received a total of 61.80 inches of rain, or 12.80 inches above the average recorded for the Shuttle Landing Facility.

These fluctuations in precipitation can impact refuge management operations. In 1998, for example, many of the refuge impoundments dried out completely. The dry conditions contributed to numerous wildfires, one of which reached over 4,000 acres in size. On the other hand, the wet conditions in 2001 made the maintenance of nonpaved roads difficult. The frequent rains and generally wet conditions also resulted in fewer opportunities for prescribed burning.

Lightning

Because of its importance in fire management, a major refuge management activity, lightning deserves special mention. The National Weather Service Office in Melbourne, Florida, states that Florida is the "lightning capital of the United States" (National Weather Service 2005). According to National Weather Service data, more than 22,000 lightning strikes occur in Brevard County each year. Regarding the intensity of lightning on the refuge itself, research at the Kennedy Space Center shows that within-cloud and cloud-to-ground discharges average 2.4 per minute per storm, with a rate of 30.6 discharges per minute recorded during a storm on July 14, 1980 (National Aeronautics and Space Administration 1984).

Wind

Wind is another important weather condition that greatly impacts the refuge. Wind patterns change throughout the day due to such factors as sea breezes and erratic winds around thunderstorms. High winds, above 20 miles per hour at the 20-foot level, are common in the winter and spring months, with occasional days with 35 to 40 mph winds. High winds are also associated with tropical systems in the summer. Several days of light and variable winds can occur in summer months when subsiding air is entrenched over the central Florida area. Since there is essentially no elevation change over the entire refuge, and therefore no barriers to the flow of air masses, the influences of weather apply equally to all portions of the refuge.

Tropical Cyclones

Tropical depressions, storms, and hurricanes can impact refuge activities and infrastructure. Large amounts of rainfall can accompany tropical cyclones. In addition, wind and wave action can result in major damage to important refuge habitats. In 2004, three hurricanes impacted the central Florida area. Beach erosion destroyed sea turtle nests and damaged beach mouse habitat on the refuge. The combination of wind and wave action resulted in several millions of dollars in damage to the refuge's impoundment dikes. Several refuge buildings also suffered damage. On top of all this, a substantial amount of staff time was spent in addressing hurricane damage both on Merritt Island National Wildlife Refuge and other refuges in Florida.

GEOLOGY AND TOPOGRAPHY

Geology

According to Schmalzer et al. (2001), Florida has a complex geologic history with repeated periods of deposition when the Florida Plateau was submerged and with erosion during periods of lower sea level when the land was exposed (Randazzo 1997). The Avon Park limestone formation is the oldest deposit known to exist under Brevard County. This was deposited in the early Eocene in an open ocean. A period of lower sea levels with resultant erosion followed. In the late Eocene, seas rose once again and the limestone of the Ocala group formation was deposited. Following another sea level falling and rising, the Hawthorne formation of calcareous clay, phosphoric limestone,

phosphorite, and radiolarian clay was laid down in the late Miocene. Overlying the Hawthorne formation are unconsolidated deposits of fine sand, shells, clay, and calcareous layers of the late Miocene or Pliocene ages. The surface strata of Merritt Island are primarily unconsolidated white-to-brown quartz sand containing beds of coquina of Pleistocene and Recent ages.

Topography

The alternating high and low sea levels during the Pleistocene and Holocene shaped the land surface of the refuge. The outer barrier island formed after sea levels rose when the Wisconsinan glaciers retreated. Merritt Island itself was formed as a prograding barrier island complex. The eastern edge of Merritt Island, where it joins Mosquito Lagoon and Banana River, forms a relic cape aligned with False Cape. The ridge and swale topography of the island is apparently the result of successive stages of the growth of this cape (White 1970). The ridges rise to a maximum of about 10 feet above sea level, while trough elevations are near sea level.

The western side of the island is substantially older. Erosion has reduced old dune ridges and the area is flatter. Elevations at the center of the island approach four feet above sea level and drop off to around one half foot at the Indian River Lagoon shoreline.

SOILS

Relatively minor differences in elevation and internal drainage of the land have resulted in major differences in soil types. Over twenty soil series, representing four soil orders, are found on the refuge. Detailed maps and descriptions of these can be found in the *Soil Survey of Brevard County, Florida* (Soil Survey Staff 1974). Based on soils characteristics, five general associations of soils have been identified on the refuge, as listed below:

Paola-Pomello-Astatula Association: These are soils found on narrow ridges in the area between the Indian River Lagoon and Banana River. They are well to excessively drained acid sands. Internal drainage is rapid, and water tables are generally below three feet. Slopes range from nearly level to strongly sloping. The natural vegetation is scrub oaks, palmetto, and grasses.

Canaveral-Palm Beach-Welaka Association: These soils are nearly level to gently sloping sands that are well to excessively drained. They are found on narrow ridges and sloughs parallel to the Atlantic Ocean. Natural vegetation is scrub oaks, cactus, palmetto, and some pine.

Myakka-Eau Gallie-Immokalee Association: These associations are nearly level, poorly drained, acid soils. They are sandy to a depth of 40 inches and loamy below. They are found on flatwoods sites between the ridges. Water tables are usually within 30 inches of the surface, and there may be standing water on these sites for short periods of time after heavy rainfall. The natural vegetation is palmetto and pines.

Copeland-Wabasso Association: These soils are nearly level and poorly or very poorly drained. The pH of these areas is higher than that of most flatwoods soils due to the presence of limestone or coquina. Natural vegetation is palm, mesic hardwoods, and pine.

Salt Water Marsh-Salt Water Swamp Association: These associations are nearly level, very poorly drained saline to brackish soils of variable texture. The marsh soils are shallow sands covered with marl or limestone, irregularly stratified mixed sand and shell, or silty clays over sand and shell. The natural vegetation is that of the salt marsh community. Swamp soils consist of mixed sand and organic matter. Natural vegetation includes salt-tolerant trees, such as mangroves.

AIR QUALITY

The air pollutants of major concern in Florida are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide (Florida Department of Environmental Protection 1999). The primary sources of these pollutants are vehicle emissions, power plants, and industrial activities. In 1999, all areas of Florida were air quality attainment areas (Florida Department of Environmental Protection 1999). The Indian River Lagoon area is considered to have good air quality. However, occasional temperature inversions, lasting up to 48 hours, can temporarily degrade local air quality below acceptable levels

Kennedy Space Center and, therefore, the Merritt Island National Wildlife Refuge, are considered an attainment or clean area under the Clean Air Act. The ambient air quality is influenced by NASA operations; land management practices, such as prescribed burning; vehicle traffic; and offsite emission sources. The daily air quality conditions are most influenced by the considerable onsite vehicle traffic, utilities fuels combustion (two regional power plants are within 10 miles of the refuge), NASA's refurbishment and maintenance operations, and incinerator operations. Space launches, training fires by the Kennedy Space Center Fire Department, prescribed burning, and wildfires on the refuge influence air quality as episodic events. Smoke from wildland fires can disrupt space center operations, such as launches, landings, and payload preparation.

The ambient air quality at Kennedy Space Center and the refuge is monitored by one Permanent Air Monitoring System, located at NASA's Environmental Health Facility. This station is equipped with analyzers for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), and total inhalable particulates (10-micron).

HYDROLOGY AND WATER QUALITY

Surface Water Hydrology

The primary surface waters on and around the refuge is the Indian River Lagoon system, which has been designated as an Estuary of National Significance. The lagoon system includes the Indian River Lagoon, Banana River, Mosquito Lagoon, and Banana Creek. These bodies of water drain approximately 838 square miles of land. They can best be described as shallow estuarine lagoons with water depths of less than five feet, with the exception of the Intracoastal Waterway which, with a project depth of 12 feet, is the deepest part of the entire system. The Banana River is directly connected to the Atlantic Ocean by an artificial inlet and locks at Port Canaveral. The Indian River Lagoon is indirectly connected to the Atlantic Ocean on the north by Haulover Canal, Mosquito Lagoon, and the Ponce de Leon Inlet, and on the south by Sebastian Inlet. Water circulation within the lagoons are not affected by tides, but instead are affected by the Intracoastal Waterway (e.g., navigation channel maintenance and boat usage), winds, inlets, and causeways.

In addition to the lagoon system, numerous creeks, mosquito control impoundments, borrow ponds, and miscellaneous wetlands exist on the refuge. By the 1960s, many of the marshes were impounded to control the production of the salt marsh mosquito (*Aedes* spp.). These impoundments contain about 7,660 acres of open water and 15,500 acres of wetlands. In addition, the refuge has more than 900 acres of borrow ponds, 5,900 acres of grassy swales, and numerous canals.

Surface Water Quality

The quality of the refuge’s surface waters is generally good, with the best areas being those adjacent to undeveloped land. These would include both the Mosquito Lagoon and the northern portion of the Indian River Lagoon, which have been designated as Class II waters by the State of Florida. The rest of the lagoon system has been designated as Class III waters. All of the surface waters within the

boundaries of the refuge have been designated as Outstanding Florida Waters. All of these designations place restrictions on the use of the surface waters. The Indian River Lagoon does have several identified water quality parameters of concern: cadmium, lead, mercury, nutrients, selenium, thallium, and dissolved oxygen (U.S. Environmental Protection Agency 2000). Monitoring of water quality is conducted by both the Kennedy Space Center and the refuge.

Ground Water Hydrology

Ground water of the refuge occurs under both nonartesian (unconfined) and artesian (confined) conditions. The surficial (nonartesian) aquifer supports the freshwater wetlands and provides groundwater discharge to the surrounding lagoons (Clark 1987). This aquifer occurs in saturated Pleistocene and Holocene deposits of sand, shell coquina, silt, and marl. The upper boundary is the water table, while the lower limit is the confining layer at the base of the Pleistocene and Holocene deposits. The surficial aquifer is recharged by direct infiltration from local rainfall. The high sand ridges in the center of the refuge, which are composed of permeable sands, are especially important for recharge of the surficial aquifer

The surficial aquifer can be divided into several subsystems. The first of these is the Dune or Barrier Island subsystem, which has a lens of freshwater three meters or less thick on top of intruded salt water. The primary dune acts as the principal recharge area. The second subsystem is the Dune-Swale subsystem, which runs north to south in the center of the refuge. Most of it is east of Kennedy Parkway (State Route 3) and includes high ridges that serve as recharge areas. The pine flatwoods and swale soils in this area have pronounced humic hardpans (spodic or B_h horizons) that restrict infiltration. Water perches above this layer and will only infiltrate slowly. The West Plain subsystem is the third division and is located in the flatwoods and hammock areas west of Kennedy Parkway. Spodic horizons limit infiltration in much of the area north of Banana Creek. South of Banana Creek, a limestone hardpan is the limiting factor. The fourth division of the surficial aquifer, the Marsh subsystem, is found under the impoundments.

The artesian aquifers found under the refuge include the Floridian aquifer. This aquifer is associated with Eocene limestones and is artesian. Secondary artesian aquifers occur within the Hawthorne formation and in the Caloosahatchee Marl Equivalent.

Ground Water Quality

Ground water can be contaminated from either point sources or nonpoint sources. Merritt Island National Wildlife Refuge/Kennedy Space Center has been used since the 1960s as the Nation's primary launch site for space exploration. Many hazardous chemicals have been used to support space operations over the years, and, especially in the early years, less than adequate care had been taken in the handling and disposal of these chemicals. Point source pollution has been documented on the refuge/Kennedy Space Center in several instances. Contaminated areas have been found in and around launch pads A and B, landfill sites, and sewage treatment plants, as well as at some abandoned processing sites. The locating and meditating of contaminated sites is an ongoing process, the majority of which is handled by NASA. The refuge has been involved on a limited basis in detecting possible point sources in the citrus grove areas where chemicals have been stored.

The citrus grove operations also have the potential for nonpoint source pollution. The application of fertilizer, insecticides, and other chemicals during grove caretaking operations falls under the area of nonpoint source pollutants. The refuge is cooperating with the Florida Research Center for Sustainable Agriculture in a study to determine the impacts of various citrus management practices on the environment, including on ground and surface waters (Adair 2003).

The areas of the refuge subject to known point source pollution and agricultural activities are relatively small. A recent study of the surficial aquifer on the refuge found that contamination in large areas of the refuge was low (Schmalzer and Hensley (2001). This investigation looked at a number of possible pollutants. Organochlorine pesticides, aroclors, and chlorinated herbicides were below detection levels. Seven polycyclic aromatic hydrocarbons occurred at low concentrations in some areas. These hydrocarbons can have both natural and human activity sources. Most trace elements were below detection levels or were found in low concentrations. They concluded that widespread contamination of the surficial aquifer on the refuge has not occurred.

BIOLOGICAL RESOURCES

The habitats on the refuge and their condition are the end result of both the physical environment and past anthropological activities. The climate, soils, and hydrology have determined which plant and animal species can exist here. Humans have then exerted their influences on the biota.

The influence of human activity on the landscape has been going on for a considerable time. Native Americans probably did little to modify the physical landscape, but may have modified ecological processes through their use of fire. The numerous thunderstorms that occur during the summer months frequently ignited wide-ranging wildland fires (Duncan et al. 1999). Many of the vegetation types found on the refuge are dependent on periodic fires for their continued existence. Native Americans used fire outside of this time period for various purposes, such as hunting and warfare (Robbins and Myers 1992).

When European settlers arrived, they also varied the natural fire regime. They also began to modify the physical landscape, starting with the construction of roads, drainage ditches, and canals. The use of the land for agriculture increased the construction of infrastructure, but major alterations to the landscape did not occur until the 1950s. During the next several decades, fire was excluded from the landscape. The vegetation on the land which is now the refuge became overgrown, reducing its utility for some native wildlife.

During this time, other important changes occurred. Some of the land was converted to agriculture, where most of it became citrus groves. In the early 1960s, fragmentation of the land increased as the infrastructure for the John F. Kennedy Space Center was constructed. To help control mosquitoes, many of the marshes were impounded.

Since the refuge was founded, much management has been done. Some management activities were directed towards restoring portions of the landscape to more natural conditions. Other activities maintained or modified the existing structures, such as the impoundments, to increase their value to wildlife. The mix of upland, wetland, and aquatic habitats that are the end result of the various natural and anthropologic phenomena are described. Figure 6 shows the refuge's existing impoundment management units and Figure 7 the refuge's burn units.

HABITAT

Schmalzer et al. (2002) lists 1,024 species of plants on the refuge. Of these, 803 are native and 221 are introduced. These plants are organized into vegetative communities. A habitat/vegetation map delineating these communities has been developed for the area inside the acquisition boundary of Merritt Island National Wildlife Refuge (Figure 8). Vegetation was classified using the terminology of the National Vegetation Classification System. In this classification system, the floristic association is the most applicable level to refer to when managing the vegetation on the refuge. However, the terminology of the classification system is seldom used by on-the-ground practitioners. Therefore,

Figure 6. Impoundment Management Units

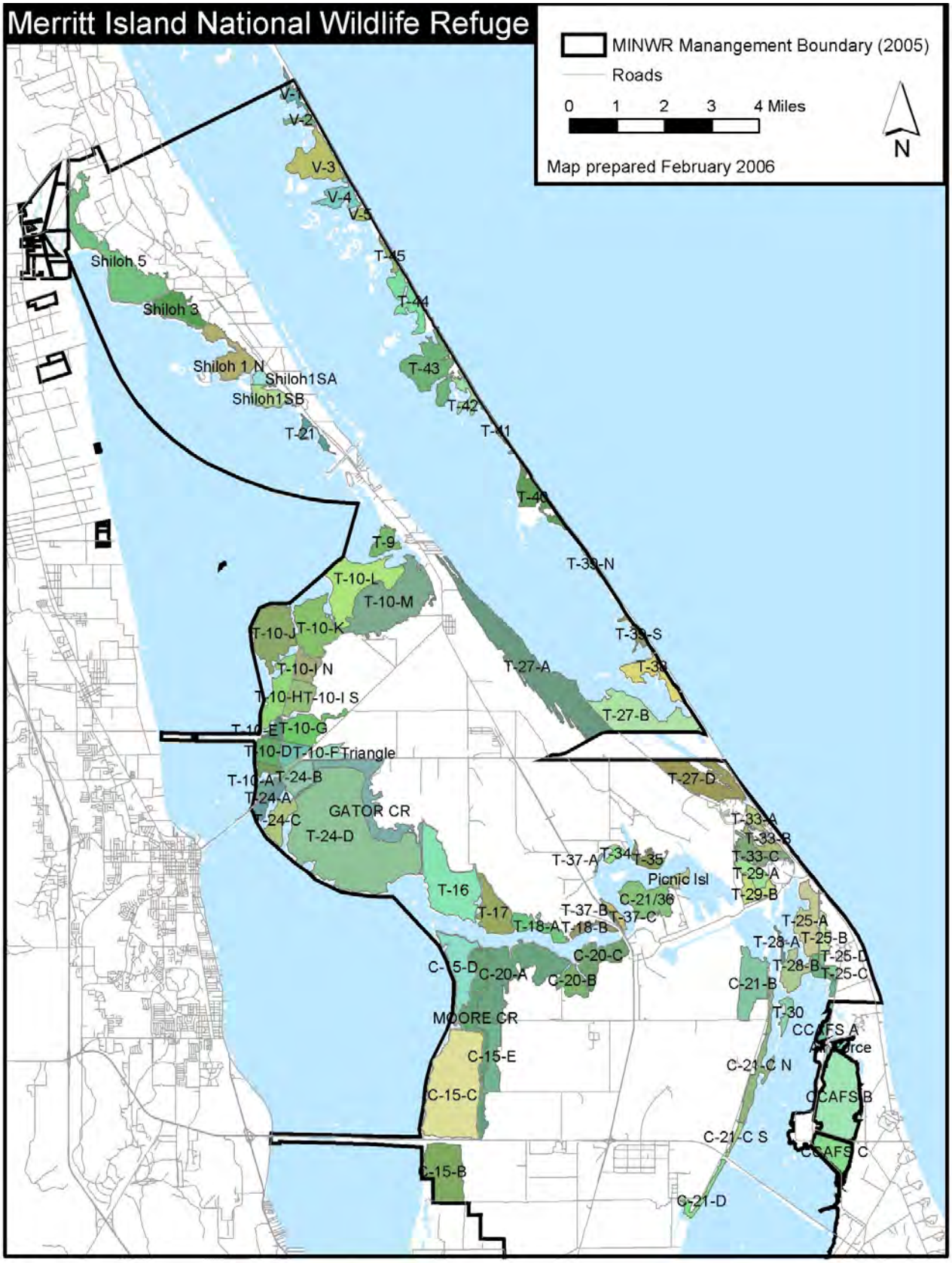


Figure 7. Burn units

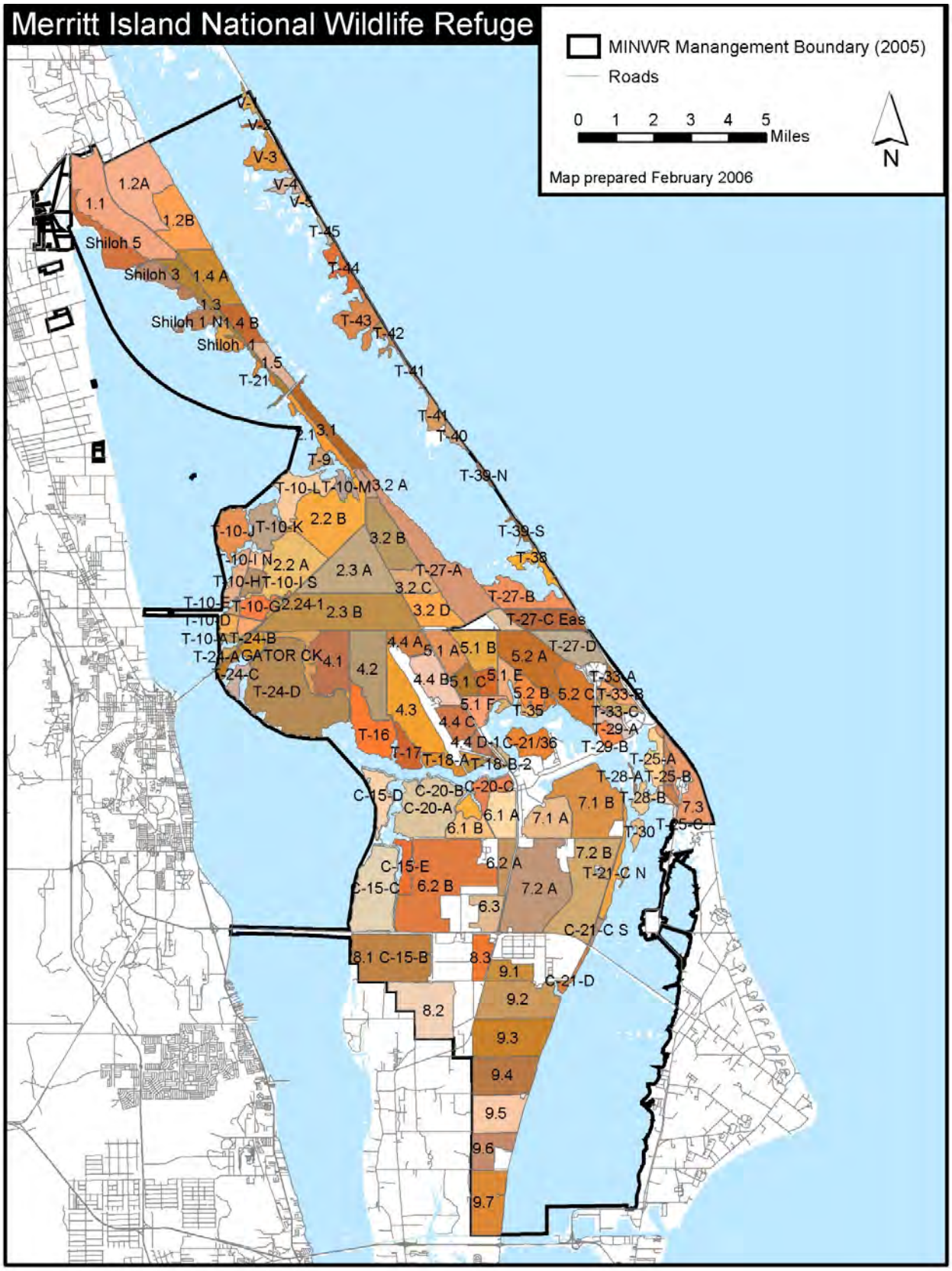
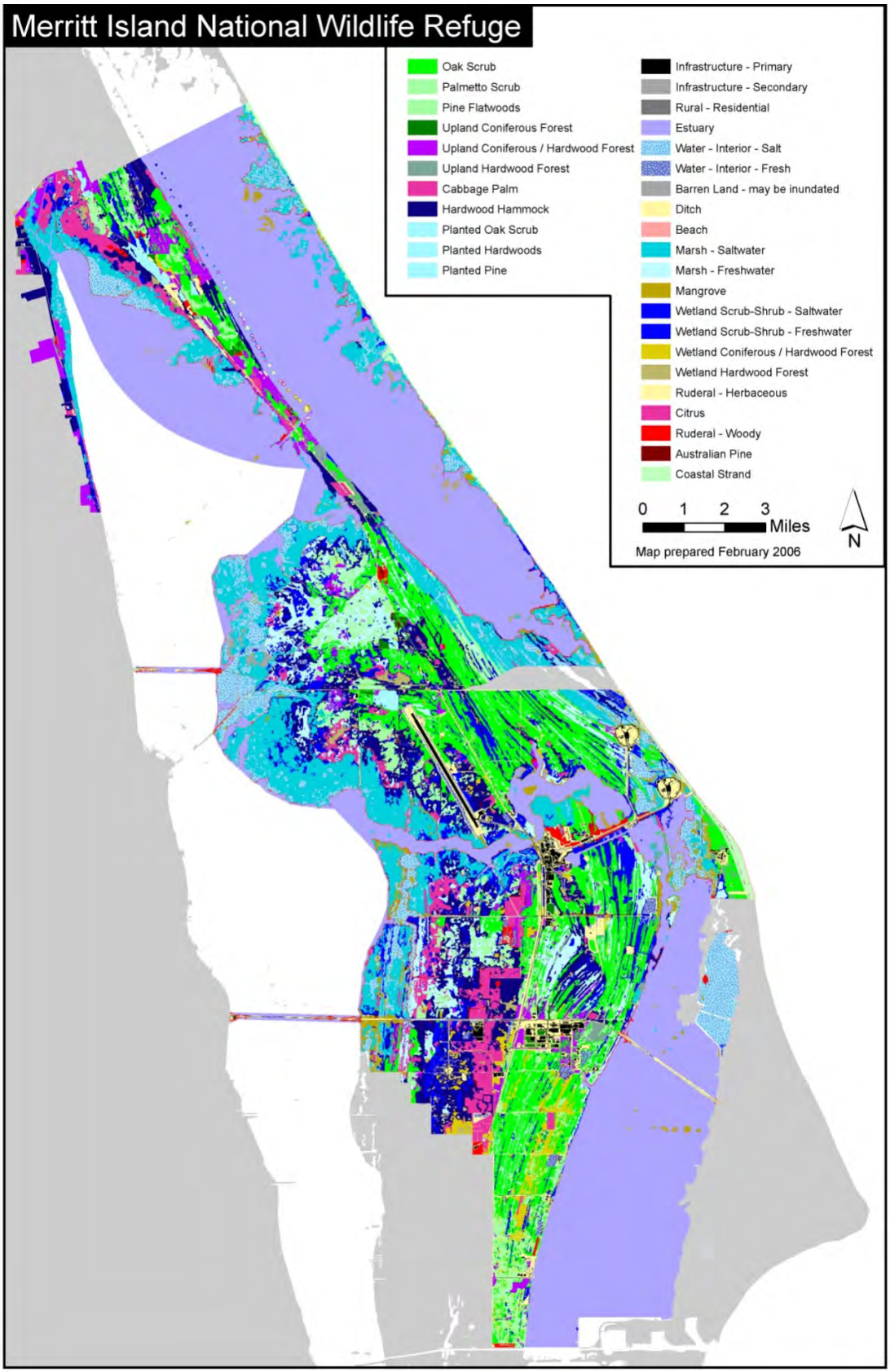


Figure 8. Refuge vegetation



the cover types shown on the map are the colloquial names that have been used in the local area for many years. Table 1 provides the mandated classification system terminology for the alliance and association levels, along with a colloquial name for the various habitat types found on the refuge. The complete table, giving the entire classification system hierarchy, is in the refuge's administrative files. A detailed description of the individual habitat types can also be found in the refuge's Habitat Management Plan (see Appendix F).

Wetland Herbaceous Communities

Marsh – saltwater (Salt marsh, impounded or otherwise); (SPARTINA BAKERII – DISTICHLIS SPICATA TIDAL HERBACEOUS ALLIANCE, Spartina bakerii – Distichlis spicata Association)
Most of the salt marshes at the refuge were impounded for mosquito control in the 1950s and 1960s. As a result, waters within the impounded salt marshes tend, on average, to have lower salinities (depending on current impoundment management and precipitation) than would otherwise be expected in unmodified salt marsh habitats. Despite this, most impoundments currently retain vegetation associations that could still be described as salt marsh. The salt marshes of the refuge (both impounded and un-impounded) are dominated by Baker's cordgrass (*Spartina bakerii*) and salt grass (*Distichlis spicata*). Other salt tolerant plants frequently encountered within the salt marshes include black needle rush (*Juncus roemerianus*), glassworts (*Salicornia spp*.), and saltwort (*Batis maritima*). In some impounded salt marshes, other, less salt tolerant plant species may also be found, including cattail (*Typha spp*.) and sawgrass (*Cladium jamaicense*).

Wetland Shrub - saltwater; (BORRICHIA FRUTESCENS TIDAL SHRUBLAND ALLIANCE)
This alliance includes areas within both impounded and un-impounded salt marsh that, in addition to Baker's cordgrass, contain shrub species, including sea oxeye (*Borrichia frutescens*); wax myrtle (*Myrica cerifera*); scattered mangroves; and the invasive, exotic Brazilian pepper (*Schinus terebinthifolius*). These shrub areas often occur above mean high water and are typically adjacent to landward areas.

Marsh – freshwater; (SPARTINA BAKERII SEASONALLY FLOODED HERBACEOUS ALLIANCE, Spartina bakerii Association)
Freshwater marshes typically occupy interdunal swale areas and are seasonally flooded (although deeper marshes may stay flooded in all but the driest years). These marshes are dominated by Baker's cordgrass, but may also contain beardgrass (*Andropogon spp*.) and sawgrass (*Cladium jamaicence*). In the absence of fire, these wetlands are often encroached by woody species such as willow, wax myrtle, and red maple.

Wetland Shrublands

Mangrove; (AVICENNIA GERMINANS-LANGUNCULARIA RACEMOSA-RHIZOPHORA MANGLE TIDAL SHRUBLAND ALLIANCE, Avicennia germinans-Languncularia racemosa-Rhizophora mangle Association)
Mangroves are found along the fringes of the marine waters and in some impoundments. The major species here are black mangrove (*Avicennia germinans*), white mangrove (*Languncularia racemosa*), red mangrove (*Rhizophora mangle*), and buttonwood (*Conocarpus erecta*). Mangroves trap and collect sediment to help stabilize shorelines and reduce flood damage. More than 100 species of fish and shellfish are dependent on mangroves. Key animal species found in this habitat include mangrove water snakes, river otters, raccoons, snook, pelicans, wood storks, herons, egrets, shorebirds, periwinkle snails, and juvenile and predatory fish.

Table 1. Vegetation and cover types on Merritt Island National Wildlife Refuge

Cover Type and (Colloquial terminology from Vegetation Map & HMP Text)	Floristic Alliance (NVCS)	Floristic Association (NVCS)	Acres
Infrastructure - primary	N/A	N/A	1390.36
Infrastructure - secondary	N/A	N/A	726.91
Rural - residential	N/A	N/A	46.24
Total Nonhabitat Acres			**2163.51**
Estuary	N/A	N/A	53069.68
Barren land - may be inundated	N/A	N/A	260.76
Water - interior - salt (Open water in impoundments)	N/A	N/A	7660.05
Marsh - saltwater (Salt marsh, impounded or otherwise)	SPARTINA BAKERII-DISTICHLIS SPICATA tidal herbaceous alliance	*Spartina bakerii-Distichlis spicata* Association	13635.37
Wetland shrub-scrub - saltwater	BORRICHIA FRUTESCENS shrubland alliance	N/A	1893.92
Mangrove	AVICENNIA GERMINANS-LANGUNCULARIA RACEMOSA-RHIZOPHORA MANGLE tidal shrubland alliance	*Avicennia germinans-Languncularia racemosa-Rhizophora mangle* Association	1659.84
Total Saline Wetland Acres			**78179.62**
Ditch	N/A	N/A	375.36
Water - interior - fresh (Borrow Pond)	N/A	N/A	960.73
Marsh - freshwater (Swale)	SPARTINA BAKERII seasonally flooded herbaceous alliance	*Spartina bakerii* Association	5912.51
Wetland shrub-scrub - freshwater (Willow)	SALIX CAROLINIANA temporarily flooded shrubland alliance	*Salix caroliniana* Association	5488.89

Cover Type and (Colloquial terminology from Vegetation Map & HMP Text)	Floristic Alliance (NVCS)	Floristic Association (NVCS)	Acres
Total Freshwater Wetlands			**12737.49**
Beach	N/A	N/A	65.98
Coastal strand	SERENOA REPENS-COCCOLOBA UVIFERA shrubland alliance	*Serenoa repens-Coccoloba uvifera* Association	718.02
Total Beach and Dune			**784.00**
Oak scrub (also scrubby flatwoods)	QUERCUS GEMINATA-QUERCUS MYRTIFOLOIA-SERENOA REPENS shrubland alliance	*Quercus geminata-Quercus myrtifolia-Serenoa repens* Association	15344.24
Palmetto scrub	SERENOA REPENS-ILEX GLABRA-LYONIA SPP. shrubland alliance	*Serenoa repens-Ilex glabra-Lyonia* spp. Association	3142.76
Planted oak scrub	QUERCUS GEMINATA-QUERCUS MYRTIFOLIA-SERENOA REPENS shrubland alliance	*Quercus geminata-Quercus myrtifolia-Serenoa repens* Association	24.81
Total Upland Shrubland			**18511.81**
Wetland hardwood forest	ACER RUBRUM-ULMUS AMERICANA seasonally flooded forest alliance	*Acer rubrum-Ulmus americana* Association	1185.64
Wetland coniferous/hardwood forest	PINUS ELLIOTTII-QUERCUS VIRGINIANA saturated temperate forest alliance	*Pinus elliottii-Quercus virginiana* Association	1603.24
Total Wetland Forest			**2788.88**
Cabbage palm (Palm Hammock)	SABAL PALMETTO temperate forest alliance	*Sabal palmetto* Association	2880.61
Hardwood Hammock	QUERCUS VIRGINIANA-SABAL PALMETTO forest alliance	*Quercus virginiana-Sabal palmetto* Association	9569.24
Upland hardwood forest	QUERCUS VIRGINIANA-SABAL PALMETTO forest alliance	*Quercus virginiana-Sabal palmetto* Association	594.57

Cover Type and (Colloquial terminology from Vegetation Map & HMP Text)	Floristic Alliance (NVCS)	Floristic Association (NVCS)	Acres
Planted hardwoods	QUERCUS VIRGINIANA-QUERCUS LAURIFOLIA forest alliance	*Quercus virginiana-Quercus laurifolia* Association	285.41
Pine flatwoods	PINUS ELLIOTTII-SERENOA REPENS alliance	*Pinus elliottii-Serenoa repens* Association	2999.18
Upland coniferous/hardwood forest	PINUS ELLIOTTII-QUERCUS VIRGINIANA saturated temperate forest alliance	*Pinus elliottii-Quercus virginiana* Association	2730.07
Upland coniferous forest	PINUS ELLIOTTII-SERENOA REPENS alliance	*Pinus elliottii-Serenoa repens* Association	274.53
Planted pine	PINUS ELLIOTTII tropical forest alliance	*Pinus elliottii* var. densa Association	203.98
Total Mesic and Upland Forest			**19537.59**
Ruderal - herbaceous (Lawns, disturbed areas)	No floristic dominance	N/A	3745.96
Australian pine	CASUARINA SPP. Forest alliance	*Casuarina* spp. Association	111.71
Ruderal - woody* (Brazilian pepper)	SCHINUS TEREBINTHIFOLIUS-MYRICA CERIFERA shrubland alliance	*Schinus terebinthifolius-Myrica cerifera* Association	1540.83
Citrus	CITRUS SPP. Woodland alliance	*Citrus* spp. Association	1930.92
Total Nonnative Vegetation*			**7329.42**
TOTAL MINWR ACRES			**142032.32**

**Although some areas are dominated by nonnative vegetation as the primary vegetation cover type, as detailed in the table, all refuge habitats are likely to have the presence of nonnative vegetation.*

Willow Swamp; (SALIX CAROLINIANA TEMPORARILY FLOODED SHRUBLAND ALLIANCE, Salix caroliniana Association)
Willow stands also have standing water on them for most of the year. They are dominated by Carolina willow (*Salix caroliniana*) with some red maple and wax myrtle. In many cases, willows have invaded upland swales and impoundments.

Wetland Hardwood Forests and Woodlands

Wetland Hardwood Forest; (ACER RUBRUM-ULMUS AMERICANA SEASONALLY FLOODED FOREST ALLIANCE); Acer rubrum - Ulmus americana Association)
The hardwood swamp areas have standing water for large portions of the year. They are dominated by red maple (*Acer rubrum*) and elm (*Ulmus americana*), but may have cabbage palm and water tolerant oaks. Some of these areas were once grassy swales that have changed over time as the result of alterations in hydrology and/or from the exclusion of fire.

Cabbage Palm Hammock; (SABAL PALMETTO TEMPERATE FOREST ALLIANCE; Sabal palmetto Association)
These hammocks are almost pure stands of cabbage palms (*Sabal palmetto*). The understory is usually open with a scattering of palmetto and other vegetation. Although cabbage palms can grow on soils with a wide range of moisture regimes, they are typically found on more or less saturated soils, such as those along the edges of impoundments. As the soils become better drained, the vegetation grades into the mesic oak/palm hammocks.

Cabbage palm hammocks can also be found on disturbed sites. Land that was once cleared for home sites or for agriculture often times comes back as stands of exotics and cabbage palms when abandoned. This situation is especially noticeable in the case of citrus groves that have gone fallow.

Mesic Hardwood Forests and Woodlands

Hardwood Hammock; (QUERCUS VIRGINIANA-SABAL PALMETTO FOREST ALLIANCE; Quercus virginiana-Sabal palmetto Association)
These hammocks are dominated by large live oaks (*Quercus virginiana*), cabbage palms, and laurel oaks (*Q. laurifolia*). The understory in some of these hammocks is palmetto (*Sabal palmetto*), while others have a mix of subtropical shrubs, such as wild coffee (*Psychotria* spp.), nakedwood (*Myrcianthes fragrans*), *Ardisia* spp., and ferns, along with the palmetto.

Upland Hardwood Forest; (QUERCUS VIRGINIANA-SABAL PALMETTO FOREST ALLIANCE; Quercus virginiana-Sabal palmetto Association)
Although classified the same as the hardwood hammocks, the upland hardwood forests occupy slightly better drained soils. These are mixed hammocks that have not only cabbage palms and live and laurel oaks, but also elms, ashes (*Fraxinus* spp.), red mulberries (*Morus rubra*), sugar berries (*Celtis laevigata*), and other overstory species. The understories may have nakedwood, wild coffee, and southern red cedar (*Juniperus virginiana* var. *siliciola*).

Oak-Cedar Hammocks; (QUERCUS VIRGINIANA-SABAL PALMETTO FOREST ALLIANCE; Quercus virginiana-Sabal palmetto-Juniperus virginiana var. siliciola Association)
These stands are similar to the upland hardwood hammocks, but have a substantial amount of southern red cedar in them. The majority of these stands are found in the Turnbull Creek area.

Planted Hardwoods; (QUERCUS VIRGINIANA-QUERCUS LAURIFOLIA FOREST ALLIANCE; Quercus virginiana-Quercus laurifolia Association)
These stands were planted on old citrus groves in the northern portion of the refuge during 1991 and 1992. The original planting density was six feet within row spacing with 12 feet between rows. By 2004 the crowns have closed within the rows. The understory consists mainly of exotic grasses left over from the citrus operation.

Xeric Hardwood Forest

Xeric Hammock; (QUERCUS GEMINATA-QUERCUS MYRTIFOLIA ALLIANCE; Quercus geminata-Quercus myrtifolia Association)
This type is found on the Paola-Pomello-Astatula soil association, which is deep, well to excessively drained soils. The overstory vegetation is sand live oak (*Quercus geminata*), myrtle oak (*Q. myrtifolia*), and Chapman's oak (*Q. chapmanii*). This vegetation type is often the end result of long periods of fire exclusion. The vegetation has become a dense, almost impenetrable stand reaching heights of 30 or more feet. The understory is sparse, consisting of clumps of palmetto. There is little in the way of an herbaceous layer. Much of this vegetation type has been restored to oak scrub. Most remaining stands are too small in area to warrant mapping.

Pine Forests and Woodlands

Pine Flatwoods; (PINUS ELLIOTTI-SERENOA REPENS ALLIANCE; Pinus elliotti-Serenoa repens Association)
The pine flatwoods forests and woodlands are generally found on the poorly drained spodosols of the Myakka-Eau Gallie-Immokalee soil association. The overstory consists of two species of pines. South Florida slash pine (*Pinus elliottii* var. *densa*) makes up the vast majority of the pine population. Pond pine (*P. serotina*) can be found in small stands on very wet areas. Pine stands range widely in stocking densities, age, and height. The understory of the pine flatwoods varies depending on the elevation of the site. Common to all flatwoods sites is saw palmetto. Additional understory species on the mesic sites can include wax myrtle (*Myrica cerifera*), gallberry (*Ilex glabra*), and *Lyonia* spp. As the soils become dryer with increased elevation, the gallberry and wax myrtle become fewer and sand live oak, myrtle oak, and Chapman's oak begin to appear. The higher flatwoods, with a high proportion of scrub oaks, are locally known as scrubby flatwoods. The pine flatwoods forests are of special interest because they provide nesting habitat for the bald eagle (*Haliaeetus leucocephalus*). Where the pine overstory is sparse, the scrubby flatwoods can provide habitat for the Florida scrub-jay (*Aphelocoma coerulescens*).

Upland Coniferous Forests; (PINUS ELLIOTTII-SERENOA REPENS ALLIANCE; Pinus elliottii-Serenoa repens Association)
The upland coniferous forest and woodlands occur on both the Myakka-Eau Gallie-Immokalee and the Canaveral-Palm Beach-Welaka soil associations. South Florida slash pine is the predominant tree species, but small patches of sand pine (*Pinus clausa*) are also found. Many of the sites occupied by these stands have been disturbed in the past. The understory has many of the same species as is found in the flatwoods, including palmetto and *Lyonia*. Shrub species favoring drier soils are also found, including sand live oak, myrtle oak, and Chapman's oak. On the disturbed sites the understory shrub layer may be absent or scattered. These areas may also contain a number of exotic grasses and forbs.

Planted Pine; (PINUS ELLIOTTII TROPICAL FOREST ALLIANCE; Pinus elliottii var. densa Association)
Abandoned citrus groves were planted to south Florida slash pine in the late 1980s and early 1990s. These have developed into uniform stands. The understory consists of exotic grasses left over from citrus operations.

Mixed Pine Hardwood Forests

Wetland Coniferous/Hardwood Forests; (PINUS ELLIOTTII-QUERCUS VIRGINIANA SATURATED TEMPERATE FOREST ALLIANCE; Pinus elliottii-Quercus virginiana Association)
These stands can be found on the Copeland-Wabasso soil association. The overstory is predominately live oak, south Florida slash pine with some cabbage palms. There may be some red maple and other wetland species in the midstory. The understory can have palmetto, wax myrtle, and other moist-soil species.

Upland Coniferous/Hardwood Forests; (PINUS ELLIOTTII-QUERCUS VIRGINIANA FOREST ALLIANCE; Pinus elliottii-Quercus spp. Association)
These stands can be found on the Copeland-Wabasso soil association, but at a slightly higher elevation. South Florida slash pine and live oak are the predominant overstory species. There may be other mesic hardwoods in the canopy, such as elms, ashes, red mulberries, and sugar berries.

Shrubland Communities

Oak Scrub and Scrubby Flatwoods; (QUERCUS GEMINATA-QUERCUS MYRTIFOLIA-SERENOA REPENS SHRUBLAND ALLIANCE; Quercus geminata -Quercus myrtifolia-Serenoa repens Association)
This community is found on the well-drained soils of the Paola-Pomello-Astatula soil association, which are located on the higher ridges of the refuge. The vegetation consists of palmetto (*Serenoa repens*), sand live oak (*Quercus geminata*), myrtle oak (*Q. myrtifolia*), and Chapman's oak (*Q. chapmanii*). As the elevation decreases towards palmetto, flatwoods, or swales, more mesic vegetation can be found. The species mix here would include gallberry (*Ilex glabra*) and various *Lyonia* species. This lower elevation species complex is also known as the scrubby flatwoods. Pines can be associated with both the true oak scrub and the scrubby flatwoods. Sand pine (*Pinus clausa*) is present on the dryer sites, while south Florida slash pine (*P. elliottii* var. *densa*) is found in the scrubby flatwoods.

Fire is essential in maintaining both the vertical and horizontal structure of the oak scrub and scrubby flatwoods. Historically, fires ranged through oak scrub areas, keeping the oaks short. The stands were open in nature with numerous sandy openings. Pine stands, although always an important component of the landscape, were scattered and sparse. In the absence of fire during the 1960s and 1970s, the oaks and palmettos became tall dense thickets with no open areas. Pine stocking increased dramatically in some areas, effectively changing the landscape from shrubland to forest. Many of these overgrown oak scrub areas have been cut and burned over the past 15 years in an attempt to create a more natural landscape. In addition, pines densities have been reduced through commercial harvesting, burning, and using mechanical treatment. Although much success has resulted in recreating the vertical structure of oak scrub, persistent openings remain lacking in many areas.

Palmetto Scrub; (SERENOA REPENS-ILEX GLABRA-LYONIA SPP. SHRUBLAND ALLIANCE; Serenoa repens-Ilex glabra-Lyonia spp. Association)
The palmetto scrub occurs on the soils of the Myakka-Eau Gallie-Immokalee soil association. The majority of the vegetation is palmetto, gallberry, wax myrtle (*Myrica cerifera*), and several species of *Lyonia*. In many instances, this type is found in close association with the oak scrub. There is no real definitive break between these two types, but rather a gradual progression from one to the other. As the elevation on the land rises, scrub oaks can be found mixed in with the palmetto scrub vegetation.

Planted Oak Scrub; (QUERCUS GEMINATA-QUERCUS MYRTIFOLIA-SERENOA REPENS SHRUBLAND ALLIANCE; Quercus geminata -Quercus myrtifolia-Serenoa repens Association)
An attempt to restore a 10-acre abandoned citrus grove near WSEG Road was conducted in 1992. Prior to planting, old citrus trees were removed and an attempt was made to control exotic grasses on the site. Sand live oak, myrtle oak, and Chapman oak were planted at a stocking rate of 400 stems per acre in August 1992. Additional oaks were planted in 1993 along with palmetto, rusty lyonia (*Lyonia fruticosa*), shiny blueberry (*Vaccinium myrsinites*), and south Florida slash pine. This effort was marginally successful (Schmalzer et al. 2002).

Coastal Strand; (SERENOA REPENS-COCCOLOBA UVIFERA SHRUBLAND ALLIANCE, Serenoa repens-Coccoloba uvifera Association)
Coastal strand is found in a narrow band immediately inland from the beach. Salt spray and poor, sandy soils are the limiting factors. The most common plants found here are saw palmetto (*Serenoa repens*), sea grape (*Coccoloba uvifera*), snowberry (*Chiococca alba*), sea oats (*Uniola paniculata*), beach grass (*Panacium amarum*), and wax myrtle (*Myrica cerifera*). Vegetation seldom reaches a height of over four feet and shows marked evidence of hedging from salt spray.

Nonnative Plant Communities

Citrus Groves; (CITRUS SPP. WOODLAND ALLIANCE; Citrus spp. Association)
Various species of citrus were planted prior to the acquisition of the lands of the refuge by the government for Kennedy Space Center. Some of these have been allowed to go fallow, while others are being managed by the Florida Research Center for Sustainable Agriculture in an effort to develop more environmentally friendly citrus culture methods.

Brazilian Pepper; (SCHINUS TEREBINTHIFOLIUS-MYRICA CERIFERA SHRUBLAND ALLIANCE, Schinus terebinthifolius-Myrica cerifera Association)
Many disturbed areas, including dikes and abandoned facilities, have been invaded by Brazilian pepper and other exotics, along with native species, such as wax myrtle. These stands are thick, almost impenetrable thickets. There is little in the way of ground vegetation.

Australian Pine; (CASUARINA SPP. FOREST ALLIANCE, Casuarina spp. Association)
Australian pine was planted around citrus groves and home sites as wind breaks. These are dense stands of Casuarina with little, if any, understory. The ground cover is almost exclusively needles and other debris from the trees.

WILDLIFE

Merritt Island National Wildlife Refuge supports a high diversity of fish and wildlife. This high biodiversity is, in part, the result of the refuge's location on the Indian River Lagoon, which is often touted as having the greatest biodiversity of any estuary in North America. However, the undeveloped nature of the refuge's landscape and diversity of habitats also contributes to the high biodiversity. The refuge's estuarine waters support a wide variety of resident and migratory birds, mammals, reptiles and amphibians, fish, and invertebrates. The estuary also provides important habitat to marine mammals (including Atlantic bottlenose dolphins and West Indian manatees) and marine reptiles (including juvenile green sea turtles). Upland and freshwater wetland areas provide additional habitats to support a variety of species.

The refuge serves as a key area for biodiversity, with a species richness that is very important to the overall ecological integrity and health of the Indian River Lagoon and the North Florida Ecosystem. The Service manages refuge resources and coordinates with neighboring land managers and agencies to conserve biological diversity.

The refuge also serves as an important site for the recovery of federal- and state-listed threatened and endangered species. The refuge's location and habitat features provide protection and management opportunities for the future of 10 federally listed threatened and endangered species that regularly occur on the refuge, as well as for the future of three additional wildlife species listed by the State of Florida as threatened or endangered (Epstein and Blihovde 2006). The 10 federally listed wildlife species that regularly occur on the refuge are the West Indian manatee; southeastern beach mouse; Florida scrub-jay; bald eagle; wood stork; piping plover; eastern indigo snake; and loggerhead, green, and leatherback sea turtles. Of the total listed animal species in the refuge's records, 17 are federally listed. However, seven of these species (the American alligator, Kemp's ridley sea turtle, Hawksbill sea turtle, Atlantic salt marsh snake, snail kite, Audubon's crested caracara, and roseate tern) either have a special listing (i.e., alligator) or have rarely or never been recorded on the refuge (i.e., Atlantic salt marsh snake). This brings the actual number of state or federally listed species that regularly occur on the refuge to 41, of which 10 are federally listed and 31 are state-listed species (which excludes the alligator and includes 28 plant species). Additional information on the refuge's listed and designated species is provided in Appendix D.

Birds

Avian species are a highly important refuge resource. To date, more than 300 species of birds (both resident and transient) have been identified using the refuge for nesting, roosting, feeding, or loafing. This includes seven species that are federally listed as threatened or endangered (Audubon's crested caracara, bald eagle, Florida scrub-jay, piping plover, roseate tern, snail kite, and wood stork); 42 species federally listed as Birds of Conservation Concern; 11 species listed by the State of Florida as threatened or endangered; and 12 species listed by the State of Florida as Species of Special Concern (see Appendix D for a listing of these birds.) Of the seven species federally listed as threatened or endangered, four regularly depend on the habitat provided by the refuge: the Florida scrub-jay, bald eagle, piping plover, and wood stork. In addition to serving as important habitat for threatened and endangered species, the refuge supports a wide variety of other resident and migratory birds. Waterfowl, wading birds, shorebirds, and neotropical migratory birds (i.e., songbirds or passerines) all depend on the diverse habitats offered by the refuge.

Florida Scrub-jay
The federally threatened Florida scrub-jay (*Aphelocoma coerulescens*) is one of the most intensively managed species on the refuge. Although there is some uncertainty concerning the specific numbers (Johnson et al. 2006), it is believed that the refuge is the site of the second largest population (about 550 family groups) of scrub-jays in Florida and in the world (Ocala National Forest in the northern part of central Florida is the number one site). Areas occupied by Florida scrub-jays are characterized as a mosaic of oak scrub, oak/palmetto, and coastal scrub habitats, as well as ruderal and disturbed areas in the coastal regions of Merritt Island and Cape Canaveral. Many of these areas include patches of remnant scrub in a human-altered landscape. Population size of the Florida scrub-jay is influenced by the amount of available habitat and habitat suitability. Prescribed fire management is a major tool in scrub habitat management.

Bald Eagle
The refuge currently supports an annual average of 11 to 13 breeding pairs of the federally threatened southern bald eagle (*Haliaeetus leucocephalus*). The eagles are known to use various pine flatwood habitats within the refuge and have used mature live pine, pine snags, and abandoned radio towers for nest sites. Bald eagles have been shown to nest within the vicinity of large water bodies, particularly with abundant access to fish and migratory waterfowl. The refuge's wetland and estuarine complex provides a diversity of excellent foraging habitats.

Piping Plover
The federally threatened piping plover (*Charadrius melodus*) uses coastal areas of the refuge during spring and fall migration. Small numbers of wintering piping plovers are known to use coastal areas north and south of the refuge. Although piping plovers do not presently winter on the refuge, they are known to use the refuge beach during fall migration. Currently no habitat on the refuge is being managed specifically for piping plovers.

Wood Stork
The federally endangered wood stork (*Mycteria americana*) is of special interest to the Service. Wood stork populations have declined sharply in Florida, from 60,000 in the 1930s to 5,000 pairs today, with the complete loss of wood stork nesting on the refuge. Wood storks were first breeding in the refuge's Moore Creek colony in 1972 (with 35 nests). Nest numbers peaked in 1980 (with 350 nests) and varied in number until 1986. A severe freeze occurred in the 1985–86 winter that destroyed all of the mangrove nest sites in the Banana River and Moore Creek. Although 250 nests were recorded in 1986 at Moore Creek, the storks abandoned the freeze-damaged rookery and no successful nesting has occurred on the refuge since 1986. Approximately 250 wood storks currently use the refuge for feeding and roosting.

Waterfowl
The refuge's estuarine waters and impounded areas provide important habitat to both resident and wintering waterfowl. Seventeen waterfowl species regularly use the refuge, although only mottled ducks typically nest on the refuge. Waterfowl numbers on the refuge vary dramatically during the year, with tens of thousands using the refuge during the winter months, but only an estimated several hundred resident mottled ducks are present during the summer months. The refuge historically supported vast numbers of wintering waterfowl, including blue-winged teal, American widgeon, northern pintail, lesser scaup, redhead, and mergansers. However, wintering population numbers have varied through the years with recent counts generally low. Of particular concern are northern pintail and lesser scaup.

Pintail population numbers have steadily declined on the refuge over the past decades, from a midwinter count of about 20,000 in 1978 to 8,315 birds in 1989, to 3,141 in 1999, and to a low of 1,376 birds in January 2003 (representing a 93 percent decline from 1978). The northern pintail stands a serious chance of being extirpated from a historical wintering area at the refuge.

The continental population of lesser scaup has been declining since the mid-1980s. The Merritt Island Refuge and its adjacent estuarine areas (in the Banana River, Indian River Lagoon, and Mosquito Lagoon) provide the most valuable wintering habitat for scaup on the Atlantic Flyway, harboring up to 62 percent of the flyway's scaup and 15 percent of the continental scaup population (Herring 2003).

Wading Birds
Sixteen species of wading birds (e.g., egrets, herons, and ibises) can be found on the refuge. Of these, one is federally listed as endangered (the wood stork) and eight species are designated Birds of Conservation Concern (BCC - federal) or Species of Special Concern (SSC - state) (see

Appendix D for a list of designated species). Fourteen of these species commonly nest on the refuge. Wading birds at the refuge use a broad range of wetland habitat types for foraging, roosting, and nesting. Refuge habitats frequented by wading birds include both natural and man-made features, including the open estuary, natural freshwater wetlands, impoundments, and roadside ditches. In addition, many wading birds use vegetated dredge spoil islands in the Indian River Lagoon and Banana River as roosting and nesting sites.

Shorebirds
As a result of its location along the Atlantic coast, the refuge provides valuable habitat to a wide variety of shorebirds. Thirty-five species of shorebirds regularly use the refuge during fall and spring migrations, taking advantage of habitat provided along the coast, along shore areas of the estuary, and within impoundments. Fourteen species commonly winter on the refuge in high numbers and seven species have been recorded as nesting on the refuge. Of the species that regularly use the refuge, one species, the piping plover, is listed both federally and by the state as threatened, while two other species (the red knot and semipalmated sandpiper) are federally designated as Birds of Conservation Concern (see Appendix D). Suitable habitat for shorebirds is provided via the current system of managing refuge impoundments for multiple species.

Passerines
The refuge hosts a great diversity of passerines, with approximately 170 species regularly occurring on the refuge. While 38 species have been recorded nesting on the refuge, the greater majority of passerines are transient, using refuge habitats during spring and fall migrations. The threatened Florida scrub-jay (discussed above) is the only federally listed passerine that occurs on the refuge.

Mammals

The refuge's mammalian fauna is characteristic of the central Florida coastal barrier ecosystem. Thirty species of mammals are known to occur on the refuge, including two marine mammals (the West Indian manatee and Atlantic bottlenose dolphin) which frequent lagoon and offshore waters. The refuge provides important habitat for two federally listed species, the West Indian manatee (state and federally listed as endangered) and the southeastern beach mouse (state and federally listed as threatened).

West Indian Manatee
Refuge waters serve primarily as a safe harbor and seagrass feeding site for an average of 300 West Indian manatees (*Trichechus manatus*) year-round and may host a peak population of over 600 individuals during months with warm water temperatures. Over a third of Florida's manatee population is found in the Indian River Lagoon system (Indian River Lagoon National Estuary Program 1996).

Southeastern Beach Mouse
The federally threatened southeastern beach mouse (*Peromyscus polionotus niveiventris)* is a subspecies of the old field mouse (*P. polionotus*) that inhabits the sand dunes and adjoining scrub along the Atlantic coastline. Extensive coastal development has resulted in the loss of coastal dunes and fragmentation of nearly all beach mouse habitats in Florida. The refuge provides habitat and protection to one of the last remaining core populations of this species.

Reptiles and Amphibians

The refuge provides habitat to 71 species of reptiles and amphibians, including three marine reptiles (the green, leatherback, and loggerhead sea turtles). Five species (American alligator, Eastern indigo snake and the three sea turtles) are federally listed as threatened or endangered. Three additional species are also listed by the state as species of special concern (the Florida pine snake, gopher frog, and gopher tortoise) (see Appendix D).

Terrestrial herps have been studied on the refuge since the 1970s. Long-term monitoring has provided considerable existing data on the biodiversity of herps on the refuge (Seigel and Pike 2003) and will be invaluable to detect long-term changes in the refuge herpetofauna. Reptiles and amphibians are critical components of refuge ecosystems. The biomass of reptiles and amphibians (i.e., herps) may exceed that of all other vertebrates in aquatic and terrestrial systems (Seigel and Seigel 2000). The ecological distribution of reptiles and amphibians on Merritt Island Refuge is a function of available habitat, which mostly reflects wetland, freshwater communities. However, several species are specific to and use terrestrial habitats and certainly are linked to the coastal ridge and trough topography on the refuge. Exotic species are becoming potential threats to the refuge. Presently on the refuge, the brown anole (*Anolis sagrei*) may be displacing native species (Campbell 2000; Campbell and Echternacht 2003). The Cuban frog (*Osteopilus septentrionalis*), which consumes smaller species, has been positively identified on the refuge. Additional research and monitoring is being conducted on gopher tortoise distribution, fecundity, and on upper respiratory tract disease.

American Alligator
The American alligator (*Alligator mississippiensis*) is federally listed as threatened only as a result of its similarity in appearance to the federally endangered American crocodile. The species is not regulated under Section 7 of the Endangered Species Act and is not in danger of becoming extinct. American alligators are abundant on the refuge, with an estimated population of over 3,000 individuals.

Eastern Indigo Snake
Eastern indigo snakes (*Drymarchon couperi*) became federally listed as threatened under the Endangered Species Act in 1978. Once common from the southern tip of South Carolina west to southeastern Mississippi and throughout Florida, the current range is restricted to southern Georgia and peninsular Florida, with a few small populations located in the Florida panhandle and Key Largo. Eastern indigo snakes have very large home ranges and use a variety of habitat types found within the refuge, including oak scrub, oak hammock, pine flatwoods, fresh and brackish wetlands, and disturbed habitats (Breininger et al. (2004). The species also shares a commensal relationship with the state-listed gopher tortoise (*Gopherus polyphemus*), whose burrows it uses as shelter from predation and temperature extremes.

Sea Turtles
Three different sea turtle species annually nest along the nearly 10-kilometer stretch of refuge beach between March and September. These turtles include the federally threatened loggerhead sea turtle (*Caretta caretta*), federally endangered green turtle (*Chelonia mydas*), and federally endangered leatherback turtle (*Dermochelys coriacea*). The loggerhead is the primary nesting turtle on the refuge with over 95 percent of the nesting and with previous annual averages of 1,300 nests (Popotnik and Epstein 2002). Green sea turtle nest numbers oscillate between 50 and 200 every other year. Leatherback sea turtles nest infrequently on the refuge beach, with only one or two nests recorded in a typical year. Management for these species includes beach protection, NASA coordination efforts, nest monitoring during the nesting season, and predator control. Primary nest predators include raccoons (*Procyon lotor*), feral hogs (*Sus scrofa*), and ghost crabs (*Ocypode quadrata*). Nest depredation was greater than 90 percent of nests during the late 1970s before predator control (Lew Ehrhart, personal communication). Today, an active predator control program has reduced the

depredation of nests well below an annual rate of 10 percent. In addition, the disorienting effects of artificial nighttime lights from NASA and U.S. Air Force facilities on nesting and hatchling sea turtles are a concern. The NASA monitors this turtle disorientation annually. The refuge coordinates efforts with NASA and the Air Force to help reduce or eliminate the adverse effects of nighttime lighting on sea turtle nesting and hatchling disorientation.

Beyond the nesting beaches, the refuge also provides a juvenile sea turtle nursery. The Mosquito Lagoon is considered a developmental habitat for sub-adult loggerhead and green sea turtles. The lagoon once supported vast numbers of wintering juvenile sea turtles and an historic sea turtle fishery that extended into the 1960s, which was thought to contribute to the decline in population numbers. Turtles may remain in Mosquito Lagoon until maturity. Turtles wintering in the lagoon are plagued by winter freezes, which can cold-stun the animals and cause mortality. The refuge has developed a plan to coordinate the handling of cold-stunned turtles and prevent moralities (Epstein 2001a). Monitoring of wintering sea turtles in the Mosquito Lagoon in the mid-1970s (Ehrhart and Yoder 1978) found higher numbers than presently found (Provancha et al. 2002) and found an increase in sea turtle fibropapillomas.

Fish

More than 140 species of freshwater and saltwater fish are known to use refuge estuarine areas, impoundments, and freshwater wetlands. Of the species known to occur in refuge waters, none are currently federal- or state-listed species. Fish within the refuge are important not only to commercial and recreational interests, but also to the ecology of the area. The refuge protects important fish habitats, such as fish spawning and fish settlement sites, ensuring healthy, sustainable fish populations. The open water estuary habitat of the Indian River Lagoon is one of the most renowned sportfishing sites in the world (Roberts et al. 2001). This system is essential to several interjurisdictional and economically important fish species, including snook, tarpon, red and black drum, spotted seatrout, and striped mullet.

Invertebrates

A wide variety of marine, freshwater, and terrestrial invertebrates are found within the refuge's boundary. While some research has been conducted regarding benthic macro-invertebrates inhabiting the open estuary and select impoundments, no systematic survey has been performed for freshwater or terrestrial invertebrates of the refuge. A keystone species, the horseshoe crab (*Limulus polyphemus*) which generally inhabits estuarine areas of the refuge, has been in decline (Jane Provancha and Gretchen Ehlinger, Dynamac, Inc., personal communication). The reason for the decline in horseshoe crab abundance is currently unknown.

Exotic, Invasive, and Nuisance Species

The occurrence and spread of exotic, invasive, and nuisance plant and animal species have been identified by Service staff and intergovernmental partners as one of the priority management issues facing Merritt Island National Wildlife Refuge. Further, nuisance native animal species are also known to have negative impacts on threatened and endangered species and on human safety. Although numerous exotic, invasive, and nuisance species occur on the refuge, only a small number have been identified by the refuge as management concern species.

In Florida, almost one-third of the plants occurring in the wild are exotic, and of the estimated 1,200 exotic species in Florida, approximately 11percent are invasive in natural areas (Schmalzer et al. 2002). Schmalzer and others reported over 50 invasive exotic plants in and around the refuge. Although there has been no comprehensive survey of exotic plants on the refuge itself, 25 of these have been observed by refuge personnel on refuge lands.

The Florida Exotic Pest Plant Council maintains a list of Category I invasive exotic plants that are altering native plant communities and Category II invasive exotic plants that have increased, but that have not yet altered native plant communities (Florida Exotic Pest Plant Council 2005). The refuge has 17 known Category I plants and two known Category II plants (Table 2) that are of management concern. These species have invaded all refuge wetland and upland habitats, as well as disturbed sites. Invasive species can have negative impacts to natural plant diversity and to wildlife habitat. Invasive species can also have negative economic and public health and safety impacts. No comprehensive survey of exotic plants has been conducted on the refuge. Control efforts by refuge staff have historically been uncoordinated and typically focused on controlling invasive plants in public use areas and along selected roads and dikes. The refuge currently receives no funding for invasive plant control. All invasive plant control efforts have been funded out of limited operations' monies and through partnerships. In 2000, the refuge began participation in a Florida Department of Environmental Protection program where public land management agencies could submit proposals for invasive plant control project funding. To date, the refuge has had eight projects funded with a value of $740,110. In addition, Canaveral National Seashore has completed four projects in cooperation with the Florida Department of Environmental Protection within the joint refuge/Seashore area. The Department's projects have focused on protecting native plant diversity and protecting wildlife habitat.

Table 2. Selected exotic species occurring on Merritt Island National Wildlife Refuge

Scientific Name	Common Name(s)	Category[1]
Plants		
Albizia julibrissin	Mimosa, Silk Tree	1
Abrus precatorius	Rosary Pea	1
Bambusa spp.	Bamboo	N/A
Bauhinia variegata	Orchid Tree	1
Casuarina spp.	Australian Pine	1
Dioscorea bulbifera	Air-Potato	1
Eichhornia crassipes	Water-Hyacinth	1
Enterolobium contortisiliquum	Costa Rica Ear Tree	N/A
Eucalyptus spp.	Eucalyptus	N/A
Ficus spp.	Fig	1
Imperata cylindrica	Cogangrass	1
Lygodium microphyllum	Old World Climbing Fern	1

Scientific Name	Common Name(s)	Category[1]
Melaleuca quinquenervia	Paper Bark Melaleuca	1
Melia azedarach	Chinaberry Tree	2
Nephrolepis cordifolia	Boston Fern/Erect Sword Fern	1
Panicum maximum	Guinea Grass	2
Psidium spp.	Guava	1
Pueraria montana	Kudzu	1
Rhynchelytrum repens	Natal Grass	1
Ricinus communis	Castor Bean	2
Ruellia brittoniana	Mexican Petunia	1
Sapium sebiferum	Chinese Tallow Tree	1
Senna pendula	Christmas senna	1
Sporoblus indicus	Smut Grass	N/A
Schinus terebinthifolius	Brazilian Pepper	1
Animals		
Sus scrofa	Feral Hog	N/A
Felis domesticus	Feral Cat	N/A
Perna viridius	Green Mussel	N/A
Pterygoplicththys spp.	Armored Catfish	N/A

1. Florida Exotic Pest Plant Council Category

Invasive animals can also cause negative natural resource impacts through direct mortality to native wildlife and by competition with native wildlife for food. Two invasive animal species are known to occur on the refuge: feral hogs and feral house cats. Hogs are present in large numbers in all upland and marsh habitats and cause extensive habitat damage. The Service suspects that they also negatively impact wildlife by direct mortality and through competition for food. Hogs are also a safety hazard due to impacts with vehicles. They cause economic damage through vehicle collisions and through destruction of landscaped areas and road shoulders by rooting. Estimates of the hog population on the refuge have varied from 5,000 to 12,000. Current control efforts include trapping by permittees and shooting by refuge staff, removing approximately 2,500 hogs from the refuge each year. The number of feral house cats occurring on the refuge is small and is usually associated with refuge and NASA facilities. It is assumed that all feral house cats occurring on the refuge are released by the public, while some are subsequently fed by the public.

Raccoons are the primary nuisance native wildlife species on the refuge. Raccoons are predators on the nests of sea turtles. The refuge operates a program to control raccoon numbers on the refuge's nesting beach to reduce the level of depredation on sea turtle nests. Other nuisance wildlife is limited to birds, alligators, and a variety of other species which impact the Space Program operations at Kennedy Space Center. The refuge staff responds to Space Center calls regarding nuisance wildlife and deals with the animal using the least intrusive method available.

The infestation of invasive plants and feral hogs is extensive on the refuge and without control efforts the level of infestation is anticipated to continue to increase resulting in even greater impacts to refuge habitats and wildlife populations.

CULTURAL RESOURCES

From its gradual emergence from the sea about a quarter million years ago to the space age, Merritt Island has remained a unique natural area attracting a diverse array of wild creatures and human occupants. The forces of wind, wave action, and fluctuating levels of the ocean formed the alternating ridges, swales, and marshes of Merritt Island. The land continues to change as the dynamic natural forces of the barrier island constantly shape and sculpt the Island.

HISTORICAL OVERVIEW

Indian Period

Over the millennium, human occupation of the island ebbed and flowed. Archaeologists say that the Island was occupied by seven distinct Native American cultures dating back 6,000 years. The first human visitors were probably small bands of nomadic hunters and gatherers that wandered in from the St. Johns River basin. At this time, sea levels were much lower than present and the shoreline could have been miles eastward, so most evidence of their culture was lost with the last sea level rise. Shellfish formed an important part of the indigenous peoples' diets as evidenced by the numerous shell middens that exist today and which have provided archaeologists with important information concerning their societies. Beginning about 2,000 B.C., the Native Americans developed clay pottery and this event marked the beginning of the Orange Period which lasted about 1,000 years. This was followed by the Transitional, St Johns I, and St Johns II periods, and finally, after 1565, the St. Augustine period.

Each period of Native American culture was marked by a distinctive type of pottery and shards of these various utensils are found in many of the middens. Evidence indicates that early indigenous people spent their winters on the barrier island in and around Mosquito Lagoon and Banana River, moving inland to the St. Johns River basin during the summer months to escape the intolerable salt marsh mosquitoes.

By the time the first European explorers arrived, the refuge formed the line between two distinctive Indian cultures. The Timucuan, a peaceful agrarian tribe, occupied the area along Mosquito Lagoon northward to Jacksonville. To the south, beginning at Cape Canaveral and the Banana River, the coast was inhabited by the fierce Ais Indians. Most of what is known of the Ais culture came from the Jonathan Dickinson Journal of 1696. Both the Timucuan and the Ais tribes disappeared in historical times, having succumbed to war, disease, and slavery at the hands of the Spanish and English. Following early English raids, some of the Ais moved to Cuba with the Spanish. Other than occasional incursions by the Seminoles, Indian occupation of the Cape area ended after the early 1700s.

Early European Settlement
For nearly 300 years, during the 16th, 17th, and 18th centuries, the Cape area was on the fringe of Spanish activity. Neither Spanish settlements nor missions were known to have occurred in the area of the refuge, though evidence of their occasional passage through the region was indicated by the presence of wild orange groves.

Following the Spanish occupation, British settlers moved into the area for a brief period from 1763 to 1784. The American Revolution brought an end to the British occupation.

Second Spanish Period
The period from 1784–1821 was termed the second Spanish Period and during this era several Spanish Land Grants were established on the refuge. The Gomez Grant forms the current northern boundary of the refuge. It became clear that Spain could no longer hold Florida and it was forced into signing the Adams-Onis Treaty in 1819 that lead to the transfer of Florida to the United States in 1821.

American Period
Florida was established as a Territory in 1821 with Andrew Jackson serving as the first territorial governor. In 1835, the Second Seminole War broke out and all plantations and settlements south of St. Augustine in east Florida were destroyed. The Second Seminole War stimulated the first substantial modern development of transportation and fortifications on the refuge. From November 1837 to April 1838, Fort Anne, near present day Haulover Canal, was constructed and occupied. In 1854 the first Haulover Canal was constructed, which served to bring in settlers and goods and to send produce to northern markets.

With the end of the Seminole War, Douglas Dummitt settled on a piece of land south of Fort Anne. Over the next 36 years he established a 1,700-tree orange grove that was reported to be the largest in the state. Dummitt's grove was the forerunner of the citrus industry in Florida and the origin of the famous Indian River Fruit industry. Dummitt's grove lasted until after his death in 1873, but in December 1894 and February 1895 two successive freezes destroyed the grove.

By 1896, the lower portion of Mosquito Lagoon was the property of the Canaveral Shooting Club and the land was spared from development. Around the same period, the Indian River Club acquired the marshes around Banana River and Banana Creek, having the same positive results in maintaining the natural values of the area. These efforts by conservationists proved beneficial to NASA, some 60 years later, when it acquired the property for the Kennedy Space Center.

In 1903 Pelican Island, located 70 miles south of Merritt Island, was established as the nation's first national wildlife refuge. However, despite efforts to protect the nesting brown pelican colony on Pelican Island, the birds abandoned Pelican Island in the mid-1920s. Paul Kroegel, the refuge manager, discovered that the birds had moved to Mosquito Lagoon and, in 1928, the island where they were nesting was designated as the North Brevard National Wildlife Refuge. The birds eventually returned to Pelican Island to the south, but the designation as the North Brevard Refuge remained. From 1930 to the end of 1950, the area was devoted to cattle grazing and citrus. Several small residential communities were becoming better established, but the ever present salt marsh mosquito remained a factor in limiting large scale residential land use on Merritt Island.

Across the Banana River on Cape Canaveral was the site where America began its exploration of space. The early focus of these launch operations was at Cape Canaveral, but by the end of the 1950s it became evident that additional lands were needed for the future of the space program. In the late 1950s and early 1960s, NASA acquired land in fee simple title and acquired submerged land from the State of Florida. The property cost was $72,872,000. During the acquisition stage, NASA

approached the Service to include the lands of the North Brevard Refuge as part of the Kennedy Space Center. A local naturalist and photographer by the name of Allan Cruickshank and others lobbied NASA to preserve some of the area for its wildlife values. NASA was under intense pressure from the citrus industry and others to retain some of the established uses of the area and viewed the establishment of the refuge as a means to appease these interests.

In 1962, the later named John F. Kennedy Space Center was officially established. On August 28, 1963 NASA entered into an agreement with the Fish and Wildlife Service to manage a portion of the Space Center as a refuge and Merritt Island National Wildlife Refuge was established. The original refuge was 25,300 acres and included the marshes east of Titusville north and south of State Route 402 and State Route 406. In subsequent years, additional lands were turned over to the refuge, including management of about 2,500 acres of orange groves. In 1975, Congress established Canaveral National Seashore, which withdrew a portion of the refuge and turned it over to the National Park Service. A joint refuge/Seashore area was established in Mosquito Lagoon, where duties and responsibilities were divided, but where the refuge retained management of wildlife and most public use activities, including hunting and fishing. Today most of NASA's lands are managed by the Department of the Interior as a national seashore and national wildlife refuge. NASA has retained title to the property and the agreement allows NASA to withdraw lands required to support space related purposes. Today the refuge manages over 139,000 acres of NASA lands and about 1,246 acres of Service and state land along the headwaters of Indian River Lagoon. Within the refuge/Seashore overlap, the National Park Service takes the lead on cultural resources.

CULTURAL RESOURCE PROTECTION

Since the refuge includes several historical and archaeological sites and since these sites are fairly accessible to disruption, vandalism, and theft, several archaeological surveys have been conducted on the refuge. Some of these sites are eligible for listing in the National Register. In the event that a previously undetected archaeological site is uncovered, activity must stop and the refuge must coordinate with the Service's Regional Archaeologist and Florida's State Historic Preservation Office. In the joint management area with the National Park Service, the Seashore is responsible for cultural resource management.

NATIONAL REGISTER

Of the 100 known archaeological sites of Kennedy Space Center/refuge, 5 are listed in the National Register of Historic Places; 23 sites are considered eligible for listing; 8 are potentially eligible for listing; 17 lack sufficient information to evaluate their eligibility for listing; 47 were evaluated to be not potentially eligible; and 8 sites either could not be relocated or sufficiently tested to evaluate their potential for listing (Deming et al. 2001). As of 1998, 116 temporal/cultural components were identified on the known 100 archaeological sites, with 78 percent of these components being prehistoric (including artifact scatters, shell middens, middens, burial mounds, lithic scatters, and single artifact occurrences) and 22 percent were historic in nature (including 15 refuse deposits, six cemeteries, a fort, canal, saltworks, homestead/grove, and sugar mill ruins) (Deming et al. 2001).

A variety of NASA facilities at Kennedy Space Center are historically significant, since they represent America's first ventures into space and America's first spaceport. In 1973, the LC-39 site was the first NASA facility at the Space Center to be listed in the National Register of Historic Places. At the time, this listing included approximately 7,000 acres and a variety of NASA facilities. By 2001, the recommendation was to alter the listing into individual nominations for 10 historic facilities (including the Vehicle Assembly Building, Launch Control Center, Crawlerway, Press Site Clock and Flag Pole,

Missile Crawler Transporter Facilities, Pad A, Pad B, Headquarters Building, Central Instrumentation Facility, and Operations and Checkout) with hundreds of contributing and noncontributing resources under the multiple property category (Deming et al. 2001).

SOCIOECONOMIC ENVIRONMENT

The refuge is located in the Indian River Lagoon region, which was generally unaffected by human activities until the early 1800s. Early activities included growing citrus, harvesting palmetto berries, and growing pineapple. By the late 1800s, commercial fisheries opened up the lagoon's resources. With repeated freezes devastating agricultural crops, cattle grazing increased in the region. Various military facilities were developed in the region during World War II. By the 1960s, NASA's space program instigated considerable growth in the area. The modern economy of the Indian River Lagoon is based on tourism and agriculture, as well as on fishing, manufacturing, real estate, services, and government. In the 1990s, citrus was a $2.1 billion industry in the lagoon region (Indian River Lagoon National Estuary Program 1996).

By 2000, Florida's population had soared to 16 million, with 77 percent living in Florida's 35 coastal counties. The resident counties of the refuge, Brevard and Volusia, are in the top 10 most populated Florida counties. In 2000, over 919,000 people lived in these two resident counties of the refuge, with another 1.26 million in the two adjacent counties, while the average growth rate from 1990–2000 in the four-county area around the refuge was over 25 percent with a 2000 total for this area of nearly 2.2 million (Table 3) (U.S. Census Bureau 2000b).

Table 3. Growth of resident and nearby counties from 1990–2000 (U.S. Census Bureau 2000b)

County	2000 Population	Growth Rate from 1990-2000 (Percentage)	Location in Relation to Refuge
Brevard	476,230	19.4	resident county
Volusia	443,343	19.6	resident county
Seminole	365,196	27.0	~13 miles west of the refuge
Orange	896,344	32.3	~9 miles west of the refuge
Four County Total	2,181,113	25.7	

Although the resident and adjacent counties of the refuge grew at an average rate of 25 percent from 1990-2000, over the same time period the nearby cities grew at varying rates from 7 to 50 percent (Table 4) (U.S. Census Bureau 2000b).

Population projections through 2015 indicate that the change in the area's county population is expected to increase at a rate of approximately 18.9 percent by 524,000 persons from 2005 to 2015 (Table 5). The projected population of the State of Florida is expected to increase by 16 percent from 2005 to 2015 to over 20 million. Highest area population growth rates are expected in Osceola County (at 26 percent), followed by Orange County (at 22 percent) and Seminole County (at 16

percent). Brevard, Indian River, and Volusia Counties are projected to grow by 14–16 percent over the 2005 population to 1.3 million. Orange County is expected to remain the most populated county in the vicinity of the refuge (Lenze 2002).

Table 4. Growth of cities adjacent to refuge during 1990–2000 (U.S. Census Bureau 2000b)

Adjacent City	2000 Population	Growth Rate from 1990-2000 (Percentage)	Location in Relation to Refuge
Titusville	40,670	3.24	~5 miles west of the refuge
Cocoa	16,412	-7.39	~6 miles south of the refuge
Cape Canaveral	8,829	10.17	~2 miles south of refuge
Oak Hill	1,378	50.27	~2 miles northwest of the refuge
New Smyrna Beach	20,048	21.19	~11 miles north of the refuge

Table 5. Projected population growth for several area counties (Lenze 2002)

County	2005 Population	2010 Population	2015 Population	Projected Growth (2005) (Percentage)
Brevard	519,100	562,300	599,400	15.5
Indian River	126,400	136,300	144,000	13.9
Orange	1,029,500	1,147,100	1,258,800	22.3
Osceola	202,600	232,100	255,400	26.1
Seminole	413,700	452,700	480,700	16.2
Volusia	483,300	525,400	560,100	15.9
State of Florida	17,616,400	19,075,600	20,388,600	15.7

Economic conditions are generally good for the two resident counties of the refuge. While the median household income for Florida in 1999 was $38,819, Brevard County's was $40,099 and Volusia County's was $35,219 (U.S. Census Bureau 2000b). While these values are slightly below the national average, it is estimated that approximately 9.5 percent of the population of Brevard County live below the poverty level, while 11.6 percent of the population of Volusia County live below the poverty line, which are both less than the national poverty rate of 12.4 percent (U.S. Census Bureau 2000a). Further, in 2000, the unemployment rate for Brevard County was below the state and national rates at 4.9 percent and Volusia County's unemployment rate was above the

state and national rates at 6.3 percent (the State of Florida's rate was 5.6 percent and the United States' rate was 5.8 percent in 2000) (U.S. Census Bureau 2000b). According to the 2002 Florida Price level Index, the cost of living in Brevard County was 4.61 percent below the state average and in Volusia County it was 4.94 percent below the state average (Bureau of Economic and Business Research 2002). In both counties, food costs were above the state average, while healthcare, housing, other goods and services, and transportation costs were below the state average (Bureau of Economic and Business Research 2002).

Despite the good economic conditions of Brevard County in general, the city of Titusville, directly adjacent to the refuge and five miles from the refuge's visitor center, has a more mixed picture, relying heavily on NASA's Kennedy Space Center and related businesses. About 12.4 percent of the population in Titusville reported incomes that were below the poverty threshold (Bureau of Economic and Business Research 2002). The city of Titusville's poverty level is equal to the state and national averages, as are the poverty rates of two other adjacent cities (Oak Hill and Mims).

The area's natural and agricultural lands are increasingly being converted to urban and suburban uses. This rapid growth and its associated impacts dramatically impact the refuge and its resources. This growth extends to the borders of the refuge, with the less intensive growth of NASA occurring within the refuge's boundary. Figure 9 shows the land use/land cover classifications in and around the refuge, and Figure 10 shows an aerial view of the development surrounding the refuge (from imagery taken in 1999 with 1-meter resolution). To the west of the refuge, across the Indian River Lagoon and the highly used Intracoastal Waterway is the city of Titusville. Development west of the refuge includes residential uses (single-family homes, condos, and mobile home parks); city parks, commercial uses (gas stations, restaurants, automobile and boat dealers, a marina, and small businesses); minor undeveloped lands; citrus groves; and urban development. To the north are residential uses, agricultural uses, and Canaveral National Seashore. The Port of Canaveral, Cape Canaveral Air Force Station, residential uses, and citrus groves are south of the refuge.

Within the 15-year life of this plan, the population of Florida is anticipated to reach 20.4 million by 2015 (Lenze 2002). Also by 2015, the two resident and two adjacent counties of the refuge are anticipated to grow to 2.9 million (Lenze 2002). The populations of Brevard and Volusia counties continue to be predominantly white (87 percent and 86 percent, respectively) and older, with considerable increases in the Hispanic category. Brevard County's median age rose to 41.4 years of age with 20 percent aged 65 and older, while Volusia County's median age is 42.4 with over 22 percent aged 65 and older (U.S. Census Bureau 2000b). The challenges and opportunities represented by the projected growth and population changes around the refuge include a rapidly aging population and subsequent impacts on the economy in terms of available workforce; a weakening per capita income, low labor force participation rate, and weak job mixture (e.g., Brevard County is overly reliant on low- paying retail sector jobs with few higher-paying jobs in other job sectors); a diversification of the local economy (especially in and around Titusville) in the face of possible downsizing activities or relocation of NASA operations at Kennedy Space Center; and the opportunity to capitalize upon strong social and economical conditions (e.g., Brevard County has a low crime rate, low poverty rate, strong job growth, well-educated population, an attractive climate, and access to the Intracoastal Waterway and the Atlantic Ocean) (Market Street Services, Inc., 2001).

The Indian River Lagoon is renowned for its recreational and ecotourism opportunities and for its world-class fishing. The lagoon's seagrass beds act as nursery grounds that support an 800-million-dollar industry to the local economy (Apogee 1996). Commercial and recreational fishing, tourism, and real estate development are the mainstays in this area. In 1995 residents and tourists valued the Indian River Lagoon at over $733 million, including spending on recreational activities (e.g., rental of

Figure 9. Land use/land cover

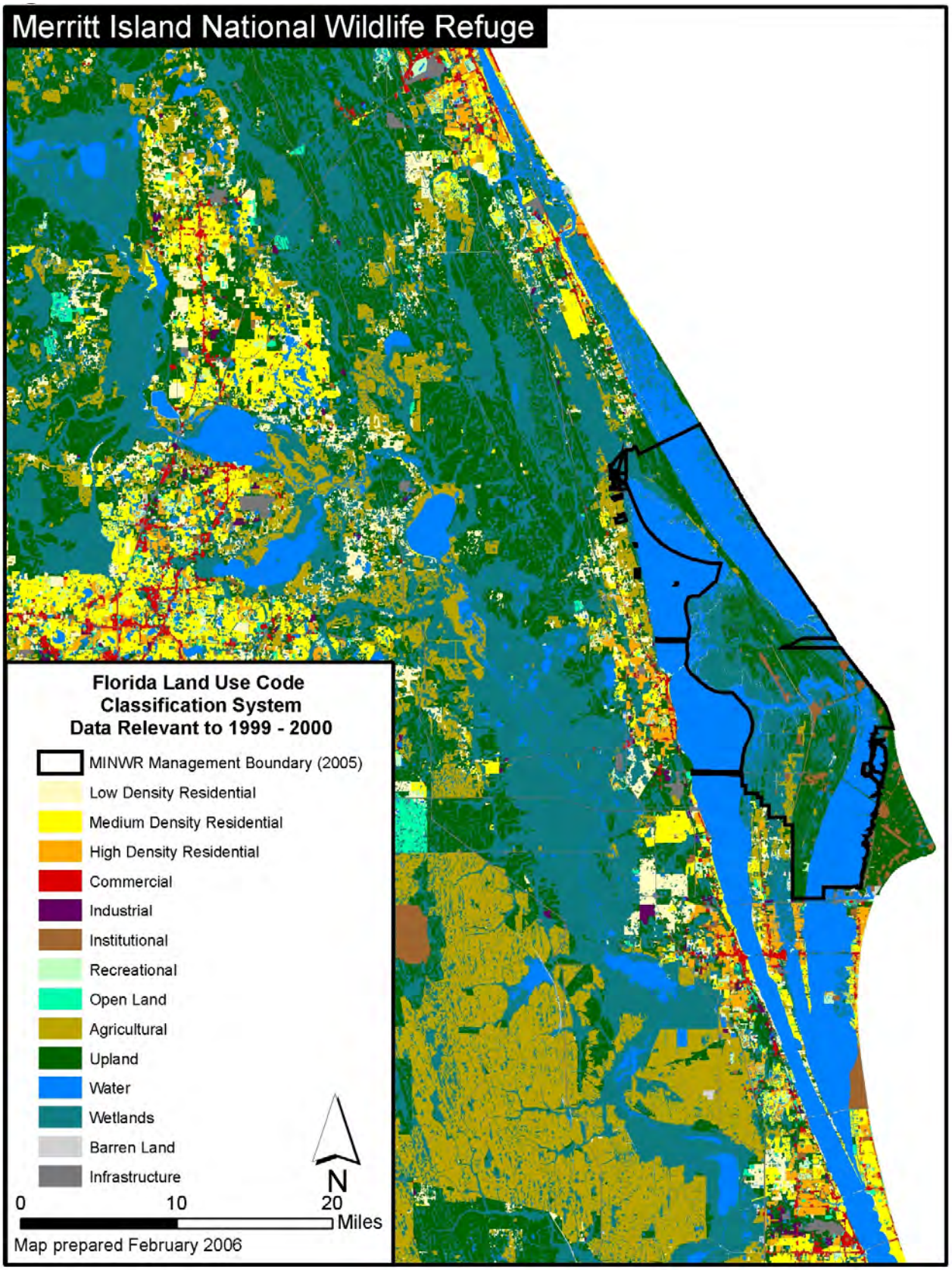
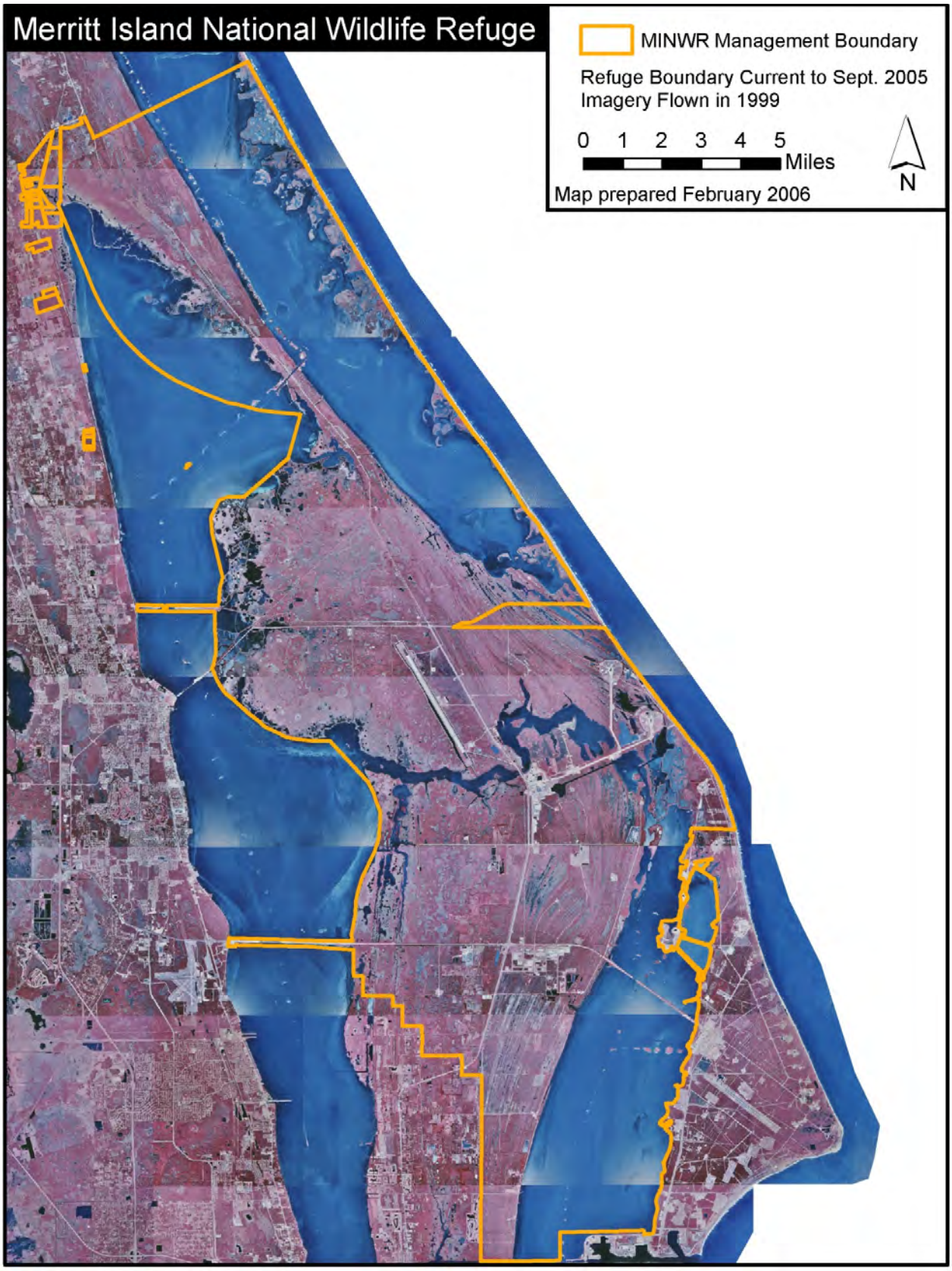


Figure 10. Aerial image



fishing boats), commercial fish landings (e.g., seafood sales), and lagoon-front property (e.g., home purchases) (Apogee 1996). [Of this $733 million, access to the resources, valued at $200 million, is not reflected in market transactions (Apogee 1996).] An estimated $54 million was spent on recreational fishing in the lagoon in 1990, with an anticipated escalation to $87 million by 2010 (Milon and Thunberg 1993). Over 15 percent of Florida's restaurants and hotels are located within the Indian River Lagoon region (Indian River Lagoon National Estuary Program 1996). Fishing in the Indian River Lagoon comprises 50 percent of Florida's east coast catch (Brevard Nature Alliance 2001). Brevard County's Office of Tourism estimated that more than 650,000 anglers fished in these waters in 2001 (Brevard Nature Alliance 2001).

Wildlife viewing has emerged as an important economic value to the State of Florida, generating an estimated $477 million in retail sales from birdwatching alone (Florida Fish and Wildlife Conservation Commission 2000). The Florida Fish and Wildlife Conservation Commission estimates that the economic impact of wildlife viewing in the state is nearly $1.8 billion (Harding 2004b) and that out-of-state visitors spend $192 per day on wildlife viewing activities (Harding 2004a). Brevard County pulls in more than $56 million from wildlife viewing activities (Florida Fish and Wildlife Conservation Commission 2004). This new trend is attracting substantial dollars for the State of Florida and the Fish and Wildlife Conservation Commission has developed birding calling cards that visitors can leave at area businesses that state they have come to that community specifically to birdwatch. The Commission also developed the Great Florida Birding Trail, a 2,000-mile trail that links birdwatching sites in Florida. With over 40 Great Florida Birding Trail sites in the Indian River Lagoon region, the Commission selected the refuge in 2001 as the Eastern Gateway for this trail.

Merritt Island National Wildlife Refuge is a destination spot for a variety of visitors, from the local fisherman to the international birder. The refuge is situated adjacent to the most visited county in Florida, Orange County (VISIT FLORIDA 2003). Orange County offers traditional tourism activities, such as Walt Disney World, Sea World, and Universal Studios in the Orlando area, and represented 26.1 percent of 2001 Florida visitors (VISIT FLORIDA 2003). In 2002, the Orlando area hosted 43 million visitors and is expected to reach 51.9 million in 2006 (Orlando/Orange County Convention and Visitors Bureau, Inc. 2004). Just 45-minutes from Orlando, the refuge receives many visitors from Orange County. Volusia County sees 4.4 percent and Brevard County see 2.9 percent of all Florida visitors (VISIT FLORIDA 2003). With nearly 1 million annual visitors to the refuge in 2003 (including over 350,000 to the refuge's exhibit at the Kennedy Space Center's visitor center and the Space Center tours) and with over 550,000 to the South District of Canaveral National Seashore (Playalinda Beach), the local economy benefits greatly from the federal conservation lands of the refuge and Seashore. The refuge's wetlands draw thousands of waterfowl every winter, which in turn attracts waterfowl hunters from all over the southeastern United States. Hunters spend almost $11 million in Brevard County, generating $657,634.00 in state tax dollars (Florida Fish and Wildlife Conservation Commission 2004). The refuge offers 36,000 acres for waterfowl hunting, half of which is managed under a $12.50 refuge hunting permit, which can generate up to $16,500 for the Fish and Wildlife Service to administer this hunt program.

REFUGE ADMINISTRATION AND MANAGEMENT

Due to the unique nature of protecting wildlife and habitat in and amongst an active space program, administration and management of the refuge involves much more than normal refuge operations. The refuge is situated in a unique position as an overlay of the Kennedy Space Center. This overview of refuge management activities is divided into land protection and conservation; visitor services; and personnel, operations, and maintenance. The habitat diversity and species richness coupled with monitoring launch impacts is cause for an intense interest in research on the refuge. Over thirty permits are issued each year for that activity. In addition, special use permits are issued

for everything from star gazing to weddings. Coordinating and planning within the confines of a spaceport complete with sensitive and top secret processing and payloads require continuous contact with Space Center and Cape Canaveral Air Force Station officials. The range of coordination issues includes smoke impacts to sensitive payloads; interdiction of illegal aliens; review of site plans for new development; maintenance of pumps and ditches; tours for visiting dignitaries; special events coordination; search and rescue; animal removal; biological data collection; and long-range planning.

Merritt Island National Wildlife Refuge also administers two unstaffed refuges: St Johns and Lake Wales Ridge. Both refuges have their own unique sets of issues and therefore also impact the management of Merritt Island Refuge.

RESOURCE PROTECTION

The Service is involved in a variety of land protection and conservation activities at Merritt Island Refuge, including lease and management agreements with the State of Florida and the management agreement with NASA, as well as coordination and agreements with Canaveral National Seashore. The refuge manages the majority of its lands and waters through a management agreement with NASA. Additional refuge lands and waters are managed through a lease agreement with the State of Florida for Tank Island and management agreements with the State of Florida for properties in the Turnbull Creek area. Thus, it is important that the refuge, Seashore, NASA, and the State of Florida coordinate management to minimize injury, mortality, and disturbance of the West Indian manatee, the Florida scrub-jay, and trust species, as well as native wildlife and habitat in general.

Although active land acquisition is not currently occurring for the refuge, the refuge's approved acquisition boundary totals over 142,000 acres. This acquisition boundary includes about 1,480 acres of inholdings in the Turnbull Creek area. Table 6 breaks down the acquisition boundary; Figure 11 shows the overall land status; and Figure 12 details the land status of the Turnbull Creek area.

Table 6. Status of all properties within the refuge acquisition boundary

Property Owner	Property Status	Acres
FWS	ownership (Turnbull Creek area)	925.70
NASA	management agreement	134,890.00
NASA	inholdings*	4,415
State of Florida	lease agreement (Tank Island)	1.00
State of Florida	management agreement (Turnbull Creek area)	320.04
Private Landowners	inholdings**	1,480.59
Total Acres within the Refuge's Acquisition Boundary (as of September 30, 2005)		**142,032.33**

** The publicly owned inholdings are the NASA operational areas. As the NASA operational areas continue to grow and expand, additional acres are extracted from the refuge. This portion of the inholding acreage figure is expected to increase over time. However, under the agreement with NASA, the Service continues to have management responsibilities in these areas.*

** The private inholdings are located within the Turnbull Creek acquisition area.*

Figure 11. Status of properties on Merritt Island National Wildlife Refuge

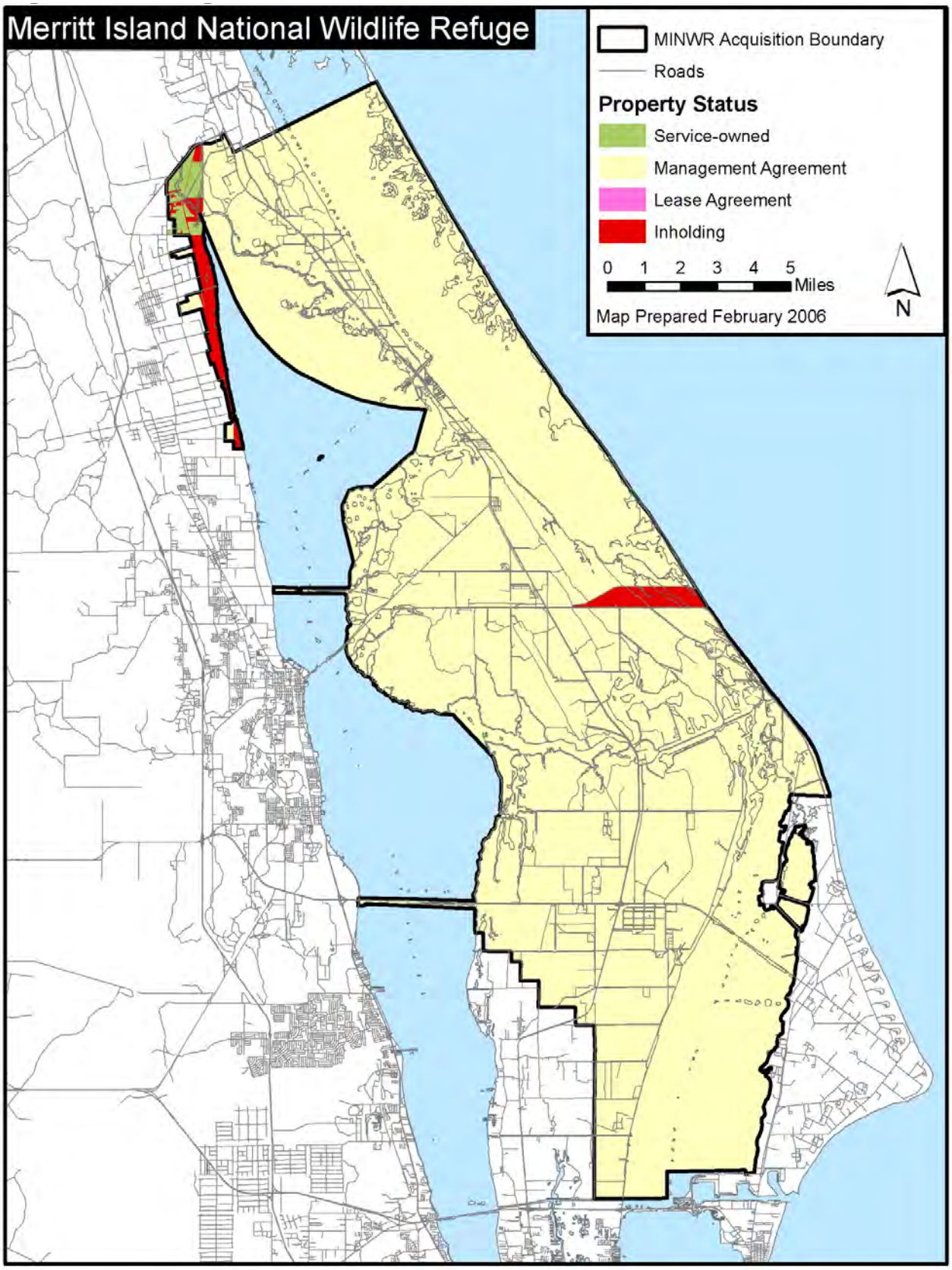
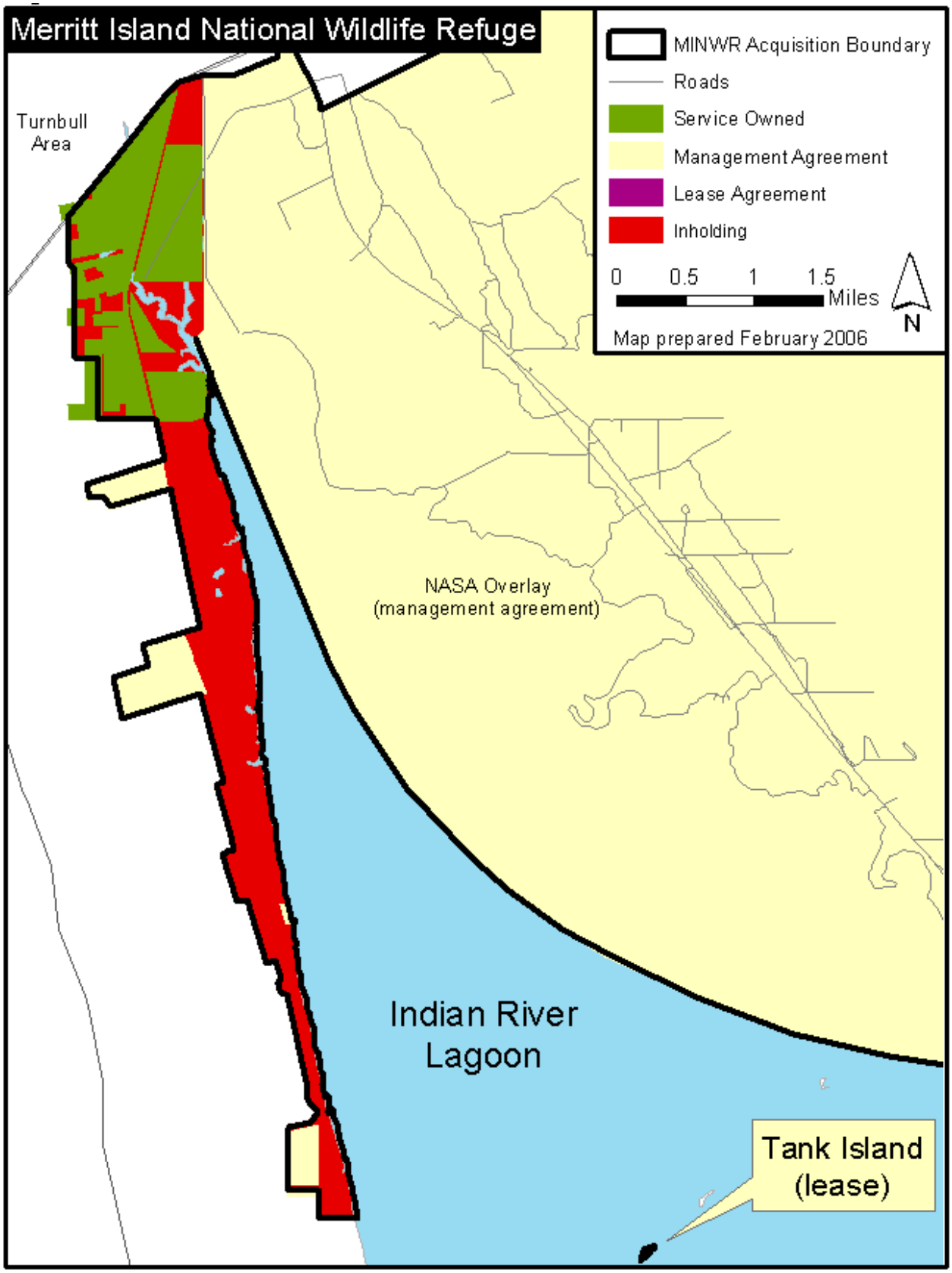


Figure 12. Status of Turnbull Creek Area



The over 140,000-acre management area of the refuge includes over 4,400 acres of operational areas of Kennedy Space Center. Table 7 summarizes the Service-owned and managed lands and waters within the refuge, where most of the refuge is managed under some sort of agreement either with NASA or with the State of Florida.

Table 7. Acreages of Service-owned and managed lands and waters within the refuge acquisition boundary

Property Owner	Method of FWS Control	Acres
FWS	Ownership (Turnbull Creek area)	925.70
NASA	Management Agreement*	134,890.00
State of Florida	Lease Agreement (Tank Island)	1.00
State of Florida	Management Agreement (Turnbull Creek area)	320.04
Total Acres Under Refuge Management (as of September 30, 2005)		**136,136.74**

** Although the NASA operational areas (4,415 acres) are extracted from the refuge, refuge management continues to have some level of responsibility for these areas as outlined in the refuge's management agreement with NASA (e.g., removal of certain wildlife from operational areas), making the refuge management total 140,551.74 acres.*

Beyond NASA and the refuge, additional federal agencies manage lands and waters adjacent to the refuge, including the National Park Service at Canaveral National Seashore and the U.S. Air Force at Cape Canaveral Air Force Station. These federally managed lands and waters total over 181,000 acres (Table 8). (See Figure 3 for an overview of the federal lands and waters in and around the refuge.)

Table 8. Acreages of federal lands in and around the refuge

Manager	Ownership/Management Type	Acreage
Merritt Island National Wildlife Refuge, FWS	Ownership	925.70
Merritt Island National Wildlife Refuge, FWS	Management and Lease Agreements with the State of Florida	321.04
Merritt Island National Wildlife Refuge, FWS	Overlay of NASA through Management Agreement	100,545.00
Merritt Island National Wildlife Refuge, FWS and Canaveral National Seashore, NPS	Overlay of NASA through Congressional Designation and Management Agreement	34,345.00
KSC Operational Areas, NASA	Ownership	4,415.00
Canaveral National Seashore, NPS	Overlay of NASA through Congressional Designation and Management Agreement	6,655.00
Canaveral National Seashore, NPS	Ownership (transferred from NASA)	1,088.00
Canaveral National Seashore, NPS	Ownership	17,775.00
Cape Canaveral Air Force Station, USAF	Ownership	15,428.00
Total Federal Ownership/Management in the Area (as of September 30, 2005)		**181,497.74**

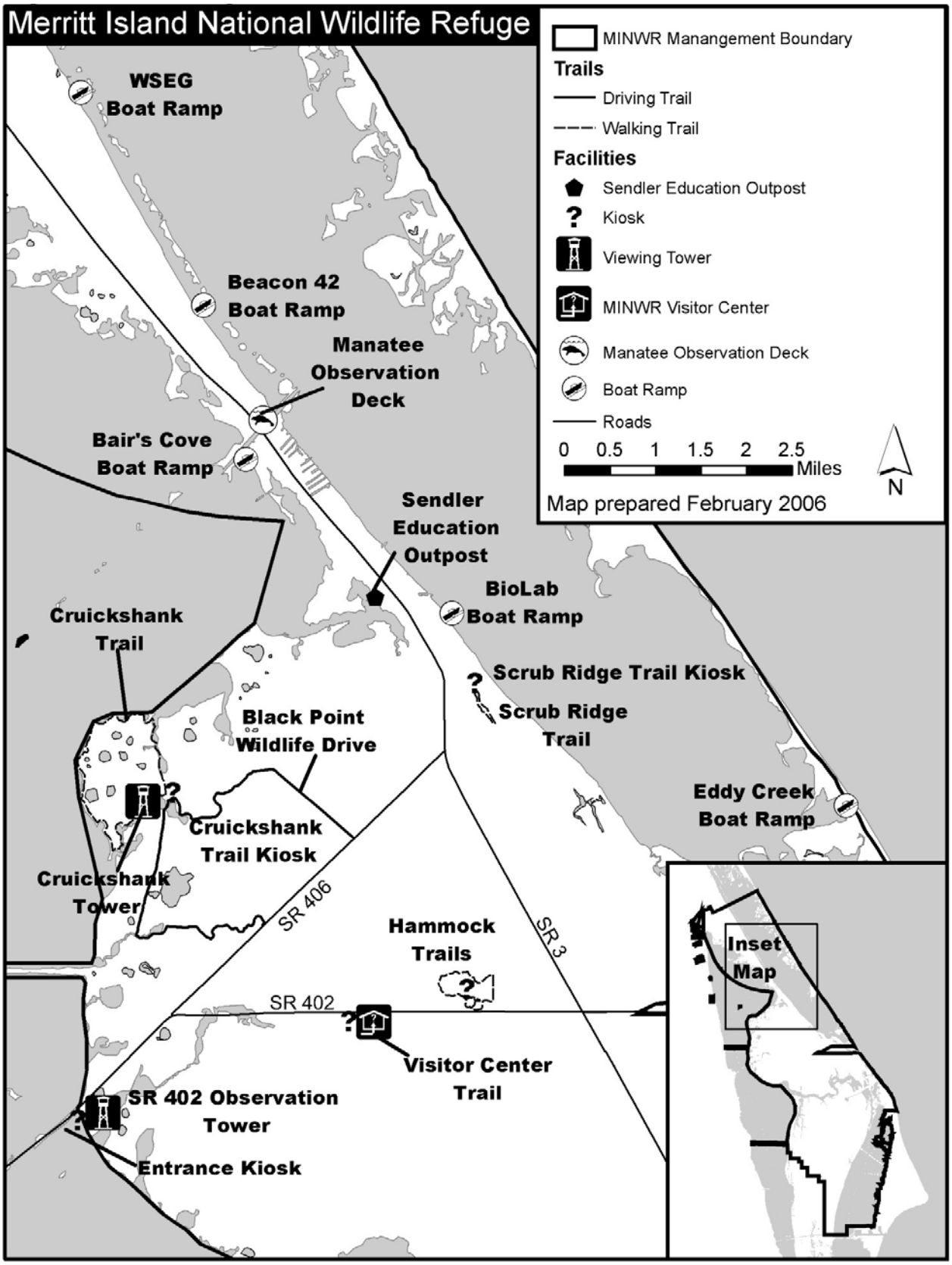
VISITOR SERVICES

The purpose of the visitor services program is to provide opportunities for appropriate and compatible wildlife-dependent recreation for public enjoyment of the refuge. Figure 13 provides an overview of existing public use facilities. The Merritt Island Refuge is considered one of the flagship refuges in the southeast and receives roughly 550,000 visitors each year. Another nearly 350,000 visitors per year enjoy a refuge exhibit and/or tour at the Kennedy Space Center visitor center. The refuge has become an international destination for birdwatchers; more than 250,000 annually visit Black Point Wildlife Drive or one of the other trails designed to provide rewarding and diverse wildlife viewing experiences. The refuge also protects some of the best estuarine flats fishing in east central Florida, with roughly 160,000 fishermen annually plying the shallow lagoon waters in search of trophy redfish and seatrout. The refuge's Visitor Services Program also provides environmental education programs for school groups, as well as opportunities for canoeing and kayaking, wildlife photography, and waterfowl hunting. Table 9 provides a breakdown of refuge visits by category.

Table 9. Refuge visitation data, 2003

Site/Activity	Number of Visitors
Visitor Center	51,043
Kiosks	102,086
Trails	30,626
Black Point Wildlife Drive	126,845
Observation Tower	80,142
Hunting	985
Fishing	163,670
Total Visitation (not including Kennedy Space Center Exhibit)	**555,397**
Kennedy Space Center Exhibit	336,089
Total 2003 Visitation	**891,486**

Figure 13. Existing visitor facilities and trails



Visitor Use Areas

Three paved former state roads provide access through the refuge: 402, 406, and 3. They are connected to two major arteries: I-95 and U.S. 1 (see Figure 1). Directional signs are located at I-95 and U.S. 1 guiding visitors to the refuge and to visitor facilities. Most public use facilities are clustered around an area referred to as the Triangle (the area contained between State Routes 402, 406, and 3). Containing most developed public use facilities within this area concentrates public impacts and helps to minimize wildlife disturbance on the refuge. Visitors can make the circuit around the triangle and sample all major habitats to experience what makes the refuge special. The developed public use facilities listed below are located in the Triangle area.

• Visitor Center	• Black Point Wildlife Drive
• Visitor Center Trail	• Oak Hammock and Palm Hammock Trails
• Cruickshank Trail	• Scrub Ridge Trail
• Manatee Observation Deck	• West Information Kiosk
• BioLab Road	• BioLab Boat Ramp
• Haulover Canal Boat Ramp	• Bair's Cover Boat Ramp

Not all visitor facilities are contained within this primary public use zone. Several boat ramps, key fishing areas, waterfowl hunting areas, canoe/kayak areas, and additional wildlife viewing sites are located outside the primary public use zone. These more dispersed uses are located within the secondary use zone. The only public use facility the refuge has south of State Route 402 is an exhibit located at NASA's Kennedy Space Center Visitor Complex. Annual visitation to NASA's visitor center is much greater than the combined total of all visits to the northern half of the refuge.

Environmental Education

With the assistance of Merritt Island Wildlife Association (the refuge's nonprofit friends group) and other partnerships, the refuge developed the Sendler Education Outpost. The facility is located at Dummitt Cove and includes a 20-foot by 40-foot covered pavilion and restrooms. The facility is designed to accommodate school groups visiting the refuge. The refuge is working with the local school board in the development of a curriculum-based program that meets state standards and incorporates the refuge's education programs and messages into the schools' teaching curriculum. The refuge hosts at least one teacher workshop per year to familiarize and train teachers in the program. Volunteers and interns are used to assist teachers in conducting the program. The refuge networks with Canaveral National Seashore, Brevard Zoo, and other organizations to promote and conduct environmental education programs at the Sendler facility.

Interpretive Programs

The refuge's visitor center serves as the departure point for refuge interpretive tours. The emphasis of the interpretive programs is in two general areas: 1) informing the public of management activities and 2) educating the public on wildlife needs and habitat requirements. The over-arching purpose of the programs is building better understanding and support for the refuge and the Refuge System. An emphasis is placed on growing the interpretive programs by recruiting and training volunteers and interns. The refuge generally conducts about 130 interpretive programs per year.

Interpretive Drive, Trails, and Sites

Black Point Wildlife Drive is the most heavily used interpretive trail and is the best wildlife viewing area of the refuge. The drive is the best location to interpret water level management and the importance of the refuge to migratory birds and these themes are emphasized in the interpretive materials. Over the years certain activities that disturb wildlife viewing on the Wildlife Drive have been eliminated. Busses and vehicles over 29 feet are no longer allowed on the Wildlife Drive. Boating, fishing, crabbing, and canoe launching are also prohibited uses.

The refuge maintains five trails and each is used to interpret different aspects of refuge management or to offer special wildlife viewing opportunities The use of prescribed burns is the most misunderstood management practice and an increased emphasis is placed on interpreting this important management tool. Fire information panels have been installed on Scrub Ridge Trail. The manatee observation deck is becoming one of the most popular interpretive destinations for visitors. On most days when temperatures are above 70 degrees, manatees are present.

Fishing

Saltwater fishing is the fastest growing public use activity. Twenty years ago, about 25,000 anglers a year used the lagoon. Today the number has increased to about 163,000. Over the last 10 years alone fishing pressure has nearly tripled. An analysis of survey data from refuge boat ramps indicates that the largest segment of anglers (52 percent) travel 51–100 miles to fish the refuge and come from the rapidly expanding metropolitan area of central Florida. This is followed by local residents (45 percent) who come from the neighboring counties of Brevard and Volusia. The population growth in the six surrounding counties is expected to increase 19 percent from 2005 to 2015, reaching 3.3 million residents (Lenze 2002). With this rapid population growth the Service anticipates fishing pressure to escalate at similar rates.

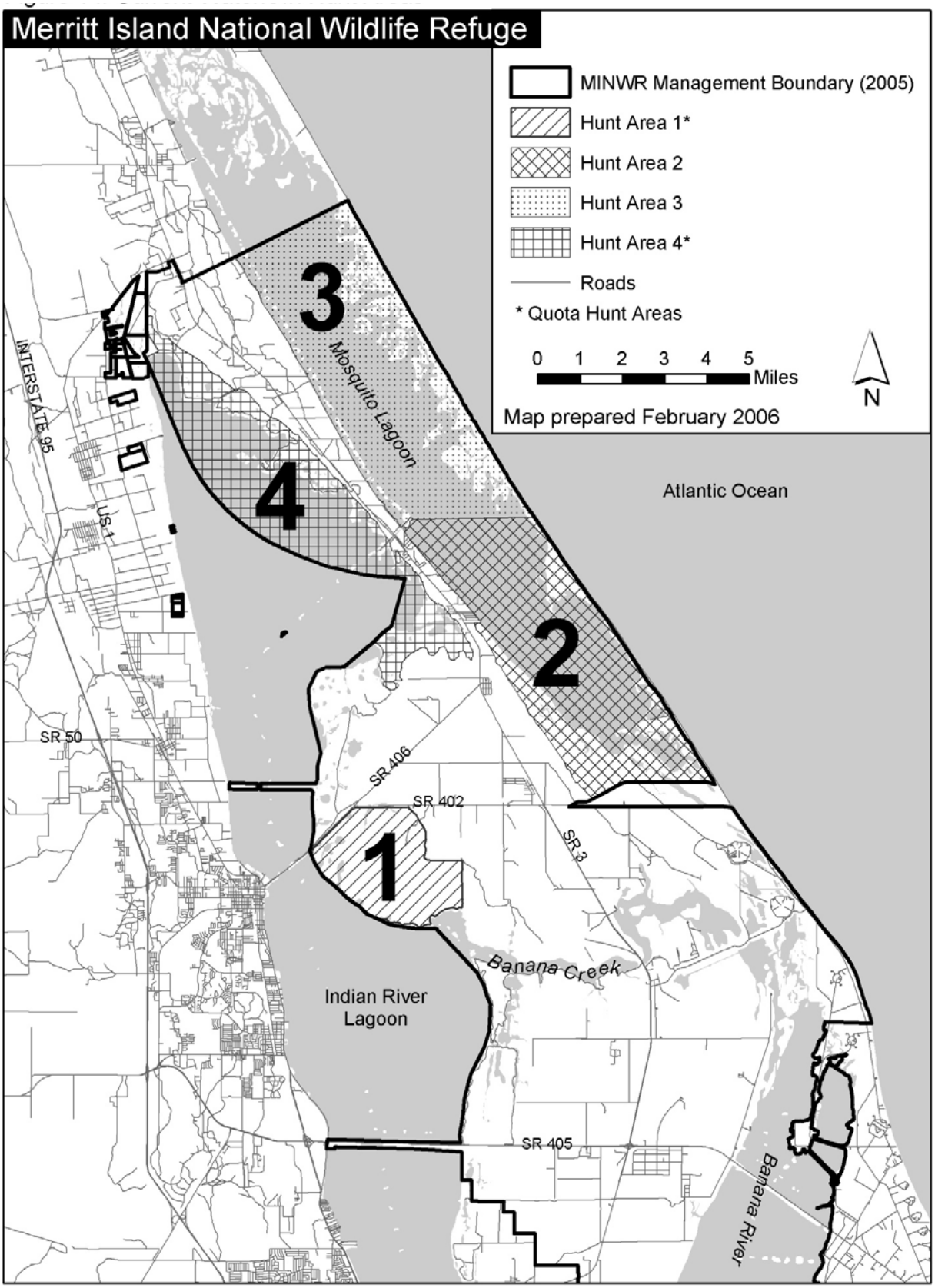
The increase in fishing pressure has resulted in habitat impacts to Mosquito Lagoon. Prop scarring on the flats is increasing. Prop scarring occurs when power boats operating in shallow water cut into the bottom and destroy linear strips of rooted sea grass and dredge cuts into the bottom. This impacts sea grasses and stirs up bottom sediment which increases turbidity. Studies show increasing levels of boating activity also negatively impact populations of waterfowl and other waterbirds. A study completed at Merritt Island in 2002 showed that lesser scaup were changing their feeding habits from daytime to nighttime. Bird nesting on historic nesting islands has also declined.

With the lack of fresh water, the refuge has limited opportunities for freshwater fishing. Most freshwater fishing occurs in several man-made borrow pits which were dug for road construction material. These borrow pits provide easy access to bank fishing opportunities for anglers who do not have a boat. However, they can become overfished and need management to sustain a quality freshwater fishery.

Hunting

Waterfowl hunting is the only hunting opportunity available on the refuge (see Figure 14 for the existing hunt areas). Waterfowl hunting has a long tradition at Merritt Island and has been permitted since 1964. Even before the refuge was established, the Canaveral Shooting Club and the Indian River Club had most of the wetlands and marshes of the refuge tied up in hunt leases. This proved to be a positive factor when NASA began acquiring lands, as large blocks were undeveloped and under a small number of owners. During the negotiations for land purchases, NASA made commitments to retain hunting and the original interagency agreement between NASA and the refuge made provisions to continue this use.

Figure 14. Current waterfowl hunt areas



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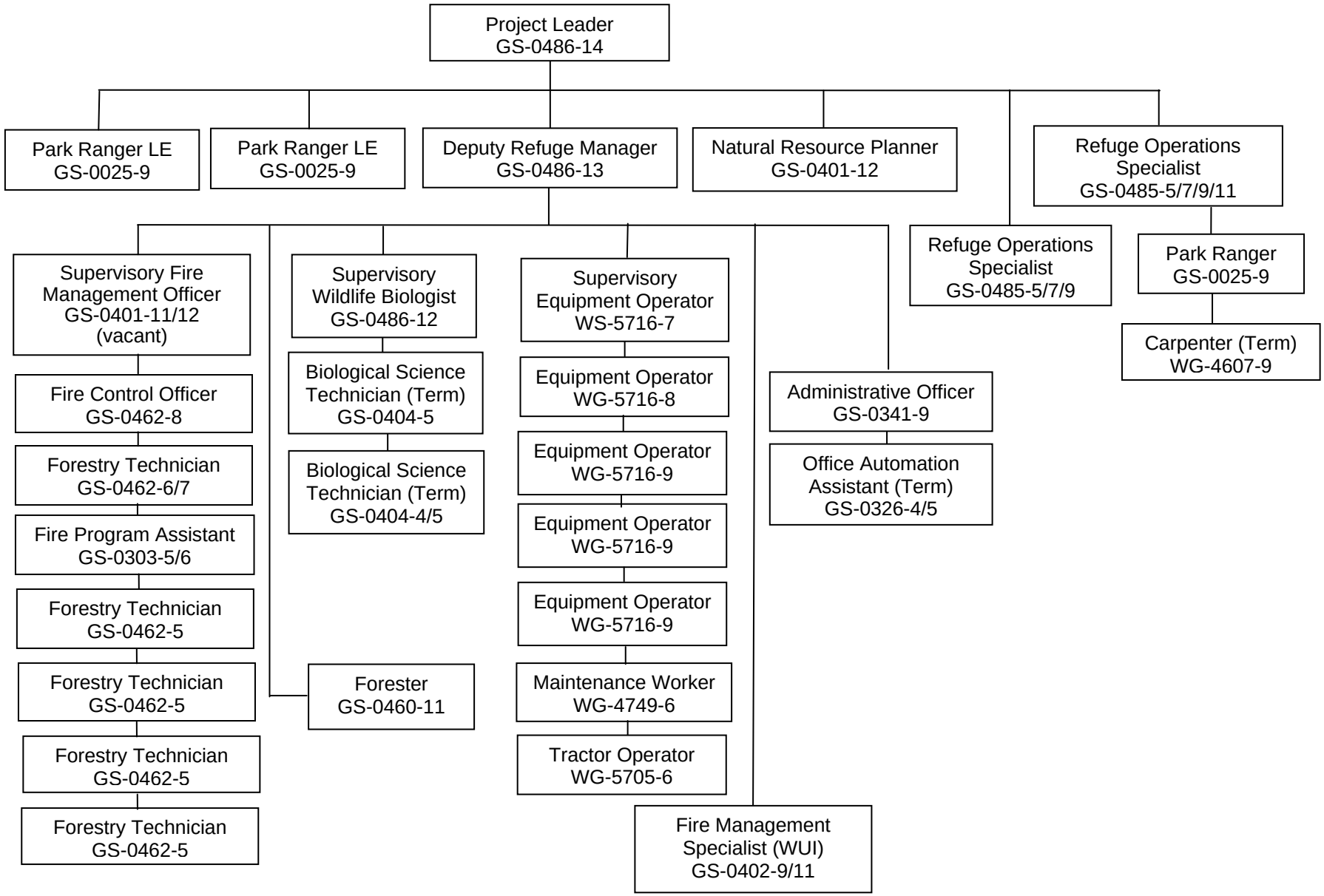
When the refuge was established, about 2,500 acres of citrus groves were active on the refuge. NASA requested that the refuge manage the groves and consolidate them under a commercial contract. In 1990 the grove contracts were valued at three million dollars. Over the years much has changed in the citrus industry. Winter freezes, increased costs of growing, and competition with international growers has caused the industry to decline in recent years. Currently only about 700 acres of citrus groves are being managed. These groves are not being managed as a commercial venture, but as a research effort with The Florida Research Center for Agricultural Sustainability. The current contract is set to expire in 2008. The Research Center is attempting to validate that growing citrus with a minimum of pesticides and fertilizers can be done, while still producing a marketable crop. Since beekeeping was a commercial activity associated with citrus groves, it has been continued. The beekeepers now make several crops of honey including palmetto, citrus, and Brazilian pepper.
Actions by the Brevard County and Volusia County mosquito control districts to impound the salt marshes of the refuge in the 1950s and 1960s resulted in 76 distinct impoundments. The refuge was required under the initial agreement with Kennedy Space Center to work closely with the mosquito control districts to minimize the impacts of mosquitoes to Space Center operations. This resulted in the maintenance of water levels at higher levels and for longer periods than necessary in relation to refuge objectives. Over the years more water control structures have been added, which has diversified the water management program. In a couple of instances the dikes have been removed and the impoundment area has been restored. The refuge is responsible for maintenance of the dikes and water control structures. Currently four pumping stations are shared between Brevard County Mosquito Control District and the refuge to meet operation and maintenance needs of both agencies.

The unfortunate loss of life during a wildfire on the refuge in 1981 resulted in an influx of interest in the refuge and its management. The special focus was on fire management. Additional funding made it possible to construct a maintenance compound of six buildings and a visitor center/office. In 1992 a Fire Program office was added. These buildings provide office space, equipment storage and maintenance space, warehouse space, and public interaction space. The size and complexity of the refuge is depicted in the infrastructure required to support the refuge. The refuge has 167 roads and dikes; 14 buildings; 11 boat ramps and parking lots; and 15 pumps. Thirty-eight heavy and specialized pieces of equipment are needed to manage refuge habitat and facilities.

The refuge currently has about 25 permanent staff members (of an approved total of 30), 11 of which are directed to the Fire Program. The remaining 14 are directed toward planning, administration, law enforcement, public use, and maintenance. Figure 15 outlines the current staffing chart. As funding allows, seasonal and temporary staff are hired to support various programs. Seventy regular volunteers annually contribute 6,500 hours to the refuge. Another 97 volunteers only work occasionally. These staff and volunteer positions are shared among the three national wildlife refuges of the Complex: Merritt Island (~141,000 acres), St. Johns (~6,300 acres), and Lake Wales Ridge (~1,800 acres). All of the staff members, except one, are assigned to the Merritt Island Refuge. The Service has stationed a Wildland/Urban Interface Specialist in Polk County, near Lake Wales Ridge National Wildlife Refuge. This position serves the refuges across Florida and assists with the Lake Wales Ridge Refuge. The satellite refuges, St. Johns and Lake Wales Ridge, are currently closed to public access. Special use permits govern research and other access into these refuges.

Facilities at the two satellite refuges are limited, with a barn building at the St. Johns Refuge and no real facilities (other than fencing and signage) at the Lake Wales Ridge Refuge. As the main refuge of the Complex, Merritt Island has the bulk of the facilities and the equipment.

Figure 15. Current organization chart



III. Plan Development

OVERVIEW

Although Merritt Island National Wildlife Refuge has had several step-down management plans in the past, no comprehensive management plan existed to address all refuge programs. In 1979, the refuge developed a master plan that only addressed future public use facilities (U.S. Fish and Wildlife Service 1979). The comprehensive conservation planning process provided an opportunity for the Service, its governmental and nongovernmental partners, and the public to take a comprehensive look at the refuge and its management, resources, and future. The planning process included public involvement in the development of this comprehensive conservation plan for the future management of the refuge. The CCP will be revised every 15 years or earlier, if monitoring and evaluation determine that significant changes are needed to achieve refuge purposes, vision, goals, and/or objectives. The basic steps of the planning process involved gathering information; scoping for public input; developing the Draft CCP/EA; gathering public input on the draft plan; developing the final CCP; and implementing and monitoring the actions identified in the final CCP.

PUBLIC INVOLVEMENT AND PLANNING PROCESS

In accordance with Service guidelines and National Environmental Policy Act requirements, public involvement was a crucial factor throughout the development of the CCP/EA for Merritt Island National Wildlife Refuge. This CCP/EA was written with input and assistance from many interested citizens, conservation organizations, and employees of local, state, and federal agencies. The participation of these stakeholders and their ideas was of great value in setting the management direction for the refuge. The Service, as a whole, and the refuge staff, in particular, are very grateful to each individual who has contributed time, expertise, and ideas to the planning process. The refuge staff remains impressed by the passion and commitment of so many people for the lands and waters administered by the refuge.

The planning process began with the gathering of information. As part of this process, the Service conducted several internal reviews: a wildlife and habitat management review, a visitor services review, and a wilderness review. The Service also formed a Core Planning Team that collected input from the public and from an Intergovernmental Coordination Planning Team.

The Core Planning Team was comprised of staff from the Merritt Island Refuge Complex, and was the primary decision-making team for this plan. Key tasks of this group involved defining and refining the refuge vision; identifying, reviewing, and filtering the issues; defining the goals; outlining the alternatives; and providing a reality check. The Planning Team members included:

- Fred Adrian, Forester, Merritt Island NWR Complex
- Cheri M. Ehrhardt, AICP, Natural Resource Planner, Merritt Island NWR Complex
- Marc Epstein, Refuge Biologist, Merritt Island NWR Complex
- Ron Hight, Project Leader, Merritt Island NWR Complex
- Steve Johnson, former Refuge Operations Specialist, Merritt Island NWR Complex
- Ralph Lloyd, Deputy Refuge Manager, Merritt Island NWR Complex
- James Lyon, Biological Science Technician, Merritt Island NWR Complex
- Gary Popotnik, former Biological Science Technician, Merritt Island NWR Complex
- Glen Stratton, Forestry Technician, Merritt Island NWR Complex
- Dorn Whitmore, Supervisor, Refuge Ranger, Merritt Island NWR Complex

The Core Planning Team met regularly to review public comments, data, and information collected to write the CCP/EA. Professional reviews of the refuge were conducted to determine the status, trends, and conditions of refuge resources and facilities. Experts from the Service, State of Florida, Brevard Mosquito Control District, University of Central Florida, and NASA Kennedy Space Center/Dynamac, Inc., participated in a wildlife and habitat management review of the refuge in 2001. A wilderness review was conducted in 2002 by Service staff. In a review of the federally owned lands within the legislatively defined boundary of the refuge, no additional lands were found suitable for designation as wilderness. A visitor services review was also conducted in 2002; it involved public use specialists and outdoor recreation planners from the Service, the National Park Service, and the Florida Fish and Wildlife Conservation Commission. This visitor services review focused on existing public use activities and recommended specific actions to improve the refuge's public use facilities and programs. The input garnered from these three reviews helped the Planning Team analyze and develop recommendations for the CCP/EA. Additional information on these three reviews is provided in Appendix H, Consultation and Coordination.

Following the initial gathering of information, a Notice of Intent to prepare a Draft CCP/EA was published in the *Federal Register* on August 26, 2002. The Service also placed advertisements in local newspapers; posted information on the refuge's website regarding the upcoming public meetings and how to submit comments; posted meeting information in the local community (e.g., at local shops, at the refuge visitor center, and at local libraries); and distributed flyers announcing the public meetings. An open house was held on September 21, 2002, at the refuge visitor center to kick off the public scoping phase. More than 180 people attended the open house, which was followed by three public scoping meetings: one on October 23, 2002, in south Merritt Island with 31 attendees; a second on October 28, 2002, in New Smyrna Beach with 17 attendees; and another on October 29, 2002, in Titusville with 55 attendees. During September and October 2002, 10 planning-related articles appeared in three local papers: *Florida Today*, *Orlando Sentinel*, and *Press Tribune*. One article appeared in November 2002, to review the wide range of comments submitted to the Service. During public scoping, more than 1,600 written comments were submitted by individuals and organizations spanning 49 states and 11 countries. Two planning updates kept the public informed of the progress of the CCP/EA. Four follow-up meetings were held in 2004 to address the public's concerns specific to Mosquito Lagoon: one on April 29, 2004, in Titusville with 65 attendees; one on May 12, 2004, in New Smyrna Beach with 25 attendees; another on November 8, 2004, in Titusville with 7 attendees; and a final one on November 22, 2004, in New Smyrna Beach with 32 attendees. More than 1,500 people were recorded on the refuge's CCP/EA mailing list.

The Draft CCP/EA for Merritt Island National Wildlife Refuge was then completed and released for public review and comment for a period of 60 days, beginning on December 27, 2006 and concluding on February 26, 2007. Prior to this public review, in March 2006, the Service mailed more than 1,400 postcards to those entities on the refuge's mailing list to notify them of the coming availability of the Draft CCP/EA for public review and comment, and to allow interested parties to request copies of the document. Information was also posted at the refuge's visitor center and on its website. In addition, the Service published a Notice of Availability of the Draft CCP/EA in the *Federal Register* on December 27, 2006.

Numerous comments were received from this public review. All were considered and evaluated in preparing the final CCP/EA for Merritt Island National Wildlife Refuge. For a detailed summary of these public comments and the Service's responses to them, please refer to Appendix J, Public Involvement.

SCOPING OF ISSUES AND CONCERNS

During the preplanning and public scoping phases of plan development, a myriad of issues, concerns, and opportunities were raised by the public, the Service, and other public agencies. The identification of issues was a major factor in determining future management goals and objectives and future projects. In addition to the general public scoping meetings, a series of meetings were conducted with federal, state, and local governmental agencies (i.e., the Intergovernmental Coordination Planning Team). Coordination with governmental partners and the public was essential to ensure support for the CCP and its identified projects. While some of the issues and concerns raised during scoping were directly related to the future of the refuge, many are not within the Service's management jurisdiction or authority, and some are completely outside of the Service's control. Several opportunities raised during scoping were addressed by the Service in this plan. The Core Planning Team later developed a list of goals, objectives, and strategies to shape the management of the refuge for the 15-year life of the plan.

In accordance with the 1997 National Wildlife Refuge System Improvement Act, the Core Planning Team, including the Service's Ecological Services North Florida Field Office, met with representatives from the Florida Fish and Wildlife Conservation Commission, including its Regional Director, to identify the priority issues for the refuge to address during the 15-year life of the plan. These priority issues are listed below:

- Spread of Exotic, Invasive, and Nuisance Species
- Threats to Threatened, Endangered, and other Imperiled Species
- Threats and Impacts of an Increasing Human Population and the Demand for Public Use Activities
- Management/Maintenance of Impounded Wetlands
- Coordination between Intergovernmental Partners
- Decline in Migratory Birds and Habitats

In addition to these priority issues, other issues also included the trust responsibilities of the refuge. The issues that the refuge will address during the 15-year life of this CCP/EA were divided into four categories: wildlife and habitat management; resource protection; visitor services; and refuge administration.

WILDLIFE AND HABITAT MANAGEMENT

More than 500 species of wildlife and over 1,000 species of plants have been documented on the refuge. The Merritt Island Refuge is one of the richest and biologically diverse refuges in the south Atlantic coastal zone. The size, habitat diversity, and location of the refuge offer fish and wildlife—including federal- and state-listed species, migratory birds, and native species—an undeveloped landscape of prime habitat. However, increased human population growth, urbanization and suburbanization, and the development of lands around the refuge will eventually increase public use demands on the refuge and are expected to increase associated impacts to the refuge. Direct and indirect activities that may impact the refuge include commercial, residential, and recreational uses (e.g., potentially resulting in reduced water quality, the spread of exotic species, and increased wildlife and habitat disturbance). Ongoing development of the landscape is consuming and fragmenting remaining off-refuge habitats, which are also used and needed by many refuge wildlife (e.g., for breeding, nesting, loafing, feeding, migrating, and dispersing). The spread of exotic, invasive, and nuisance species; the threats to threatened, endangered, and other imperiled species; the management/maintenance of impounded wetlands; and the decline in migratory birds and associated habitats are priority wildlife and habitat management issues that need to be addressed in the 15-year life of the plan.

Exotic, Invasive, and Nuisance Species
Although the refuge includes numerous exotic, invasive, and nuisance species that are likely to be found in every refuge habitat, the most troublesome that are known to occur include Australian pine; Brazilian pepper; Old World climbing fern; cogongrass; melalueca; feral hogs; feral cats; and raccoons. Although raccoons are the only native species currently on this list, their higher than normal numbers, lack of predators, and devastating impact on endangered and threatened sea turtle nests have led the Service to control them by lethal means on the refuge. Unknown impacts from exotic, invasive, and nuisance species may prove to be even more troublesome in the future, especially for aquatic species. Exotic, invasive, and nuisance species disrupt natural systems and processes, sometimes eliminating the natural functions of a habitat. For example, advanced succession and exotic species have made some refuge islands unsuitable for ground- and shoreline-nesting birds. Over time, the landscape is expected to continue to be developed and new exotic, invasive, and nuisance species are expected to find their way to the refuge, further negatively impacting native wildlife and habitats.

Threatened, Endangered, and Imperiled Species
The refuge provides habitat for 93 species of plants and animals that regularly occur on the refuge and that are listed by the Federal Government or the State of Florida as endangered, threatened, of special management concern, or commercially exploited, including globally declining species. These regularly occurring listed species include 10 federal-listed wildlife species; three state-listed wildlife species; 36 wildlife species of federal management concern; 11 state wildlife species of special concern; and 33 state-listed plant species. The refuge is especially important to sustaining and recovering several threatened, endangered, and imperiled species, including the Florida scrub-jay, southeastern beach mouse, sea turtles, wood stork, West Indian manatee, and bald eagle. The refuge is a highly important site for the Florida scrub-jay and is the only site currently meeting the recovery goals for scrub-jays. The refuge provides core habitat for the southeastern beach mouse, and may serve as a source population for reintroduction of this species to former habitats. The refuge provides important sea turtle nesting beaches and a juvenile sea turtle nursery in the estuary. Although wood storks are numerous on the refuge, they do not seem to currently nest on the refuge as they have in the past. The refuge provides nearly year-round habitats for the West Indian manatee and provides a no-motor zone sanctuary. Bald eagles consistently nest on the refuge.

Ongoing human development throughout the landscape, wildlife and habitat disturbance, habitat fragmentation on and off the refuge, and degrading habitat quality further impact these species.

Impounded Wetlands
Under the agreement between the Service and NASA, the refuge works with the local mosquito control districts and other governmental agencies in managing the impounded wetlands of the refuge. In managing these impoundments to meet wildlife and habitat goals, while also meeting mosquito control goals, the refuge has created several management designations for the impounded wetlands. Managed (primary) impoundments are those that have greatest potential for wetland wildlife management. Impoundments having had marginal management potential are identified for fisheries management and characterized as having a potential for either being reconnected or restored. An unmanaged impoundment is one that is kept open-flowing and is primarily managed for fisheries. If the impoundment produces unacceptable levels of mosquitoes, then the management type would be coordinated with local mosquito control districts. However, if unmanaged impoundments do not produce mosquitoes, they would be considered for restoration. Impoundments characterized as restoration were determined not to be manageable for wildlife for various reasons and approved for restoration by the Brevard Mosquito Control District. Needless to say, the numerous agencies involved with the refuge have differing and sometimes conflicting missions and ideas regarding the management and maintenance of the impounded wetlands of the refuge.

Migratory Birds
The refuge's combination of large open estuary habitats, natural and spoil islands, impounded wetlands, ridge and swale topography, pine flatwoods, and palm and oak hammocks is an important ecological landscape feature that represents a large collection of relatively undisturbed habitats that are used by a variety of migratory birds. The refuge is designated a Globally Important Bird Area and serves as a key overwintering and stopover site for a variety of waterfowl, shorebirds, and neotropical migratory birds. As the landscape continues to develop, the refuge will become even more important to these species as one of the remaining undeveloped tracts along the Atlantic Flyway.

The refuge currently plays an important role for a few specific species of migratory birds, including lesser scaup, northern pintail, and mottled duck. Large numbers of migratory and resident waterbirds use the estuarine waters and adjacent habitats of the refuge for feeding and loafing. Within the Atlantic Flyway (along the entire eastern coast of the U.S.), no other site winters such large numbers of interior lesser scaup—a waterfowl species well below national density levels and goals of the flyways and the Service. The refuge is an area of national importance, harboring up to 62 percent of all Atlantic Flyway-wintering lesser scaup and 15 percent of the continental population (Herring 2003). However, scaup populations wintering at the refuge have declined over the last six years.

Other Wildlife and Habitat Management Issues
Refuge habitats serve other key roles in supporting wildlife, including providing important fish spawning and settlement sites, a juvenile fish nursery, and bird rookeries. The refuge's estuarine waters are large, shallow, and saline to brackish basins that do not have a direct connection to the ocean. Extensive submerged beds of sea grasses form the vegetative nursery and basis for an aquatic community of oysters, clams, shrimp, crabs, and hundreds of species of fish that thrive in the warm shallow waters. The refuge's seagrass beds are some of the highest quality in the lagoon system, presumably from the undeveloped nature of the landscape surrounding the lagoon waters. Four species of sea grass are common to the refuge: shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), turtle grass *(Thalsssia testudinum*), and widgeon grass (*Ruppia maritima*). Water quality and clarity are critical components in the distribution patterns of the seagrass beds in the refuge. Protection of seagrass habitat has an important, logical connection to the density of many fish and macrofaunal invertebrates using the refuge's estuarine waters. The refuge seagrass community is often stated to be the best and most extensive, representing 40 percent of the entire Indian River Lagoon system. Water quality and appropriate and compatible public use are important to sustaining these seagrass beds and the wildlife which rely on them into the future. Further, the seagrass beds of the refuge are highly important to a variety of species. One hundred and thirty-two species of fish have been identified in the lagoon waters of the refuge (Paperno 2001). The refuge provides habitats supporting important life history needs of many of these fish species, most importantly red drum, black drum, and spotted seatrout. Water quality and appropriate and compatible public use are important to sustaining these fishery resources into the future.

The refuge's lagoon waters also harbor important colonial wading bird nesting rookeries and roost sites. The natural marsh and spoil marsh islands are used extensively by several key wading bird species for nesting and loafing. Increased disturbance by refuge users is a growing problem for the birds that use these nesting and loafing areas.

RESOURCE PROTECTION

Resource protection issues include acquiring or otherwise managing inholdings, protecting cultural resource sites, and providing sufficient law enforcement.

Although the refuge has minor issues with inholdings in the Turnbull Creek area, no significant land protection conservation issues exist. Although a partnership acquisition effort by the Service, the State of Florida, Brevard County, and Volusia County began in 1990 for the Turnbull Creek area of the refuge and despite the fact that about 1,246 acres were acquired and/or turned over to the refuge for management (as of September 30, 2005), acquisition has generally stopped. About 1,480 acres of inholdings exist in the Turnbull Creek area. Brevard County has very recently renewed its interest by reopening negotiations and acquiring new appraisals on various properties within the acquisition boundary.

The refuge includes 110 known cultural resource sites dating from prehistory to very modern times: from Indian burial mounds and shell middens to forts, cemeteries, sugar mills, and canals to space rocket launch pads. Although many of the cultural resource sites are located within the Security Area of the Kennedy Space Center and are not open to the general public, they are not protected from potential use by over 15,000 badged personnel. Neither the refuge nor the Space Center knows the exact locations of all the known sites, making protection and management difficult. Looking to the future, issues to be addressed involving the refuge's historical and archaeological resources include the potential for disturbance, vandalism, and theft.

High and increasing demands for public use of the refuge are likely to continue to result in greater levels of user conflicts, illegal activities, and wildlife and habitat disturbances. The refuge currently has only two law enforcement officers to cover millions of annual visitors and commuters (to the refuge, to the Seashore, and to Kennedy Space Center) accessing and using the refuge 24 hours a day; to cover more than 140,000 acres, spanning 35 miles in length, including over 50,000 acres of estuarine habitats in three separate waterways; and to cover two satellite refuges (the St. Johns and Lake Wales Ridge national wildlife refuges).

VISITOR SERVICES

The refuge's priority visitor services management issues are related to the growth of the human population, the impacts associated with the growing population, and the associated demand for public use activities. The Service is committed to providing appropriate, compatible, and quality public use opportunities and to increasing awareness and understanding of wildlife and habitats to limit the impacts to and disturbance of wildlife and habitat. This planning process identified the importance of addressing the increasing impacts from human activities and use (e.g., lethal and sublethal impacts from boating activities; collisions; wildlife disturbances; decreased water quality; erosion; development; and increased pollution, runoff, trash, and illegal access).

The refuge currently has more than one million annual visitors (where, based on 2003 visitation, ore than 550,000 were direct visits to the refuge and over 350,000 were incidental visits to the refuge's display at the Space Center's visitor center and on the tour of the Space Center and the refuge). The current population of the four counties in and around the refuge is over two million, with three million expected by 2015 (Lenze 2002). The State of Florida has more than 900,000 registered recreational boats (Florida Fish and Wildlife Conservation Commission 2004) with an additional 400,000 seasonal boats entering the state annually (Shelly Gurr, FWC, 2005 personal communication), many of which use the Intracoastal Waterway and pass through the refuge. The growth rate from 2005 to 2015 for the communities around the refuge is expected to average over 30 percent, with the State of Florida's anticipated growth rate for the same time period at 27 percent (Lenze 2002). The refuge is facing a variety of negative impacts from the increasing human population and public use activities. For example, increased boat traffic along the Intracoastal Waterway and elevated fishing pressure are negatively impacting users, wildlife, and habitat, especially in Mosquito Lagoon, which experienced nearly triple the users from 1990 to 2000 to nearly 124,000 boats annually.

REFUGE ADMINISTRATION

Key issues related to refuge administration involve staffing and funding, intergovernmental coordination, and commercial harvesting. Lack of sufficient staffing and funding to address management concerns continue to be issues for the refuge. In addition to having overlays with NASA and the National Park Service, the refuge has more than 60 governmental partners, including various local governments, state and federal agencies, and tribal governments. Given the complexity of refuge management and the need for the involvement of multiple partners in developing and implementing solutions, intergovernmental coordination was identified as one of the priority issues to be addressed in the comprehensive conservation plan. Wildlife and habitat impacts and conflicts with other users from commercial harvesting activities is another important issue for the refuge to address.

IV. Management Direction

INTRODUCTION

The Service manages fish and wildlife habitats considering the needs of all resources in decision-making. However, first and foremost, fish and wildlife conservation assumes priority in refuge management. The National Wildlife Refuge System Improvement Act of 1997 requires the Service to maintain the ecological health, diversity, and integrity of refuges. A refuge is a vital link in the overall function of an ecosystem. Refuges in the North Florida Ecosystem include imperiled coastal areas and lagoonal islands, such as those protected at Merritt Island Refuge. To offset the historic and continued loss of habitats within the ecosystem, the refuge and other public lands and waters provide a biological safety net for native species, trust resources, and state and federally listed species.

VISION

Merritt Island National Wildlife Refuge was established as an overlay of NASA's Kennedy Space Center, where technology and the environment peacefully coexist, where bald eagles nest in plain view of NASA launch pads.

Through a motivated, experienced, highly skilled, and well-trained workforce of staff and volunteers and with the active participation of the partners, the refuge will strive to maintain its unique natural wildlife and habitat diversity and its important ecological landscape features as a model of excellence in natural resource management. The management of wildlife and habitat on the refuge will be an active, science-driven, comprehensive endeavor. The refuge will actively seek partnerships with all possible sources to further conservation stewardship and protection of natural resources. Research projects conducted on the refuge will support the information needs of the refuge.

The major component habitat types of the refuge will be maintained in a viable and sustainable condition. As one of the three core populations of Florida scrub-jay, the refuge will maintain the last, large, relatively unfragmented tract of scrub on the east coast of Florida. Merritt Island Refuge will be a leader in the use of fire to manage habitats and fuels in central Florida. Estuarine habitats will have good water quality and will support healthy seagrass beds. And refuge lands will be kept free of exotic, invasive, and nuisance species. Refuge fish and wildlife populations will be naturally diverse and self-sustaining. Fish and wildlife populations will be maximized consistent with refuge goals and available habitat to also benefit the visiting public. The refuge will take necessary actions to maximize the reproductive success of rare, threatened, and endangered species. Migratory birds, threatened and endangered species, and other trust species will have priority in management decisions. Waterfowl, songbirds, wading birds, and waterbirds will be abundant and easily viewed by visitors. Fish populations will be abundant and will be protected from over harvest by recreational and commercial users. The refuge will take necessary actions to minimize the impacts of wildlife to space program activities and to the safety of Space Center employees, official visitors, and the visiting public.

The refuge will promote, maintain, and develop appropriate and compatible public use opportunities, which will enhance the public's awareness and appreciation of the refuge's natural resources and of the National Wildlife Refuge System. Emphasis will be placed on providing quality, wildlife-dependent recreational activities that are compatible with the purposes and natural resources of the refuge and with the Refuge System's directive of wildlife first. The refuge will work in partnership with Canaveral National Seashore, Kennedy Space Center, Merritt Island Wildlife Association, Florida Fish and Wildlife Conservation Commission, and others to coordinate and enhance visitor services and

protection and to provide current and consistent information in order to best serve the public. The neighboring community will realize that the refuge enhances the quality of their lives by providing opportunities for wildlife observation, wildlife-dependent recreation, and ecotourism. The community will support and serve the refuge through ethical outdoor behavior, partnerships, volunteer programs, and cooperative events.

GOALS, OBJECTIVES, AND STRATEGIES

The goals, objectives, and strategies delineated are the Service's response to the resource problems, issues, concerns, and needs expressed by the Service, the public, and the governmental partners. They reflect the Service's commitment to achieve the purposes and vision of Merritt Island National Wildlife Refuge, the mission of the National Wildlife Refuge System, and the mandates of the Fish and Wildlife Service. The Service intends to accomplish these goals, objectives, and strategies over the 15-year life of this CCP/EA.

The National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997, states that national wildlife refuges must be protected from incompatible or harmful human activities to ensure that Americans can enjoy the Refuge System long into the future. Before activities or uses are allowed on a national wildlife refuge, the uses must be found to be compatible. A compatible use is one that will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge [§668ee(1) USC]. "Wildlife-dependent recreational uses may be authorized on a refuge when they are compatible and not inconsistent with public safety" [§668dd(d)(3)(A)(iii) USC]. See Appendix E for the compatibility determinations.

WILDLIFE AND HABITAT MANAGEMENT

Wildlife and habitat management goals include rare, threatened, and endangered species; migratory birds; exotic, invasive, and nuisance species; and wildlife and habitat diversity.

Wildlife and Habitat Management Goal 1: Rare, Threatened, and Endangered Species
Conserve, protect, and enhance populations of rare, threatened, and endangered species of plants and animals at existing or increased levels on the refuge and conserve, protect, manage, and restore their native east central Florida coastal and estuarine habitats occurring on the refuge to contribute to recovery goals.

Discussion: Listed species are plants or animals that have been listed by a state and/or federal agency with special protection or conservation designations. Those species with regulatory protection are protected by law, such as state and federal threatened and endangered species. There may be species in Florida that are protected, but not listed here because the species either has not been confirmed, it has been extirpated from the refuge, or it only occurs rarely or incidentally (see Epstein and Blihovde 2006 for additional information).

The refuge's expansive and protected habitats provide undisturbed, natural-like habitat for many species. The refuge serves as a vital area for species like the southeastern beach mouse, Florida scrub-jay, and West Indian manatee. Many protected areas are a combination of refuge and NASA restrictions and these sanctuaries are important to many fish and wildlife species. Due to its location, size and diversity of undisturbed habitats, level of federal protection, and unique landscape features, the refuge lends itself to the possible future of a number of species and possible future reintroduction of declining species.

There are no known federally listed plants on the refuge and all listings for plants are state designations. Of the total listed animal species, 17 are federally listed. However, seven of these species (the American alligator, Kemp's ridley sea turtle, Hawksbill sea turtle, Atlantic salt marsh snake, snail kite, Audubon's crested caracara, and roseate tern) either have a special listing (i.e., alligator) or have rarely been recorded on the refuge. This brings the actual number of state or federal listed wildlife species that regularly occur on the refuge to 41: 10 federal and 31 state species (which excludes the alligator and includes 28 plant species). Currently, 93 plant and animal species regularly occurring on the refuge have a state or federal designation (as threatened, endangered, of special concern, or commercially exploited). However, 124 species occurring on the refuge have a special state, federal or non-governmental organization designation: one amphibian, 10 reptiles, 69 birds, six mammals, and 38 plants. These are plants and animals that include listed species, species of special management concern, or have a nonregulatory designation.

1.a. Florida Scrub-jay - Scrub Habitat

Discussion: Four Primary Core Recovery Units are delineated within the State of Florida. These units are the only sites where it would be possible to support at least 400 breeding pairs of scrub-jays in perpetuity. The continued existence of all of the units is essential for the continued existence of the species. The Florida scrub-jay population on the refuge is part of the Merritt Island Primary Core Recovery Unit, which also includes lands owned and/or managed by Cape Canaveral Air Force Station and Canaveral National Seashore.

The primary core recovery unit presents a unique opportunity to manage habitat for the Florida scrub-jay. In spite of the presence of some infrastructure, large tracts of relatively unfragmented, contiguous habitat are present, especially on the refuge. A large population of scrub-jays exists here and the ongoing program focuses on managing and restoring scrub habitat. A long-term database exists on jay demographics provided by monitoring efforts from NASA's environmental program at Kennedy Space Center. These assets should help enable the refuge to successfully support Florida scrub-jay recovery. Maintaining viable scrub habitat would not only improve the chances of long-term survival of the scrub-jay, but would also address the conservation of many other scrub-associated species.

The management of the Florida scrub-jay landscape can be a complex venture. The effects of past land use and management practices have had a profound effect on the suitability of the area for jays and other scrub fauna. The shrubland areas of the refuge have changed dramatically over the years (Duncan and Schmalzer 2004). Aerial photography flown in 1943 shows that this landscape was much more open than it is now. Openings consisting of sand and some herbaceous vegetation were common throughout most of the oak scrub areas. The coverage of pine woodlands in both the scrub and palmetto areas was scattered. Although there were stands of hardwoods throughout the refuge, most were small in area. The swales associated with the shrublands were grassy, with few woody species present. Although some roads were present, they were narrow and few and far between. Duncan and Schmalzer (2004) showed that with little human alteration to the landscape, naturally ignited fires in the 1920s and 1940s would have spread extensively. Present-day observations of fires in the shrubland areas would lead us to believe that many of these fires would have been very intense (Adrian 2003). The refuge's vegetation map (Figure 8) shows the locations of the shrubland habitats. [Figure 7 in the Habitat Management Plan (Appendix F) shows the locations of just the shrubland habitats.]

Over time, the landscape that now makes up the refuge was altered by development. The once large patches of shrublands were fragmented by roads, agriculture, and structures. The hydrology of the area was changed through ditching for drainage associated with in increased infrastructure. Fire, an important component to the shrubland ecosystem, was excluded from much of the region.

The removal of fire from the landscape allowed the vegetation to become overgrown, reducing its suitability as habitat for the scrub-jay and other scrub fauna. To effectively manage the shrub landscape to the benefit of scrub-jays, the effect of these past actions must be addressed.

Optimal scrub-jay habitat landscapes include focal patches that have optimal characteristics within a matrix of habitat that does not lower the suitability of the focal patches. Optimal focal patches have 20 to 30 percent of the area in openings, have greater than 50 percent of the shrub layer comprised of scrub oaks (*Quercus* spp.), have a shrub height between three and six feet, have a pine canopy cover of less than 15 percent, and are 300 feet from a forest edge. As noted above, the landscape matrix in which these patches reside consists of areas of palmetto, scattered pines, and grassy swales. This presents a vista that is open with few visual barriers.

It is obvious, therefore, that to achieve a viable scrub-jay population in and around the refuge, it would be necessary not only to restore and manage specific patches of scrub, but also to restore the landscape in which these patches exist. This would require the transformation, as much as possible, of the landscape to the way it appeared prior to the impacts of the aforementioned anthropological activities. The aerial imagery, from the 1940s, is available to help target historical conditions. Since this imagery was taken before the fire exclusion period and before most of the present infrastructure was constructed, the vegetative matrix represented by this photography has been selected as a target for the restored landscape.

Specific management actions required to achieve restoration would include reducing the height of overgrown scrub areas, removing woody vegetation from swales, reducing forest cover and density, and removing the visual barriers that are found along perimeters of scrub management units. Both mechanical treatment of vegetation and the judicious application of fire would be necessary in most restoration activities. Once restored, the proper maintenance of scrub areas is essential. The re-treatment of scrub patches should be based on field inventory, rather than some assigned rotation. In other words, rather than assign a fire rotation of four years to a site, managers should periodically assess the area, scheduling a burn when the height of the scrub approaches six feet.

The management of the shrubland landscape may be one area where the possible effects of climate change attributed to global warming may actually help meet management goals and objectives. It is conceivable that a warmer, drier climate would stress both forests and shrub species. This may be especially true on the higher sand ridges where a large portion of scrub habitat occurs. 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.

Li's data is from a long-term elevated atmospheric CO_2 study being done on the refuge which was initiated in 1990. It is a cooperative effort between the Smithsonian Environmental Research Center, NASA, Dynamac Corporation, and later the Department of Energy. The results of this investigation suggest that elevated CO_2 (EC) can alter nitrogen cycling (Hungate et al. 2006) and the distribution of other soil nutrients (Johnson et al. 2003). EC in the atmosphere also has the potential to increase the sequestering of anthropological carbon scrub ecosystems (Hymus et al. 2003). In addition, it was discovered that photosynthetic capacity was affected by EC, although this effect varied among the several species of scrub oaks (Ainsworth 2002).

Another important consideration in maintaining a viable scrub-jay population is the transfer of genetic material between subpopulations found in an area. Four areas of the refuge have extensive acreages of oak scrub and scrubby flatwoods. These are known as Scrub Reserve Units

(Breininger et al. 1996) (Figure 16). It is important that connectivity be maintained between these areas. Again, the use of mechanical treatment and fire would be required to open and maintain these linkages. In addition, the construction of additional roads and buildings in these corridors should be discouraged.

It is important to consider that when altering the present landscape, such as reducing forest coverage, scrub and scrub-jay management activities should not impact the objectives pertaining to eagle habitat or native wildlife and habitat management. When planning where to concentrate restoration or landscape alteration, it should also be remembered that it has been shown that scrub-jays do not move far. For this reason, it is best to concentrate on restoring scrub which is adjacent to occupied areas. A more complete description of planned activities, along with a detailed description of optimal scrub conditions, is documented in Chapter IV of the Merritt Island National Wildlife Refuge Habitat Management Plan (see Appendix F).

In order to effectively carry out the strategies under the several objectives listed, it would be necessary to develop at least two staff positions. One would be at the professional level and should be knowledgeable in scrub landscape ecology. The other might be at the technician level and should be familiar with inventory methods for both wildlife and vegetation. In both cases, knowledge of how fire works in the scrub landscape would be required. It would be helpful if the individuals associated with scrub management be skilled in the application of fire.

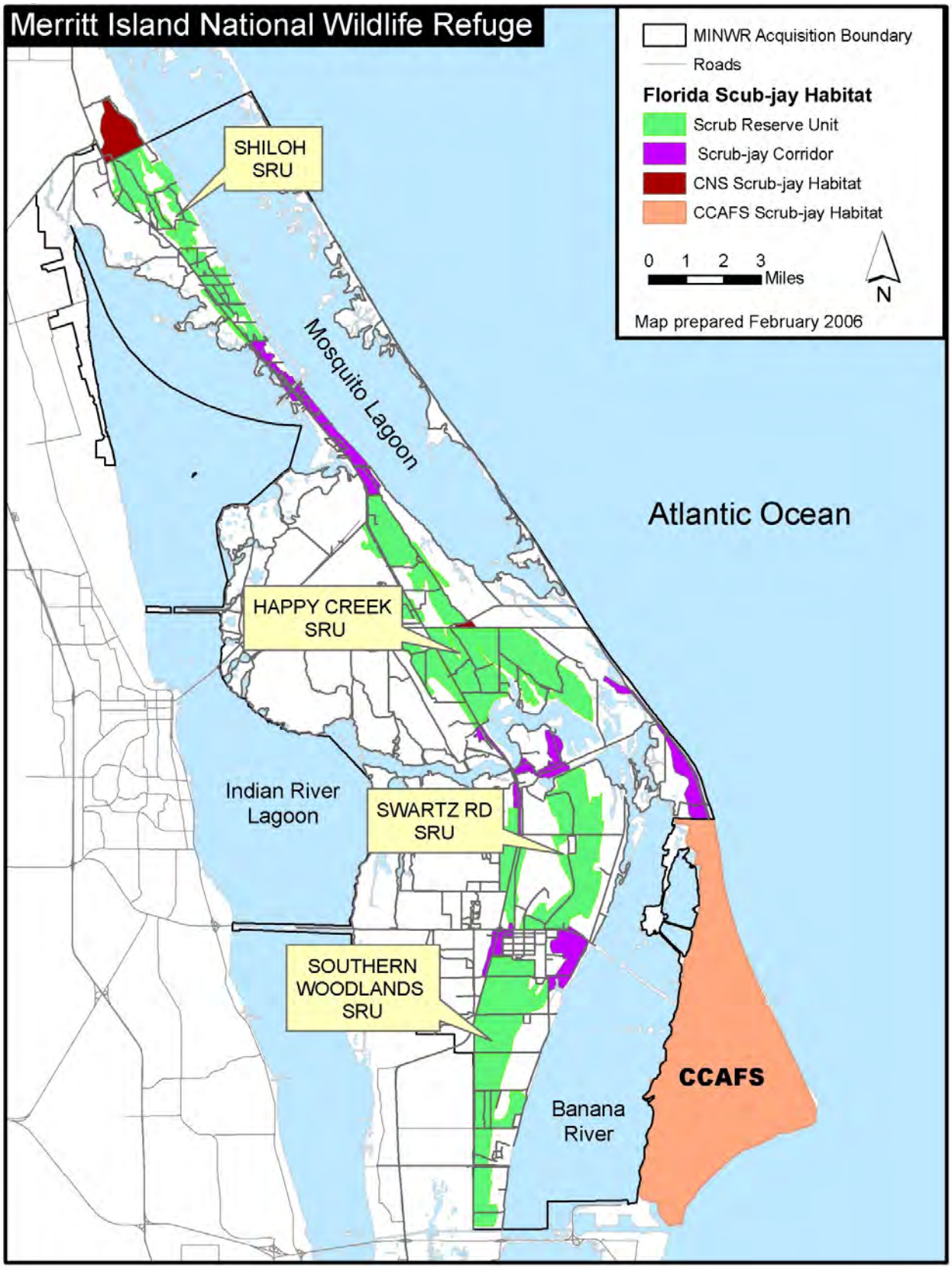
Objective 1.a(1): Annually maintain 500–650 Florida scrub-jay family groups with 350–500 territories being in optimal condition to support scrub-jay recovery efforts.

Discussion: The 2001 population estimate of Florida scrub-jays in this core recovery unit was 665 pairs, which is close to the recovery population size of 697 pairs. In that year, Cape Canaveral Air Force Station accounted for 114 family groups (Stevens and Knight 2003). This indicates that the number of jay groups on the refuge could be expected to be about 550. While this population meets the stated goal, there is some uncertainty (Johnson et al. 2006), and it would be preferable to support as many jay families as the habitat would allow.

Objective 1.a(2): Continue to annually provide 11,000 to 13,000 acres of oak scrub/scrubby flatwoods in optimal condition to support Florida scrub-jay recovery efforts.

Discussion: Table 1 shows that the refuge has a little over 15,340 acres of oak scrub and scrubby flatwoods on the refuge. Using 23 acres per family group territory as an average territory size, one would estimate that 12,650 acres of scrubland is occupied, leaving approximately 2,700 acres of potential jay habitat unoccupied. It is likely that some of this habitat occurs in small isolated patches that are not large enough to sustain jays. However, some habitat is not occupied because it is in poor condition. Restoration would be required to attract jays to these areas. It is important to realize that not all of this scrub could be in optimal condition at the same time. Management activities would, of necessity, remove some well-managed territories from optimal status for a period of time. When vegetation is removed by fire or mechanical means, there are from one to two years where the vertical structure is too short to meet optimal conditions. On the other end of the management cycle, just prior to subsequent burning, there would be times when the vertical structure may well be too tall. In a well managed scrub landscape, approximately 70 percent of the scrub habitat would be optimal, while the other 30 percent is either recovering from or being prepared for treatment. Seventy percent of the scrub habitat shown in Table 1 is 10,738 acres. In order to increase this to the acreage targeted, conversion of vegetation from other types would be necessary. Plans are being developed to remove the majority of timber from approximately 1,000 acres of scrubby flatwoods in the southern part of the refuge, as well as to restore 100 acres of fallow groves to scrubland.

Figure 16. Locations of Scrub Reserve Units



1.b. Bald Eagle - Flatwood and Scrub Habitats

Objective 1.b(1): Annually maintain 11–15 successful nesting pairs of bald eagles on the refuge.

Discussion: In the 1880s it had been estimated that approximately 100 pairs of bald eagles (*Haliaeetus leuccocephalus*) nested in the vicinity of Merritt Island. During the early part of the 20th Century, bald eagles on Merritt Island numbered between 15 and 24 breeding pairs (Howell 1954). Anthropogenic changes in the landscape, especially during the 1950s, reduced this number to only one or two pairs by the 1970s (Hardesty and Collopy 1990). Declines in eagle abundance appeared greater on Merritt Island than was experienced on the mainland. The most likely cause of this was exposure to organochlorine compounds which were applied extensively during the 1940s and 1950s (Hardesty and Collopy 1990). Refuge annual narratives reported that no eagles were nesting on refuge lands in 1963. Since then the number has increased to an average of 12 nests.

Bald eagle habitat encompasses not only nesting substrate, but also foraging areas, perch trees, and areas devoid of disturbance. The impoundments and marshes on the refuge, along with portions of the Indian River Lagoon system both on and adjacent to refuge provide ample foraging habitat. While these areas are not specifically managed for eagle foraging, activities aimed at maintaining populations of migratory birds provide prey for the eagles. Fishery resources in the impoundments and estuaries also provide an important food source.

Hardesty and Collopy (1990) described various aspects of eagle habitat on the refuge. On the landscape scale, the distance between active nests averaged approximately 1.4 miles. Where alternate nests were present, the distance between the primary and alternate nest was about 0.3 miles. The distance from active nest trees to the nearest water averaged around 3,000 feet. Nest sites tended to be in areas without human disturbance. Distances to primary roads averaged 4,700 feet, while the distance to occupied buildings was about 13,000 feet. There are notable exceptions to this norm however. A large nest has existed for many years close to Kennedy Parkway (SR 3), just south of the Vehicle Assembly Building. In addition, in recent years, eagle nests have been found in both dead trees and on artificial structures. Regardless of these anomalies, selection of potential nesting sites for management should use the parameters described by Hardesty and Collopy (1990).

Eagle nest trees are described as being large, living south Florida slash pine (*Pinus elliottii* var. *densa*). The heights of these trees were almost 21 percent greater than surrounding trees, with heights of the nests themselves at the approximate level of the surrounding canopy. Nest trees had substantially larger diameters at both breast height and nest height than did the overall stand. Crowns were typically shallower than surrounding trees and nests were situated at the junction of several large branches (Hardesty and Collopy 1991). This crown configuration is common in mature to senescent south Florida slash pines.

The stands of pines in which the nest trees resided also had specific characteristics. These stands had basal areas of about 35 square feet per acre. They also had more snags than similar nonnest stands. Hardesty and Collopy (1990) do not address specific nest stand size, rather they recommend that a primary management zone of 1,500 feet, and a secondary zone with a one-mile radius be established for each active nest. This equates to 160 acres in the primary zone and over 3,000 acres in the secondary zone. There are few pine stands on the refuge that are 3,000 acres in size, and most do not even reach the 160-acre limit. It would seem more reasonable for management activities directed towards providing nesting habitat be limited to a distance of 0.5-mile from an existing and/or historic eagle nesting site.

Most refuge management activities concerning eagle habitat would fall into the realm of forest and woodlands management. While these are discussed in detail in Chapter V of the Habitat Management Plan (Appendix F), some discussion is warranted here. The purpose of these activities is to protect existing nest sites and to ensure that suitable nesting substrate is available in the future. Management in stands containing existing nests should involve maintaining stocking level near 35 square feet of basal area per acre. To achieve this, thinning would need to be done occasionally. Marking of trees to be removed is recommended to provide positive control of the operation. Trees in competition with the nest tree should be considered for removal. Other large trees in the stand should also have competing trees removed. Further away from the actual nest tree, efforts should be made to create a range of stem densities. Thinning should be heavier around trees that have the potential to become future nest trees, while a lighter cut could be done elsewhere. This would not only provide sufficient stocking to provide for mortality, but would also create diversity within the pine forest. Harvesting would be done by commercial timber companies.

In addition to managing mature stands, efforts must be made to provide a range of age classes within the forest. To do this, small areas, about five to ten acres in size, should be selected for regeneration. The most efficient way for the refuge to regenerate pine stands is through natural regeneration. Seed trees are left on the site until sufficient seedlings are present. The parent trees could be left for a considerable period of time and removed when harvest operations are conducted nearby.

The use of prescribed fire is important to the maintenance of the pine forest ecosystem. However, fire, both wildfire and prescribed fire, could pose a threat to existing eagle nests. Procedures have been developed, and are constantly being refined, to reduce this threat. Reduction of vegetation under the nest tree immediately prior to the ignition of a prescribed fire is one part of this endeavor. Careful burn out under the tree along with wetting the nest with helicopter bucket drops are also techniques that have been used successfully.

Management of the eagle population on the refuge is not limited to manipulation of forests and foraging areas. The refuge must work closely with Kennedy Space Center to reduce the impact of their operations on eagles. This obviously includes discouraging the building of structures and other facilities in close proximity to existing nests. Construction should also be discouraged in areas that have the potential to become nesting habitat.

Reduction of mortality is another arena where coordination with the Space Center is needed. Kennedy Space Center employees need to be made aware of the possibility of eagles feeding on road kills. Efforts to get these employees to reduce their speeds when driving by flocks of vultures on the chance that an eagle may be present should be made.

The refuge conducts an annual eagle nest survey each January to determine the occupancy of known eagle nests. This information is shared with the Florida Fish and Wildlife Conservation Commission, NASA Master Planning, and Dynamac Corporation. The data is used to determine eagle habitat characteristics using GIS and to develop a spatial-temporal baseline of eagle nesting.

1.c. Sea Turtles - Beach and Estuary Habitats

Objective 1.c(1): Continue to annually maintain 6.3 miles (10 km) of refuge beach in a high-quality condition for nesting leatherback, green, and loggerhead sea turtles to support an annual target of 1,250 loggerhead sea turtle nests and a biannual target of 210 green sea turtle nests to support sea turtle recovery efforts.

Discussion: The coastal beach and dune system serves as habitat for many listed species, including threatened or endangered sea turtles and endemic species (e.g., Florida beach mouse, *Peromyscus polionotus* sp.). The undeveloped 10-km barrier beach extends from the south boundary of the Canaveral National Seashore to the north boundary of the Cape Canaveral Air Station. The Merritt Island beach is a coastal barrier beach and part of the Canaveral coastal barrier complex. The beach has a generally stable, low energy profile; however, the midsection receives more wave energy then the north or south ends. The higher energy section experiences erosion and the marine scarp extends to the dune face and into the transitional scrub habitat. Erosion is threatening specific points of the beach and dune near NASA's shuttle launch pads. The lower energy sites have typical beach and dune foreshore development with a low erosion upper beach. The upper sandy beach is largely bare with little vegetation, except for isolated beach plants (e.g., sea rocket, *Cakile* spp.). The dunes are vegetated primarily with sea oats (*Uniola paniculata*), morning glories (*Ipomoea* sp.), and typical dune grasses (Johnson and Barbour 1990), but do not have an extensive secondary dune field. There is a very quick transition from the primary dune to coastal strand and a saw palmetto/scrub community.

The loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas*), and leatherback sea turtle (*Dermochelys coriacea*) nest on the Merritt Island beach from April through September (Popotnik and Epstein 2002). From 1991–2001, the mean annual number of nests recorded for loggerheads was 1,338 [standard deviation (SD) = 320.6] and for green sea turtles was 54 (SD = 72.0). In total, six leatherback nests were recorded between 1991 and 2001. In 2005 a total of 881 nests were found, but the actual number of nests would be higher due to periodic beach access closures from hazardous operations and launches at Kennedy Space Center and Cape Canaveral Air Force Station. Of the 881 nests found in 2005, 695 were loggerhead nests, 183 were green nests, and 3 were leatherback nests. The short-term trend of the number of nesting sea turtles is down since 2001; however, the impact of the 2004 and 2005 hurricanes may have influenced nesting in the last couple of years.

Mosquito Lagoon has been shown to be an important wintering area for juvenile loggerhead and green sea turtles. Mosquito Lagoon is considered a developmental habitat primarily for subadult loggerhead and green sea turtles (Mendonca et al. 1982). Turtles may remain in the lagoon until maturity. Turtles wintering in the lagoon are plagued by winter freezes, which can cold stun the animals and can cause mortality. The refuge has developed a plan to coordinate the handling of cold stunned turtles and prevent mortalities (Epstein 2001a). The Mosquito Lagoon was thought to have supported thousands of sea turtles at one time. A sea turtle fishery that existed extended into the 1960s was thought to contribute to the decline in population. Monitoring of wintering sea turtles in the Mosquito Lagoon in the mid-1970s (Ehrhart and Yoder 1978) found higher numbers than presently found (Provancha et al. 2002) and found that the recent occurrence of sea turtle fibropapillomas is apparent. Additionally, recent trends suggest a shift in species composition with the increased occurrence of green sea turtles and decreased numbers of loggerhead sea turtles than was observed in the past (Jane Provancha, Dynamac, Inc., personal communication).

Primary conservation efforts would be to work with NASA and Cape Canaveral Air Force Station to reduce development and adverse beach activities, such as educational efforts with Space Center employees, providing data and feedback on lighting and disorientation issues, and to encourage monitoring of coastal erosion rates. Other factors that may negatively influence sea turtle production on the refuge beach relate to impacts to beach habitat from storms that erode shoreline and dune systems. Sea level rise and the associated beach and dune changes would likely negatively impact sea turtle nesting habitat and nesting success. Additionally, this would lower the beach dune profile that protects (shades) nesting and hatchling sea turtles from the disorienting effects of nighttime artificial lights from nearby NASA and Air Force launch pads. Both the Air Force and NASA are presently working with the Fish and Wildlife Service's Ecological Services Office to develop appropriate artificial lighting plans for the conservation of sea turtles on refuge beaches. The Service

does monitor the regional and global trends of these populations most notably through its sea turtle coordinator. The Merritt Island Refuge supports coordinated monitoring and research throughout the individual species' ranges and not just at the local level.

The refuge beach and dune system is an important habitat for many species. For further information, please refer to Chapter VII of the Habitat Management Plan (Appendix F) on beach and dune habitat management and conservation.

Strategies:

- Continue to encourage the monitoring of juvenile sea turtles in Mosquito Lagoon.
- Provide consideration for the conservation of marine turtles in Mosquito Lagoon and other refuge estuaries.
- Identify potential impacts and adapt management to maintain lagoonal habitats for sea turtles.
- Continue to coordinate winter cold stun events with multiple agencies. [See the refuge's cold stun protocols (Epstein 2001a).]

Objective 1.c(2): Continue to annually maintain an annual sea turtle nest depredation rate of less than 10 percent to support sea turtle recovery efforts.

Discussion: Primary sea turtle nest predators at the refuge include raccoons (*Procyon lotor*), feral hogs (*Sus scrofa*), and ghost crabs (*Ocypode quadrata*). Overall, a depredation rate of sea turtle nests over the past 11 years is approximately 6 percent. Sea turtle nest depredation is well documented. Llewellyn Ehrhart (personal communication) indicated that nest depredation was as great as 90 percent during the late 1970s along the same refuge beaches. Recent data show that an active and highly effective predator control program has kept the overall depredation of sea turtle nests well below an annual rate of 10 percent. Furthermore, a recent evaluation of nest depredated suggests that mortality of eggs from depredated nests may be lower then previously believed.

Strategies:

- Seek Service support through the Endangered Species program to hire a staff member (Biological Science Technician) to annually monitor and conduct the predator control program on the beach in conjunction with sea turtle survey work.
- Continue to work closely with the refuge's exotic mammal trappers in conjunction with the removal of hogs and other potential large predators from refuge beaches. (For additional information, see Chapter IX of the Habitat Management Plan, addressing Exotic, Invasive, and Nuisance Species.)

1.d. Southeastern Beach Mouse - Beach and Dune Habitats

Objective 1.d(1): Continue to annually maintain about 100 acres of coastal dune community dominated by forbs and beach grasses to support southeastern beach mouse recovery efforts.

Discussion: The 328-acre refuge beach extends from Canaveral National Seashore's southern boundary to Cape Canaveral Air Force Station's northern boundary. This coastal beach and dune system serves as habitat for many federally listed species, including the southeastern beach mouse (*Peromyscus polionotus niveiventris*). The refuge may harbor one of the few remaining sustainable populations of this subspecies of the old field mouse, which inhabits undeveloped, contiguous beach systems of the Canaveral National Seashore, Merritt Island Refuge, and the Cape Canaveral Air Force

Station. The historic range of this small mammal has been reduced by approximately 80 percent. This suggests that the refuge may, in part, harbor a core population of this subspecies. Therefore, the refuge population may be a valuable source for consideration of reintroductions to other sites. The primary and secondary dune system is the principal habitat for the southeastern beach mouse at Merritt Island. Beach mice are most often found along the primary dune line in areas where sea grape (*Coccoloba uvifera*) was abundant. In many locations along the study area, small mammal communities are comprised of three species: *Peromyscus polionotus*, *Peromyscus gossypinus*, and *Sigmodon hispidus*. This finding, along with the observation that *Sigmodon hispidus* were most often found in the scrub areas where beach mice seemed to be excluded, may warrant further studies of the small mammal communities in this area. Recent erosion from oceanic storms has caused the westward migration of the beach into the coastal strand. The rate of beach and dune migration is being monitored by Dynamac Corporation in consultation with the refuge. The refuge beach and dune systems transition quickly into coastal scrub, which would be impacted by sea level rise. Rapid changes in sea level rise could outpace the natural changes in beach and dune habitat succession.

1.e. West Indian Manatee - Estuary Habitats

Objective 1.e(1): Continue to annually maintain and protect 50,000 acres of refuge estuarine habitat to support an anticipated spring peak population target of 500 or more West Indian manatees.

Discussion: The Florida manatee (*Trichechus manatus latirostris*) is a federally endangered sub-species of the West Indian manatee and inhabits estuaries, lagoons, and slow-moving rivers. The Florida manatee was listed as endangered in 1967 and Critical Habitat was designated in 1976 (U.S. Fish and Wildlife Service 2001). Manatees are found along most of Florida's coastal waters and rivers and are year-round residents of the refuge. Statewide numbers are thought to be less than 4,000 individuals. The Florida Fish and Wildlife Conservation Commission estimates that 47 percent of the state's manatee population is distributed along the state's Atlantic coast (FWC unpublished data).

Manatees consume on average 10–15 percent of their body weight of submerged aquatic vegetation daily. Manatees feed on a wide variety of aquatic vegetation, but seagrasses are their primary foods in coastal areas (i.e., manatee grass, *Syringodium filiforme* and shoal grass, *Halodule wrightii*). Thus, maintaining quality seagrass meadows in refuge waters is an important objective. Submerged aquatic vegetation mapping of the Banana River, Indian River Lagoon, and Mosquito Lagoon (collectively the Indian River Lagoon system) shows that the refuge provides excellent foraging habitat for manatees (Provancha and Provancha 1988). Although the health of seagrass meadows has shown a trend towards degradation over time in most of the Indian River Lagoon, current data suggest that seagrass distribution within the refuge's boundaries has been relatively stable and healthy over the past decade (Robert Virnstein, personal communication). Since 1991, annual counts of manatees within the waters of the refuge have increased from approximately 150 animals to over 350 presently. In 1990, a 13,568-acre manatee refuge (sanctuary) was established south of the NASA causeway in the Banana River under the National Wildlife Refuge System Administration Act. The new area protected the largest warm water concentration of manatees in the United States (Merritt Island National Wildlife Refuge Annual Narrative 1990, unpublished report). The designation established a no motor zone in the Banana River.

The area remains open to public use (with new limits after September 11, 2001); however, motorized watercraft is prohibited. Observations made before and after the manatee refuge was established revealed an increase in the number of manatees using this habitat. The northern Banana River and Indian River Lagoon are the most important spring habitat along the east coast of Florida (U.S. Fish and Wildlife Service 2001). Injury from boat strikes is the most important threat to the species. The no motor zone protects manatees from contact with boats during times when they are present in the area.

The possibility of global climate change and associated sea level rise may impact the West Indian manatee. Continued mapping of sea grass beds, warm water refugia, and seasonal migration and habitat use patterns will be coordinated with the U.S. Geological Survey's Sirenia Project.

1.f. Wood Stork

Objective 1.f(1): Within the 15-year life of this CCP/EA, reestablish wood stork nesting on the refuge to support wood stork recovery efforts.

Discussion: The Moore Creek impoundment (600 acres) is the site of a former, large wood stork nesting colony. Wood stork nest numbers peaked in 1980 (350 nests) and varied in number until 1986. A severe freeze occurred in 1985-86 that destroyed all of the mangrove nest sites. Although there were 250 nests in 1986, the storks abandoned the rookery and no confirmed nesting has occurred at this site since 1986. In 1997, 25 wood stork artificial nest structures were constructed and installed at the former rookery area in hopes of restoring the rookery. However, great blue herons are the only bird to use the structures to date. There are approximately 200-300 wood storks using the refuge for feeding and roosting, with highest densities in winter.

For additional information on wood stork nesting and recovery on the refuge, please refer to Chapter IV of the Habitat Management Plan (Appendix F).

Wildlife and Habitat Management Goal 2: Migratory Birds
Maintain and actively manage refuge coastal barrier island wetlands and uplands primarily to contribute to migratory bird priorities of the refuge and peninsular Florida physiographic area, while providing consistency with regional and national goals.

Discussion: The refuge's wetlands rank highest in the State of Florida regarding numbers of migrating waterfowl counted during the official U.S. mid-winter counts, and rank as one of the highest regarding the number of successful waterfowl hunters (birds per hunter trip). Within the Atlantic Flyway (the entire east coast of the United States), no other site winters such large numbers of lesser scaup—a waterfowl species well below national density levels and goals of the flyways and the Fish and Wildlife Service. The refuge is an area of national importance, harboring up to 62 percent of all Atlantic Flyway wintering scaup and 15 percent of the continental population (Herring 2003; Herring and Collazo 2004). However, scaup populations wintering at the refuge have declined over the last six years. Additionally, the refuge is a highly important area for east coast pintails. Historically and presently, the Merritt Island Refuge has ranked second in wintering pintail populations along the Atlantic coast. Pintail population numbers have steadily declined on the refuge over the past decades, from a mid-winter count of about 20,000 in 1978 to 8,315 birds in 1989; to 3,141 in 1999; and to a low of 1,376 birds in January 2003, a 93 percent decline from 1978. The northern pintail stands a serious chance of being extirpated from a historical wintering area at the refuge. Consistent low annual population counts at the refuge support the need to prioritize the evaluation of this species. The refuge plays an important role because (1) pintails are and have been well below nationally set density goals, and (2) those pintails that do migrate to the Atlantic coast may be a unique population segment of the entire North American population—a segment with an affinity for historically used sites below Virginia (e.g., coastal North and South Carolina and eastern Florida).

The refuge's impoundments and their freshwater/brackish vegetative communities provide life history requirements for many species of wetland wildlife (Epstein 2001b), such as the Florida mottled duck, a resident duck unique to the State of Florida. The managed wetlands also harbor federally listed species, such as the wood stork, southern bald eagle, American alligator, and over 15 federal species of special management concern.

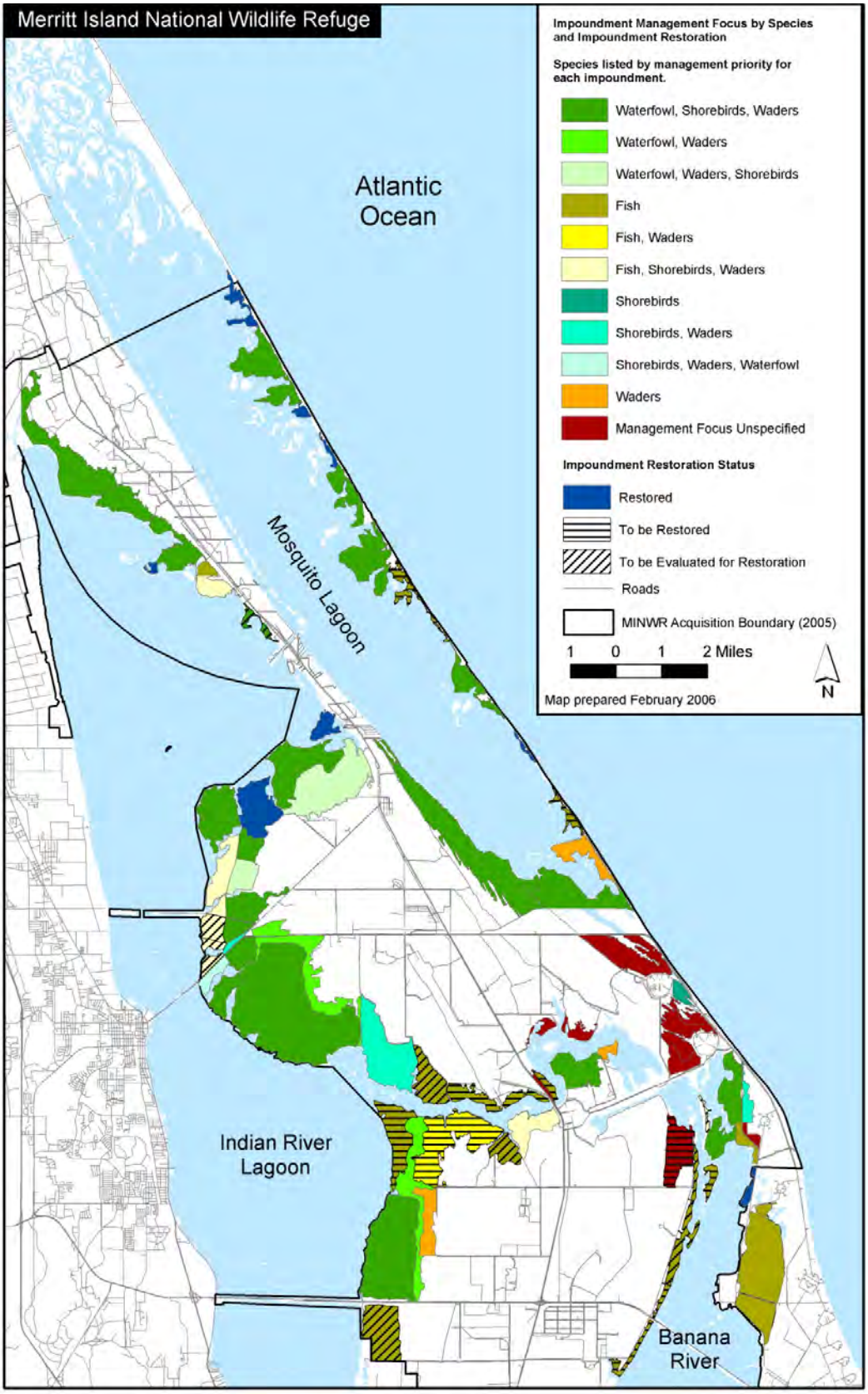
Because migration chronologies of waterfowl and shorebirds vary seasonally (e.g., overwintering birds, early spring migrants, and late spring migrants), management must provide suitable habitat conditions and food resources for a variety of species at different times (e.g., winter, early spring, and late spring). Providing diversity in management and habitat within the complex of wetlands would assist in meeting resource needs for multiple species. Staggered (graduated) drawdown is still a recommended management practice because it provides a continuous supply of habitat over the course of the season. Gradual drawdown is also used because it provides a diversity of habitat (e.g., mudflat, shallow water, and moderate water) due to variation in wetland bottom contour. However, the particular manipulations need to reflect seasonal differences in precipitation and management objectives (e.g., desirable habitats).

Management emphasizes achieving desired habitats to accommodate the different waterfowl and shorebird species by maintaining a diversity of preferred habitats, including a high interspersion of vegetation and open water/mudflat, where applicable. Parkinson et al. (2006) found that some impoundment wetlands had experienced sufficient substrate erosion that, if reconnected, they would flood to a sufficient depth as to preclude revegetation. Possible loss of sediment during decades of impoundment needs to be considered in restoration planning. Within the wetland management program, emphasis is placed on multi-species use through water level management and by having diversified management objectives among impoundments. Gradually decreasing water depths in selected impoundments from winter to spring accommodates the needs of different water depth preferences among the wide range of migratory and resident waterfowl, shorebirds, wading birds, and diving birds. Many other species benefit from these conditions, such as feeding bald eagles, osprey, other raptors, alligators, reptiles, birds, and mammals. Therefore, a fish and wildlife guild is developed based on the habitat structure and quality. Having impoundments in varying habitat conditions from those in submerged aquatic vegetation management to those that are free-flowing and supporting dense emergent wetlands augments the diversity and availability of different habitats to these species. In managed systems, habitats are managed for featured species groups; however, the primary focus may change over time to allow the wetlands to rejuvenate. Thus, the wetland management program is dynamic and changes to meet the needs of multiple species, while achieving a high standard in habitat quality.

Approximately 16,000 of 22,000 impounded wetlands acres (~73 percent) would be managed with waterfowl as the primary focus during August through January. After January and the end of the waterfowl hunting season, impoundment management may shift towards meeting multi-species objectives, including meeting water depth preferences and habitat for migratory shorebirds and wading birds. Therefore, after January, there would be an additional 11,000 of the 16,000 acres (69 percent) that may be used for multi-species management. However, habitat management objectives would supersede wildlife population objectives in that water management may reflect the required need to manage wetlands to ensure that proper and/or healthy habitats are available in the future. Impoundments managed with a focus of waterfowl would also provide for food and cover habitat for multiple species, including rails, wading birds, shorebirds, and diving birds.

Figure 17 outlines the primary management focus of the refuge's impoundments. For additional information on specific impoundments, habitat management and habitat manipulation, please see Chapter IV of the Habitat Management Plan (Appendix F).

Figure 17. Impoundment management focus



2.a. Waterfowl

Objective 2.a(1): Maintain 15,000–16,000 acres within impounded wetlands with a primary management focus on waterfowl from August to January of each year.

Discussion: It is unlikely that sea level rise will impact the integrity of impoundment infrastructure during the 15-year lifespan of this CCP/EA. However, the refuge will continue to monitor the viability of maintaining impoundments for waterfowl, given the impacts of climate change.

Strategies:

- Continue to develop water level management capabilities to limit stress on waterfowl and shorebirds from uncontrolled water level changes due to fluctuations in lagoon water levels.
- Within 12 years of the approval of this plan, evaluate the featured species management of wetlands for waterfowl to accommodate multiple species, including the percentage use of wetlands by waterfowl, shorebirds, and wading birds. Evaluate the potential of individual impoundments to seasonally provide for multiple species groups.
- Encourage preferred emergent vegetation, including annual and perennial seed producing native species.
- Provide suitable habitat (water/salinity/vegetation) to accommodate annual foraging, sanctuary, molting, and other life history needs for a minimum of 25,000 dabbling ducks and 38,000 diving ducks (e.g., scaup and redheads).
- Consider changes to the refuge's Visitor Services Program to help sustain refuge's waterfowl population.

Objective 2.a(2): Continue to annually maintain and protect 50,000 acres of refuge estuarine habitat to support an average annual migration of 60,000 lesser scaup.

Discussion: Not usually thought of as primary waterfowl habitat, the Indian River Lagoon serves as one of the most important waterfowl habitat systems in the country, primarily for lesser scaup (Herring 2003). However it may also have been historically important to migratory populations of redhead (*Aythya americana*) and canvasback (*A. valisineria*) ducks. Presently, lesser scaup are the primary species using the lagoon in great numbers, which have been recorded in the hundreds of thousands in the open water habitat of the Indian River Lagoon.

Recent studies (Herring 2003) indicate that Merritt Island National Wildlife Refuge and the adjacent estuarine areas south to Vero Beach provide the most valuable wintering habitat for scaup in the Atlantic Flyway. However, surveys of scaup populations suggest that the species is declining. The refuge's survey in 2001 yielded 83,173 scaup in the lagoon, a value 26.6 percent below the 30-year mean for the region. However, Herring (2003) found that although the Indian River Lagoon appears to be providing good, wintering habitat, the birds may still be arriving back on the breeding grounds in poor condition. Although this suggests they are not fulfilling their nutritional requirements after leaving Florida in the spring, Herring (2003) also suggested that increasing boater disturbance to flocks rafting on open water could reduce their health and additional studies are needed to determine the overall impacts to wintering scaup populations.

Strategies:

- Protect scaup and their habitat from disturbance.
- Educate NASA and Cape Canaveral Air Force Station security staff to limit disturbance to scaup, especially from airboat use in the North Banana River.
- Educate the refuge's users on the value of the lagoon to scaup and why lower disturbance is needed to help maintain scaup populations.
- Encourage research to determine why scaup use certain areas over other areas with equally good habitat.
- Continue to work with the partners to address water quality issues in and around the refuge.
- Work with the partners to address disturbance issues on and adjacent to the refuge.

Objective 2.a(3): Support an average annual breeding population target of 250 pairs of mottled duck.

Discussion: Unique to peninsular Florida, the Florida mottled duck (*Anas fulvigula fulvigula*) is prized as a game bird and has an intrinsic aesthetic value. Changes in south Florida's landscape from agricultural to urban development raised concerns about the status of mottled duck. The refuge provides an important habitat base for mottled ducks in the rapidly developing east-central portion of the state. Management that emphasizes high-quality, dense upland nesting cover in close proximity to shallow, emergent aquatic habitat is recommended (Steve Rockwood, FWC, personal communication). Providing relatively large blocks of dense nesting habitat would help minimize depredation. Additionally, the close proximity of shallow, emergent aquatic habitat would enhance duckling and female survival. For additional information, please refer to the Chapter IV of the Habitat Management Plan (Appendix F).

2.b. Shorebirds

Objective 2.b(1): Annually maintain a minimum of 2,500 acres of impounded wetlands with a primary management focus on migratory shorebird habitat.

Discussion: Migratory shorebirds represent a very diverse group of waterbirds that range in size from the 5-inch-long least sandpiper (*Calidris minutilla*) to the 16-inch-long large marbled godwit (*Limosa fedoa*) that are relatively common migrants on the refuge. This group of birds is considered to be neotropical wetland migrants because they usually breed in the Arctic and northern Canada and migrate south across the states to the southern reaches of South America and back to the Arctic in one season. Increasing habitat changes and fragmentation along their migration routes have increased the need to provide protection and quality habitat in order for these species to secure their nutritional needs for long open-ocean migration. The refuge's coastal location and the importance of the managed wetland habitats could be linked directly to shorebird species, such as dunlin (*C. alpine*), greater and lesser yellowlegs (*Tringa melanoleuca* and *T. flavipes,* respectively), dowitchers (*Limnodromus* spp.), peep sandpipers (*Calidris* spp.), and plovers (*Charadrius* spp.*)* that use the refuge as a wintering or staging area. Recent studies have demonstrated the importance of the refuge to dunlins (Kelly 2000) and other shorebirds. Further studies are presently documenting the migration and use patterns of different waterbirds on the refuge (Collazo and Epstein, unpublished data). Understanding the migration patterns and food, habitat, and water depth requirements of these species—and incorporating these considerations into annual water level management plans—would be vital for development of multi-species management actions on the refuge. For additional information on shorebirds and wetland management, please see Chapter IV of the refuge's Habitat Management Plan (Appendix F).

Strategies:

- Within 12 years of the approval of this CCP/EA, evaluate each managed impoundment to determine the acres suitable for migratory, overwintering, and breeding shorebird habitat.
- Also within 12 years of the approval of this CCP/EA, determine seasonal water level conditions needed to accommodate each species group on the refuge.
- Develop integrated mosquito control and migratory bird management practices. Work with Brevard and Volusia mosquito control districts.
- Coordinate with national and regional shorebird management plans.

2.c. Wading Birds

Objective 2.c(1): Annually maintain a minimum of 1,500 acres of impounded wetlands with a primary management focus on wading bird habitat.

Discussion: The refuge has a rich diversity of long-legged wading birds that use refuge habitats for breeding, nesting, feeding, and roosting. Approximately 17 species of wading birds (*Ardeidae*) are commonly found, with some species very abundant [e.g., white ibis (*Eudocimus albus*), snowy egret (*Egretta thula),* and great egret (*Ardea alba)*] and/or others not so abundant, but which may have state or regional management concern designations, including the reddish egret (*Egretta rufescens*), roseate spoonbill (*Ajaia ajaja*), and the endangered wood stork (*Mycteria Americana*). The wetland management program for featured species includes consideration of providing preferred habitat, food, and resource availability for wading birds. Under this program, wading birds benefit as water levels drop from winter to spring. The drop in water levels concentrates fish for enhanced availability at times of the year linked with wintering and breeding. Stolen and Collazo (2004) found that impoundments can produce abundant fish populations and that impoundment habitats managed as a complex of wetlands under a variety of hydrologic conditions were highly beneficial to wading birds. The refuge also continues to work with the local mosquito control districts to improve management actions for wading birds. For additional information and strategies on wading bird and multi-species management, please see Chapter IV in the Habitat Management Plan (Appendix F).

2.d. Water Control Structures

Objective 2.d(1): Within 1 year of the approval of this CCP/EA, develop a standardized riser size and a tamper-proof design for all water control structures to be installed in refuge impoundments, as replacement or installation is necessary.

Discussion: The refuge's water control structures need to be capable of fully controlling water within and among the impoundments. At present, many of the water control structures allow uncontrolled flow of estuarine water into the impoundments, which disrupts water management and water quality objectives in impoundments with set seasonal water depth goals. Having water control structures that stabilize water level management capabilities to limit stress on habitat, waterfowl, and shorebirds during water level changes (e.g., changes in lagoon amplitude) is desirable. These water control structures would provide the means to stop, manage, or allow water to flow within and among impoundments, based on the stated focus of a particular impoundment. Development of improved water control structures is an ongoing process within the framework of the existing hydrology and management needs. For detailed design information about these structures, please see Chapter IV of the Habitat Management Plan (see Appendix F).

2.e. Neotropical Migratory Birds

Objective 2.e(1): Within 5 years of CCP/EA approval, initiate research to determine usage and habitat requirements of neotropical migratory birds on the refuge.

Discussion: Merritt Island Refuge has approximately 46,000 acres of upland habitats. The coastal physiography, including ridge and trough topography across the uplands, provides a mixture of dry and wet habitats. Much of the uplands are crisscrossed by wetlands and wetland potholes. Upland habitats include mature maritime forest (live oak) in both mesic and hydric hammocks, palm hammocks (hydric palmetto hammocks), pine flatwoods (mostly slash pine), beach, dune, back barrier coastal strand, and Florida scrub (wet and dry areas, with a coastal characteristic). Of the approximate 1,900 acres of citrus groves, about 800 acres are presently being phased out of management. The primary focus of management of upland habitats is for threatened and endangered species, with special attention give to the Florida scrub-jay. Prescribed fire and mechanical manipulation are the principle components used to manage upland habitats. Generally, uplands (which may include interspersed wetlands) are burned on a five- to eight-year rotation that provides a wide diversity of habitats. The Merritt Island Refuge's size and location along the central Atlantic coast makes it a potentially important site for neotropical migratory birds and may be more important to specific guild species (Hunter 1999). Special attention could be given to integrating neotropical migratory bird management into the current upland habitat management program that is geared primarily to recovery efforts for the Florida scrub-jay. The refuge lacks baseline information on neotropical migratory birds and associated habitats.

Strategies:

- Encourage educational institutions to carry out research projects that would determine migratory bird use in shrub lands, pine lands, and hammock areas of the refuge.
- Continue breeding bird surveys.
- Continue the use of volunteers to assist in bird monitoring programs.
- Develop baseline inventories and monitoring programs for neotropical migratory birds.
- Determine refuge management activities that could be integrated with on-going programs (e.g., for Florida scrub-jays) that would enhance habitats for neotropical birds.
- Promote understory growth for native species that produce fleshy fruit. In many cases, such as palmetto, the continued application of fire would encourage fruiting of these plants.
- Promote diversity of native species and community structure to provide appropriate food and cover. Prescribed fire could be useful in both altering vegetative structure and encouraging native plants.
- Monitor mesic hammocks to ensure their continued health and survival. In the past, sufficient regeneration has transpired in openings that have occurred from natural phenomena, such as wind throw, lightning strikes, or other mortality of the canopy trees. If this is not sufficient in the future, active management may become necessary.
- Protect habitats that are known to be important to migratory birds, such as coastal scrub and hardwood hammocks.
- Link refuge migratory bird conservation efforts to efforts and plans of the North Florida Ecosystem, as well as to regional and national efforts and management plans.
- Focus management considerations on Florida Priority Bird Species (Hunter 1999).
- Determine the role of Merritt Island Refuge to local conservation efforts.
- Develop partnerships and/or volunteer programs to survey birds on the refuge and on local, adjacent conservation lands.

- Develop and provide specific burn rotation prescriptions where necessary, recognizing the importance of maintaining hardwood hammocks and other areas with low frequency fire return intervals.
- Include considerations for cabbage palm removal in abandoned citrus groves for improved painted bunting habitat, in addition to providing corridors for other wildlife.
- Determine the role and importance of optimum scrub habitat for migratory land birds.
- Promote grassy-herbaceous ground cover in wetland swale/trough habitats for migratory species (e.g., wintering Henslow's sparrows).

2.f. Migratory Birds

Objective 2.f(1): Annually maintain about 300 acres of beach and dune habitat for migratory bird use.

Discussion: The coastal beach and dune system is exceedingly vulnerable and important to many species, including Wilson's and piping plovers (*Charadrius wilsonia* and *C. a. tenuirostris,* respectively) and colonial nesting shorebirds (Charadriiformes) (Millsap et al. 1990; Johnson and Barbour 1990). The Florida coastal zone is one of the most attractive areas for people to live and work. However, continued loss, modification, and disturbance of coastal habitats augment the necessity to protect and manage the refuge's beach and dune habitat. The refuge has conducted bird surveys on the beach in accordance with the International Shorebird Survey protocol. Data suggest there are summer (shorebirds, May–October) and winter (diving birds, October–April) components to bird guilds using the beach area. Wilson's plovers nest on the upper beach and dune system at the refuge from April through July (Epstein 1999)**.** The refuge recognizes the importance of the beach and dune habitats for multiple species, such as nesting sea turtles, the southeastern beach mouse, and migratory birds, and would adapt management plans to ensure the protection and management of this habitat. For additional information on habitat management of the refuge's beach and dune system, please refer to Chapter IV of the Habitat Management Plan (Appendix F).

Wildlife and Habitat Management Goal 3: Exotic, Invasive, and Nuisance Species
Control and eliminate, where feasible, exotic, invasive, and nuisance species on the refuge to maintain and enhance the biological integrity of the refuge's native coastal and estuarine habitats of east central Florida.

Discussion: The occurrence of exotic plants and animals on the refuge has been identified by staff and governmental partners as one of the most important management issues facing the refuge. Over 50 invasive exotic plants have been reported in and around refuge areas (Schmalzer et al. 2002) and 25 exotic plant species have been observed by refuge personnel on refuge lands (see Table 2). Exotic plants currently with the greatest known infestation levels on the refuge include Brazilian pepper, Australian pine, melalueca, Guinea grass, air potato, and cogongrass. Two exotic animal species are known to occur on refuge lands: feral hogs and feral house cats. Feral hogs occur in all refuge habitats and population levels are high. Feral cat population levels are low and they tend to occur in the vicinity of human developments on the refuge and on NASA controlled lands. Invasive species have negative impacts to natural plant diversity and to wildlife habitat. In addition, exotic animal species also cause direct mortality to native wildlife and complete with native wildlife for food resources. Exotic species could also have negative economic and public health and safety impacts. The infestation of exotic plants and feral hogs is extensive on the refuge and without control efforts the level of infestation is anticipated to continue to increase, resulting in even greater negative impacts to refuge habitats and wildlife populations. The constant threat also exists for new exotic species to colonize the refuge and for new exotic species to become established in Florida and on the refuge. It is important to constantly monitor the occurrence of exotic species on the refuge and to

be alert to new species in the state and in the vicinity of the refuge. A more complete discussion of exotic, invasive, and nuisance species and their management on the refuge is included in the Merritt Island National Wildlife Refuge Habitat Management Plan (Appendix F).

3.a. Exotic Plants

Objective 3.a(1): Within two years of CCP/EA approval, develop and annually thereafter maintain a refuge-wide baseline exotic plant database.

Discussion: The first step in managing invasive plants on the refuge is to complete an exotic plant database, including a GIS component, of all refuge lands. This database should identify the number of exotic/invasive plant species present on the refuge and the coverage and stocking level for each species. Every five years refuge lands should be re-surveyed to identify infestations of new exotic plants and to determine the coverage and stocking level for all exotic plant species in order to assess the effectiveness of control efforts and to re-direct ongoing control efforts as needed. The exotic plant GIS database should also be updated every five years in conjunction with re-survey efforts. After the initial exotic plant survey, an operational plan should be prepared identifying level of control efforts to be devoted to each exotic plant species, priority treatment areas, and other factors.

It is possible that the effects of global warming could increase the spread of some species of exotic plants. The most likely candidates for this increase would be *Melalueca* and Brazilian pepper. The periodic surveys described above will help establish baseline data on present infestation and should also help determine if rates of infestation are increasing.

The refuge currently receives no funding for exotic plant control. To date, all exotic plant control has been funded out of limited operations' monies and by grants received from the Florida Department of Environmental Protection. Exotic plant control would be enhanced through several actions: partner with NASA and Dynamac to provide GIS assistance, seek funding for contractors to do exotic plant surveys, seek funding for a Wildlife Biologist to oversee the exotic plant control program, seek funding to help support a GIS Specialist, continue to work in partnership with Canaveral National Seashore to coordinate control efforts and seek funding for exotic plant control, and continue to seek funding from Florida Department of Environmental Protection to hire contractors to control exotic plants.

Objective 3.a(2): Within five years of approval of this CCP/EA, eliminate all known Old World climbing fern, Australian pine, *Melalueca*, cogongrass, kudzu, bamboo, and eucalyptus from the refuge and annually maintain a level of no infestation of these seven species on the refuge.

Discussion: The level of infestation and biology of certain exotic plant species make it possible to eliminate these species from the refuge. These species include: Old World climbing fern, Australian pine, melalueca, cogongrass, kudzu, bamboo, and eucalyptus. The only exception to this is Australian pine around actively farmed citrus groves. These Australian pines would remain and not be treated until citrus farming ends and the groves are restored to native habitats. The exotic species identified would be considered eliminated when all known new plants and all re-growth from previous infestations could be killed each year. It is anticipated that this level of control could be attained within five years after plan approval. The key to elimination of these exotic species is annual surveys and control efforts. When available, the refuge should use biological control agents.

Objective 3.a(3): Integrate the exotic plant program into all refuge resource management programs to annually treat 30 percent of the refuge to control and, where feasible, eliminate exotic plants, including Brazilian pepper and Guinea grass.

Discussion: Several exotic plant species (such as Brazilian pepper and Guinea grass) would be extremely difficult to eliminate from the refuge due to their current high infestation levels, their extensive distribution, and their high propagation rates. Elimination of these species would also be extremely costly. For these species, the management strategy would be to apply as much control as possible to a specified portion of the refuge each year, concentrating on upland and wetland areas away from dikes, roads, and public use areas. To make control of these species within these areas as effective as possible, exotic plant control would also be incorporated into other refuge management activities, such as prescribed burning, scrub restoration, and water level management. Key to the effectiveness of these wide-area control efforts would be advances in biological controls of exotic plant species. Advances in biological control agents for exotic plants would be monitored and when biological control agents become effective and available, the refuge would pursue the introduction of these agents into refuge populations of exotic plants.

Each year one-third of the refuge would be identified for control efforts and funding and manpower would be concentrated in this area. Treatment areas would move each year so that on a three-year cycle the entire refuge would be covered. When possible and where feasible, efforts would be made to re-treat the previous year's treatments.

Objective 3.a(4): Annually spray along the perimeter of all dikes, firebreaks, public use roads, and other public use areas to treat these target areas for exotic plants.

Discussion: The areas along dikes, public use roads, fire breaks, and other public use areas (including parking lots, boat ramps, and viewing areas) are easily accessible. Exotic plants in these areas are easily treated with power sprayers and wick applicators and by mowing. These areas include approximately 200 miles of dikes and 150 miles of public use roads and fire breaks and total approximately 2,500 acres in area. If left untreated, exotic plants along dikes, roads, and fire breaks tend to move into new habitats through seed and propagule transport enhanced by mowing and maintenance activities. So it is extremely important to control exotic plants along these features. Also, control of exotic plants in public use areas and along public use roads helps provide a natural viewscape for refuge visitors. Exotic plants and control activities in public use areas provide the opportunity to interpret the negative impacts of exotic plants and the techniques and management activities used to control these plants.

In addition to chemical and mechanical treatments, the refuge would also control exotic plants on dikes by seeking partners to restore impoundments which are not needed for refuge management activities or for mosquito control. Impoundment restoration includes removing the dike and reconnecting the impounded wetland habitats to the estuary. This technique not only eliminates the exotic plants which grow on the dike, it could help control exotic plants in the wetland by increasing salinity and water levels, while also providing other habitat and wildlife benefits identified elsewhere in this plan.

3.b. Feral Hogs

Objective 3.b(1): Within two years of approval of this CCP/EA and for three consecutive years thereafter, annually remove a minimum of 4,000 feral hogs from refuge lands. After these three years, evaluate the estimated hog population and adjust the target take to continue to lower the feral hog population on the refuge.

Discussion: Feral hogs are one of the most abundant exotic animals of the refuge. Estimates of the feral hog population vary from 5,000 to 12,000. Feral hogs cause substantial damage to wildlife habitat and complete with native wildlife for food resources. Feral hogs also cause direct mortality to some species of native wildlife (e.g., feral hogs predated 38 sea turtle nests in 2003). In addition,

feral hogs cause damage to lawns, road shoulders, and other areas by their rooting activities. They are also a safety hazard being involved in numerous vehicle collisions each year. The goal is to reduce the feral hog population to the lowest level possible. Numerous research efforts have shown that it is very difficult and expensive to eliminate feral hogs from a large tract of good habitat. Refuge staff acknowledges that eliminating feral hogs from the refuge is probably not feasible.

Efforts to control feral hogs on the refuge began in 1972. From 1972 through 1995, volunteers were used to trap and capture feral hogs. From 1995 through 2004, three permitted hunters were used to remove feral hogs from the refuge. From 1995 through 2004 the use of traps was not required. In an attempt to increase the number of hogs removed from the refuge, the number of trappers and permit requirements regarding trapping were changed in 2004. The current system employs four permitted trappers and up to 50 assistant trappers. Trappers are selected by random drawing from a pool of applicants. Permits are valid for five years and are renewed annually subject to satisfactory performance by the trapper. Each trapper is required to operate a certain number of traps each month from October through April. Trappers are also allowed to capture hogs with the use of trail dogs. All hogs must be removed from the refuge alive and are considered property of the trapper when removed. Trappers must dispose of the hogs in accordance with the law. On occasion, refuge staff shoots hogs that pose an immediate problem due to safety concerns, property damage, or wildlife/habitat impacts.

Recently, trappers have removed approximately 2,500 hogs from the refuge each year. The refuge staff believes that the number of hogs removed from the refuge needs to be increased to about 4,000. In an attempt to do this, the changes outlined above were implemented in 2004. Refuge staff would monitor the number of hogs taken and work in cooperation with the trappers to attempt to increase the take to 4,000. After three years, the staff would evaluate the hog population and adjust the target take figure to a level which would keep the hog population at a low level.

Wildlife and Habitat Management Goal 4: Wildlife and Habitat Diversity
Protect, manage, and enhance the natural diversity of fish, wildlife, and habitats and the important landscapes of the refuge's coastal barrier island system to ensure that refuge fish and wildlife populations remain naturally self sustaining.

Discussion: The intrinsic landscape at the refuge is very diverse and ecologically supports many native and migratory species of animals and plant communities that are both aquatic and upland in nature. The diversity of habitats includes an oceanic, maritime interface that transitions to beach and dune communities. The barrier island topography includes extensive estuarine wetlands and lagoon systems and an upland landscape characterized by diverse vegetative communities that are largely fire maintained. Inherent within this system is a complex of aquatic resources, including an extensive fishery (e.g., fish nursery areas, sport fishes, and shellfish) that is highly influenced by water quality and public uses. The refuge supports colonial bird nesting and roosting areas, neotropical migratory birds, resident and wintering waterfowl, shorebirds, wading birds, and ten federally threatened and endangered species [two of which are considered statewide core populations (Florida scrub-jay and the southeastern beach mouse)].

Maintaining the natural integrity and biodiversity of the refuge includes having the professional staff with the knowledge and background of the ecology and management of these systems (e. g., fire and wetland ecology, fisheries and coastal zone management, and wetland and upland wildlife). Integrated within the managed forest, scrub, and wetland habitats is an effort to restore degraded habitats to natural-like systems. This includes citrus grove and scrub restoration, coastal wetland restoration, and exotic species control. The complexity of maintaining self-sustaining fish and wildlife populations would be reflected in the Service's ability to properly manage and maintain the biological integrity of refuge habitats.

The refuge overlays the Kennedy Space Center and is contiguous with Cape Canaveral Air Force Station. These installations are potential sources of contamination on the refuge with the rapid development of the space program and decades of farming (primarily citrus). Several Superfund sites have been identified at Cape Canaveral and zinc and PCB contamination is documented on refuge property. Biota samples collected on the refuge contained detectable levels of contaminants, including DDE, endosulfan sulfate, arsenic, cyanide, and zinc (Youngman 1998). Because of the surrounding and historical land use, the potential exists for trust resources on the refuge to be exposed to environmental contaminants through dietary ingestion and other means. The National Wildlife Refuge System Improvement Act mandates that the health and integrity of refuge lands be maintained. The refuge would continue to coordinate among all Service and NASA programs to develop baseline data to help identify existing and future threats. This information would provide needed baseline data for the refuge in fulfilling its requirements under the National Wildlife Refuge System Improvement Act of 1997.

For additional information, see Chapter IV in the Habitat Management Plan (Appendix F).

4.a. Natural and Spoil Islands

Objective 4.a(1): Within 5 years of approval of this CCP/EA, evaluate and characterize all spoil, altered natural, and natural marsh islands for restoration and management.

Many spoil islands were created with the dredging of the Atlantic Intracoastal Waterway and the Kennedy Space Center barge canals on the refuge have been documented to subsequently be important rookeries sites for colonial wading birds, shorebirds, and mottled ducks. Similarly, many natural marsh islands within the refuge's boundary are rookery sites for wading birds and/or shorebirds. Vegetative succession has advanced over many of the islands, which have become forested with mangrove, oaks, palmetto, and exotic species. Many of the forested islands are now used by colonial nesting birds as important breeding areas. However, on some of the spoil islands, advanced succession has made them unsuitable for ground and shoreline nesting birds. The refuge has identified some islands to clear and restore to sandy habitats for gulls, terns, plovers, and mottled ducks. When newly created, these spoil islands would provide bird habitat (Erwin et al. 1994; Erwin et al. 2003). The refuge remains open to using these sites for controlled dredge spoil deposition for habitat restoration. Some natural marsh islands that were historically drag-lined ditched for mosquito control have been identified for wetland restoration.

Strategies:

- Survey all islands to determine which serve as rookery sites, in need of protection.
- Consider a diversity of habitats to include providing nesting habitat for black skimmers, least terns, and mottled ducks.
- Determine how to protect islands from erosion and from issues associated with recreational use of the area (e.g., boat wake issues and wildlife disturbance).
- Provide for exotic species control on these islands.
- Where appropriate, reuse sand/shell material from islands scraped down to elevate other islands (i.e., consider using dredge material or unneeded material from other islands).

Objective 4.a(2): Within the 15-year life of the CCP/EA, restore to native vegetation seven altered natural islands in Mosquito Lagoon.

Objective 4.a(3): Within 10 years of approval of this CCP/EA, select, clear, and maintain three islands down to the sand/shell substrate within the Banana River for terns and other ground nesting birds.

Objective 4.a(4): Within 10 years of approval of this CCP/EA, select, clear, and maintain two to three islands down to grassy and herbaceous cover within the Banana River for mottled ducks and other grass nesting birds.

Objective 4.a(5): Within 5 years of approval of this CCP/EA, evaluate the options for shoreline stabilization of Tank and Mullethead islands to ensure continued existence of these important rookeries.

Objective 4.a(6): Establish buffers of 300 to 450 feet for nesting and roosting islands, including Bird, Little Bird (Preacher's), Pelican, Tank, and Mullethead islands.

4.b. Seagrass Beds

Objective 4.b(1): Work with the partners to maintain the current level of approximately 27,000 acres of seagrass beds on the refuge.

Discussion: The refuge includes approximately 76,500 acres of estuarine habitat. The open estuary waters include areas of the Banana River, Banana Creek, Mosquito Lagoon, and the Indian River Lagoon. In 1991, the lagoon became a part of the National Estuary Program. Collectively, all open water and wetlands of the refuge are part of the Indian River Lagoon system. The State of Florida designated the waters of the refuge as Outstanding Florida Waters. The refuge harbors over half of the wetland acreage and more than 40 percent of the seagrass coverage in the entire lagoon system. The system is designated as Essential Fish Habitat (Magnuson-Stevens Act) and a candidate site under consideration for designation as a Marine Protected Area. The Atlantic Intracoastal Waterway traverses the refuge through the Indian River Lagoon and Mosquito Lagoon.

Protection of primary seagrass habitat has an important, logical connection to the density of many fish and macro-faunal invertebrates using the refuge's estuarine waters. This primary fish habitat has an estimated fisheries economic impact of about $12,000 per acre per year (Virnstein and Morris 1996). Based on this estimate, the 28,000 acres of seagrass within the refuge's boundaries (based on 1999 mapping) would contribute over $300 million per year in fisheries resources. The seagrass communities are presently being mapped and monitored by the St. Johns River Water Management District and NASA. Any refuge effort to protect and restore seagrass habitat would be consistent with local, state, regional, and national goals.

Strategies:

- Within two years of approval of this CCP/EA, work with the partners and use existing plans (e.g., Walters et al. 2001 and St. Johns River Water Management District Surface Water Improvement and Management Plan) to develop and integrate a comprehensive environmental monitoring program for the Indian River Lagoon system within the refuge to ensure environmental health and biological integrity of estuarine fish and wildlife resources, populations, and habitats.
- Work with the partners to monitor water quality, especially related to petroleum.

- Work with partners to address water quality, especially offsite nonpoint source pollution sites.
- Evaluate ways to stabilize dike slopes to minimize associated runoff and erosion to limit turbidity in the estuarine waters to benefit seagrass beds.
- Monitor and prevent degradation of seagrass beds below existing estimated coverage by managing or denying uses that would further degrade the aquatic communities.
- Use an adaptive management approach to incorporating ongoing research and monitoring results into management options and decisions impacting seagrass beds.
- Consider additional research needs, including impacts of large quantities of drift macroalgae, their relationship to nutrients, suspended solid concentrations, and nitrogen, with site specific characteristics (e.g., high total phosphorous and nitrogen concentrations in Turnbull Creek).

Objective 4.b(2): Within the 15-year life of this CCP/EA, decrease prop scarring to levels at or below the Florida Fish and Wildlife Conservation Commission's established definition of light scarring where less than 5 percent of the seagrasses are scarred.

Discussion: The estuarine waters of the Mosquito Lagoon, the Indian River Lagoon, and Banana River are generally large, shallow basins that do not have a direct connection to the ocean. The closest oceanic inlets are Ponce Inlet (20 miles north) and Sebastian Inlet (40 miles south). Therefore, there is very little to no daily tidal amplitude in the generally shallow lagoon waters of the refuge. The lagoon waters are affected by seasonal tidal amplitude produced by the equinoxes (sun and moon gravitational affects that produce spring tides). There are two spring tides: one each spring and fall. The fall amplitude brings the highest water level conditions to the lagoon waters and refuge wetlands. However, wind speed and direction directly impacts daily amplitude. A strong southerly wind (e.g., southwest) pushes water north in the lagoon and increases water levels or river amplitude in the northern Indian River Lagoon and Banana River. At the same time, this could lower river amplitude in the Mosquito Lagoon as the water is pushed north. Salinity is largely a factor of seasonal rainfall.

Except for the Intracoastal Waterway, the lagoon waters are characteristically shallow flats (five feet or less) that support highly productive seagrass meadows. The refuge's seagrass beds are some of the highest quality in the entire Indian River Lagoon system, presumably due to the undeveloped nature of the landscape surrounding the Lagoon waters. Seagrass coverage within the refuge waters as mapped in 1999 was approximately 27,065 acres (Joe Beck, St. Johns River Water Management District, personal communication). Seagrass coverage for the major water bodies within the refuge's boundaries was Banana River (10,306 acres), Indian River Lagoon (5,279 acres), and Mosquito Lagoon (11,480 acres). Four species of seagrasses are common to the refuge, including: Shoal grass (*Halodule wrightii*), Manatee grass (*Syringodium filiforme*), Turtle grass *(Thalassia testudinum*), and Widgeon grass (*Ruppia maritima*). The seagrass meadows have remained largely unchanged over the past 55 years in refuge waters (Virnstein 1999), except that propeller scaring from outboard motors is widespread in the shallow waters of the Mosquito Lagoon. Water quality and clarity are critical components in the distribution patterns of the seagrass bed in the refuge. Any potential change in sea level rise could impact both water quality and clarity.

Strategies:

- Use the Florida Fish and Wildlife Conservation Commission's propeller-scaring evaluation system to determine existing and future impacts to seagrass communities. "Light scarring is defined as the presence of scars in less than 5 percent of the delineated polygon, moderate scarring as the presence of scars in 5 to 20 percent of the polygon, and severe scarring as the presence of scars in more than 20 percent of the polygon" (page 11, Sargent et al. 1995).

- Evaluate the implementation and effectiveness of the new Pole and Troll zones to limit impacts to seagrasses.
- Monitor and protect seagrass beds from further impacts by managing or eliminating adverse activities.
- Evaluate the human uses of estuarine systems to help management maintain biological integrity (e.g., water quality conditions, wildlife disturbance, and impacts to substrates and seagrasses).
- Identify shallow water areas where seagrass needs to be protected (e.g., from propeller scarring) and implement protection measures based on seagrass mapping, water depth, severity of disturbance, and agency recommendations.
- Develop zones of use for public use that are consistent with meeting multiple objectives of fisheries and aquatic resource management and protection.
- Use existing workshops and conferences to assist in identifying monitoring and research needs, combining common efforts, and sharing information and data.

4.c. Fisheries

Objective 4.c(1): Within five years of approval of this CCP/EA, develop an inventory of the baseline estuarine fisheries resources of the refuge and then every fifth year thereafter re-inventory to evaluate management actions necessary to maintain population levels.

Discussion: The Indian River Lagoon system is characterized by high biodiversity and productivity, and ranked as one of the most diverse systems in the world (Indian River Lagoon National Estuary Program 1996). Within the Lagoon waters of the refuge, 132 fish species have been identified (Paperno 2001). A keystone species of the Lagoon system, the horseshoe crab *(Limulus polyphemus*) generally inhabits estuarine systems and was very common in refuge waters. In recent years, researchers have noticed a decline in the numbers of horseshoe crabs (Jane Provancha and Gretchen Ehlinger, Dynamac, Inc., personal communication). The reason for the decline in horseshoe crabs is presently unknown. Horseshoe crabs influence species diversity and productivity in the lagoon and their eggs are a vital prey component of numerous species, including migrating shorebirds and many species of fish.

The refuge's open estuary and wetland habitats are used as stopover and wintering habitat for hundreds of thousands of migratory birds, many of which are dependent on fisheries for food. The open water estuary habitats are some of the most renowned sportfishing sites in the world (Roberts et al. 2001). As user demand for fishing increases with the popularity of the area, the refuge could expect to receive increased boating activity within the seagrass communities, impacting fisheries and the species which rely upon them. The Mosquito Lagoon wetlands, seagrass beds, open bottom, and channel habitats support a diverse biota which includes some of the most valuable regional recreational fisheries, including several interjurisdictional and economically important fishes. The species most sought by recreational and commercial sport anglers are the red drum (redfish), spotted seatrout, and black drum. Other species, such as common snook (*Centropomus undecimalis*), tarpon (*Megalops atlanticus*), and jacks (family Carangidae), are a smaller part of these fisheries, but are not as common, nor are they as locally valued as the previously mentioned species. The first three of these species belong to the same family, Sciaenidae (the drum-croaker family). This family is found in estuaries worldwide and has been prized as prime food fishes. They are well known as sound producers, yet primarily produce sound to call mates to spawn at night beginning as the sun sets. Each species produces a distinctive sound. This has allowed the spawning sites and period for each species in the Mosquito Lagoon to be determined based on underwater sound recordings. Sound intensity for each species is directly proportional to the number of eggs/larvae in the water column

following a spawning event. Effective spawning is extremely important for any aquatic species so that they can replenish local populations, which are constantly suffering natural mortalities due to predation, aging, and disease, as well as harvest by humans. After spawning, the larvae and early juvenile stages seek vital nursery grounds where they can avoid predation, yet obtain sufficient food to grow rapidly and mature. In the Mosquito Lagoon these nursery grounds are primarily seagrass meadows. Wetlands, deeper channels, and mouths of freshwater tributaries are also important. The importance of fish spawning areas has been described as analogous to bird rookery areas (Grant Gilmore, personal communication).

Increased regional human population growth and recreational and commercial use of refuge waters are coupled with the lack of knowledge of the resources and the proper management required to adequately sustain viable fish populations and other aquatic resources. Recreational and commercial harvests have increased and expanded in refuge waters to include fin fishes, mollusks, and crustaceans. Recreational and commercial boating activities have damaged seagrass beds (i.e., through prop dredging) and may also disrupt wildlife populations. However, appropriate and compatible boating activities are very manageable and the refuge could promote quality environmental and recreational conditions.

Strategies:

- Protect habitats and critical life history needs for native fish and wildlife populations.
- Continue to encourage monitoring and research of species that represent the native biological diversity of refuge waters.
- Encourage monitoring of any resources that may indicate serious ecological disturbance in the refuge lagoonal system, such as horseshoe crabs.
- Determine the requirements for self-sustaining red drum, spotted seatrout, and black drum fisheries populations.
- Coordinate with the Service's South Florida Fisheries Resource Office and the Florida Fish and Wildlife Conservation Commission to conduct creel surveys and other independent surveys to determine catch per unit effort and angler success on waters adjacent to the refuge.
- Encourage periodic monitoring of fish spawning and settlement sites.
- Evaluate fish larval survival dynamics within the different management basins of the Banana River restricted area, no motor zone, and open public water bodies.
- Ensure longevity of fish spawning sites and research needs.
- Encourage research on the impacts of large quantities of drift macroalgae, their relationship to nutrients, suspended solid concentrations, and nitrogen, with site specific characteristics (e.g., high total phosphorous and nitrogen concentrations in Turnbull Creek).
- Develop fish tagging programs, including sonic monitoring of movements within the refuge's lagoon system.
- Coordinate with the Service's South Florida Fisheries Resource Office on all aspects of fisheries management on waters adjacent to the refuge.

4.d. Estuarine Wetlands

Discussion: The refuge manages 90,917 acres in the estuary, wetlands, and impoundments. Managing NASA lands and waters at the Kennedy Space Center, which includes a national wildlife refuge and mosquito control activities, requires a highly coordinated effort. The majority of the estuarine wetlands of the refuge is now impounded as a result of the original mosquito control activities conducted between early-1950 and mid-1960. Additionally, many acres of marsh islands were modified by dragline ditching and draining for the purpose of mosquito control. Between 1963 and 1993, the refuge installed as many water control structures in the impoundments as budgets

would allow. In 1994, the refuge entered into a partnership with the Brevard Mosquito Control District and the St. Johns River Water Management District to reconnect the impoundments to the estuary by installing culverts through the dikes. The purpose of reconnecting the impoundments to the lagoon system was to enhance and restore hydrological connection. It also provided a limited means of managing water depths and vegetative community types. The refuge continues to evaluate the estuarine wetlands to provide best management practices and to find opportunities to restore modified systems to more natural-like marshes. For additional information on estuarine wetland management and restoration, see Chapter IV of the Habitat Management Plan.

Objective 4.d(1): Within the 15-year life of this CCP/EA, restore approximately 1,200 acres across 10 targeted impounded wetlands to mimic natural hydrologic function.

Discussion: Specific impoundments have been identified for restoration to natural-like conditions. For additional information and to review an outline of identified restoration sites, see Table 3 in the Habitat Management Plan (Appendix F).

Objective 4.d(2): Within the 15-year life of this CCP/EA, evaluate the potential to restore approximately 3,100 acres across 11 targeted impounded wetlands to mimic natural hydrologic function.

Discussion: Specific sites have been identified that need to be further evaluated for restoration to natural-like conditions (designated To Be Evaluated for Restoration). This may require additional coordination efforts with partners and/or further evaluation on impacts to refuge programs. For additional information and to review an outline of identified sites, see Table 3 in the Habitat Management Plan, Appendix F.

Objective 4.d(3): Within seven years of approval of this CCP/EA, re-evaluate management of all impounded wetlands to ensure that best management practices are being used among impoundment habitats.

Discussion: The refuge has elevated the importance and the value of having more natural-like habitats with very ambitious upland and wetland restoration and enhancement programs. Over 550 wetland acres have been completely restored since 1996. The wetland restoration program has coordinated closely with the Service's Division of Fisheries, local mosquito control districts, Kennedy Space Center and St. Johns River Water Management District to accomplish restoration projects. The purpose is to promote native plant and animal communities and less altered hydrological fluctuations by completely restoring certain impoundment wetlands, dragline-ditched wetlands, and other altered wetlands to a more natural-like or enhanced condition. Where restoration is not an option and where reconnection of impoundments is not necessary or needed to meet stated migratory bird or other refuge objectives, the refuge would provide consideration to the reconfiguration of impoundments, including restoring/reconnecting some portions, while maintaining some portions as managed systems. For additional information on fisheries management, please refer to Chapter IV of the Habitat Management Plan (Appendix F).

Strategies:

- Consider restoring impoundments to more natural-like wetlands and systems that are not actively managed for wildlife, while also ensuring that they do not become mosquito production issues.
- Consider using open marsh water management for controlling mosquitoes in impoundments and restored wetlands that may pose mosquito production issues that are in proximity (20 miles) to urban communities.

- Where full restoration is not an option, identify impoundments that could be managed with an open connection to the estuary to promote a more natural-like hydrological exchange.
- Continue to work with the St. Johns River Water Management District to identify appropriate restoration sites and alternative methods to increase hydrological exchange between marshes and the lagoon system.
- Within 10 years of the approval of this CCP/EA, inventory and characterize the invertebrate fauna in aquatic communities in 12 impoundments: three waterfowl impoundments, three rotational impoundment management (RIM) impoundments, three restored impoundments, and three open impoundments to further refine the restoration objectives.

Objective 4.d(4): Within the 15-year life of this CCP/EA, restore approximately 200 acres across six dredge impacted wetlands in Mosquito Lagoon to mimic natural-like hydrologic function and evaluate and identify an additional 100 acres of degraded ditched estuarine wetlands on other parts of the refuge that require restoration.

Discussion: Dragline-ditched wetlands include the natural marsh islands in the Mosquito Lagoon, including the ditched islands and interior wetlands previously identified by the refuge and Kennedy Space Center (National Aeronautics and Space Administration 2001) for mitigation. These include, but may not be limited to the islands west of V-3 and V-4 (e.g., Vann's Island), T-42, T-40 (i.e., Widgeon Bay and Cucumber islands), Banana Creek (C-20-C Island), and east Banana Creek's dredged wetlands.

4.e. Interior Wetlands

Objective 4.e(1): Within the 15-year life of this CCP/EA, evaluate and restore altered freshwater wetlands as integral parts of the landscape to mimic natural hydrologic function.

Discussion: In an effort to promote native plant and animal communities and less altered hydrological fluctuations, the refuge has identified potential freshwater wetlands that could be restored by filling historically ditched wetlands and returning other altered wetlands to a more natural-like or enhanced condition (National Aeronautics and Space Administration 2001). The interior wetlands are a key ecological feature of the refuge's landscape due to the coastal ridge and swale topographic and physical profile. The majority of these wetlands is not a part of wetland manipulations, but is managed passively within the confines of the upland blocks or the refuge burn units and integrated landscape features. Where hydrology has been altered and/or fire suppression has caused the wet swales to succeed to woody vegetation, mechanical manipulation or herbicides may be used for vegetation restoration. These wetlands would primarily be managed as part of the contiguous upland landscape. Where altered, efforts to restore natural features would be made to mimic natural conditions and functions. Sea level rise could alter the wetland characteristics and make them more brackish. Additional information on interior wetlands is located in Chapter IV of the Habitat Management Plan (Appendix F).

Strategies:

- Identify, enhance, and/or restore interior freshwater systems to a more natural-like system by filling ditches, reestablishing hydrological conditions, and restoring native plant communities in altered sites (e.g., citrus groves).
- Continue to work with Kennedy Space Center on planned restoration of freshwater systems on the refuge.

- Plug or fill ditches as necessary.
- Target overgrown swales in the scrub/shrub landscape for restoration to enhance scrub-jay habitat.

4.f. Upland Habitat Diversity

Objective 4.f(1): Within the 15-year life of this CCP/EA, determine the appropriate matrix of upland vegetative communities necessary to support native wildlife diversity.

Discussion: The uplands of Merritt Island National Wildlife Refuge have a wide variety of vegetation types, both native and exotic. Table 1 lists eleven distinct native vegetation types along with three nonnative species groups. The refuge's location on the central east coast of Florida (see Figure 1) contributes to this diversity, as does its subtropical climate. As one would expect, the wide range of upland habitats on the refuge support a great number of wildlife species. Included in this array are four federally listed species: the Florida scrub-jay (*Aphelocoma coerulescens*), the bald eagle (*Haliaeetus leucocephalus*), the eastern indigo snake (*Drymarchon couperi*), and the southeastern beach mouse (*Peromyscus polionotus niveiventris*). The uplands also support numerous other native species of birds, mammals, reptiles, and amphibians.

In order to maintain this diversity of plants and animals, active management is required. Although by necessity some management actions would be directed towards maintaining or improving habitat for a specific species, it is important to recognize where that particular patch of habitat exists in the overall landscape. The work done on one particular segment of refuge may well affect adjacent areas. For example, the filling of old drainage ditches when restoring citrus groves would change the amount of water reaching wetland areas. To make the situation even more complex, habitat management activities designed to enhance conditions for one species could sometimes make that particular area of the refuge less suitable for another species. One example concerns the trade offs between managing the scrubby flatwoods. On one hand, the removal of timber to create a shrubland habitat would increase the suitability of the area for the Florida scrub-jays. On the other hand, timber harvesting would reduce the amount of potential future bald eagle nest trees. One of the approaches to resolving this dilemma is to select a landscape that, in the past, has provided habitat for most, if not all, of the indigenous species on the refuge and direct management activities toward recreating this landscape scene. The refuge is fortunate in that aerial photography of Merritt Island from 1943 is available. These aerial photographs show how the landscape looked before the infrastructure and facilities developed to support Kennedy Space Center were constructed. It also gives management a view of how the vegetation was configured prior to excluding fire and planting citrus groves.

When analyzing these photographs, one finds that the refuge had much less forest present in the 1940s than present today. Hardwood hammocks have increased in size since the 1940s, and hardwoods have invaded the once grassy swales that are scattered throughout the upland areas. The pine component of the landscape has also increased. In many of the scrubby flatwoods areas, the pine stocking has increased from two to five stems per acre by ten or twenty fold. The imagery from the 1940s also shows that the shrubland areas were more open. Scrub oaks and palmetto stands were broken up by patches of sandy openings and herbaceous plants. These changes in the vegetation mix have most likely altered the suitability of habitat for many species. The reestablishment of the proportions of forests and shrublands that existed in the 1940s could help solve the conflict between eagle nesting strata and Florida scrub-jay habitat previously mentioned. Since sustainable populations of both species were present during that time period, it follows that by simulating that landscape, the refuge could continue to provide for both species in the future.

Another important component in maintaining the biological integrity of the refuge would be to ensure that fire is once again a viable ecological force. Although other factors are involved in the equation, the removal of fire from the landscape during the 1950s, 1960s, and 1970s was one of the more important management actions altering the landscape. The exclusion of fire not only contributed to the increase of forest cover, but also resulted in the closing in of the shrublands. In the absence of fire, many of the open areas within the shrublands disappeared, and the scrub oak and palmetto vegetation became tall and thick. Using prescribed fire would help open up the shrublands and reduce the extent and density of forests. Fire also increases diversity by creating a matrix of burned and unburned patches throughout the landscape. As burned vegetation grows back, a series of niches develops. By using fire periodically throughout the refuge uplands, the various serial stages could be provided in perpetuity.

Other means of altering the vegetation exist to create and maintain diversity in the uplands. Timber harvesting has been used successfully in the past. Mechanical treatment of overgrown scrub has also worked well. In addition, both the planting of scrub and the chemical treatment of woody vegetation in the upland swales show promise as management tools.

More detailed descriptions of these and other management options in the upland areas of the refuge are available in the refuge's Habitat Management Plan (Appendix F).

4.g. Herpetological Species

Objective 4.g(1): Within five years of approval of this CCP/EA and every third year afterwards, monitor a minimum of 5 percent of the refuge for changes in herpetological population dynamics.

Discussion: Terrestrial herps have been studied on the refuge since the 1970s. Long-term monitoring has provided considerable existing data on the biodiversity of herps on the refuge (Seigel and Seigel 2000) and would be invaluable to detect long-term changes in the refuge's herpetofauna. Reptiles and amphibians are a critical component of refuge ecosystems. The biomass of reptiles and amphibians (herps) may exceed that of all other vertebrates in aquatic and terrestrial systems (Seigel and Seigel 2000). The ecological distribution of herps on Merritt Island Refuge would be a function of available habitat, which mostly reflects wetland communities. However, several species are specific to and use terrestrial habitats and certainly are linked to the coastal ridge and trough topography on the refuge. Exotic herp species are becoming potential threats to the refuge. Presently on the refuge, the brown anole (*Anolis sagrei*) may be displacing native species (Campbell 2000; Campbell and Echternacht 2003). The Cuban frog (O*steopilus septentrionalis*), which consumes smaller species, has been positively identified on the refuge. Additional research and monitoring is being conducted on gopher tortoise distribution, fecundity, and on upper respiratory tract disease.

Strategies:

- Work with existing partners and researchers to identify a habitat-based protocol for monitoring 5 percent of the refuge every third year for changes in reptile and amphibian populations.
- Encourage studies to continue to document long-term terrestrial reptile and amphibian populations on the refuge.
- Determine the relationship of herp populations to habitat conditions and management.
- Encourage studies of the relationship of snakes, habitat, and scrub-jay populations.
- Develop a baseline inventory of the forested uplands of the refuge to determine their importance for herpetological species.

4.h. Citrus Groves

Discussion: Citrus groves were present on Merritt Island when NASA acquired the land for the Kennedy Space Center. When the refuge was created by agreement with NASA, the management of the groves was turned over to the refuge. Originally there were about 2,500 acres of groves. At first the owners of the groves at the time of acquisition were allowed to continue to farm them. In the 1970s the groves were bid out to commercial citrus interests and operated under contract. The government received a percentage of the gross grove receipts. In the middle 1980s abnormally cold winters resulted in severe damage to the groves in the north end of the refuge. These were taken out of production and planted to native oaks and pines. By 1989, only 1,500 acres of groves were in production. A severe freeze occurred on Christmas of that year. The damage to the trees from this freeze, along with unfavorable economic conditions, led to the termination of commercial citrus operations on the refuge by the middle 1990s. An additional 26 acres of fallow citrus groves were added when lands in the Turnbull area were acquired. The current locations of citrus groves are shown in Figure 18.

Fallow groves soon become overgrown with Brazilian pepper, exotic grasses, and cabbage palms. The refuge has, in the past, submitted projects to restore fallow groves to native habitat. In the meantime, to prevent the entire grove area from becoming stands of exotic plants, the refuge entered into a Memorandum of Understanding with the Kerr Center for Sustainable Agriculture, a nonprofit organization, to manage some of the citrus areas. Under this Memorandum of Understanding, the Kerr Center, which eventually became the Florida Research Center, manages 714 acres of citrus. The remaining 780 acres have been abandoned. The Florida Research Center's mission was to develop more environmentally benign methods for growing citrus which became the Sustainable Citrus Program. Reduced use of pesticides for insect and weed control, and alternative methods of fertilization have been used to reduce the amount of chemicals used in citrus care-taking. The refuge's current agreement with the Florida Research Center expires in 2008.

Eventually the refuge plans to eliminate citrus groves, but it is unlikely that this would be accomplished within the 15-year life of this CCP/EA. For this time period, there are four possibilities for the groves (Table 10). Restoration to native habitat is planned for 301 acres. Of this, 80 acres on fallow groves on sandy soils is programmed to be converted to scrub vegetation (Figure 19). The other 221 acres, which are on more moist soils, would be restored to mesic hardwood hammock (Figure 20). Some additional acreage may be partially restored and used as corridors to connect some of the sub-populations of scrub-jays on the refuge. The second possibility is to use the groves for new construction of NASA facilities, rather than allowing that development in more natural areas. NASA has been and would continue to be encouraged to build facilities in fallow groves. Recently, NASA planned to put an industrial park in a grove area. However, the partnership with the State of Florida on this is progressing slowly and, at the present time, it is unlikely to occur in the near future.

At best, the first two options would only account for approximately a third of the groves. It is possible that about 700 acres of the remaining acreage could continue to be farmed by either the Florida Research Center or some other entity. The overall refuge objective is to end citrus grove operations. However, if there is a demonstrated opportunity to use the groves for other programs such as alternative fuels, these options will be considered. The control of exotic vegetation in all fallow grove areas needs to be considered in the decision making process. More details concerning the options for citrus grove management is available in Chapter VI of the Habitat Management Plan (Appendix F).

Figure 18. Locations of citrus groves

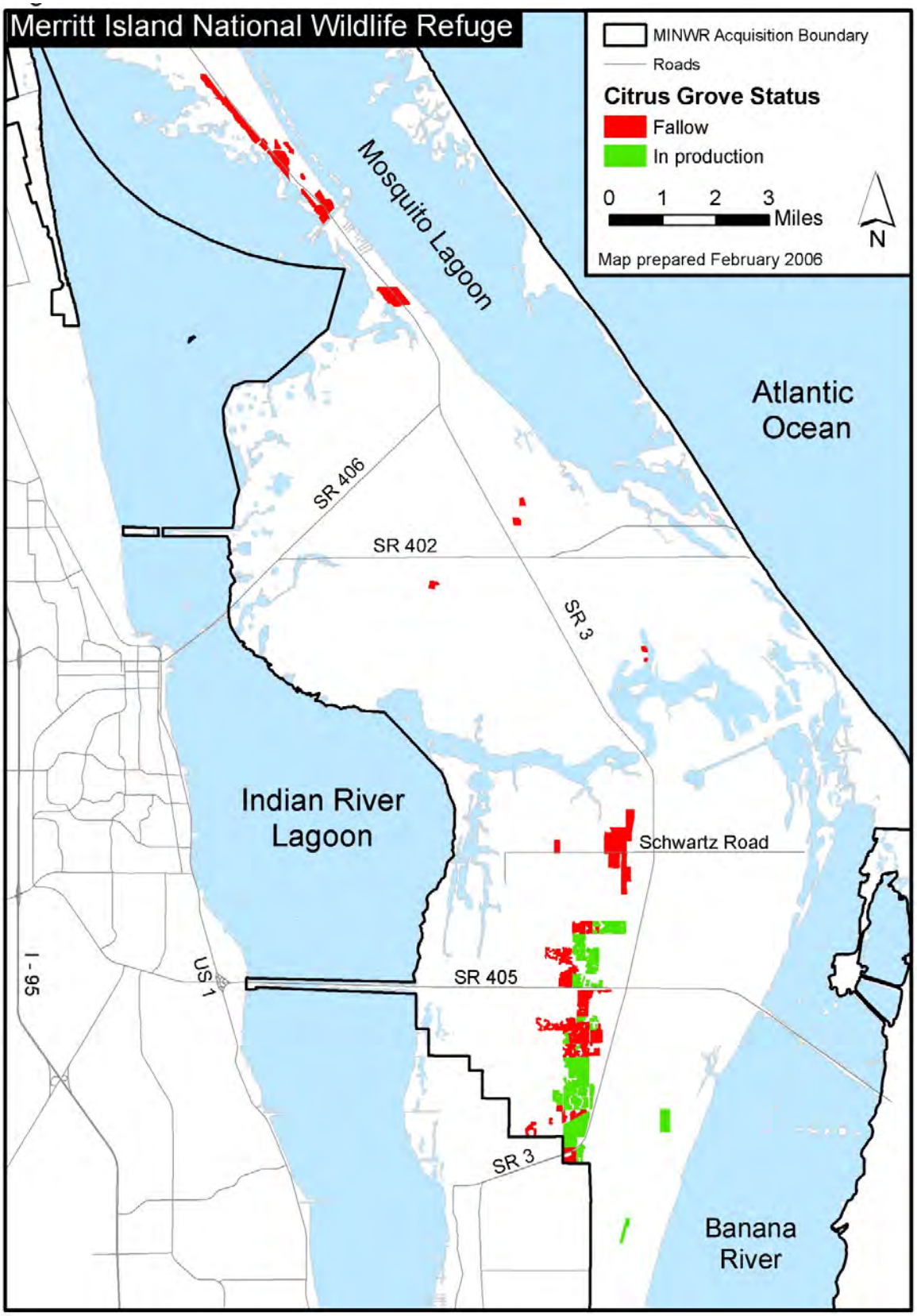


Figure 19. Fallow groves selected for restoration to Florida scrub-jay habitat

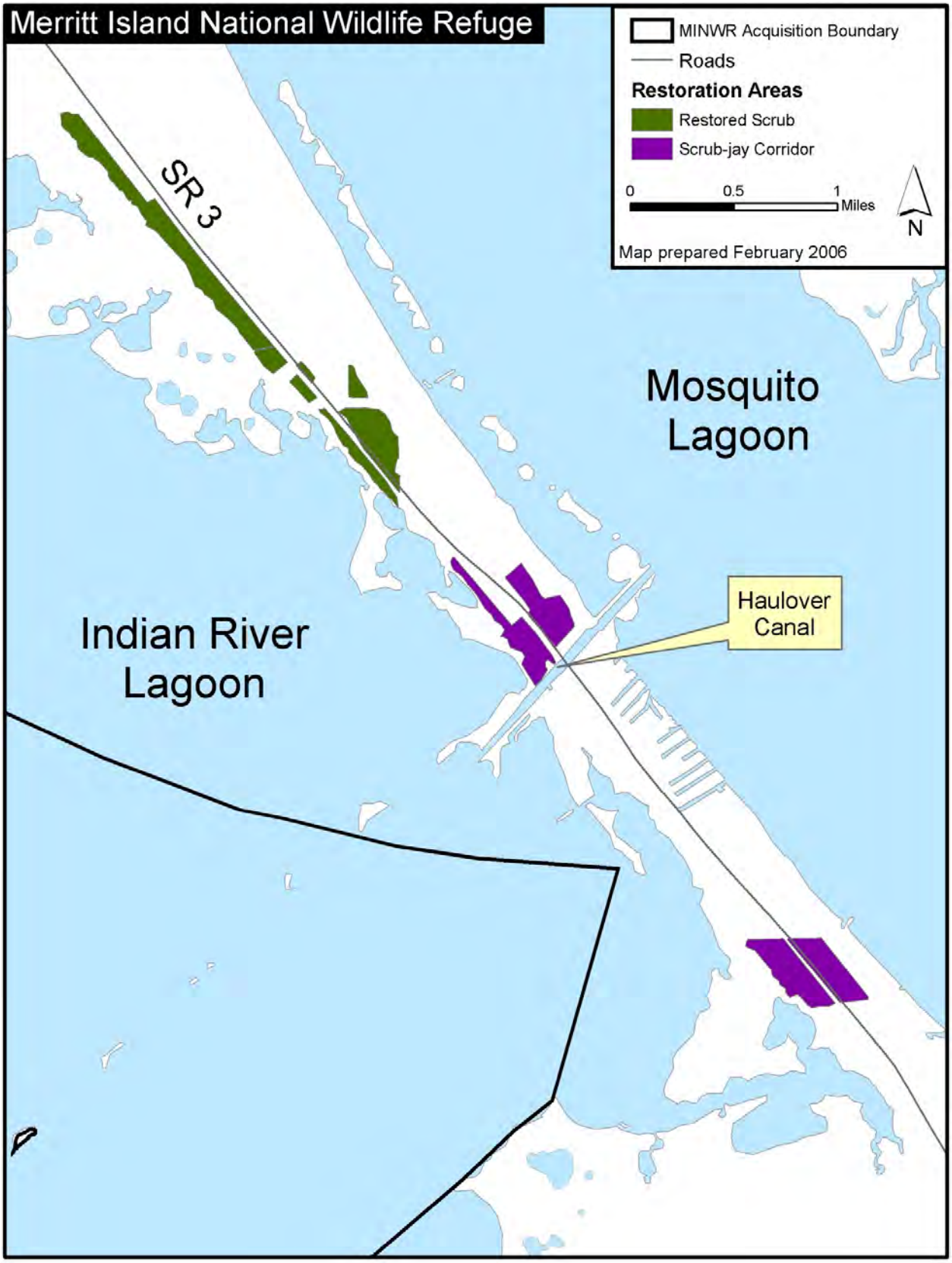
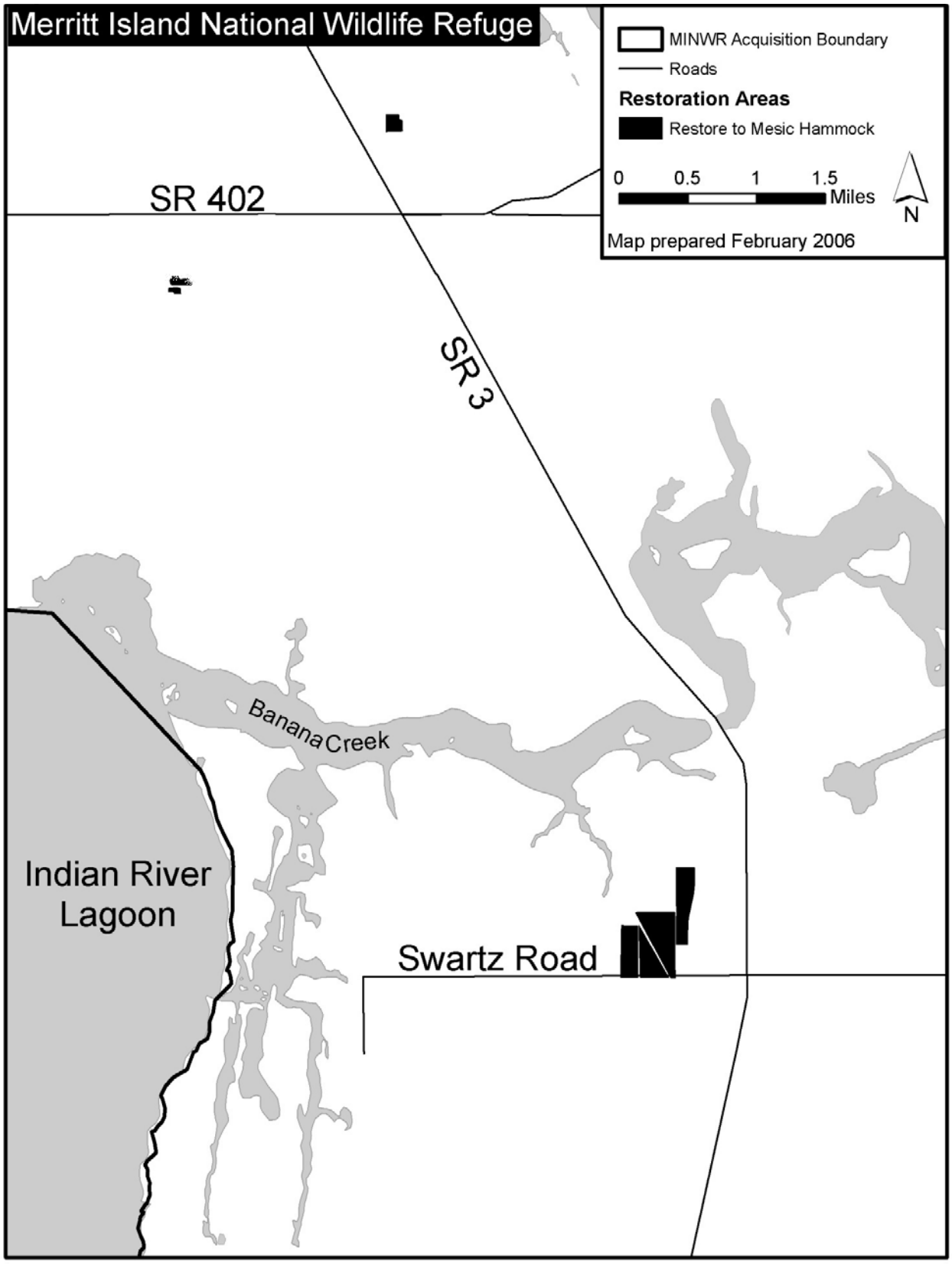


Figure 20. Fallow groves to be restored to mesic hammock



Objective 4.h(1): Before 2008, evaluate the role of approximately 1,100 acres of citrus groves on the refuge to determine which groves are targeted for future restoration to native habitat and which groves are targeted for development by NASA. In the interim, the refuge will continue to manage these groves to limit the presence of exotic, invasive, and nuisance species.

Objective 4.h(2): Within the 15-year life of this CCP/EA, restore 200 targeted acres of abandoned citrus groves to native habitat: 120 acres for Florida scrub-jay habitat on sand ridge sites and 80 acres for neotropical migratory birds in the more mesic areas.

Table 10. Present and future disposition of citrus groves

Group	Total Acres	Present Disposition		Future Disposition			
		Farmed	Fallow	Farmed	Restored	Return to NASA	Not Determined
1	231.9	199.5	32.4	**199.5**	**0.0**	**0.0**	**32.4**
2	285.0	262.2	22.8	**262.2**	**0.0**	**0.0**	**22.8**
3	313.4	29.0	284.4	**0.0**	**0.0**	**0.0**	**313.4**
4	369.4	223.6	145.8	**223.6**	**0.0**	**0.0**	**145.8**
5	526.0	0.0	529.0	**0.0**	**301.5**	**80.1**	**17.4**
TB*	26.3	0.0	26.3	**0.0**	**0.0**	**0.0**	**26.3**
AB**	178.9	0.0	178.9	**0.0**	**0.0**	**0.0**	**178.9**
Total	**1930.9**	**714.3**	**1219.6**	**685.3**	**301.5**	**80.1**	**737.0**

**TB = Turnbull Area*
*** Acres located in the MINWR Acquisition Boundary, but not yet managed by the refuge.*

4.i. Roadways

Objective 4.i(1): Minimize the loss of wildlife due to vehicular impacts.

Discussion: The refuge has several former state roads (i.e., routes 3, 402, and 406) that provide access to the area for the public, as well as for employees of Kennedy Space Center, Cape Canaveral Air Force Station, Canaveral National Seashore, and the refuge. With approximately 15,000 employees at the Space Center, traffic along these roads is substantial, particularly during shift changes. The refuge has observed that shift changes that occur during dusk and dawn hours could seriously impact wildlife. Road kills (e.g., river otters, raccoons, opossums, hogs, deer, armadillos, and various reptiles and birds) are common. Scrub-jays are especially vulnerable to vehicular collisions. This not only poses a threat to public safety and personal property, but it also greatly impacts refuge wildlife. Secondary impacts then occur from the abundance of road kills and carrion left on roadways, including vehicles striking animals that are feeding on carrion (e.g., bald eagles and vultures). Vulture population numbers (e.g., black and turkey vultures) at the Space Center appear to be excessively high and the road kill carrion may be supporting an abnormally large resident population. The vultures in turn cause damage to personal property, buildings, and equipment. Further, health concerns may exist related to excrement left at roost sites and on or around buildings and facilities used by vultures as roosting and loafing areas. The refuge would like to find ways to reduce road kills and reduce the adverse secondary impacts from the abundance of carrion on roadways.

Strategies:

- Develop an educational program for the Space Center and Cape Canaveral Air Force Station employees to increase awareness and understanding regarding the impacts of road kills (e.g., from speeding) to wildlife and to the Space Center.
- Close State Route 406 from State Route 402 to State Route 3 to all nighttime traffic.
- Develop and install appropriate warning signs in sensitive wildlife crossing areas.
- Work with the Space Center to reduce speed limits in sensitive wildlife crossing areas.
- Develop baseline data to measure mortality on refuge roadways that would complement existing information and document wildlife mortality.
- Seek additional ideas to assist in reducing road strike hazards.
- Evaluate habitat management activities adjacent to roadways (e.g., citrus groves).
- Work with the Florida Fish and Wildlife Conservation Commission to develop upland hunts to better manage a growing white-tailed deer population and to help control the feral hog population along State Route 3 north of Haulover Canal.

RESOURCE PROTECTION

Resource protection goals of the refuge address the existing acquisition boundary, a minor boundary expansion, and cultural resources.

Resource Protection Goal 1: Existing Acquisition Boundary
Acquire or obtain management authority for the east central Florida coastal and estuarine natural resources found within the refuge's existing acquisition boundary.

Discussion: Figures 11 and 12 provide the land status for the refuge, especially by identifying the remaining inholdings in the Turnbull Creek area.

1.a. Existing Acquisition Boundary

Objective 1.a(1): Throughout the life of this CCP/EA, work with the State of Florida, Brevard and Volusia counties, and other partners to complete acquisition of the ±1,480.59 acres of inholdings within the refuge boundary area known as Turnbull Creek.

Discussion: These inholdings are part of the refuge's approved acquisition boundary and are part of a multi-partner effort to protect these lands in perpetuity. The Service, Brevard County, Volusia County, and St. Johns River Water Management District have all purchased lands in and around the Turnbull Creek area.

Strategies:

- Prioritize the purchase of the Munson property (Volusia County parcel number 43-19-34-02-00-0031). Once acquired, convert it to a residence for a refuge law enforcement officer.
- Annually contact the owners of each inholding tract to verify the status and to express the Service's interest in acquiring these properties.
- Attempt to obtain a first right of refusal agreement on each tract.
- Encourage the tract owners to participate in the Partners for Wildlife Program.
- Work with the partners for the refuge to manage all properties acquired within the Turnbull Creek area.

Resource Protection Goal 2: Minor Boundary Expansions
Conduct minor boundary expansions of the refuge's acquisition boundary to restore former refuge lands, to include lands currently under management and/or service ownership, and to address proposed lease changes.

2.a. Bill's Hill

Objective 2.a(1): Work with Canaveral National Seashore to obtain management authority or fee title ownership to the Bill's Hill property.

Discussion: Although previously managed as part of the refuge, the Bill's Hill property (see Figure 21) was transferred by NASA in fee simple to the National Park Service as a site for a future visitor center, based on the language in the congressional legislation that established the Seashore. Bill's Hill is located half way between the north and south districts of the Seashore along U.S. Highway 1. Over time, the concept of a Seashore visitor center at this site has diminished. The property contains approximately 1,088 acres of scrubby flatwoods that are contiguous to the refuge's Habitat Management Unit 1 (see Chapter IV of the Habitat Management Plan, Appendix F). This acreage could be easily added into the management unit with specific habitat objectives. The National Park Service is currently conducting its own planning effort to update its General Management Plan. If it concludes that the property would not have a public use objective, then the property could be transferred to the refuge. This action would require a minor expansion to the refuge's currently approved acquisition boundary.

2.b. Lands Currently Under Refuge Management

Objective 2.b(1): Modify the existing refuge management boundary to reflect current agreements with NASA and the State of Florida and to include lands currently under refuge management.

Discussion: This objective is administrative in nature. As part of the refuge, the Service currently manages small pieces of property that are outside of the refuge's approved acquisition boundary. Often this is a result of a land acquisition, where the tract acquired includes property within and outside of the approved acquisition boundary.

2.c. Tank Island

Objective 2.c(1): Seek approval from the State of Florida to amend the existing lease agreement for Tank Island to include the water bottoms out 450 feet from shore to create a protective buffer for this productive rookery island.

Discussion: The refuge has a lease agreement with the State of Florida to manage a spoil island known locally as Tank Island (Figure 22). The lease is No. 4163 and was executed on March 10, 1999. Tank Island has been a historic rookery for multiple species of wading birds. Prior to 1999, human activity, such as camping and shore fishing, caused the birds to abandon the island. After it became part of the refuge and was closed to public access, the birds returned. The current lease agreement places refuge management jurisdiction at the mean high water line. A recent study by Rodgers and Schwikert (2002) indicates various set-back distances to prevent disturbance to the birds. The refuge should work with the State of Florida to develop an amendment to the lease to enable the refuge to enforce a closure zone out to 450 feet around the Island. This action would also require a minor expansion of the refuge's approved acquisition boundary.

Figure 21. Location of Bill's Hill tract

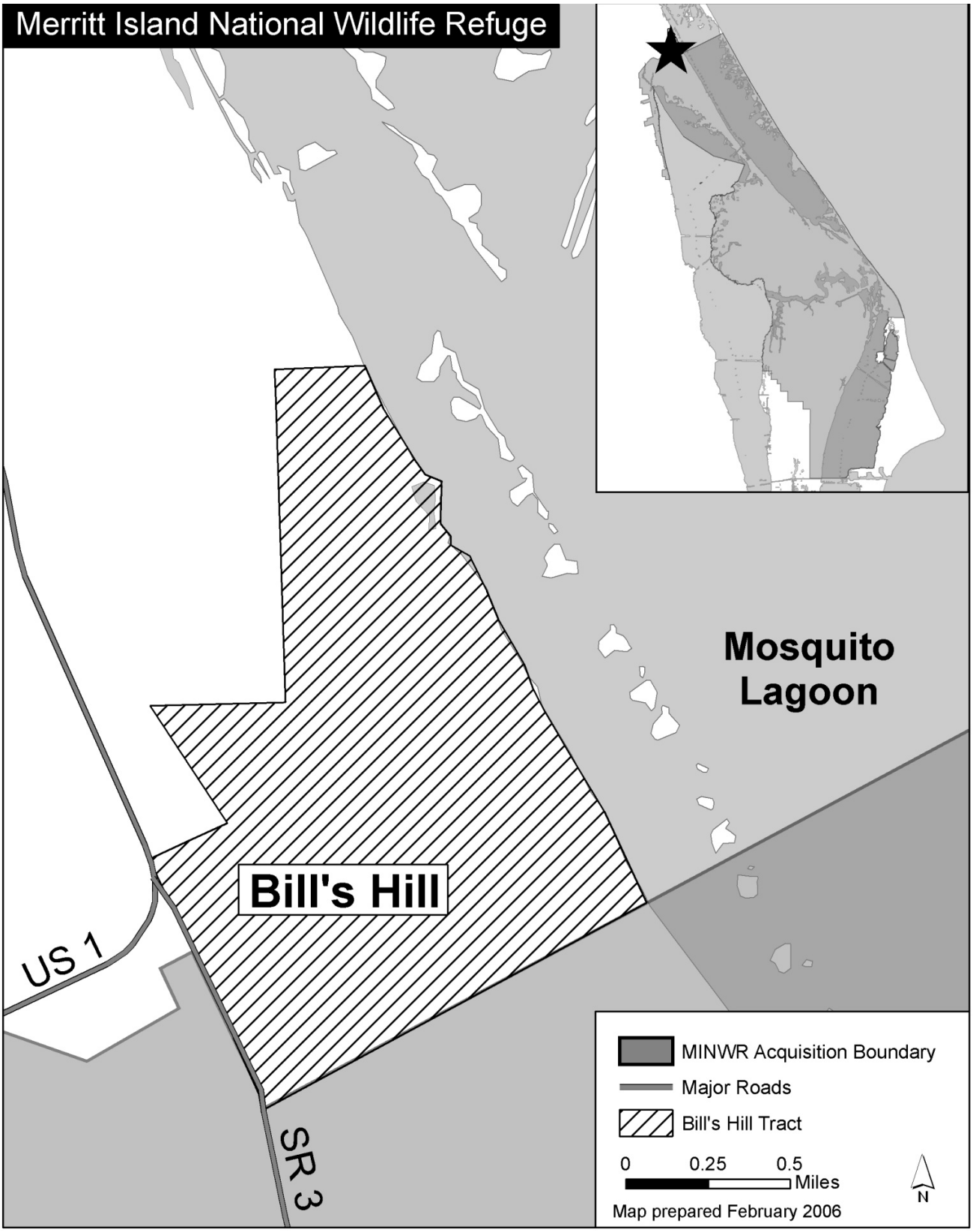
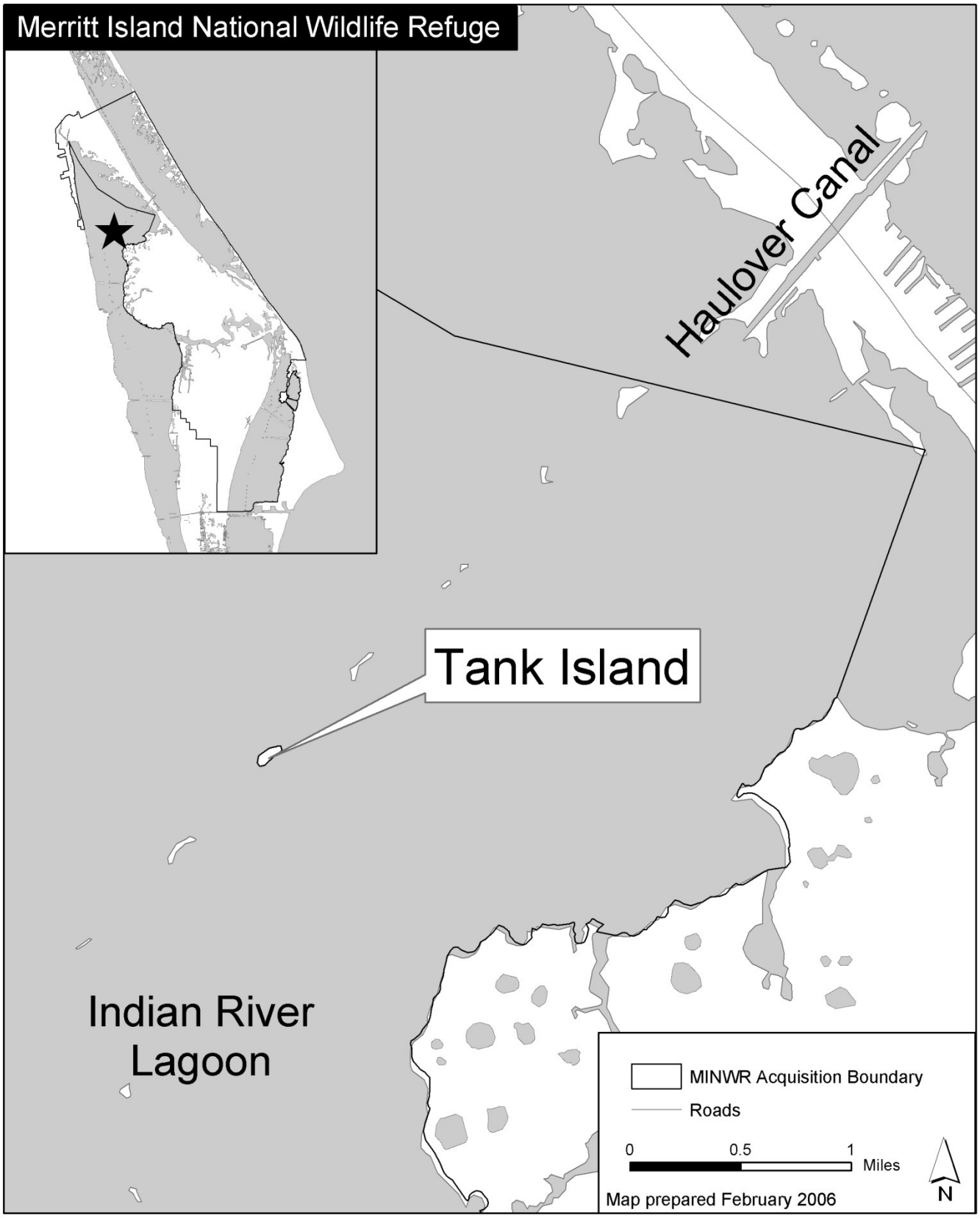


Figure 22. Location of Tank Island



Resource Protection Goal 3: Cultural Resources
Maintain and preserve in perpetuity the archaeological and historical resources of the refuge exemplifying the natural and cultural history of coastal Florida and the north Indian River Lagoon system dating from the archaic period to the present.

Discussion: Over much of the refuge, cultural resources are protected by the Kennedy Space Center, Canaveral National Seashore, and/or the refuge. Cultural resources on federal lands are protected under several acts and agency policy. Before any of the three agencies could commence new construction, an archaeological assessment must be completed. In the overlap area with Canaveral National Seashore, the National Park Service takes the lead in managing cultural resources and NASA takes the lead in the operational areas of Kennedy Space Center. Outside of these areas, the refuge is the lead agency for cultural resource protection.

The refuge would collaborate with the other agencies to review literature to document known and unknown cultural sites; consult with the Seminole and Miccosukee tribes when artifacts are discovered; consult with the State Historic Preservation Office, local historians, and the Regional Archaeologist when new sites are discovered or known sites are found disturbed; and add any new discoveries to the cultural resources' database. During patrols, law enforcement officers would routinely check known sites for damage or for signs of vandalism or disturbance.

Within the newly acquired refuge lands that fall outside the Kennedy Space Center, cultural resources are not as well documented. The refuge would conduct literature searches and would talk with the State Historic Preservation Office, local historians, and other agencies to document the location of known sites, adding any new discoveries to the database. Within the 15-year life of the plan, the refuge would seek funding to complete a cultural resources assessment on the acquired Turnbull Creek lands and make it a regular practice to visit these sites during routine law enforcement patrols.

3.a. Kennedy Space Center Overlay

Objective 3.a(1): Locate or relocate and protect all known cultural resource sites found within the refuge's overlay of Kennedy Space Center within five years of approval of this CCP/EA.

Discussion: Although several archaeological studies have been conducted by NASA and National Park Service on and around the refuge, several cultural resource sites have not been able to be relocated. The refuge would continue to work with NASA and the Park Service to protect known sites.

Strategies:

- Coordinate with the Regional Archaeologist.
- Coordinate with appropriate staff from Canaveral National Seashore and Kennedy Space Center.
- Coordinate with Seminole and Miccosukee Native American tribes, especially when artifacts are discovered or turned in to the refuge.
- Use key refuge staff members with detailed knowledge before they retire or leave the refuge.
- Develop a secured cultural resources' GIS database.
- Develop a protection program.
- Develop a regular patrol and enforcement program for the refuge's cultural resource sites within one year of plan approval.

3.b. Turnbull Creek Area

Objective 3.b(1): Within five years of approval of this CCP/EA, identify and protect any cultural resource sites in the refuge's Turnbull Creek area.

Discussion: Little is known about the cultural resources that may exist in the properties of the Turnbull Creek area. To date, the Service has not conducted any studies or assessments on these properties.

Strategies:

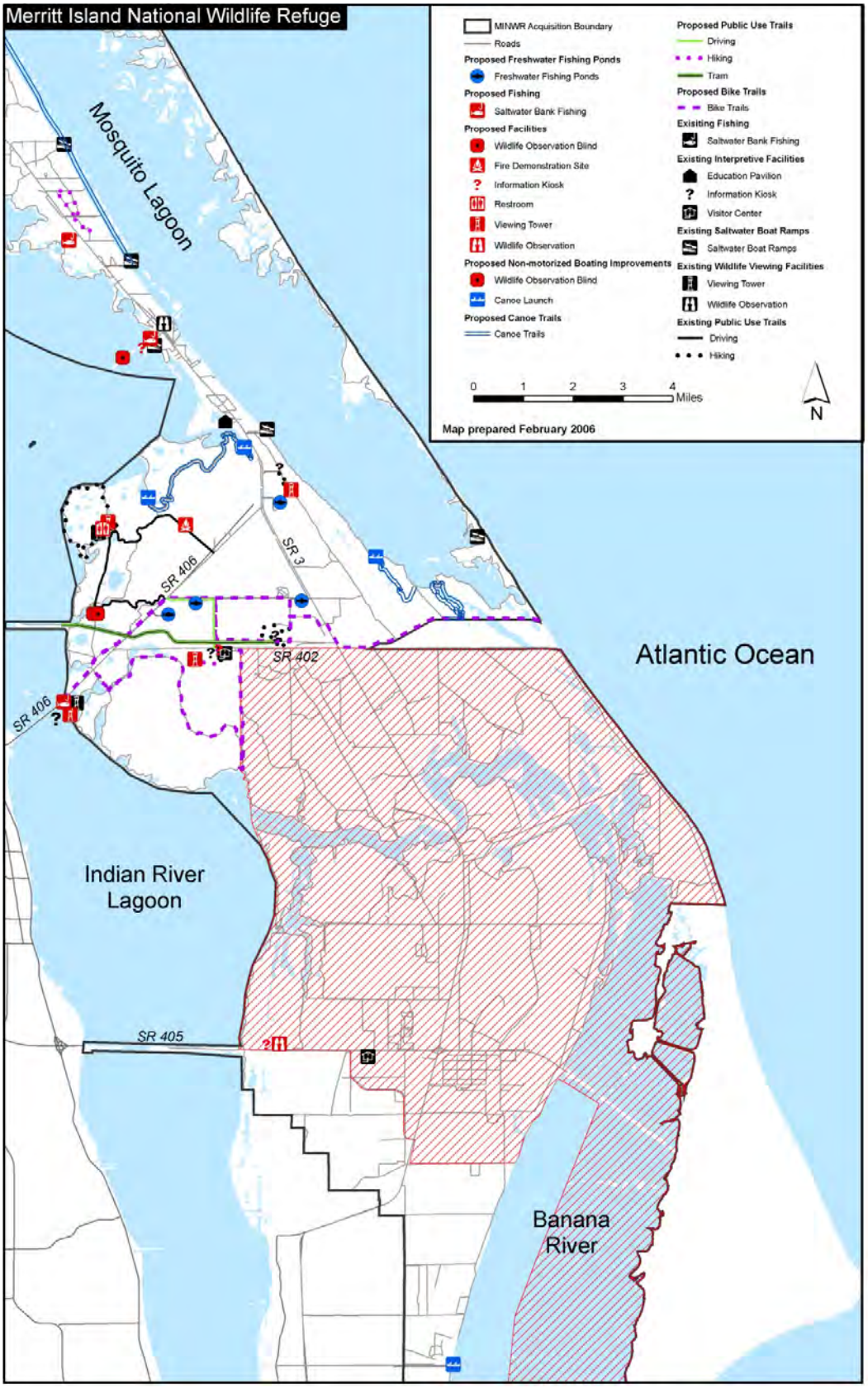
- Conduct literature reviews.
- Coordinate with the Regional Archaeologist.
- Coordinate with appropriate staff from Canaveral National Seashore, Kennedy Space Center, Brevard and Volusia counties, and Oak Hill.
- Coordinate with Seminole and Miccosukee Native American tribes, especially when artifacts are discovered or turned into the refuge.
- Consult with the State Historic Preservation Officer.
- Consult with the local historical society.
- Add any qualifying sites to the refuge's cultural resources' database and protection program.
- Develop a protection program.
- Develop a regular patrol and enforcement program for the refuge's cultural resource sites within one year of approval of this CCP/EA.

VISITOR SERVICES

The vision of the National Wildlife Refuge System includes a strong people component, where visitors find national wildlife refuges welcoming, safe, and accessible, with a variety of opportunities to enjoy and appreciate fish, wildlife, and plants. The National Wildlife Refuge System Improvement Act sets forth hunting, fishing, wildlife viewing, wildlife photography, and environmental education and interpretation as the priority public uses of the Refuge System. These wildlife-dependent uses are to be accommodated when and where appropriate and compatible with the purpose(s) of a refuge. The recreational activities occurring on the refuge, by policy, cannot materially interfere with or detract from the refuge's purposes. Compatibility determinations have been completed for all approved recreational activities and are found in Appendix E of this plan. To ensure a quality wildlife-dependent recreational experience while achieving a wildlife-first mandate, a high level of coordination must occur between the refuge's visitor programs and other management activities. Figure 23 shows the existing and proposed visitor facilities for Merritt Island National Wildlife Refuge.

A Visitor Services Plan has been developed and included as part of this comprehensive conservation plan. This section provides goals, objectives, and some discussion of the recreational activities and visitor services planned for the next 15 years. Readers looking for a more detailed discussion of these topics should refer to the Visitor Services Plan (Appendix G).

Figure 23. Existing and proposed visitor facilities



Visitor Services Goal 1: Welcome and Orient Visitors
Visitors will feel welcome and find accurate, timely, and appropriate orientation material and information on visitor facilities, programs, and management activities.

1.a. Information

Objective 1.a(1): Within two years of approval of this CCP/EA, at least 75 percent of sampled adult visitors who stop at the visitor center or entrance kiosks will find appropriate and sufficient information to guide themselves to refuge facilities as determined by regular sampling.

Objective 1.a(2): Within two years of approval of this CCP/EA, at least 75 percent of sampled adult visitors who stop at the visitor center will indicate, through regular sampling, that they received the information they needed and were treated in a courteous and friendly manner.

Objective 1.a(3): Within five years of approval of this CCP/EA, at least 25 percent of adult visitors who stop at Kennedy Space Center's visitor center will indicate through regular sampling that they received information about the refuge and could find refuge visitor facilities.

Visitor Services Goal 2: Provide Quality Hunting Opportunities
Hunters will enjoy quality hunting experiences that lead to support for refuge management.

2.a. Waterfowl Hunting

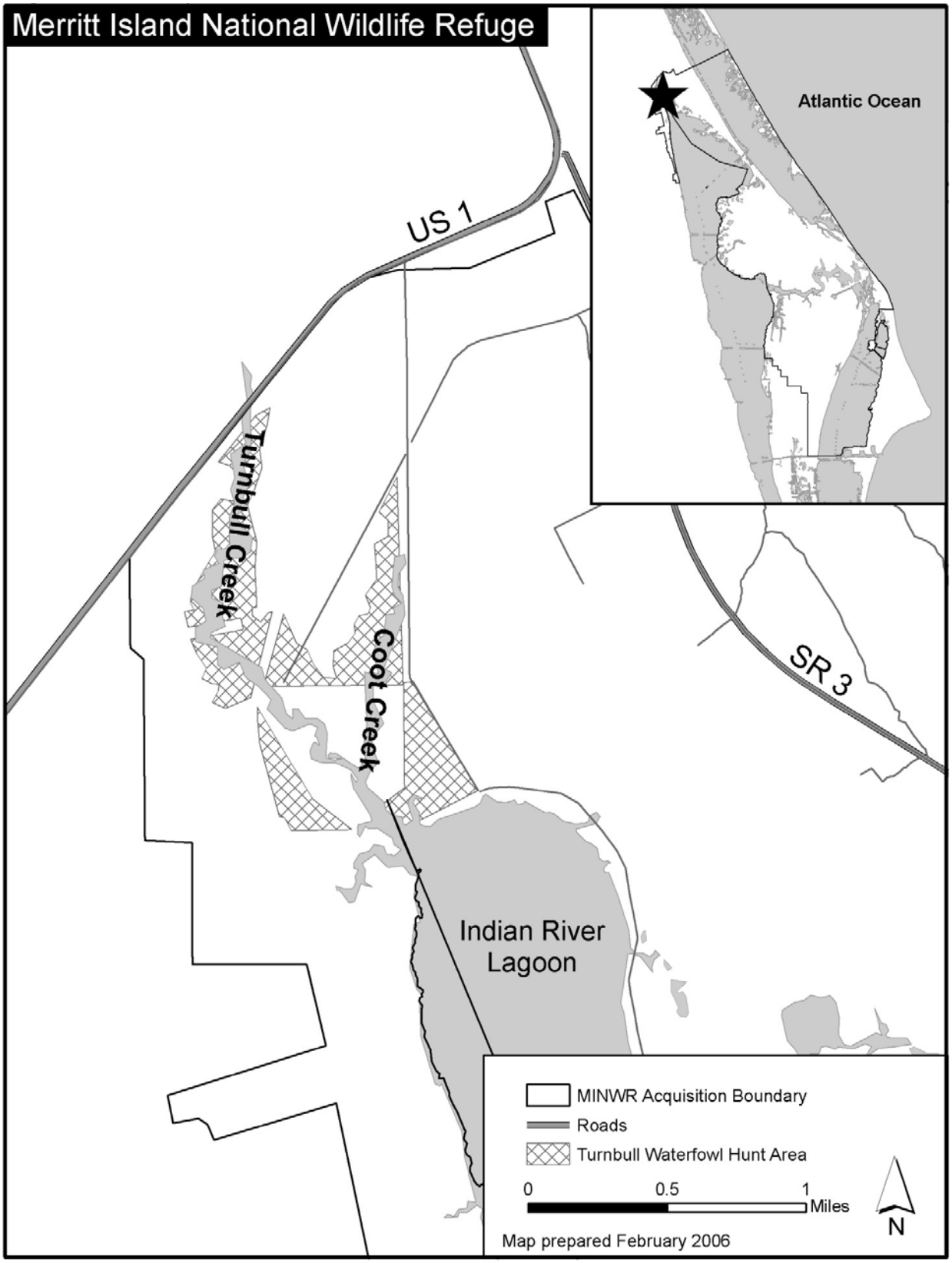
Discussion: As mandated by the National Wildlife Refuge System Improvement Act, hunting is identified as one of the six priority wildlife-dependent recreational uses on national wildlife refuges. Hunting must be appropriate and compatible with the refuge's purposes. To ensure a quality wildlife-dependent recreational experience while achieving a wildlife-first mandate, the number of individuals participating in the activity and conflicts among users may be limited by (1) establishing special regulations; (2) zoning and separating different uses; (3) permitting uses at certain times of the year; and (4) establishing quotas. Other situations exist where future refuge closures or restrictions may be warranted. Examples of these situations include, but are not limited to, protection of endangered species; protection of colonial bird nesting colonies or roost sites; establishment of sanctuary areas for waterfowl; closure of a hunt due to population declines; and safety of other visitors.

Waterfowl hunting is well established on the refuge, dating back to the early 1960s when the refuge was first established. Deer and feral hog hunts are a new proposed use, but are a management action to help control populations. Both animals are responsible for numerous traffic accidents and impact Space Center employees, especially individuals working the late shifts. In the case of hogs, the animal is feral and competes with native mammals, impacts habitats by uprooting vegetation, and may contribute to the spread of noxious exotic plants. This hunt would only be proposed for lands north of Haulover Canal. Alligator hunts would be evaluated, and if deemed necessary, may be used to control populations. The deer/hog and alligator hunts would be administered in cooperation with the Florida Fish and Wildlife Conservation Commission.

Figure 24 shows the refuge's proposed expanded waterfowl hunt areas.

Objective 2.a(1): At least 75 percent of the sampled waterfowl hunters who go through the waterfowl hunt check station annually will understand and support the refuge's wetland management and waterfowl hunting programs.

Figure 24. Proposed additions to waterfowl hunt areas



Objective 2.a(2): Through annual critiques of the waterfowl hunting program, improvements will be made where waterfowl hunters will have minimal conflicts with other visitors, experience no hunting-related safety incidents, experience hunter densities not exceeding one party per 40 acres, and regularly have the opportunity to see and harvest waterfowl.

2.b. Upland Game Hunting

Objective 2.b(1): Within two years of approval of this CCP/EA, the refuge will work with the Florida Fish and Wildlife Conservation Commission to develop a deer and feral hog hunt program.

Objective 2.b(2): At least 75 percent of the sampled upland game hunters who go through the upland hunt check station annually will understand and support the refuge's fire, forestry, and upland game hunting programs.

Objective 2.b(3): Annually, deer and feral hog hunters will have minimal conflicts with other visitors, will have no hunting-related safety incidents, will average hunter densities not exceeding one hunting party per 100 acres, and will have the opportunity to see and harvest deer and feral hogs. Figure 25 shows the refuge's proposed deer and feral hog hunt areas.

2.c. Alligator Hunting

Objective 2.c(1): Within the 15-year life of this CCP/EA, evaluate the feasibility of developing a limited alligator hunt program in cooperation with the Florida Fish and Wildlife Conservation Commission.

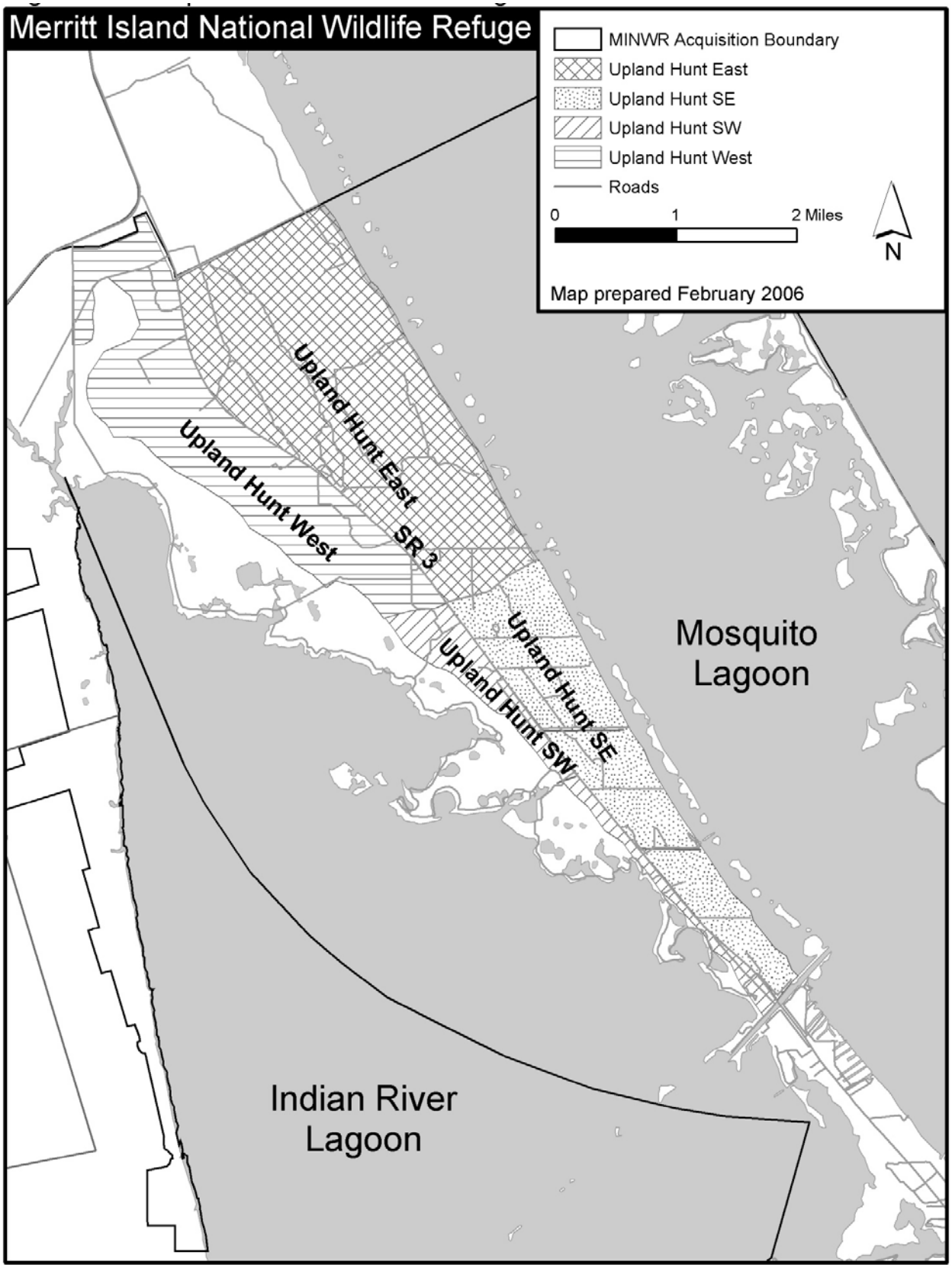
Discussion: Before alligator hunting could be approved for the refuge, a compatibility determination would need to be prepared. In addition, the effects of sea level rise and the possibility of salinity changes will be evaluated prior to establishing refuge alligator hunts.

Visitor Services Goal 3: Provide Quality Fishing Opportunities
Members of the fishing public will enjoy their fishing experiences, display ethical behavior, and support refuge management.

Discussion: Fishing is identified in the National Wildlife Refuge System Improvement Act as a priority recreational use and has been determined to be compatible (see Appendix E). To ensure a quality recreational experience and to meet the wildlife-first mandate, this activity is regulated through (1) establishing special regulations; (2) zoning different uses; (3) regulating boat speeds and equipment; and (4) establishing closed areas. Other restrictions or refuge closures may be warranted to protect endangered species, wintering waterfowl, and colonial bird nesting colonies or roost sites, including closing areas due to habitat impacts, overfishing, safety of visitors, and whether resources are available to administer the program.

Flats fishing is a use that has increased rapidly over the last 10 years due to the development of boats that can operate in shallow water and due to the population growth in central Florida. Flats fishing boats have caused impacts to the shallow water grass flats through prop scarring and the level of use has affected the quality of the fishing experience. Pole and Troll zones have been established in about 3,000 acres of the 20,000-acre Mosquito Lagoon as an adaptive management action to improve the quality of the fishing experience and to decrease habitat impacts. Regulations within the zones may be modified to achieve the desired results. The Pole and Troll zones have been met with widespread public support from the fishing and environmental communities. If this strategy proves successful, additional zones may be designated in other shallow water portions of the refuge.

Figure 25. Proposed deer and feral hog hunt areas



3.a. Estuary Flats Fishing

Objective 3.a(1): Within five years of approval of this CCP/EA, a quality flats fishing program will be developed that is supported by at least 75 percent of the regularly sampled fishing public, allowing users to see and harvest fish, and ensures that minimal conflicts occur between fishermen or with other users of the lagoon system.

3.b. Estuary Bank Fishing

Objective 3.b(1): Within five years of approval of this CCP/EA, bank fishing improvements will be made at three locations, which will allow users of all abilities to enjoy saltwater fishing on the refuge.

3.c. Freshwater Fishing

Objective 3.c(1): Within five years of approval of this CCP/EA, enter into a partnership to enhance freshwater fishing opportunities, improving four freshwater ponds that will allow members of the fishing public to harvest fish and minimize conflicts with other users.

Visitor Services Goal 4: Provide Quality Wildlife Observation and Photography Opportunities
Wildlife observers and photographers of all abilities will enjoy and value the diversity of refuge wildlife and will support efforts to maintain high-quality wildlife habitat.

4.a. Wildlife Viewing Improvements

Objective 4.a(1): To improve wildlife viewing on Black Point Wildlife Drive, within three years of approval of this CCP/EA, develop and maintain two 10-person wildlife viewing observation blinds with two spotting scopes and create needed vegetative buffers.

Objective 4.a(2): To improve accessibility, within 10 years of approval of this CCP/EA, develop and maintain Americans with Disabilities Act-approved restrooms and a viewing tower on Black Point Wildlife Drive.

4.b. Other Viewing Enhancements

Objective 4.b(1): To enhance wildlife viewing and photography opportunities, by 2014, three new trails will be developed and one trail expanded, including: a connecting road between the visitor center and Black Point Wildlife Drive, Pine Flatwoods Trail, Huntington Road Trail, and an extension to the Visitor Center Trail.

4.c. Nonmotorized Boating Improvements for Wildlife Viewing

Objective 4.c(1): Within five years of approval of this CCP/EA, wildlife viewing and fishing access will be enhanced by developing canoe/kayak trails or launch sites in ten locations.

Objective 4.c(2): Within five years of approval of this CCP/EA, enhance wildlife viewing of a wading bird rookery through the development of a viewing complex that includes a kiosk and canoe/kayak launch facility on the northwest corner of Haulover Canal and a dock and observation blind near Mullet Head Island.

Objective 4.c(3): Within five years of approval of this CCP/EA, the refuge will work with Canaveral National Seashore to connect refuge and Seashore canoe trails.

Visitor Services Goal 5: Environmental Education
Provide quality, appropriate, and compatible wildlife-dependent environmental education opportunities to promote understanding and awareness of the value of the refuge, its natural resources, and the human influences on ecosystems.

5.a. Environmental Education

Objective 5.a(1): Within two years of approval of this CCP/EA, provide two teacher workshops per year for north Brevard County teachers to acquaint them with refuge environmental educational curriculums.

Objective 5.a(2): Within two years of approval of this CCP/EA, recruit and train 5-10 volunteers to independently assist teachers in conducting the environmental education programs.

Objective 5.a(3): Within five years of approval of this CCP/EA, at least 30 percent of north Brevard grades 4-9 will participate in curriculum-based environmental education programs that focus on the importance of habitat diversity. The impacts of sea level rise and global warming will be part of the curriculum.

Objective 5.a(4): Within five years of approval of this CCP/EA, develop four curriculum-based environmental education programs that are geared to four habitats of the refuge: lagoon waters, wetlands, scrub, and pine flatwoods.

Visitor Services Goal 6: Interpretation – Interpret Key Resources
Visitors of all abilities will enjoy their visits and increase their knowledge, understanding, and support for the refuge and the National Wildlife Refuge System.

6.a. Visitor Center

Objective 6.a(1): Within five years of approval of this CCP/EA, at least 75 percent of adult visitors regularly sampled at the visitor center will be able to identify that they are visiting a national wildlife refuge, where wildlife comes first.

6.b. Interpretive Programs

Objective 6.b(1): Within five years of approval of this CCP/EA, increase the number of interpretive programs by 25 percent over 2005 levels.

Objective 6.b(2): After attending a program, at least 75 percent of adult visitors sampled will be able to successfully identify one wildlife management technique used by the refuge or identify the connection between managing habitat and wildlife populations.

6.c. Interpretive Trails

Objective 6.c(1): Within five years of approval of this CCP/EA, at least 75 percent of adult visitors sampled at Black Point Wildlife Drive will be able to successfully identify water level management as a positive factor in managing for migratory birds.

Objective 6.c(2): Within five years of approval of this CCP/EA, at least 75 percent of adult visitors sampled at Black Point Wildlife Drive, Scrub Ridge Trail, or Pine Flatwoods Trail will be able to successfully identify the positive wildlife and habitat values of prescribed burning in the coastal ecosystem.

6.d. Manatee Observation Deck

Objective 6.d(1): Within five years of approval of this CCP/EA, at least 75 percent of adult visitors regularly sampled at the Manatee Observation Deck will be able to successfully identify the positive benefits and importance of manatee protection.

6.e. Guided Interpretive Tours

Objective 6.e(1): Within 10 years of approval of this CCP/EA, increase interpretive opportunities by providing a guided tour using an alternative transportation system, such as a tram or train.

6.f. Kennedy Space Center Visitor Complex

Objective 6.f(1): Within five years of approval of this CCP/EA, at least 75 percent of sampled adult visitors who have taken the NASA's Kennedy Space Center bus tour will be able to identify Merritt Island National Wildlife Refuge as part of the National Wildlife Refuge System, where wildlife comes first.

Visitor Services Goal 7: Recreation

All public use activities will be appropriate and compatible and visitors will support priority public use activities that minimize wildlife and habitat disturbance.

Discussion: The National Wildlife Refuge System Improvement Act identifies six specific high priority wildlife-dependent recreation uses. They are hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation. Fundamental to the provisions of these uses are viable and diverse fish and wildlife populations and the habitats upon which they depend. These priority uses, along with all other uses, must be appropriate and compatible with the refuge purposes and the mission of the National Wildlife Refuge System.

To ensure a quality wildlife-dependent recreational experience while achieving a wildlife-first mandate, the number of refuge uses is limited and certain actions are taken to limit conflicts between users by (1) zoning activities; (2) designating trails, dikes roads, structures, and sites for specific recreation activities; (3) establishing closed areas to provide wildlife sanctuaries; (4) establishing special regulations; (5) minimizing conflicts with other management or visitor programs; and (6) controlling or prohibiting certain recreational activities that disturb wildlife. Several current uses would be affected with the implementation of this plan.

Jogging does not meet the definition of a wildlife-dependent recreation activity and would be eliminated as an approved activity. Bicycle riding on refuge walking trails presents a safety concern for other trail users and would be eliminated. Bicycle riding would be restricted to established roads where it does not present a safety concern to bicyclists or motorists. The refuge would work with partners to establish three bicycle trails for wildlife viewing where safety issues could be reduced and wildlife impacts eliminated. When one or more of these bicycle trails are established, bicycle riding on Black Point Wildlife Drive would be eliminated.

Other uses would be studied and adaptive strategies developed to deal with activities that cause wildlife disturbance, such as activities or vehicles that generate loud noises and disturb wildlife. The area of greatest concern is on Black Point Wildlife Drive, where the potential for visitors versus wildlife conflicts are greatest. Strategies such as developing "stay in your vehicle zones," developing new signs that stress proper wildlife viewing etiquette, establishing vegetative screens, and developing other strategies to reduce the potential for wildlife disturbance may be implemented. These and other adaptive strategies may be used at other locations if wildlife conflicts arise.

7.a. Ethical Wildlife Viewing - Delivering the Message and Correcting Problems

Objective 7.a(1): Over the life of this CCP/EA, the visitor center will provide current information related to appropriate and compatible recreational activities and will help visitors understand that their behavior can reduce wildlife disturbance.

Objective 7.a(2): Within two years of approval of this CCP/EA, work a wildlife viewing etiquette message into the interpretive materials for Black Point Wildlife Drive.

Objective 7.a(3): Within two years of approval of this CCP/EA and periodically thereafter, develop signs and update brochures to inform the public of wildlife disturbances and prohibited activities.

Objective 7.a(4): Within five years of approval of this CCP/EA, evaluate the wildlife impacts of the most common recreational activities occurring on Black Point Wildlife Drive and make modifications to reduce or eliminate the disturbances.

Objective 7.a(5): Within seven years of approval of this CCP/EA, at least 50 percent of sampled visitors on Black Point Wildlife Drive will display ethical wildlife viewing behavior, as determined through observational surveys.

Objective 7.a(6): Within seven years of approval of this CCP/EA, wildlife/visitor and visitor/visitor conflicts on Black Point Wildlife Drive will be reduced by 50 percent from 2006 levels, as determined through observational surveys.

Objective 7.a(7): Within 10 years of approval of this CCP/EA, develop three bicycle trails and make other facility improvements to move bicycle riders into appropriate areas where wildlife disturbance and visitor impacts will be reduced.

Objective 7.a(8): With CCP/EA approval, eliminate jogging.

7.b. Establishing Visitor Zones

Objective 7.b(1): With CCP/EA approval, two visitor use zones will be established to concentrate the most intensive visitor use activities and facilities within an identified primary zone and disperse other less intense uses in a secondary zone. Figure 26 shows the proposed public use zones.

Visitor Services Goal 8: Communicate Key Issues with Offsite Audiences
Kennedy Space Center workers and local residents will recognize the refuge and support its purposes.

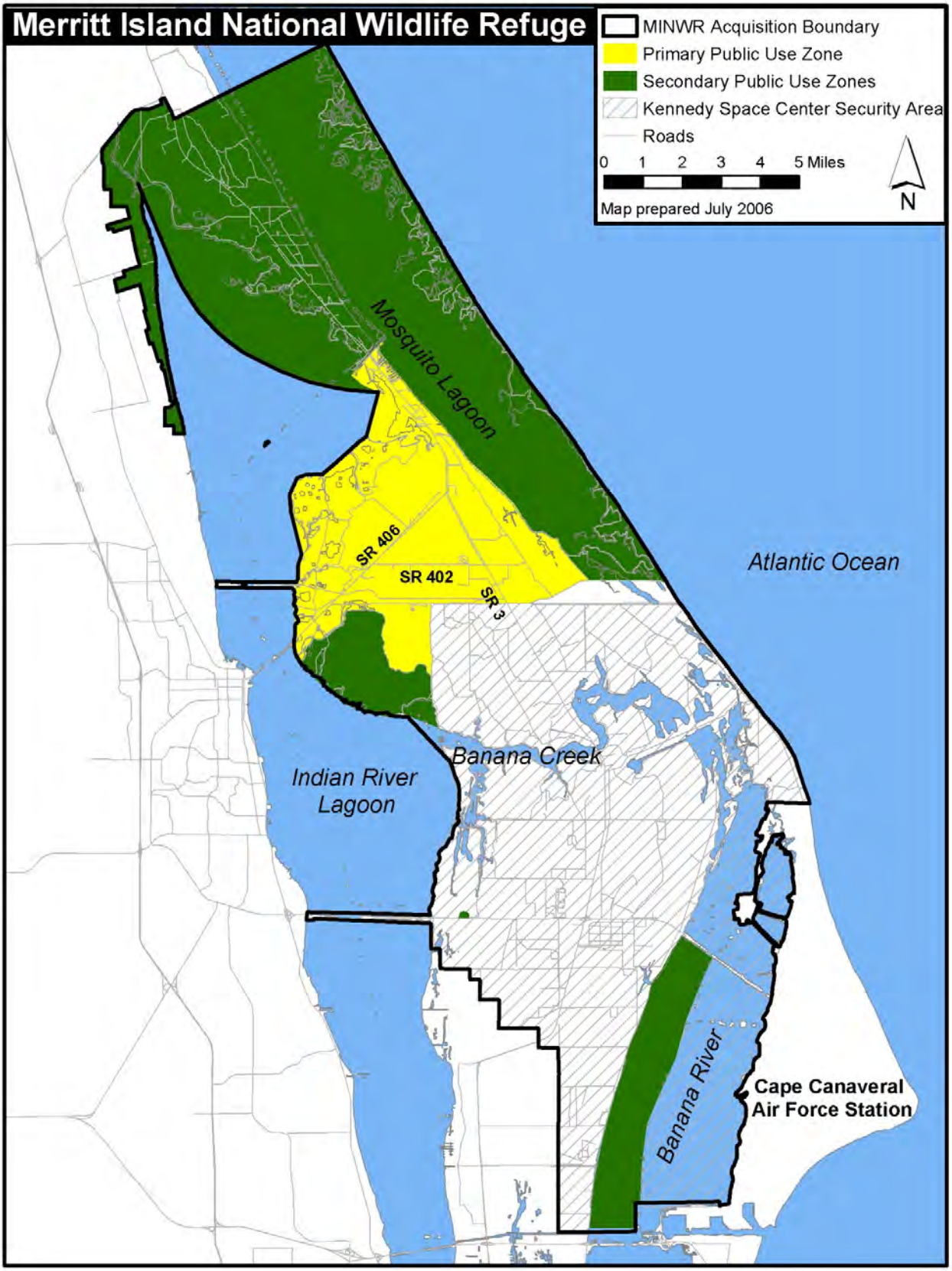
8.a. Kennedy Space Center Workers

Objective 8.a(1): Within five years of approval of this CCP/EA, at least 75 percent of regularly sampled members of Kennedy Space Center's workforce will be able to recognize that the refuge overlays NASA lands and will understand the importance of the refuge to migratory birds, threatened and endangered species, and other wildlife.

8.b. Local Residents

Objective 8.b(1): Within 5 years of approval of this CCP/EA, at least 50 percent of regularly sampled local residents will be able to recognize the location of the refuge and will understand the importance of the refuge to migratory birds, threatened and endangered species, and other wildlife.

Figure 26. Proposed public use zones



Visitor Services Goal 9: Build Volunteer Programs
A sufficient number of skilled and trained volunteers will be available to support the refuge in meeting its mission and purposes.

9.a. Volunteer Training

Objective 9.a(1): Within 5 years of approval of this CCP/EA, at least 75 percent of needed volunteer positions will be filled and each individual will receive adequate training to proficiently perform assigned duties with minimal supervision.

9.b. Volunteer Job Satisfaction

Objective 9.b(1): Within five years of approval of this CCP/EA, at least 75 percent of volunteers will annually report that they are highly satisfied with their positions.

Visitor Services Goal 10: Build Support of Friends Group
The Merritt Island Wildlife Association will be an advocate for the refuge, supporting all refuge goals and objectives and providing financial and in-kind support of refuge programs.

10.a. Merritt Island Wildlife Association Membership

Objective 10.a(1): Over the 15-year life of this CCP/EA, the refuge will continue to maintain a close working relationship with the Merritt Island Wildlife Association, assisting in promoting the growth in membership and financial revenues, providing input on refuge needs, and working to align interests.

10.b. Merritt Island Wildlife Association Employment

Objective 10.b(1): Over the 15-year life of this CCP/EA, encourage the Merritt Island Wildlife Association in its hiring practices to hire employees who will assist the refuge in running the visitor center and the visitor services program by assisting with visitor information and orientation, interpretive activities, and environmental education programs.

10.c. Merritt Island Wildlife Association Outreach

Objective 10.c(1): Over the 15-year life of this CCP/EA, encourage the Merritt Island Wildlife Association to become proactive in assisting the refuge in reaching new visitors and expanding the visitor services program.

Visitor Services Goal 11: Law Enforcement
The refuge will have a sufficient law enforcement staff to protect the visiting public, refuge facilities, and wildlife resources and all officers will have adequate training and equipment to perform their duties.

11.a. Law Enforcement

Objective 11.a(1): Within 5 years of approval of this CCP/EA and through random annual surveys, at least 90 percent of visitors will report that they feel safe and can affirm that law enforcement personnel and refuge regulations are adequately protecting visitors and wildlife.

Objective 11.a(2): Within five years of approval of this CCP/EA, law enforcement officers will contact 10 percent of visitors participating in consumptive recreation activities (i.e., hunting and fishing).

Objective 11.a(3): Within two years of approval of this CCP/EA, law enforcement officers will spend at least 75 percent of their work time in the field.

Objective 11.a(4): Within five years of approval of this CCP/EA, there will be a 50 percent reduction over 2004 levels in the number of reported boat-related manatee deaths or injuries in and around the refuge.

Objective 11.a(5): Within 10 years of approval of this CCP/EA, there will be a 50 percent reduction over 2004 levels in reported drug violations, vehicle break-ins, and illicit sexual offenses in the primary public use zone of the refuge.

Objective 11.a(6): Within 15 years of approval of this CCP/EA, the refuge manager, law enforcement agencies, and the public will be able to contact a refuge law enforcement officer 24 hours a day, seven days a week to respond to law enforcement emergencies, search and rescue operations, and other law enforcement situations.

Visitor Services Goal 12: Concession Operations
The refuge will evaluate a concession agreement to improve visitor services and streamline administration operations.

12.a. Concession

Objective 12.a(1): Within the 15-year life of this CCP/EA, prepare a written evaluation regarding the establishment of a concession operation to bring all commercial operations under a single point of contact.

Visitor Services Goal 13: Fee Program
The refuge will implement a fee program to enhance visitor services and the visitor experience.

Discussion: Fees are needed to help maintain refuge visitor facilities and to offset some portion of the operating costs for various programs. Fees are proposed for three programs: quota hunts and waterfowl hunt permits, sportfishing permits, and Black Point Wildlife Drive. The fee for quota hunts would be increased from $12.50 to $15.00 and the new permit would be good for only one day, instead of for the weekend. The fee for the sports fishing and hunting permit and Black Point Wildlife Drive would be $5 for a weekly permit or $20 for the annual permit. The America the Beautiful Passes and Federal Duck Stamps would be honored and substituted for annual passes.

In addition to visitor fees, the refuge works in cooperation with Canaveral National Seashore in managing commercial guide permits. The cost of guide permits has been increased from $250 for a two-year permit (in 2005) to $250 per year (starting January 1, 2006). These commercial permits would be capped at 2005 levels (as of September 30, 2005) and no new permits would be issued, unless a current permit holder fails to renew his/her permit. Thereafter, guide fishing permits would be capped at approximately 70 permits.

13.a. Quota Hunt Permits

Objective 13.a(1): Within two years of approval of this CCP/EA, the refuge will charge fees for quota hunt permits sufficient to defray administrative and maintenance costs to operate the program.

13.b. Sportfishing Permits

Objective 13.b(1): Within two years of approval of this CCP/EA, the refuge will implement an annual fee for sportfishing permits sufficient to defray administrative and maintenance costs to operate the program.

13.c. Black Point Wildlife Drive

Objective 13.c(1): Within two years of approval of this CCP/EA, the refuge will implement a fee for Black Point Wildlife Drive to help defray the administrative and maintenance costs.

13.d. Commercial Guide Permits

Objective 13.d(1): Within five years of approval of this CCP/EA, commercial guide permits will be capped at no more than 70 permits and the fees will be sufficient to defray the program costs.

Visitor Services Goal 14: Improve Refuge Appearance
The landscape of the refuge will be free of litter and visitors will report how clean the refuge appears.

14.a. Litter

Objective 14.a(1): Decrease litter on the refuge by 50 percent within five years of approval of this CCP/EA, and by 75 percent within ten years of approval of this CCP/EA through a phased approach to address litter problems and to change user behavior.

REFUGE ADMINISTRATION

General refuge administration goals and objectives address staff, volunteers, facilities, and equipment, as well as unwanted wildland fire.

Refuge Administration Goal 1: Refuge Management
Provide sufficient staff, volunteers, facilities, and equipment to implement a comprehensive refuge management program to protect and manage the natural and cultural values of the refuge's east central Florida coastal barrier island system.

1.a. Unwanted Wildland Fire

Objective 1.a(1): Continue to suppress 95 percent of all unwanted wildland fires occurring on the refuge within the first 24 hours to protect refuge and NASA resources and facilities, and to provide for the health and safety of refuge staff, NASA staff, and visitors.

Discussion: Unwanted wildland fire (wildfires) could be an important impediment to both refuge and Space Center operations. More importantly, they present a real danger to visitors and employees of both organizations. In 1981, two refuge employees were killed during wildfire suppression activities. It is of the utmost importance that the refuge maintains a fire management staff that is well-trained, well-equipped, and sufficient to suppress wildland fires in a timely and safe manner.

Causes of Unwanted Wildland Fire: The vast majority of wildfires on the refuge result from lightning. Studies at Kennedy Space Center show that there is an average of one cloud-to-ground lightning strike per square mile per month. This works out to 1,500 lightning strikes per year on the burnable vegetation of the refuge. In addition to the lightning fires, a small number of human- and equipment-caused ignitions occur each year.

Number and Size of Wildland Fires: Between 1981, when accurate recording of fire activity was started, and 2005, the refuge averaged slightly over 18 wildfires per year. The number of ignitions and the amount of acreage burned varies greatly. In 1981, 42 wildfires burned over 16,000 acres. The period between 1988 and 2001 was also active with a total of 91 wildfires. The largest of these, the Ransom Road Fire in 1998, was over 4,000 acres. This fire shut down Kennedy Parkway (State Route 3) several times and smoke hampered Space Center operations for over a week. On the other hand, the wet period between 2002 and 2005 averaged only 6 wildfires per year, where most of these were smaller than one acre in size.

Fire Preparedness - Personnel: After the fatalities in 1981, a substantial effort was made to properly train refuge personnel for wildland fire suppression. Most of the staff members who were physically capable of doing wildland firefighting received sufficient training to qualify at least as a Firefighter Type 2. Through additional training and/or the hiring of qualified people, the refuge obtained personnel qualified in other key fireline positions, such as Helicopter Manager, Tractor Plow Operator, Engine Operator, and Incident Commander. Training has continued over the years and additional specialized fire qualifications have been added.

Fire Preparedness - Equipment: The fire situation in 1981 also brought the realization that refuge's fire fighting equipment was inadequate. Surplus military vehicles that served as engines were replaced with four-wheel drive trucks with slide-in pump units. These, in turn, were replaced with increasingly more sophisticated equipment. At the present time, the refuge has four fully equipped Type 6 Wildland Engines.

Two Caterpillar D-6 dozers with six-disk plows, along with appropriate transport vehicles, were acquired shortly after 1981. Over the years the refuge has upgraded the D-6s and purchased new tractor-trailers upon which to move them. Two smaller crawler tractors are available for fire operations and share a two-disk plow. Early on, a large marsh buggy was used for fire operations in the wetland areas of the refuge. In recent years, an M-3 Marshmaster amphibious tracked vehicle has been obtained and fitted with fire suppression equipment to better serve this need.

Highly trained firefighters using the ground-based firefighting equipment previously discussed cannot alone achieve the refuge's fire suppression objective. The fuels present on the refuge have been shown to be able to support fires that could quickly overwhelm engines and tractor plow units. In addition, the ridge and swale topography of the refuge lands could slow or prevent access to fires. The use of helicopters to provide quick and efficient initial attack was begun on the refuge in 1981. Beginning in that year, the refuge contracted for an exclusive use fire suppression helicopter. This ended in 2000.

For a while, the refuge had an agreement with Kennedy Space Center to use NASA helicopters for fire operations. This was marginally successful. Problems with availability and fire knowledge plagued this arrangement. After September 11, 2001, security demands on the NASA ships increased and the agreement was eventually discontinued. At the present time the Service helicopter is stationed in Titusville, and the refuge uses it as much as possible. However, this arrangement does not provide refuge fire operations with a helicopter that is consistently available for initial attack. The Service aircraft has other missions and is frequently on assignments out of the area for extended periods of time. If a fire helicopter is needed while the Service ship is unavailable, refuge Incident Commanders must depend on being able to borrow a carded aircraft from another refuge or to rent one.

Fuels Management: Many of the vegetation types on the refuge are fire maintained (Adrian 2003). Without periodic fire, fuel loading in these types quickly becomes extremely heavy. The accumulation of excess fuels was one of the major factors in the fatalities in 1981. Reducing fuel levels could reduce the intensity of wildfires and reduce the risk involved in suppressing them. Two methods of fuels reduction are used on the refuge.

Mechanical Treatment: Mechanical treatment could be done in either the overstory in timbered areas or the shrub layer in many vegetation types. When working in the pine forests and woodlands, timber removal is usually done through a commercial timber harvest (see Chapter V, Habitat Management Plan, Appendix F). The purpose of these harvesting operations is to reduce the stand density, thereby reducing the chance of crown fires. In some cases, commercial operators would remove snags in addition to live timber. Commercial operators have also been used to remove cabbage palms along firelines, but this is usually done by refuge employees. Both the snags and the palms contribute to spotting during fire operations.

Manipulating the shrub layer could be done by several methods: shearing, chopping, or rotary cutting (see Chapters IV and V, Habitat Management Plan, Appendix F). This technique is useful in reducing the height of stands of scrub oak and palmetto. These lower fuels could then be prescribed burned under moderate conditions.

Prescribed Fire: Mechanical treatments leave large amounts of dead and down materials. These activity fuels could create an increase in fire danger themselves. For this reason, most mechanical operations are followed by a prescribed fire. Not only does the fire consume the biomass, but it also releases nutrients. Without the use of fire, it would take many years for this to happen during the decomposition process. Prescribed fire is also used to meet resource management goals and objectives. In the case of the flatwoods and scrub vegetation, two of the most common fire-maintained vegetation types, the need for fuels reduction burns coincides very well with the need to burn for habitat management.

Strategies:

- Continue to train firefighting staff to meet operational needs in accordance with interagency standards.
- Use fire assignments to meet task book training needs and to keep firefighters' qualifications current.
- Aggressively pursue a contract for an initial attack helicopter.
- Continue to upgrade firefighting equipment.
- Add an additional storage space for firefighting equipment.

1.b. Administrative Facilities

Objective 1.b(1): Within one year of approval of this CCP/EA, site and develop an administrative office facility.

Discussion: The refuge's offices are clustered at the visitor center and at the maintenance compound. Offices in the visitor center include the public use and law enforcement programs and an office for the Merritt Island Wildlife Association (the refuge's friends group). The maintenance compound includes administrative offices in the administrative trailer, fire offices in the fire building and fire cache, and maintenance offices in the shop building, as well as a warehouse facility, pole barns, equipment storage garages, gas pumps, and other facilities.

During 2003, a surplus triple-wide trailer was acquired from NASA to serve as a temporary administrative office for the refuge. Before 2003, the existing combination office/visitor center was deemed insufficient to handle the support structure of a cooperating association, sales outlet, numerous volunteers, and 60,000 annual visitors to the building, while also supporting the refuge's daily administrative functions. The triple-wide trailer was established within the maintenance compound due to the ease of utility hookup. Hurricanes of 2004 and 2005 caused some roof damage to the trailer and required an evacuation of critical records during each event. Subsequent storm damage funding was made available to replace the office trailer. NASA agreed to design and contract the construction of a 2,800 square foot block building to serve as the refuge's office. The new office building is to be located along the entrance road to the maintenance compound. Utilities would be shared with the Maintenance Compound. The triple-wide trailer would be used as support for the biological and fire programs on an interim basis for as long as it remains structurally sound.

The existing fire management building has served the program well with one exception: the briefing room (18 feet by 24 feet) is not large enough to accommodate fire briefings and training requirements. The building should be expanded to double the size of this room.

Objective 1.b(2): Within five years of approval of this CCP/EA, work within Kennedy Space Center's utility systems to upgrade refuge water, sewer, telephone, fax, and computer utilities.

Discussion: The refuge headquarters compound is dependent upon onsite wells and septic tanks and upon Space Center utilities for telephone, fax, and computer communications. The well water is declared unfit for human consumption by the Space Center due to concerns for contamination by a nearby polluted Space Center site. Bottled water is made available for consumption. Well water is used for other nonconsumptive activities. The refuge has two septic systems serving its offices, one at the visitor center and another at the maintenance compound. The Space Center has both sewer connections and water lines located at the Shuttle Landing Facility, which is located near the refuge's headquarters. Connecting to this facility would require installation of sewer and water lines for approximately two miles.

Over the years, the refuge has used nearly all of the available communication capacity. In addition, some of the lines are dedicated to supporting Canaveral National Seashore's entrance facilities. Upgrade of the system is needed to keep up with the information and communication demands of today.

Strategies:

- Work with NASA to pipe Cocoa municipal water to the refuge's headquarters.
- Connect to the Space Center's sewer system at the Shuttle Landing Facility to serve the refuge's offices.
- Work with NASA to expand the capacity for telephone, fax, and computer lines.

Objective 1.b(3): Within three years of approval of this CCP/EA, construct a dormitory facility and recreational vehicle pad facilities within the refuge headquarters compound for researchers, interns, volunteers, and temporary firefighters to replace the existing BioLab dormitory facility .

Discussion: A major asset to the refuge for research support is the BioLab facility, which is a NASA building used by the refuge (and formally by Canaveral National Seashore) to house researchers and volunteers. The almost pristine conditions of the Mosquito Lagoon and the outstanding condition of the estuarine waters relative to the Indian River Lagoon make the refuge a highly desirable location for estuarine research. The availability of the BioLab facility to researchers offsets research costs considerably when compared to the cost of having to rent motel rooms and/or apartments. Between June

1997 and April 2002, 75 individuals from 11 different universities and/or government agencies used the facility. Researchers and students were involved in 17 different projects during this time. The facility offers onsite housing to researchers, students, and volunteers during their courses of study. This is a valuable asset to provide in-kind support to attract needed researchers to do projects on the refuge.

Beyond researchers, interns provide an essential component of the public use program for visitors on the refuge. Interns support visitor center operations, assist with interpretive and educational programs, and disseminate information. Interns are provided a small stipend, but free housing in the BioLab facility is a key component to making this program successful. Located about 8 miles north of the refuge's headquarters, the BioLab is approximately 40 years old and has been used for various purposes over the years. It was retrofitted to living quarters and laboratory space in the early 1990s. Fresh water supply problems and building deterioration brought the building close to being closed. In 2004 a new well was installed which alleviated the water problem. In 2005 a new roof was installed to prevent further water damage. Working with the Merritt Island Wildlife Association and NASA, further repairs would be made to ensure that the building would be available for a few more years. The long-term solution to the need for housing interns, volunteers, researchers, and temporary firefighters is to construct a dormitory within the refuge's headquarters compound. This facility would be connected to the support systems (i.e., water, electric, telephone, and septic) of the compound. In addition the building would be better controlled and secured than the isolated BioLab. An additional feature would be the construction of recreational vehicle hookups and concrete pads. Some interns and volunteers would take advantage of the recreational vehicle pad option, especially those who are retired.

1.c. State Route 406

Objective 1.c(1): Within two years of approval of this CCP/EA, repave State Route 406 from State Route 402 to State Route 3 to meet highway standards.

Discussion: The portion of State Route 406 located between State Routes 402 and 3 is the only access for visitors to reach Black Point Wildlife Drive and is the primary artery for visitor access to Haulover Canal. In 1996 one inch of asphalt was added to the roadway. Before then, the roadway had started to fail with numerous potholes. The one inch of asphalt has held the roadway in fair condition; however, strict weight limits have restricted heavy traffic. During the road work project on Black Point Wildlife Drive in 2003, two additional inches of asphalt were added to one end of State Route 406 to enable trucks to access the Wildlife Drive to conduct needed repairs. The State Route 406 roadway is now beginning to crack and fail and must be resurfaced to enable visitors to have a safe route to travel. Planning and completion of this effort would be a joint project between the Service and the Federal Highway Administration.

1.d. Refuge Staffing

Objective 1.d(1): Within the 15-year life of this CCP/EA, provide a full complement of 61.5 (61 full-time and one half-time) permanent staff to protect and manage the natural and cultural resources of the refuge, while providing opportunities for appropriate and compatible public use.

Discussion: To serve the purposes of the refuge and to accomplish the outlined goals and objectives of the comprehensive conservation plan, additional staff and volunteers would be required. Along with additional staff, additional support equipment and facilities would be needed (e.g., office space, computers, and vehicles). See Figure 27 for the proposed overall staffing chart. The staffing for each of the refuge program areas would be as follows: Office Administration, five staff; Biological Program, nine staff; Law Enforcement Program, four staff; Public Use Program, 5.5 staff; Exotic, Invasive, and Nuisance Species Program, four staff; Fire Program, 14 staff; and Maintenance

Program, 11 staff. The refuge would emphasize recruiting and retaining staff, supporting applicable training and certification programs. Spanning several refuge programs (including management, biology, law enforcement, public use, exotics, and fire), one desired skill set for refuge staff would involve geographic information systems (GIS), including digitizing skills, using global positioning systems (GPS), developing and maintaining GIS databases, managing and manipulating GIS databases, and analyzing and mapping GIS data. New hires in some program areas would include a job description requirement to have expertise with GIS or would be trained to use GIS to facilitate refuge management and decision-making.

1.e. Refuge Signs

Objective 1.e(1): Maintain an effective network of signs meeting the National Wildlife Refuge System's standards to notify the public of refuge boundaries, public use areas, and closed areas by annually reposting, replacing, and/or maintaining 20 percent of the refuge signs.

Discussion: The refuge maintains signs in accordance with Service standards. In addition, highway signs are administered in accordance with the Uniform Code of Traffic Standards. The network of signs informs the public of refuge boundaries, closed areas, public facilities, sensitive wildlife areas and rules and regulations designed to protect the public and the natural resources.

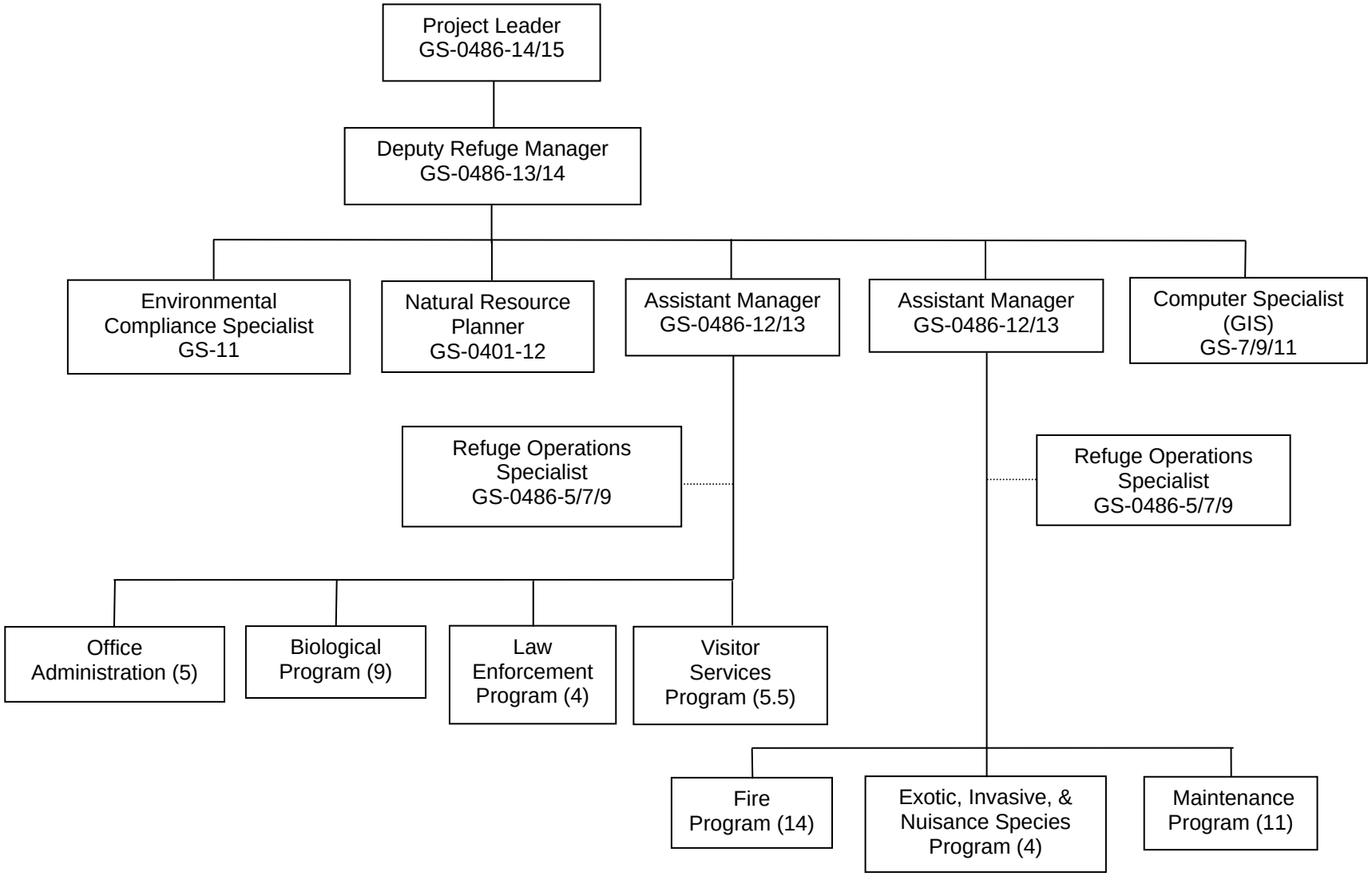
Refuge Administration Goal 2: Intergovernmental Coordination
Foster a strong and effective working relationship with existing partners and new partners for the purposes of accomplishing refuge management goals and protecting the natural and cultural resources of the refuge's coastal and estuarine habitats.

Discussion: Government is required to reinvent itself based on the economic conditions, shifting national priorities, national defense, and hurricane recovery. The public has an expectation that more of the Service's goals be accomplished through partnerships and that government must become more efficient. The Director of the Fish and Wildlife Service has stated that the Service must emphasize working cooperatively with others; develop a more integrated approach to problem-solving and share resources to get the job done; and make choices and find efficiencies in both resource and business management practices. This focus reinvigorates the refuge's current intergovernmental coordination efforts. Numerous federal, state, and local agencies could be considered partners for the refuge. However, more could be done to inform and educate the partners of the value of the refuge and the refuge's goals. In the same vein, the Service is willing to help other agencies with issues, such as fire management, nuisance wildlife, exotic plant control, and specific wildlife conservation issues. Much of this coordination could be accomplished by regular meetings and by developing personal relationships with individuals within other agencies.

2.a. Existing Partners

Objective 2.a(1): Improve refuge coordination with NASA in order to make refuge goals and objectives an important component in the planning and implementation of NASA's operations at Kennedy Space Center.

Figure 27. Proposed organizational chart



Discussion: Since the refuge is an overlay of the Kennedy Space Center, the most important relationship for the refuge is a positive interactive relationship with both NASA and the Space Center. This relationship also includes the various contractors on site. As the Space Center transitions into a new era with space exploration and growing relationships with nongovernmental partners, it is critical that the management objectives of the refuge be included in any planning initiatives. Space Center employees and contractors need to understand the role of the refuge and hopefully come to place a high value on the resources it protects. In addition, they should come to understand that they play an integral role in the protection and management of the resources.

Strategies:

- Brief the Kennedy Space Center Director and senior staff annually on current and future refuge plans.
- Meet regularly with Space Center environmental staff to better communicate on research, monitoring activities, potential new development projects, and opportunities to improve habitat.
- Continue to respond appropriately to NASA requests for technical support in dealing with wildlife issues or controversies at the Space Center.
- Build personal relationships with staff in various programs, including law enforcement, maintenance, master planning, environmental management, Internet technology, weather, payload processing, and National Test Directors.
- Invite site managers and other NASA officials to periodic demonstrations and viewings of actual refuge operations. Include social events where appropriate.
- Participate in special Space Center events sponsored by NASA (e.g., the Energy and Environmental Awareness celebration).

Objective 2.a(2): Improve refuge coordination with the U.S. Air Force in order to make refuge goals and objectives an important component in the planning and implementation of operations at Cape Canaveral Air Force Station.

Discussion: With Cape Canaveral Air Force Station located adjacent to Kennedy Space Center and the refuge and with overlapping management concerns (e.g., scrub-jays and sea turtles), the Service must improve coordination with the Air Force Station.

Strategies:

- Revise the agreement between the U.S. Air Force and the Service as it applies to Cape Canaveral Air Force Station. Resolve issues, such as fire suppression and technical support.
- Brief the Cape Commander and senior staff annually on current and future refuge plans.
- Meet regularly with the Cape's environmental staff to better communicate on issues such as sea turtle nest predation and lighting, monitoring of wildlife, habitat restoration, and prescribed burning.
- Invite site managers and other U.S. Air Force officials to periodic demonstrations and viewings of actual refuge operations. Include social events where appropriate.
- Participate in special events sponsored by the Air Force Station.

Objective 2.a(3): Improve refuge coordination with the National Park Service in order to make refuge goals and objectives an important component in the planning and implementation of operations at Canaveral National Seashore, and make National Park Service goals and objectives an important component of refuge planning.

Discussion: Because the Seashore and refuge are both part of the U.S. Department of the Interior; a portion of the Seashore is an overlay of the refuge; the two share land and water boundaries; and the two have shared resource protection goals and objectives, it is imperative that the Seashore and refuge continue to improve coordination efforts.

Strategies:

- Meet regularly with the Seashore's Park Superintendent and senior staff to ensure that both agencies are aware of current and future plans. In addition, seek ways to resolve issues and discover ways to be more efficient in management.
- Meet regularly with the Seashore environmental staff to better communicate on research, monitoring, and habitat management.
- Meet regularly with the Seashore interpretive staff to better communicate on research, monitoring, and habitat management.
- Meet annually with the Park Superintendent and senior staff to review commercial and public use regulations to ensure consistency.
- Continue to co-sponsor the biennial Mosquito Lagoon Symposium
- Invite Seashore staff to social events where appropriate.
- Participate in special events sponsored by the National Park Service at Canaveral National Seashore.
- Coordinate to strive for consistency between laws and regulations for activities in Mosquito Lagoon.

Objective 2.a(4): Improve refuge coordination with the Florida Fish and Wildlife Conservation Commission as it applies to programs of mutual interest, including public use activities, research, law enforcement, wildlife, and habitat management.

Strategies:

- Sponsor an annual meeting with the Regional Director of Florida Fish and Wildlife Conservation Commission and the Seashore Park Superintendent to ensure consistency between laws and regulations applied to Mosquito Lagoon.
- Invite Florida Fish and Wildlife Conservation Commission staff to visit the refuge for an orientation and to social events where appropriate.
- Participate in appropriate special events sponsored by the Commission.

Objective 2.a(5): Improve refuge coordination with the St. Johns River Water Management District as it applies to programs of mutual interest, including the refuge's Wetland Management Plan, the Water Management District's Surface Water Improvement and Management Plan, and the Indian River Lagoon National Estuary Program.

Strategies:

- Continue to participate in the Indian River Lagoon National Estuary Program Advisory Board.
- Meet regularly with the Water Management District's staff to seek habitat restoration projects on the refuge that accomplish objectives of the refuge and that also meet the criteria under its Surface Water Improvement and Management Plan.
- Invite Water Management District staff to social events where appropriate.
- Participate in appropriate special events sponsored by the Water Management District.

Objective 2.a(6): To further goals and objectives in programs of mutual interest, continue to work with local governmental partners, such as Brevard County (including Mosquito Control District, Environmentally Endangered Lands Program, Parks and Recreation, County Commissioners, and Sheriffs Department), the Brevard County Tourist Development Council, and the city of Titusville.

Strategies:

- Continue to seek input and encourage these entities to be involved and informed of refuge activities and plans.
- Meet annually with the Brevard Mosquito Control District to ensure that water management objectives for impoundments are coordinated.
- Maintain mutual aid agreements in the event of emergencies or disasters.
- Work with Canaveral National Seashore and local partners to support the development of an alternative transportation connection between the city of Titusville and the Atlantic Ocean (i.e., bicycle path).
- Work with the Brevard County Environmentally Endangered Lands program to assist with management of Kaboord Sanctuary.

Objective 2.a(7): Continue to work with nongovernmental partners, such as Ducks Unlimited, United Waterfowlers Association, Audubon Society, Wild Birds Unlimited, Florida Conservation Association, Fish and Wildlife Foundation, and Mosquito Lagoon Outfitters to discover areas of mutual interest.

Strategy:

- Maintain a dialogue with these groups to keep them informed of refuge activities and seek opportunities for grants or other funding.

2.b. New Partners

Objective 2.b(1): Seek new partnerships, some of which may not be the conventional partners of the refuge.

Strategies:

- Identify and maintain a list of problems, issues, and opportunities with which the refuge could use partnership involvement.
- Take advantage of networking to seek partners.

Refuge Administration Goal 3: Commercial Harvesting
Limit the impacts to the natural resources of the northern Indian River lagoon system from commercial harvesting activities to current levels until these activities can be phased out from the refuge.

3.a. Commercial Fishing Permits

Objective 3.a(1): Upon CCP/EA implementation, limit commercial fishing permits to those users holding permits for 2004/2005.

Discussion: The refuge works in cooperation with Canaveral National Seashore to administer commercial harvest permits. Commercial harvest permits cover commercial fishing activities such as, but limited to, netting, hook and line fishing, crabbing, clamming, shrimping, and bait fishing. These commercial fishing activities have occurred in these waters since the refuge was established. Fish and Wildlife Service policy guidelines require these activities to be eliminated.

With the adoption of this CCP/EA, the refuge policy would be to issue commercial harvest permits only to those individuals who have a current permit. Approximately 70 permit holders currently exist. If the permit is not renewed, it would expire and cannot be renewed in future years. If an individual elected to not renew the permit, the permit may be passed to other members of the immediate family, such as: father, mother, sons, or daughters. Through attrition, commercial harvesting would be slowly eliminated, but would not cause economic hardship to families that depend upon this industry for their livelihoods. The commercial fishing program will sunset in 2018 and all permits will end by October 1, 2018.

3.b. Beekeeping Permits

Objective 3.b(1): Upon CCP/EA implementation, limit beekeeping operations only to those users holding permits in 2004/2005.

Discussion: Historically, beekeeping on refuge lands supported the cultivation of citrus. When the refuge was established, beekeeping was permitted to continue in support of citrus growing, in accord with the Service's agreement with NASA. Beekeepers are awarded apiary sites on the basis of highest monetary bid in a sealed bid process. Beekeepers are limited to a maximum of 10 apiary sites. Each year beekeepers must pay for all the sites they are awarded. If a beekeeper does not pay for his sites, his/her permit is cancelled and those sites are re-bid for award to other beekeepers.

Since citrus management is scheduled to be eliminated over time and since beekeeping does not support the refuge's purposes or mission, it is the intent of the refuge to phase out beekeeping, but not to cause financial hardship to the beekeepers that currently have apiary sites on the refuge. To do this, future beekeeping operations would be limited to the eight beekeepers holding permits in 2005 and to the 50 apiary sites existing in 2006. Apiary permits would not be transferable from one beekeeper to another beekeeper. If a beekeeper gives up or fails to pay for his/her apiary sites, his/her permit would be permanently cancelled. As permits are cancelled, those apiary sites would be opened to bid by other 2005 beekeepers under the maximum of 10 sites per beekeeper limit. If bids are not received for an apiary site, that site would be dropped from the program. Over time, beekeeping on the refuge would be reduced and eventually eliminated through the attrition of beekeepers and by the elimination of unwanted apiary sites. The beekeeping program will sunset in 2016 with the removal of all apiary sites and the end of all permits by October 1, 2016.

V. Plan Implementation

INTRODUCTION

As required by the National Wildlife Refuge System Improvement Act of 1997, the Service will manage all refuges in accordance with an approved comprehensive conservation plan, 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.

FUNDING NEEDS AND PERSONNEL

This CCP/EA recommends funding that is substantially above current budget allocations and subject to congressional allocations on an annual basis. The recommended staffing outlined is not a commitment from Congress or the Service for staff, operational, maintenance, and/or project increases, but represents a future management framework to meet the goals, objectives, and strategies identified in this plan. Other possible funding sources include grants, entrance fee receipts, mitigation funds, donations, and partners. Table 11 lists the current refuge staff of 26 permanent positions, as well as the annual costs associated with these positions. Temporary and term positions are used when funding from sources other than base operation is available. See Figure 15 for the existing staffing chart.

Table 11. Current staff and annual costs

Position	Estimated Annual Recurring Cost (Thousands)	Position	Estimated Annual Recurring Cost (Thousands)
Refuge Manager (Project Leader)	$121	Equipment Operator	$67
Deputy Refuge Manager	$102	Equipment Operator	$67
Refuge Operations Specialist (Assistant Manager)	$55	Equipment Operator	$67
Administrative Officer (Budget Office Assistant)	$65	Equipment Operator	$58
Natural Resource Planner	$87	Maintenance Worker	$59
Forester	$74	Tractor Operator	$51
Fire Management Specialist (Wildland Urban Interface Specialist)	$73	Supervisory Fire Management Officer/Fire Control Officer	$74
Supervisory Wildlife Biologist	$91	Forestry Technician	$58

Position	Estimated Annual Recurring Cost (Thousands)	Position	Estimated Annual Recurring Cost (Thousands)
Refuge Operation Specialist (Visitor Services)	$87	Forestry Technician	$43
Park Ranger (Visitor Center Manager)	$67	Forestry Technician	$43
Park Ranger (Refuge Law Enforcement Officer)	$72	Forestry Technician	$43
Park Ranger (Refuge Law Enforcement Officer)	$83	Forestry Technician	$43
Supervisory Equipment Operator (Maintenance Leader)	$76	Fire Program Assistant	$43
TOTAL			**$1,769,000**

The Refuge System currently faces a backlog of project, operational, maintenance, and equipment needs. The current Refuge Operating Needs (RONS) system provides a list of proposed projects for the refuge, over and above the base operating budget of the refuge, which was $2,018,000 in fiscal year 2005. The refuge's RONS and Service Asset and Maintenance Management (SAMMS) needs will continue under this plan. Upon approval of this CCP/EA, the RONS and SAMMS databases will be updated to reflect the needs outlined in the CCP/EA.

To achieve the goals, objectives, and strategies outlined in Chapter IV, additional personnel, operations, maintenance, facilities, and funds are needed. Table 12 outlines the proposed staff and associated costs for 61.5 full-time employees (FTE), which would replace the existing staff of 26 (see Figure 27 for the proposed staffing chart).

Table 12. Proposed staff and annual costs

Proposed Position	Estimated Annual Recurring Cost (Thousands)
Refuge Management (9 FTE)	
Project Leader	$152
Deputy Refuge Manager	$129
Assistant Manager	$109
Assistant Manager	$109
Environmental Compliance Specialist	$77
Computer Specialist (GIS)	$63

Proposed Position	Estimated Annual Recurring Cost (Thousands)
Natural Resource Planner	$92
Refuge Operations Specialist	$52
Refuge Operations Specialist	$52
Office Administration (5 FTE)	
Office Manager/IT Specialist	$92
Office Assistant	$52
Office Assistant (Property, personnel)	$52
Office Assistant (Budget)	$52
Automated Office Clerk (Reception)	$52
Biological Program (9 FTE)	
Supervisory Refuge Biologist	$109
Biologist (Uplands/Fire Ecologist)	$77
Biologist (Wetlands)	$77
Biologist (Marine)	$77
Forestry Technician	$52
Biological Science Technician	$52
Biological Science Technician	$52
Biological Science Technician	$52
Biological Science Technician	$52
Law Enforcement Program (4 FTE)	
Lead Law Enforcement Officer	$77
Law Enforcement Officer	$63
Law Enforcement Officer	$63
Law Enforcement Officer (Marine)	$63
Visitor Services Program (5.5 FTE)	
Supervisory Refuge Ranger	$92
Refuge Ranger (Visitor Center, Volunteers)	$77
Refuge Ranger (Environmental Education)	$63
Refuge Ranger (Outreach)	$63

Proposed Position	Estimated Annual Recurring Cost (Thousands)
Refuge Ranger (Interpreter)	$63
Refuge Ranger (0.5 FTE Fee Collector)	$21
Exotic, Invasive, and Nuisance Species Program (4 FTE)	
Biological Science Technician	$52
Laborer	$41
Laborer	$41
Laborer	$41
Fire Program (14 FTE)	
District Fire Management Officer	$92
Assistant Fire Management Officer	$77
Wildland and Urban Interface Specialist	$77
GIS Specialist	$63
Fire Program Assistant/Dispatcher	$52
Wildfire Specialist	$63
Prescribed Fire Specialist	$63
Equipment Operator (Firefighter)	$59
Equipment Operator (Firefighter)	$59
Aviation Manager	$63
Forestry Technician (Engine Captain)	$47
Forestry Technician (Engine Captain)	$47
Forestry Technician (Engine Captain)	$47
Forestry Technician (Engine Captain)	$47
Maintenance Program (11 FTE)	
Maintenance Supervisor	$79
Maintenance Mechanic	$69
Equipment Operator	$69
Maintenance Worker	$55
Maintenance Worker (Public Use, Mower)	$52
Laborer (Trails)	$44

Proposed Position	Estimated Annual Recurring Cost (Thousands)
Laborer (Posting)	$44
Laborer (Trash)	$44
Equipment Operator	$63
Equipment Operator	$63
Tractor Operator	$52
Total	**$4045.00**

RESEARCH

In addition to ongoing projects, a variety of needed research projects exist today. These research projects cover a wide variety of issues and have a focused priority on management-oriented projects, including those listed below:

- Address threats and impacts to refuge wildlife and habitat from exotic species.
- Address listed species recovery and management efforts.
- Address species of management concern (e.g., reddish egret or gopher tortoise).
- Address estuarine fisheries, wildlife disturbance, and public use.
- Address wildlife diseases (e. g., sea turtle fibropapilloma and avian viral disease monitoring).
- Address the impacts of reduced water quality, contaminants, and pollution on estuarine aquatic flora and fauna.
- Conduct research into integrated fisheries and wildlife in managed wetlands systems.
- Continue to encourage NASA support contracts for long-term monitoring programs that directly support refuge operations and management.
- Identify and encourage research projects that have substantial benefits to the refuge and species conservation and management (e.g., abiotic factors, sea turtle monitoring, endangered species research, public use, seagrass mapping, and others).
- Encourage research to document historical, ecological landscape features and demonstrate the changes that have occurred relative to habitat and species restoration.
- Develop a research and monitoring program for the American alligator to determine hormonal concentrations and bioaccumulation of contaminates, and to determine population dynamics in conjunction with proposed hunting programs.

In addition to research, there are many basic monitoring and inventory needs, including:

- Monitor other native and endemic wildlife to determine wildlife guilds and habitat associations.
- Develop and maintain a species inventory for the Merritt Island Refuge.
- Encourage community characterization studies for invertebrates, amphibians, reptiles, mammals and birds, and their management priority status among listed species and species of special concern.
- Develop GIS databases.

- Develop an inventory of historical maps and photography.
- Monitoring programs to track progress in the refuge's efforts for recovery of listed species should be developed.
- Additionally, adaptive management programs could monitor changes in wildlife populations associated with upland and wetland management programs.
- Encourage monitoring of bird rookeries, estuarine fisheries, seagrass beds, juvenile sea turtles, manatee habitat, rafting waterfowl, and other waterbirds using the system.
- Monitor the impacts of wildlife diseases on refuge populations. Encourage independent monitoring of wildlife diseases to receive recommendations on impacts to local populations and management issues (e.g., upper respiratory tract disease impacts on gopher tortoise populations, West Nile virus impacts on scrub-jay populations).
- Develop a monitoring or research program to determine the connection of the refuge beach and nearshore fisheries community, with special focus on any unique features that promote use by sharks, drums, and sea turtles (or other important fisheries species).
- Determine the role and function of the refuge nearshore habitats for the conservation of marine fisheries populations (e. g., nursery habitat, feeding area, and sanctuary area).
- Develop or encourage a monitoring program to evaluate the fisheries population dynamics in the Mosquito Lagoon by working with the Florida Fish and Wildlife Conservation Commission and other partners.

PARTNERSHIPS

The refuge would maintain and continue an aggressive approach to work with others to conserve, protect, and enhance fish and wildlife and their habitats. The Service is fully committed to maintaining and expanding joint endeavors and cooperation with educational institutions, researchers, local governments, state government agencies, and other federal agencies, as well as organizations, schools, volunteers, and conservation organizations. To this end, the refuge would maintain and enhance existing partnerships, which include those listed partners, as well as the residents and business owners of the area.

Potential new partnerships for the refuge include business owners; commercial tour operators; additional local elementary, middle, and high schools; hunting and fishing organizations; new and retired residents; additional research centers and universities; and National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

STEP-DOWN MANAGEMENT PLANS

The Service would prepare step-down management plans to provide strategies and implementation schedules for meeting goals and objectives identified in this CCP/EA. Since the Habitat Management Plan and Visitor Services Plan were prepared during the planning process of the CCP/EA, only five plans would need to be updated during the 15-year life of this CCP/EA: Law Enforcement, Hunting, Inventorying and Monitoring, Fire Management, and Hurricane and Disaster Preparedness. Table 13 lists these plans and their proposed completion schedules.

Table 13. Step-down management plans and completion schedules

Step-down Management Plans to be Updated	Completion Schedule (2008-2023)
Law Enforcement	By 2023
Hunting	By 2008
Inventorying and Monitoring	By 2023
Fire Management (updated every 5 years)	2008, 2013
Hurricane and Disaster Preparedness (updated annually)	annually

MONITORING AND ADAPTIVE MANAGEMENT

Monitoring the Service's performance, while implementing this CCP/EA, is critical to successful implementation of the plan. Monitoring and evaluation allows the Service, other government agencies, the public, and the partners to measure and evaluate progress. Upon approval of this CCP/EA and public notification of the decision, the Service will begin implementing the objectives and strategies identified in the CCP/EA. The Service will monitor, evaluate, and determine whether or not progress is being made towards achieving the refuge's purposes, vision, and goals. Monitoring will address habitat or population objectives and the effects of management activities. Through adaptive management and evaluation of monitoring and research, results may indicate the need to modify refuge objectives and/or strategies.

PLAN REVIEW AND REVISION

The Service will review this CCP/EA annually to decide if it requires any revisions. The CCP/EA will be modified along with associated management activities whenever this review or other monitoring and evaluation determine that changes are needed to achieve the refuge's purposes, vision, and goals. The Service will revise this CCP/EA when significant new information becomes available, ecological conditions change, major refuge expansion occurs, or when the Service identifies the need to do so during CCP/EA review. At a minimum, this CCP/EA will be revised every 15 years. All CCP/EA 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 will continue to inform and involve the public regarding the management of Merritt Island National Wildlife Refuge.

Appendix A. - Glossary

ACE (or USACE) – U.S. Army Corps of Engineers.

adaptive ecosystem management - Use of the findings of ecology to manage natural resources, not for maximum commodity production (a traditional industrial forest), or for preservation of current conditions (a traditional reserve), but for the perpetuation of patterns and processes that allow the ecosystem to persist. This management style stresses experimentation, collaboration, and re-evaluation.

adaptive management - responding to changing ecological conditions so as to not exceed productivity limits of a specific place.

alternative - a reasonable way to fix the identified problem or satisfy the stated need (40 CFR 1500.2).

amphidromous fish - fish that can migrate from fresh water to the sea, or vice versa, not for the purpose of breeding, but at other times during the life cycle of the fish.

anadromous - fish that spend a large proportion of their life cycle in the ocean and return to freshwater to breed.

appropriate use - according to draft policy, an appropriate use is an existing or a proposed use that meets at least one of three criteria. (1) A use is appropriate if it is a priority public use or is necessary for the safe, practical, and effective conduct of a priority public use on the refuge. (2) A use is appropriate if it contributes to fulfilling the System mission, or the refuge purposes, goals, or objectives as described in a refuge management plan approved after October 9, 1997, the date the National Wildlife Refuge System Improvement Act of 1997 was passed. (3) A use is appropriate if the Refuge Manager documents in writing reasons why the use should be considered appropriate and obtains concurrence from the Refuge Supervisor.

aquatic - growing in, living in, or dependent upon water.

BCC - Bird of Conservation Concern, FWS.

biogeography - the science that studies the geographic distribution of organisms.

biological integrity - biotic composition, structure, and function at the genetic, organism, and community levels consistent with natural conditions, and the biological processes that shape genomes, organisms, and communities.

biological or natural diversity (also biodiversity) - the abundance, variety, and genetic constitution of animals and plants in nature; the total variety of life and its processes, including the variety of living organisms and the genetic differences between them and the communities and ecosystems in which they occur.

biota - the plants and animals of an area.

biotic community - biological community or association, ecological community; an assemblage of species living in a prescribed area or physical habitat.

BLM - Bureau of Land Management.

BMCD - Brevard Mosquito Control District.

breeding habitat - habitat used by migratory birds or other animals during the breeding season.

buffer zones - protective land borders around critical habitats or water bodies that reduce runoff and nonpoint source pollution loading; areas created or sustained to lessen the negative effects of land development on animals and plants and their habitats.

candidate species - those species for which the Service has sufficient information on biological vulnerability and threats to propose them for listing.

carrying capacity - the size of the population that can be sustained by a given environment.

catadromous fish - fish that spend most of their lives in fresh water but migrate to sea to reproduce.

Categorical Exclusion - a category of actions that do 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).

CCAFS - Cape Canaveral Air Force Station, U.S. Air Force.

CCP - Comprehensive Conservation Plan.

CE - Commercially Exploited, State of Florida.

CFR - Code of Federal Regulations.

Challenge Cost Share Program - a grant program administered by the US Fish and Wildlife Service providing matching funds for projects supporting natural resource education, management, restoration and protection on Service lands, other public lands and on private lands.

community type - a particular assemblage of plants and animals, named for the characteristic plants.

compatibility determination - the process required before any public use is allowed to occur on a refuge. A compatible use is one which, in the sound professional judgment of the Refuge Manager, will not materially interfere with or detract from fulfillment of the Refuge System Mission or refuge purpose(s). The 1997 National Wildlife Refuge System Improvement Act requires that a compatibility determination must be made by FWS before any use may be allowed on a refuge.

compatible use - an allowed use that will not materially interfere with, or detract from, the purposes for which the unit was established (Service Manual 602 FW 1.4). A compatible use is one that has been determined to be so through the compatibility determination process.

Comprehensive Conservation Plan (CCP) - 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, help fulfill the mission of the System, maintain and, where appropriate, restore the biological integrity, diversity, and environmental health of each refuge and the System, and meet other mandates.

conservation - the management of natural resources to prevent loss or waste. Management actions may include preservation, restoration, and enhancement.

conservation agreements - written agreements reached among two or more parties for the purpose of ensuring the survival and welfare of native species of fish and wildlife and/or their habitats, or to achieve other specified conservation goals. Participants voluntarily commit to implementing specific actions that will remove or reduce the threats to these species.

conservation easement - a legal agreement between a landowner and a land trust (a private, nonprofit conservation organization) or government agency that permanently limits a property's uses in order to protect its conservation values.

cooperative agreement - the legal instrument used when the principal purpose of the transaction is the transfer of money, property, services or anything of value to a recipient in order to accomplish a public purpose authorized by federal statute and substantial involvement between the Service and the recipient is anticipated.

CNS - Canaveral National Seashore.

cultural resource - evidence of historic or prehistoric human activity, such as buildings, artifacts, archaeological sites, documents, or oral or written history. Cultural resources include historically, archaeologically, and/or architecturally significant resources.

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 form a field offices background or literature search described in Section VIII. of the Cultural Resource Management Handbook (Service Manual 614 FW 1.7).

database - a collection of data arranged for ease and speed of analysis and retrieval, usually computerized.

diadromous - fish that migrate from freshwater to saltwater or the reverse: a generic term that includes anadromous, catadromous and amphidromous fishes.

digitizing - the process of converting information from paper maps into geographically referenced electronic files for a geographic information system (GIS).

dispersal - the movement of organisms away from a location, such as point of origin.

easement - an agreement by which a landowner gives up or sells one of the rights on his/her property. For example, a landowner may donate a right-of-way across his/her property to allow access.

ecological integrity - the integration of biological integrity, natural biological diversity, and environmental health; the replication of natural conditions (Part 601, Chapter 3, FWS Manual).

ecology - the branch of science that studies the distribution and abundance of organisms and the relationship between organisms and their environment.

ecosystem - a biological community together with its environment, functioning as a unit. For administrative purposes, the Service has designated 53 ecosystems covering the United States and its possessions. These ecosystems generally correspond with watershed boundaries and vary in their sizes and ecological complexity.

ecosystem approach - a way of looking at socio-economic and environmental information based on ecosystem boundaries, rather than town, city, or county boundaries.

ecosystem-based management - an approach to making decisions based on the characteristics of the ecosystem in which a person or thing belongs. This concept takes into consideration interactions between the plants, animals, and physical characteristics of the environment when making decisions about land use or living resource issues.

ecotourism - a type of tourism that maintains and preserves natural resources as a basis for promoting economic growth and development resulting from visitation to an area.

emergent wetland - wetlands dominated by erect, rooted, herbaceous plants.

Endangered Species Act - adopted in 1973 to provide protection for species in danger of becoming extinct.

> **§4** - outlines procedures and criteria for (1) identifying and listing threatened and endangered species; (2) identifying, designating, and revising critical habitat; (3) developing and revising recovery plans; and (4) monitoring species removed from the list of threatened and endangered species.
> **§7** - outlines procedures for interagency cooperation to conserve federally listed species and designated habitat.
> **§9** - prohibits the taking of endangered species of fish and wildlife, as well as most threatened species of fish and wildlife.
> **§10** - provides exceptions to the §9 prohibitions, with the most relevant exceptions being scientific take permits (to enable scientific research or to enhance propagation or survival of a listed species) and incidental permits (as part of an otherwise legal activity).

endangered species (E), federally - a federally protected species which is in danger of extinction throughout all or a significant portion of its range.

endemic - native to and restricted to a particular geographical region.

environment - the complex of climatic, geologic, hydrologic, soils, and biotic factors acting upon organisms.

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 education - education aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution (Stapp et al. 1969).

environmental health - Abiotic composition, structure, and functioning of the environment consistent with natural conditions, including the natural abiotic processes that shape the environment.

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-tern 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).

EPA - Environmental Protection Agency.

estuaries - deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land.

estuarine wetlands - "The estuarine system consists of deepwater tidal habitats and adjacent tidal wetlands that are usually semi-enclosed by land but have open, partly obstructed, or sporadic access to the open ocean, and in which ocean water is at least occasionally diluted by freshwater runoff from the land" (Cowardin et al. 1979).

exemplary community type - an outstanding example of a particular community type.

extinction - dying out, usually global, of a species for any reason.

extirpated - no longer occurring in a given geographic area; the removal, elimination, or disappearance of a species or subspecies from a part of its range.

fauna - the collection of wildlife in a particular region.

FCREPA - Florida Committee on Rare and Endangered Plants and Animals.

FCT - Florida Communities Trust.

FDACS - Florida Department of Agriculture and Consumer Affairs.

FDCA - Florida Department of Community Affairs.

FDEP - Florida Department of Environmental Protection.

FDOF – Florida Division of Forestry

federal land - public land owned by the federal government, including lands such as national forests, national parks and national wildlife refuges.

federally endangered species - any species which is in danger of extinction throughout all or a significant portion of its range.

federally listed species - a species listed under the federal Endangered Species Act of 1973, as amended, either as endangered, threatened or species at risk (formerly candidate species).

federally threatened species - any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

FWC or FFWCCC - Florida Fish and Wildlife Conservation Commission.

FIND - Florida Inland Navigation District.

Finding of No Significant Impact (FONSI) - A document prepared in compliance with the National Environmental Policy Act, supported by an environmental assessment, 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).

Fire behavior - the manner in which a fire reacts to fuel, weather and topography.

FIT - Florida Institute of Technology.

flora - the collection of plants in a particular region.

Florida Natural Areas Inventory (FNAI) Global Rank - a ranking of a species, natural community, bird rookery, spring, sinkhole, cave, or other ecological feature based on the world-wide status of that element.

G1	critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1,000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor
G2	imperiled globally because of rarity (6-20 occurrences or less than 3,000 individuals) or because of vulnerability to extinction due to some natural or man-made factor
G3	either very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals) or found locally in restricted range or vulnerable to extinction from other factors
G4	apparently secure globally (may be rare in parts of range)
G5	demonstrably secure globally
T1	G1 equivalent for subspecies or varieties
T2	G2 equivalent for subspecies or varieties
T3	G3 equivalent for subspecies or varieties
T4	G4 equivalent for subspecies or varieties
T5	G5 equivalent for subspecies or varieties

Florida Natural Areas Inventory (FNAI) State Rank - a ranking of a species, natural community, bird rookery, spring, sinkhole, cave, or other ecological feature based on the status of that element in Florida.

S1	critically imperiled in Florida because of extreme rarity (5 or fewer occurrences or less than 1,000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor
S2	imperiled in Florida because of rarity (6-20 occurrences or less than 3,000 individuals) or because of vulnerability to extinction due to some natural or man-made factor
S3	either very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals) or found locally in restricted range or vulnerable to extinction from other factors
S4	apparently secure in Florida (may be rare in parts of range)
S5	demonstrably secure in Florida
SU	due to lack of information, no rank or range can yet be assigned

FNAI - Florida Natural Areas Inventory.

Fuels management - any manipulation or removal of wildland fuels to reduce the likelihood of ignition or to lessen potential damage from fire or to reduce resistance to control and suppression.

FWS (or USFWS or Service) - US Fish and Wildlife Service.

geographic information system (GIS) - a computerized system used to compile, store, analyze and display geographically referenced information.

goal - descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units.

grant agreement - the legal instrument used when the principal purpose of the transaction is the transfer of money, property, services or anything of value to a recipient in order to accomplish a public purpose of support or stimulation authorized by federal statute and substantial involvement between the Service and the recipient is not anticipated.

grassroots conservation organization - any group of concerned citizens who come together to actively address a conservation need.

habitat - the place where a particular type of plant or animal lives. An organism's habitat must provide all of the basic requirements/components for life and should be free of harmful contaminants.

habitat conservation - the protection of an animal or plant's habitat to ensure that the use of that habitat by the animal or plant is not altered or reduced.

habitat degradation - the process of transitioning from a higher quality to a lower quality wildlife habitat.

habitat fragmentation - breaking up of a specific habitat into smaller unconnected areas. A habitat area that is too small may not provide enough space to maintain a breeding population of the species in question.

HBOI - Harbor Branch Oceanographic Institute

herbicide - a chemical agent used to kill plants or inhibit plant growth.

HMP - Habitat Management Plan.

HSWRI - Hubbs-Sea World Research Institute

hydric - wet.

hydrologic or flow regime - characteristic fluctuations in river flows.

hydrology - the scientific studies of the properties, distribution, and effects of water in the atmosphere, on the earth's surface, and in soil and rocks.

indicator species - a species which, in the context of the surrounding landscape or in comparison with related communities, seems to be most indicative of the particular community.

Integrated Pest Management (IPM) - sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks.

interjurisdictional fish - populations of fish that are managed by two or more states or national or tribal governments because of the scope of their geographic distributions or migrations.

interpretive facilities - structures that provide information about an event, place or thing by a variety of means including printed materials, audiovisuals or multimedia materials. Examples of these would be kiosks which offer printed materials and audiovisuals, signs and trailheads.

interpretive materials - any tool used to provide or clarify information, explain events or things, or serve to increase awareness and understanding of the events or things. Examples of these would be: (1) printed materials such as brochures, maps or curriculum materials; (2) audio/visual materials such as videotapes, films, slides, or audio tapes; and (3) interactive multimedia materials, such as CD ROM and other computer technology.

introduction - a plant or animal moved from one place to another by man.

invasive exotic species - nonnative species which have been introduced into an ecosystem, and, because of their aggressive growth habits and lack of natural predators, displace native species.

issue - any unsettled matter that requires a management decision; e.g., a Service initiative, an opportunity, a management problem, a threat to the resources of the unit, a conflict in uses, a public concerns, or the presence of an undesirable resource condition. Issues should be documented, described, and analyzed in the CCP even if resolution cannot be accomplished during the planning process (Service Manual 602 FW 1.4).

KSC - John F. Kennedy Space Center, NASA.

land trusts - organizations dedicated to conserving land by purchasing land, receiving donations of lands, or accepting conservation easements from landowners.

LAPS - Land Acquisition Priority System (of the US Fish and Wildlife Service)

limiting factor - an environmental limitation that prevents further population growth.

littoral zone - the shore zone from the high water mark to a depth where light is barely sufficient for rooted aquatic plants to grow.

local community - the area or locality in which a group of people resides and shares the same government.

management alternative - a set of objectives and the strategies needed to accomplish each objective (Service Manual 602 FW 1.4).

management plan - a plan that guides future land management practices on a tract of land. In the context of this environmental impact statement, management plans would be designed to produce additional wildlife habitat along with the primary products, such as timber or agricultural crops.

management strategy - a general approach to meet unit objectives. A strategy may be broad, or it may be detailed enough to guide implementation through specific actions, tasks, and projects (Service Manual 602 FW 1.4).

marginal habitat - a habitat with low species diversity due to adverse physical or other conditions.

mesic - moderately moist or requiring moderate amounts of moisture, as in plants.

mitigation - actions taken to compensate for the negative effects of a particular project or action. Wetland mitigation usually takes the form of restoration or enhancement of a previously damaged wetland or creation of a new wetland.

MIWA - Merritt Island Wildlife Association, the friends' group of the Refuge.

MIPCRU - Merritt Island Primary Core Recovery Unit.

MPA - Marine Protected Area.

mosaic - a variety of different habitats intermixed in a relatively small area; several successional stages intermixed within a vegetation type.

MRC - Marine Resources Council.

NABCI - North American Bird Conservation Initiative.

NASA - National Aeronautics and Space Administration.

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 (from 40 CFR 1500).

National Wildlife Refuge System (NWRS) - all lands, waters, and interests therein administered by the US Fish and Wildlife Service as wildlife refuges, wildlife ranges, wildlife management areas, waterfowl production areas, and other areas for the protection and conservation of fish, wildlife, and plant resources.

native - the plant and animal species, habitats, or communities that originated in a particular region or area, or those that have established in a particular region or area without human influence.

native plant - a plant that has grown in the region since the last glaciation and occurred before European settlement.

natural conditions - conditions thought to exists from the end of the Medieval Warm Period to the advent of the industrial era (approximately 950 AD to 1800 AD), based upon scientific study and sound professional judgment.

NAWMP - North American Waterfowl Management Plan.

NEPA - National Environmental Policy Act.

niche - the ecological role of a species in a community.

NMFS - National Marine Fisheries Service.

NOAA - National Oceanic and Atmospheric Association.

nonpoint source pollution - nutrients or toxic substances that enter water from dispersed and uncontrolled sites.

Notice of Intent (NOI) - a notice that environmental documents (e.g., an environmental impact statement) will be prepared and considered (40 CFR 1508.22). Published in the *Federal Register*.

NPS - National Park Service.

NRCS - Natural Resources Conservation Service.

NWR - National Wildlife Refuge.

NWRA - National Wildlife Refuge Association.

NWRS - National Wildlife Refuge System.

NVCS - National Vegetation Classification System.

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. Objectives are attainable, time-specific, and measurable.

occurrence site - a discrete area where a population of a rare species lives or a rare plant community type grows.

organochlorine pesticides - chemicals made primarily of hydrogen, carbon and chlorine that persist for a long time in the environment.

PAC - Polycyclic Aromatic Hydrocarbons.

PAMS - Permanent Air Monitoring System.

Partners for Wildlife Program - a voluntary habitat restoration program undertaken by the Fish and Wildlife Service in cooperation with other governmental agencies, public and private organizations, and private landowners to improve and protect fish and wildlife habitat on private lands while leaving the land in private ownership.

partnership - a contract or agreement entered into by two or more individuals, groups of individuals, organizations or agencies in which each agrees to furnish a part of the capital or some in–kind service, i.e., labor, for a mutually beneficial enterprise.

PCRU - Primary Core Reserve Unit.

PIF - Partners in Flight.

phosphorite - a rock containing a high concentration of phosphorous.

polycyclic aromatic hydrocarbons (PAHs) - fused ring aromatic compounds, ubiquitous pollutants in the atmosphere and relatively resistant to biodegradation.

population monitoring - assessments of the characteristics of populations to ascertain their status and establish trends related to their abundance, condition, distribution, or other characteristics.

prescribed fire - the intentional application of fire to wildland fuels to achieve identified land use objectives (Service Manual 621 FW 1.7).

Primary Core Recovery Units - populations of the Florida scrub-jay that must be kept viable for the species to be considered fully recovered.

priority public uses - hunting, fishing, participating in environmental education, participating in environmental interpretation, observing wildlife, and photographing wildlife. These six priority public uses are outlined in the 1997 National Wildlife Refuge System Improvement Act.

private land - land that is owned by a private individual, group of individuals, or non– governmental organization.

private landowner - any individual, group of individuals or nongovernmental organization that owns land.

private organization (or NGO) - any nongovernmental organization.

protection - mechanisms such as fee title acquisition, conservation easements or binding agreements with landowners that ensure land use and land management practices will remain compatible with maintenance of the species population at the site.

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 land - land that is owned or otherwise managed by the local, state, or federal government.

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 (CFR 1505.2).

recovery - improvement in the status of listed species to the point at which listing is no longer appropriate under the criteria set out in §4(a)(1) of the Endangered Species Act; the process by which species' ecosystems are restored so they can support self-sustaining and self-regulating populations of the listed species as persistent members of native biotic communities.

refuge goals - descriptive, open-ended and often broad statements of desired future conditions that convey a purpose but do not define measurable units (Writing Refuge Management Goals and Objectives: A Handbook).

refuge purposes - 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, a refuge unit, or refuge subunit, and any subsequent modification of the original establishing authority for additional conservation purposes (Service Manual 602 FW 1.4).

refuge lands and waters - those lands and waters in which the Service holds full interest in fee title, or partial interest, such as agreement or easements.

Refuge Operating Needs System (RONS) - the Refuge Operating Needs System is a national database which contains the unfunded operational needs of each refuge. We include projects required to implement approved plans, and meet goals, objectives, and legal mandates.

reintroduction - the process of relocating a plant or animal species to a location where it historically occurred.

restoration - management actions that return a vegetative community or ecosystem to its original, natural condition or to something close to its natural state.
RH - Relative Humidity.

RIM - Rotational Impoundment Management.

RMIS - Refuge Management Information System, FWS; includes RONS and SAMMS.

RONS - Refuge Operating Needs System, FWS.

runoff - water from rain, melted snow, or agricultural or landscape irrigation that flows over the land surface into a water body.

SAMMS - Service Asset Maintenance Management System, FWS.

SAV - Submerged Aquatic Vegetation.

scoping - a process used to determine the scope of issues to be addressed.

Service (or FWS or USFWS) - US Fish and Wildlife Service.

Service presence - the existence of the Service through its programs and facilities which it directs or shares with other organizations; the public awareness of the Service as a sole or cooperative provider of programs and facilities.

SJRWMD - St. Johns River Water Management District.

soil association - a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil

species - a distinctive kind of plant or animal having distinguishable characteristics that can interbreed and produce viable young; a category of biological classification.

species abundance - the relative distribution of the number of individuals of each species in a community.

species diversity - either the absolute number of species or a measure of both the number of species and their relative abundance.

species of management concern - species present in the watershed for which the Refuge has a special management interest. A list of such species would include a mix of federally listed threatened and endangered species; migratory bird, especially declining species, neotropical migrants, colonial waterbirds, shorebirds, and waterfowl; marine mammals; sea turtles; interjurisdictional fish; state-listed threatened, endangered, special concern, and commercially exploited species; Audubon Watch List species for Florida; species on the Florida Natural Areas Inventory list; species listed by the Florida Committee on Rare and Endangered Plants and Animals; and key indicator species.

spodic horizon - a mineral soil horizon or layer characterized by the alluvial accumulation of amorphous material composed of aluminum and organic carbon with or without iron.

SRU - Scrub Reserve Unit.

SSC - Species of Special Concern, State of Florida.

state land - public land owned by a state such as state parks or state wildlife management areas.

step-down management plans - step-down management plans describe management strategies and implementation schedules. Step-down management plans are a series of plans dealing with specific management subjects (e.g., croplands, wilderness, and fire) (Service Manual 602 FW 1.4).

stopover habitat - habitat used during bird migration for rest and feeding.

strategy – a specific action, tool, technique, or combination of actions, tools, and techniques used to meet unit objectives.

succession - a natural sequence of changes in plant species and community structure over time, leading to a hypothesized stable climax community.

surficial aquifer - shallow beds of shells and sand that lie less than 100 feet underground. They are separated from the Floridan aquifer from a confining bed of soil

take - to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to collect to engage in any such conduct.

TCF - The Conservation Fund.

threatened species (T), federally - a federally protected species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

TNC - The Nature Conservancy.

TPL - Trust for Public Land.

trust resource - one that through law or administrative act is held in trust for the people by the government. A federal trust resource is one for which trust responsibility is given in part to the federal government through federal legislation or administrative act. Generally, federal trust resources are those considered to be of national or international importance no matter where they occur, such as endangered species and species such as migratory birds and fish that regularly move across state lines. In addition to species, trust resources include cultural resources protected through federal historic preservation laws, nationally important and threatened habitats, notably wetlands, navigable waters, and public lands such as state parks and National Wildlife Refuges.

UCF - University of Central Florida.

UF - University of Florida.

unfragmented habitat - large blocks of unbroken habitat of a particular type.

unwanted wildland fire - any fire burning in wildland areas that does not meet management objectives. In other words a wildfire.

upland - dry ground; other than wetlands.

USACE (or ACE) – U.S. Army Corps of Engineers.

USC – U.S. Code.

USFWS (or FWS or Service) – U.S. Fish and Wildlife Service.

USGS – U.S. Geological Survey.

vegetation - plants in general or the sum total of the plant life in an area.

vegetation type - a plant community with distinguishable characteristics.

viable population - a population that will continue to occur in the area for the foreseeable future. In population modeling, minimum viable population (MVP) is the smallest number of individuals that are needed to maintain a species population in the long term.

visitor center - a permanently staffed building offering exhibits and interpretive information to the visiting public. Some visitor centers are co-located with refuge offices, others include additional facilities, such as classrooms or wildlife viewing areas.

visitor contact station - compared to a visitor center, a contact station is a smaller facility which may not be permanently staffed.

VSP - Visitor Services Plan.

watershed - the geographic area within which water drains into a particular river, stream or body of water. A watershed includes both the land and the body of water into which the land drains.

WCS - Water Control Structure.

wetlands - The U.S. Fish and Wildlife Service's definition of wetlands states that "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water" (Cowardin et al. 1979).

wildland - land other than that dedicated for other uses such as agriculture, urban, mining or parks.

wildland fire - a fire burning in the wildland areas.

wildlife - the mix of living organisms; includes plants and animals.

wildlife-dependent recreational use - "A use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation." These are the six priority public uses of the System as established in the National Wildlife Refuge System Administration Act, as amended. Wildlife-dependent recreational uses, other than the six priority public uses, are those that depend on the presence of wildlife. We also will consider these other uses in the preparation of refuge CCPs, however, the six priority public uses always will take precedence.

wildlife diversity - a measure of the number and relative abundance of wildlife species in an area.

wildlife management - the practice of manipulating wildlife populations, either directly through regulating the numbers, ages, and sex ratios harvested, or indirectly by providing favorable habitat conditions and alleviating limiting factors.

xeric - dry or desert-like conditions.

Appendix B. - References

Adair, R.C., Jr. 2003. *The Sustainable Citrus Program at the Merritt Island National Wildlife Refuge Citrus Groves: Annual Report 2003.* Florida Research Center, Vero Beach, Florida. 89 pp.

Adrian, F.W., R.C. Lee, Jr. and J.E. Sasser. 1982. *Upland Management Plan for Merritt Island National Wildlife Refuge.* U.S. Fish and Wildlife Service, Titusville, Florida.

Adrian, F.W. 1991. *Forest and Upland Habitat Management Plan, Merritt Island National Wildlife Refuge.* U.S. Fish and Wildlife Service, Titusville, Florida. 22 pp.

Adrian, F.W. 2003. *Fire Management Plan, Merritt Island National Wildlife Refuge.* U.S. Fish and Wildlife Service, Titusville, Florida.

Ainsworth, E.A., P.A. Davey, G.J. Hymus, B.G. Drake and S.P. Long. 2002. Long-term response of photosynthesis to elevated carbon dioxide in a Florida scrub-oak ecosystem. *Ecological Applications* 12: 1267-1275.

Apogee Research, Inc. 1996. *Economic Assessment and Analysis of the Indian River Lagoon.* Apogee Research, Inc., Bethesda, Maryland.

Arctander, P., J. Fjeldsa and A. Jensen. 1984. Sejlads med lufpudebade, jagt og andre forstyrrelser af jugle of sealer ved Saltholm jaj-september 1984. Milljoministeriet, Fredningsstyrelsen, Denmark.

Bauer, H.G., H. Stark and P. Grenzel. 1992. Disturbance factors and their effects on water birds wintering in the western parts of Lake Constance. *Der Ornithologische Beobachter* 89: 81-91.

Bergman, R.D. 1973. Use of southern boreal lakes by post-breeding canvasbacks and redheads. *Journal of Wildlife Management* 37: 160-170.

Breininger, D.R., V.L. Larson, R. Schaub, B.W. Duncan, P.A. Schmalzer, D.M. Oddy, R.B. Smith, F.W. Adrian and H. Hill. 1996. *A Conservation Strategy for the Florida Scrub-jay on John F. Kennedy Space Center/Merritt Island National Wildlife Refuge: An Initial Scientific Basis for Recovery.* NASA-TM-111676, Kennedy Space Center, Florida.

Breininger, D.R., M.L. Legare and R.B. Smith. 2004. Eastern indigo snakes *(Drymarchon couperi)* in Florida: Influence of edge effects on population viability. Pages 299-311 in H. R. Akçakaya, M. Burgman, O. Kindvall, P. Sjorgren-Gulve, J. Hatfield and M. McCarthy, eds., *Species Conservation and Management: Case Studies.* Oxford University Press.

Brevard Nature Alliance. 2001. Natural Resources and Conservation Report. Titusville, Florida.

Bureau of Economic and Business Research. 2002. *2002 Florida Price Level Index.* University of Florida, Gainesville, Florida. 9 pp.

Burger, J. 1981. The effects of human activity on birds at a coastal bay. *Biological Conservation* 21: 231-241.

Burger, J. 1995. Beach recreation and nesting birds. Pages 281-295 in T.L. Knight and K.J. Gutzwiller, eds., *Wildlife and Recreationists: Coexistence through Management and Research.* Island Press, Washington, D.C. 372 pp.

Cahoon, D.R., R.H. Lowers, E.A Reyier, J. B Stewart and P.F. Hensel. 2004. Draft final report, Wetlands Initiative (in preparation). Pages 9.1-9.11 in R.E. Brockmeyer and J. Stewart. St. Johns River Water Management District, Environmental Protection Agency.

Campbell, T. 2000. *Analysis of the Effects of an Exotic Lizard (Anolis sagrei) on a Native Lizard (Anolis carolinensis) in Florida, using Islands as Experimental Units.* Ph.D. Thesis, University of Tennessee, Knoxville, Tennessee. 336 pp.

Campbell, Todd S. and Arthur C. Echternacht. 2003. Introduced species as moving targets: Changes in body sizes of introduced lizards following experimental introductions and historic invasions. *Biological Invasions* 5(3): 193-212.

Clark, Edward E. Engineers-Scientists, Inc. 1987. KSC Ground Water Survey. Kennedy Space Center, Florida.

Cowardin, Lewis M, Virginia Carter, Francis C. Golet and Edward T. LaRoe. 1979. *Classification of Wetlands and Deepwater Habitats of the United States.* U.S. Fish and Wildlife Service, Washington, D.C. 30 pp.

Dahlgren, R.B. and C.E. Korschgen. 1992. *Human Disturbance of Waterfowl: An Annotated Bibliography.* Resource Publication 188, U.S. Fish and Wildlife Service, Washington D.C. 62 pp.

Deming, Joan G., Carrie J. Scupholm and Kimberly Hinder. 2001. Cultural Resource Management Plan. National Aeronautics and Space Administration, John F. Kennedy Space Center, Brevard and Volusia Counties, Florida. Sarasota, Florida. 79 pp.

Dobb, E. 1998. Reality check: the debate behind the lens. *Audubon* January-February, 1998.

Duncan, B.W. and P.A. Schmalzer. 2004. Anthropogenic influences on potential fire spread in a pyrogenic ecosystem in Florida, USA. *Landscape Ecology* 19: 153-165.

Duncan, B.W., S. Boyle, D.R. Breininger and P.A. Schmalzer. 1999. Coupling past management practice and historic landscape change on John F. Kennedy Space Center, Florida. *Landscape Ecology* 14: 291-309.

Ehrhart, L.M. and R.G. Yoder. 1978. Marine turtles of Merritt Island National Wildlife Refuge, Kennedy Space Center, Florida. *Proceedings of the Florida Interregional Conference on Sea Turtles,* July 1976. Florida Marine Research Publications, No 33.

Epstein, M. 1999. Incidental impact to nesting Wilson's plovers during the sea turtle nest monitoring season. *Florida Field Naturalist* 27(4): 173-176.

Epstein, M. 2001a. *Cold-stunned Sea Turtle Rescue Plan for Merritt Island National Wildlife Refuge, including the Mosquito Lagoon, North Indian and Banana Rivers: Protocol for Response.* U.S. Fish and Wildlife Service, Titusville, Florida. 5 pp.

Epstein, M. 2001b. Managing wetlands for multiple objectives: Atlantic Flyway. *Waterfowl Habitat Restoration, Enhancement and Management in the Atlantic Flyway,* 4th Edition. Environmental Management Committee, Atlantic Flyway Council, Tech. Sect. U.S. Fish and Wildlife Service.

Epstein, M. and R. Lloyd. 2001b. Draft Wetland Management Plan: Merritt Island National Wildlife Refuge. Unpublished Report, U.S. Fish and Wildlife Service. 26 pp.

Epstein, Marc and Boyd Blihovde. 2006. Listed Species of the Merritt Island National Wildlife Refuge. Unpublished Report, U.S. Fish and Wildlife Service. Titusville, Florida.

Erwin, R.M., D.H. Allen and D. Jenkins. 2003. Created versus natural coastal islands: Atlantic waterbird populations, habitat choices, and management implications. *Estuaries* 26(4A): 949-955.

Erwin, R.M., J.S. Hatfield and T.J. Wilmers. 1994. The value and vulnerability of small estuarine islands for conserving metapopulations of breeding waterbirds. *Biological Conservation* Vol. 71.

Florida Department of Environmental Protection. 1999. *Air Quality Monitoring Report: 1999.* Tallahassee, Florida. 99 pp.

Florida Exotic Pest Plant Council. 2005. *List of Florida's Invasive Species.* Florida Exotic Pest Plant Council, accessed at http://www.fleppc.org/05list.htm.

Florida Fish and Wildlife Conservation Commission. 2000. *Birding Economics.* Accessed at http://floridabirdingtrail.com/fwc/viewing/gfbt/economics.htm.

Florida Fish and Wildlife Conservation Commission. 2004. *2003 Boating Accident Statistical Report.* Tallahassee, Florida.

Francis, Mark. 2002. *How Cities Use Parks for Community Engagement.* City Parks Forum Briefing Papers, American Planning Association, Chicago, Illinois. 4 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.

Hardesty, Jeff L. and Michael W. Collopy. 1990. *Nesting Ecology, Habitat Use, and Dispersal of the Southern Bald Eagle on John F. Kennedy Space Center (Merritt Island National Wildlife Refuge) and Vicinity, Florida: Phase One.* Annual Report to the National Fish and Wildlife Foundation.

Hardesty, Jeff L. and Michael W. Collopy. 1991. *History, Demography, Distribution, Habitat Use, and Management of the Southern Bald Eagle (Haliaeetus l. leucocephalus) on Merritt Island National Wildlife Refuge, Florida.* Final Report to the National Fish and Wildlife Foundation. Department of Wildlife and Range Sciences, School of Forest Resources and Conservation, University of Florida. Gainesville, Florida.

Harding, David B. 2004a. *Economic Value/Consumer Surplus.* Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Harding, David B. 2004b. *Fish and Wildlife Recreation Creates Huge Economic Boon for Florida - Economic Impacts 2003.* Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Harms, W.R. 1990. Quercus virginiana Mill. live oak. Pages 751-754 in R.M. Burns and B.H. Honkala, technical coordinators, *Silvics of North America, Volume 2, Hardwoods.* Agricultural Handbook 654, U.S. Department of Agriculture, Forest Service. Washington, D.C.

Herring, Garth and Jaime Collazo. 2004. Winter survival of lesser scaup in east-central Florida. *Journal of Wildlife Management* 68(4): 1082-1087.

Herring, Garth. 2003. *Nutrient Reserves and Local Population Dynamics of Winter Lesser Scaup in East-central Florida.* Thesis, North Carolina State University, Raleigh, North Carolina.

Howell, J.C. 1954. A history of some bald eagle nest sites in east central Florida. *The Aux* Vol 71.

Hume, R.A. 1976. Reaction of goldeneyes to boating. *British Birds* 69: 178-179.

Hungate, B.A. D.W. Johnson, P. Dijkstra, G. Hymus, P. Stiling, J.P. Megonigal, A.L. Pagel, J.L. Moan, J. Li, C.R. Hinkle and B.G. Drake. 2006. Nitrogen cycling during seven years of atmospheric CO_2 enrichment in a scrub-oak woodland. *Ecology* 87(1): 26-40.

Hunter, C. 1999. Florida WatchList (Priority Bird Species). Unpublished draft, October 31, 1999. 6 pp.

Hymus, G.J., D.P. Johnson, S. Dore, H.P. Anderson, C.R Hinkle and B.G. Drake. 2003. Effects of elevated atmospheric CO_2 on net ecosystem CO_2 exchange of a scrub-oak ecosystem. *Global Change Biology* 9: 1802-1812.

Indian River Lagoon National Estuary Program. 1996. *The Indian River Lagoon Comprehensive Conservation and Management Plan.* St. Johns River Water Management District, Palatka, Florida. 357 pp.

Johnson, D.W., B.A. Hungate, P. Dijkstra, G. Hymus, C.R. Hinkle and B.G. Drake. 2003. The effects of elevated CO_2 on nutrient distribution in a fire-adapted scrub-oak forest. *Ecological Applications* 13(5): 1388-1399.

Jackson, Jeremy B.C., Michael X. Kirby, Wolfgang H. Berger and Karen A. Bjorndal. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293(5530): 629-637.

Jahn, L.R, and R.A. Hunt. 1964. *Duck and Coot Ecology and Management in Wisconsin.* Wisconsin Conservation Department, Technical Bulletin 33. 211pp.

Johnson, A.F. and M.B. Barbour. 1990. Dunes and maritime forest. Pages 429-480 in R.L. Myers and J. Ewel, eds., *Ecosystems of Florida.* University Central Florida Press, Orlando, Florida.

Johnson, F.A., T. Beech, R.M. Dorazio, M. Epstein, and J. Lyon. 2006. Abundance and detection probabilities of Florida scrub-jays at Merritt Island National Wildlife Refuge using spatially replicated counts. Draft Report, USFWS, Division of Migratory Bird Management, Gainesville, Florida. 16 pp.

Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. *Wildlife Society Bulletin* 19: 242-248.

Kelly, A. Christine. 2000. *Shorebird Populations and Habitat Quality at Merritt Island National Wildlife Refuge.* M.S. Thesis, North Carolina State University, Raleigh, North Carolina.

Klein, M. L. 1993. Waterbird behavior responses to human disturbances. *Wildlife Society Bulletin* 21: 31-39.

Knight, R.L. and D.N. Cole. 1995. Wildlife response to recreationists. Pages 71-79 in R.L. Knight and K.J. Gutzwiller, eds., *Wildlife and Recreation: Coexistence thorough Management and Research.* Island Press, Washington, D.C. 372 pp.

Korschgen, C.E. and R.B. Dahlgren. 1992. *Human Disturbance of Waterfowl: Causes, Effects and Management.* U.S. Fish and Wildlife Service Leaflet 13.2.15. 7 pp.

Korschgen, C.E., L.S. George and W.L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. *Wildlife Society Bulletin* 13: 290-296.

Laskowski, H., T. Leger, J. Gallegos, and F. James. 1993. Behavior Response of Greater Yellowlegs, Snowy Egrets and Mallards to Human Disturbance at Back Bay National Wildlife Refuge. Unpubished Report #51510-01-92. U.S. Fish and Wildlife Service, Washington, D.C. 25 pp.

Leatherman, S.P. and P.J. Kershaw. 2001. *Sea Level Rise and Coastal Disasters – Summary of a Forum.* National Research Council, National Academy Press. Washington, DC. 20pp.

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.

Lewis, Megan. 2002. *How Cities Use Parks for Economic Development.* City Parks Forum Briefing Papers, American Planning Association, Chicago, Illinois. 4 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 a Florida scrub-oak ecosystem. *Photsynthetcia* 25(1): 51-58.

Lohrey, R.E. and S.V. Kossuth. 1990. Pinus elliottii Englem. slash pine. Pages 338-347 in R.M. Burns and B.H. Honkala, technical coordinators, *Silvics of North America, Volume 1, Conifers.* Agricultural Handbook 654, U.S. Department of Agriculture, Forest Service, Washington, D.C.

Madsen, J. 1995. Impacts of disturbance on migratory waterfowl. *Ibis* 137: S67-S74.

Market Street Services, Inc. 2001. Economic and Demographic Profile. Prepared for Brevard Tomorrow, Atlanta, Georgia. 44 pp.

Mendonca, M.T. and L.M. Ehrhart. 1982. Activity, population size and structure of immature *Chelonia mydas* and *Caretta caretta* in Mosquito Lagoon, Florida. *Copeia* (1): 161-167.

Millsap, B.A., J.A. Gore, D.E. Runde and S.I. Cerulean. 1990. Setting priorities for the conservation of fish and wildlife species in Florida. *Wildlife Monographs* 111: 1-57.

Milon J.W. and E. Thunberg. 1993. *A Regional Analysis of Current and Future Florida Resident Participation in Marine Recreational Fishing.* Florida Sea Grant College Program, Sea Grant Report #112, University of Florida, Gainesville, Florida.

Moorhead, Kevin K. and Mark M. Brinson. 1995. Response of wetlands to rising sea level in the lower coastal plain of North Carolina. *Ecological Applications* 5(1): 261-271.

Morton, J.M. 1995. Management of human disturbance and its effects 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 Edition. Environmental Management Commission, Atlantic Flyway Council Technical Section, and Delaware Division of Fish and Wildlife, Dover, Delaware. 1114 pp.

Morton, J.M., A.C. Fowler and R.L. Kirkpatrick. 1989a. Time and energy budget of American black ducks in winter. *Journal of Wildlife Management* 53: 401-410.

Morton, J.M., R.L. Kirkpatrick, M.R. Vaughan and D.F. Stauffer. 1989b. Habitat use and movements of American black ducks in winter. *Journal of Wildlife Mangement* 53: 390-400.

National Aeronautics and Space Administration. 2001. Wetlands Restoration Plan. Planning Report, Restoration Efforts with U.S. Fish and Wildlife Service. Unpublished report. 148 pp.

National Aeronautics and Space Administration. 1984. *Master Plan, John F. Kennedy Space Center.* Titusville, Florida.

National Weather Service. 2005. Accessed at http://www.srh.noaa.gov/mlb/ltgcenter/ltgmain.html. National Weather Service Office, Melbourne, Florida.

Paperno, R. 2001. *Estuarine Fish Species List for Merritt Island National Wildlife Refuge.* Florida Fish and Wildlife Conservation Commission. Personal communication.

Parkinson, R.W., R.R. DeLaune, C.T. Hutcherson and J. Stewart. 2006. Tuning surface water management and wetland restoration programs with historic sediment accumulation rates: Merritt Island National Wildlife Refuge, east central Florida, USA. *Journal of Coastal Research* 22: 1268-1277.

Patrick Air Force Base. 2004. Operational climatic data summary KTTS. Accessed at https//:www.patrick.af.mil/45OG/45ws/data/SLF climo.htm.

Paulus, S.L. 1984. Activity budgets of nonbreeding gadwalls in Louisiana. *Journal of Wildlife Management* 48: 371-380.

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.

Popotnik, Gary J. and M. Epstein. 2002. "Characterization of Sea Turtle Nesting Trends and Depredation Rates at the Merritt Island NWR, Kennedy Space Center, Florida." Poster presentation for the 22nd Annual Symposium on Sea Turtle Conservation and Biology. U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge, Abstract p. 10.

Provancha, J.A, M.J. Mota, R. Lowers, D. Scheidt and E. Reyier. 2002. Relative abundance and distribution of marine turtles inhabiting Mosquito Lagoon: Summary of 2001 surveys. Abstract in *Third Biennial Mosquito Lagoon Conference.* U.S. Fish and Wildlife Service and National Park Service, Titusville, Florida.

Provancha, J.A. and M.J. Provancha. 1988. Long-term trends in abundance and distribution of manatees (*Trichechus manatus*) in the northern Banana River, Brevard County, Florida. *Marine Mammal Science* 4(4): 323-338.

Randazzo, A.F. 1997. The sedimentary platforms of Florida: Mesozic to Cenozoic. Pages 39-56 in A.F. Randazzo and D.S. Jones, eds., *The Geology of Florida.* University Press of Florida, Gainesville, Florida.

Reed, D.J. and D.R. Cahoon. 1993. Marsh submergence vs. marsh accretion: Interpreting accretion deficit data in coastal Louisiana. Pages 243-257 in *Coastal Zone 93: Proceedings of the 8th Symposium.* Coastal and Ocean Management.

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.

Roberts, C.M., J.A. Bohnsak, F. Gell, J.P. Hawkins and R. Goodridge. 2001. Effects of marine reserves on adjacent fisheries. *Science* 294: 1920-1923.

Robins, E.L. and R.L. Myers. 1992. *Seasonal Effects of Prescribed Burning in Florida: A Review.* Tall Timbers Miscellaneous Publication 8. Tall Timbers Research Station, Tallahassee, Florida. 96 pp.

Rodgers, J.A., Jr. and H.T. Smith. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbances in Florida. *Wildlife Society Bulletin* 25(1): 139-145.

Rodgers, James A., Jr. and Stephen T. Schwikert. 2002. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboard-powered boats. *Conservation Biology* 16(1): 216-224.

Sargent, F.J., T.J. Leary, D.W. Crewz and C.R. Kruer. 1995. *Scarring of Florida's Seagrasses: Assessment and Management Options.* Florida Department of Environmental Protection, Florida Marine Research Institute. St. Petersburg, Florida.

Schmalzer, P.A. and M.A. Hensley. 2001. Background characteristics of groundwater in the surficial aquifer of Kennedy Space Center, Merritt Island, Florida. *Florida Scientist* 64: 250-273.

Schmalzer, P.A., M.A. Hensley and C.A. Dunlevy. 2001. Background characteristics of soils of Kennedy Space Center, Merritt Island, Florida: Selected elements and physical properties. *Florida Scientist* 64(3): 161-190.

Schmalzer, P.A., T.E Foster and B.W. Duncan. 2002. *Revised List of Flora and List of Threatened and Endangered Plants for the John F. Kennedy Space Center Area, Florida.* NASA/TN-2002-21175. John F. Kennedy Space Center, Florida.

Schmalzer, P.A., S.R. Turek, T.E. Foster, C.A. Dunlevy, and F.W. Adrian. 2002. Reestablishing Florida scrub in a former agricultural site: Survival and growth of planted species and changes in community composition. *Castanea* 67: 146-160.

Seigel, R.A. and D.A. Pike. 2003. *Continued Studies on Amphibians and Reptiles of the Kennedy Space Center, Merritt Island National Wildlife Refuge, and Canaveral National Seashore.* Annual Report. Towson University. 29 pp.

Seigel, Richard A. and Nadia A Siegel. 2000. Inventory and Monitoring of Herpetological Communities on the Kennedy Space Center/Merritt Island National Wildlife Refuge/Canaveral National Seashore: Annual Report. Unpublished report to Merritt Island National Wildlife Refuge. Southeastern Louisiana University, Lafayette, Louisiana.

Skagen, S.K. 1980. Behavioral response of wintering bald eagles to human activity on the Skagit River, Washington. Pages 231-241 in R.L. Knight, G.T. Allen, M.V. Stalmaster and C.W. Servhenn, eds., *Proceedings of the Washington Bald Eagle Symposium.* The Nature Conservancy, Seattle, Washington.

Soil Survey Staff. 1974. *Soil Survey of Brevard County, Florida.* U.S. Department of Agriculture, Soil Conservation Service. Washington, D.C. 123 pp.

South Florida Water Management District. 2005. Indian River Lagoon License Plate, Coastal Ecosystems, West Palm Beach, Florida. Accessed at http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_lagoon/snook_tag.html.

Speight, M.C.D. 1973. Outdoor recreation and its ecological effects: A bibliography and review. *Discussion Papers in Conservation No. 4.* University College of London, England. 35 pp.

Stapp, Wiliam B., D. Bennet, W. Bryan, J. Fulton, J. MacGregor, P. Nowak, J. Wan, R. Wall and S. Havlick. 1969. The concept of environmental education. *Journal of Environmental Education* 1(1): 30-31.

Sterling, T. and A. Dzubin. 1967. Canada goose molt migrations to the Northwest Territories. *Transactions of the North American Research Conference* 32: 367-369.

Stevens, T. and G. Knight. 2003. *Status and Distribution of the Florida Scrub-jay (Aphelocoma coerulescens) at Cape Canaveral Air Force Station, Florida.* Annual Report 2002-2003, 45th CES/CEV, Patrick Air Force Base, Florida.

Stevenson, Phillip W. and Kenneth Sulak. 2001. Egress of adult sport fish from an estuarine reserve within Merritt Island National Wildlife Refuge, Florida. *Gulf of Mexico Science* 2: 77-89.

Stolen, E. and J. Collazo. 2004. Wading bird foraging habitat use investigations. Chapter 16 in R. Brockmeyer and J. Steward, eds., *Wetland Initiative Draft Final Report.* St. Johns River Water Management District, Palatka, Florida.

Thompson, D. 1973. Feeding ecology of diving ducks on Keokuk Pool, Mississippi River. *Journal of Wildlife Management* 37: 367-381.

U.S. Census Bureau. 2000a. County Population Estimates. Accessed at http://www.census.gov/population/www/estimates/popest.html. U.S. Bureau of the Census, Population Division. Washington, D.C.

U.S. Census Bureau. 2000b. U.S. Census 2000 Redistricting Data (Public Law 94-171). Accessed at http://www.census.gov and http://factfinder.census.gov.

U.S. Department of Agriculture. 1941. Climate and man. Yearbook of Agriculture. U.S. Government Printing Office, Wahington D.C.

USDA. 2007. Natural Resources Conservation Service Plant Data Base. Accessed on April 2, 2007 at http://plants.usda.gov.

U.S. Department of Energy. 1999. *Carbon Sequestration Research and Development.* Washington, D.C.

U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. 2001. *National Survey of Fishing, Hunting, and Wildlife-associated Recreation.* Washington, D.C.

U.S. Environmental Protection Agency. 2000. Total Maximum Daily Load (TMDL) Program. Accessed at http://www.epa.gov/owow/tmdl/index.html, http://www.epa.gov/iwi/303d/03080202_303d.html (Cape Canaveral area), and http://www.epa.gov/iwi/303d/03080203_303d.html (Vero Beach area). Office of Water, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Fish and Wildlife Service. 1979. *Merritt Island National Wildlife Refuge Master Plan.* USFWS Southeast Regional Office, Atlanta, Georgia. 5 pp.

U.S. Fish and Wildlife Service. 1996. *North Florida Ecosystem Unit Management Plan for Fish and Wildlife Service Trust Resources.* USFWS Southeast Regional Office, Atlanta, Georgia. 17 pp.

Virnstein, R.W. 1999. Seagrass meadows: Fish and wildlife factors. *Florida Naturalist* 72(2): 18-19.

Virnstein, R. W. and L.J. Morris. 1996. *Seagrass Preservation and Restoration: A Diagnostic Plan for the Indian River Lagoon.* Technical Memo 14, St. Johns River Water Management District, Palatka, Florida. 43 pp.

VISIT FLORIDA. 2003. *2002 Profile of Domestic Visitors to Florida.* VISIT FLORIDA Research Department, Tallahassee, Florida.

Wade, D.D. and O.G. Langdon. 1990. Sabal palmetto (Walt.) Lodd. ex J.A. and J.H. Schult, cabbage palmetto. Pages 762-767 in R.M. Burns and B.H. Honkala, technical coordinators, *Silvics of North America, Volume 2, Hardwoods.* Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, D.C.

Walters, L., A. Roman, J. Stiner and D. Weeks. 2001. *Water Resources Management Plan: Canaveral National Seashore, Florida.* National Park Service. 224 pp.

White, W.A. 1970. *The Geomorphology of the Florida Peninsula.* Geological Bulletin No. 51. Bureau of Geology, Florida Department of Natural Resources, Tallahassee, Florida. 164 pp.

Wikipedia. 2005. Mountain Biking. Accessed at http://en.wikipedia.org/wiki/Mountain.biking.

Wolder, M. 1993. *Disturbance of Wintering Northern Pintail at Sacramento National Wildlife Refuge, California.* M.S. Thesis, Humbolt State University, Arcata, California. 62 pp.

Youngman, R.W. 1998. Letter dated 19 January 1998 to Marc Epstein of the U.S. Fish and Wildlife Service, Merritt Island National Wildlife Refuge.

Appendix C. - Relevant Legal Mandates

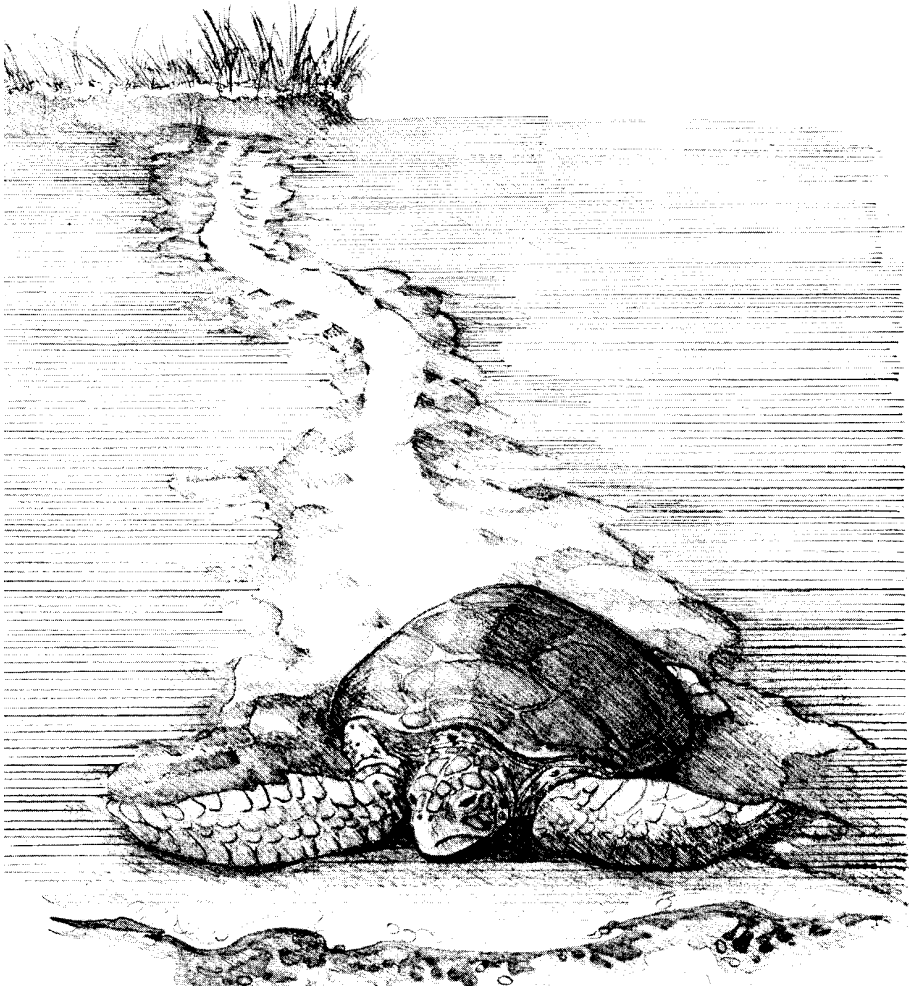
Several procedural and substantive requirements of federal and applicable state and local laws and regulations affect refuges. The key laws, treatises, conventions, and executive orders are listed.

- Lacey Act (1900), as amended
- Antiquities Act (1906)
- Weeks-McLean Law (1913)
- Canadian United States Migratory Bird Treaty (Convention between the United States and Great Britain for Canada for the Protection of Migratory Birds) (1916)
- Migratory Bird Treaty Act (1918 and 1978)
- Migratory Bird Conservation Act (1929), as amended
- Migratory Bird Hunting and Conservation Stamp Act (1934)
- Fish and Wildlife Coordination Act (1934), as amended
- Historic Sites Act (1935)
- Refuge Revenue Sharing Act (1935), as amended
- Convention between the United States of America and the Mexican States for the Protection of Migratory Birds and Game Animals (1936)
- Federal Aid in Wildlife Restoration Act, as amended (1937)
- Bald and Golden Eagle Protection Act (1940), as amended
- Convention of Nature Protection and Wildlife Preservation in the Western Hemisphere (1940)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (1943)
- Flood Control Act (1944), as amended
- Transfer of Certain Real Property for Wildlife Conservation Purposes Act (1948)
- Refuge Trespass Act (1948)
- Federal Property and Administrative Services Act (1949), as amended
- Federal Aid in Fish Restoration Act (1950)
- Fish and Wildlife Act (1956), as amended
- Waterfowl Depredations Prevention Act, as amended (1956)
- Fish and Wildlife Coordination Act (1958)
- Cooperative Research and Training Units Act (1960)
- Wetlands Loan Act (1961)
- Refuge Recreation Act (1962), as amended
- Water Resources Planning Act (1962), as amended
- Refuge Revenue Sharing Act (1964), as amended
- Wilderness Act (1964)
- Land and Water Conservation Fund Act (1965), as amended
- National Wildlife Refuge System Administrative Act (1966)
- National Historic Preservation Act (1966)
- Feedom of Information Act (1967)
- Architectural Barriers Act (1968)
- National Trails System Act (1968)
- Wild and Scenic Rivers Act (1968)
- National Environmental Policy Act (1969)
- Executive Order 11514, Protection and Enhancement of Environmental Quality (1970)
- Executive Order 11593, Protection and Enhancement of the Cultural Environment (1971)

- Clean Water Act (1972)
- Convention on Wetlands of International Importance (1972)
- Executive Order 11644 - Use of Off-road Vehicles on Public Lands (1972), as amended (Executive Order 11989, 1977)
- Federal Environmental Pesticide Control Act (1972), as amended
- Federal Water Pollution Control Act Amendments (1972), as amended
- Endangered Species Act (1973), as amended
- Rehabilitation Act (1973)
- Archaeological and Historic Preservation Act (1974)
- Environmental Education Act (1975)
- Federal Land Policy Management Act (1976)
- Clean Air Act (1977), as amended
- Clean Water Act (1977)
- Executive Order 11988, Floodplain Management and Wetlands Preservation (1977)
- Executive Order 11989, Use of Off-road Vehicles on Public Lands (1977)
- Executive Order 11990, Protection of Wetlands (1977)
- Fish and Wildlife Improvement Act (1978)
- American Indian Religious Freedom Act (1978)
- Archaeological Resources Protection Act (1979)
- Administrative Procedures Act (1979)
- Fish and Wildlife Conservation Act (1980)
- Executive Order 12372 - Intergovernmental Review of Federal Programs (1982)
- The Food Security Act (1985)
- Emergency Wetlands Resources Act (1986)
- North American Wetlands Conservation Act (1989)
- Federal Noxious Weed Act (1990)
- Native American Graves Protection and Repatriation Act (1990)
- Americans with Disabilities Act (1992)
- Wild Bird Conservation Act (1992)
- Executive Order 12898, Environmental Justice in Minority Populations and Low-income Populations (1994)
- Secretarial Order 3127 (602 DM 2), Contaminants and Hazardous Waste Determination (1995)
- Executive Order 12996, Management and General Public Use of the National Wildlife Refuge System (1996)
- Executive Order 13007, Indian Sacred Sites (1996)
- National Refuge System Improvement Act (1997) (and subsequent policies)
- Executive Order 13084, Consultation and Coordination with Indian Tribal Governments (1998)

Appendix D. - Biota

LISTED SPECIES OF THE MERRITT ISLAND NATIONAL WILDLIFE REFUGE



Compiled by:
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Merritt Island National Wildlife Refuge
February 2006

LISTED SPECIES OF THE MERRITT ISLAND NATIONAL WILDLIFE REFUGE

Listed species are plants or animals that have been listed by a state and/or federal agency with special protection or conservation designations. Included on this list are species designated by nongovernmental agencies that do not provide regulatory protection (see below). Those species with regulatory protection are protected by law, such as state and federal endangered and threatened species. State Species of Special Concern (SSC) and Commercially Exploited are afforded special protection, recognition, or consideration (Florida Administrative Code 39-1.004 and Chapter 5B-40). Birds of Conservation Concern are those migratory and nonmigratory bird species (not already listed as federally Threatened or Endangered) with the highest conservation priority (USFWS 2002). Brief explanations of species designations are listed below. Definitions of species designations and status are listed in Appendix 1.

Types of Designations Used in this List:

Agencies and Organizations Listing Species

Florida Fish and Wildlife Conservation Commission **(FWC)**
Florida Department of Agriculture and Consumer Services **(FDA)**
US Fish & Wildlife Service **(FWS)**
Florida Natural Areas Inventory **(FNAI)**
Florida Committee on Rare and Endangered Plants and Animals **(FCREPA)**

Listing Designation

Similarity of Appearance T(S/A) means the species is similar in appearance to a threatened taxon. The American alligator in this case with the American crocodile, but the alligator is not a threatened species under the meaning or intent of the threatened designation.

Endangered (E) means “without special management efforts, these species are considered rare enough to become extinct.” (Federal and State)

Threatened (T) means “without special management efforts, these species are likely to become endangered in the foreseeable future.” (Federal and State)

Species of Special Concern (SSC) means that the species warrants special protection because of concern that it could become threatened. (State; see Sullivan 2004))

Birds of Conservation Concern (BCC) replaced the Nongame Birds of Management Concern (SMC). These birds have the highest conservation concern for the US Fish and Wildlife Service (other than the birds listed as federally Threatened or Endangered) (Federal; see USFWS 2002).

Rare (R) means the species is considered rare by the Florida Committee on Rare and Endangered Plants and Animals (nongovernment).

Commercially Exploited (C) means plants that are protect due to Commercial Exploitation.

Rare (R) means the species is considered rare by the Florida Committee on Rare and Endangered Plants and Animals (nongovernment).

FNAI means that the species has been ranked by the Florida Natural Areas Inventory (nongovernment).

FCREPA means the species is listed by Florida Committee on Rare and Endangered Plants and Animals (nongovernment).

This list is based on species with a federal, state, or nongovernment designation; it is not a comprehensive list of species for the refuge. There are 124 unique species included under this list: 1 amphibian, 10 reptiles, 69 birds, 6 mammals, and 38 plants. There may be species in Florida that are protected but not listed here because the species either has not been confirmed or has been extirpated from the refuge. This list includes species that are considered rare and do not occur on the refuge every year or there have been incidental reports (see Literature Cited section). The total number of listed species presently known to exist or regularly occur on the refuge is categorized (Tables 1 and 2).

Among the 124 species listed here, 50 are listed as state or federal threatened or endangered plants and animals (21 animals and 28 plants) and 5 are plants that are listed by the state as Commercially Exploited (Table 3). There are no known federally listed plants on the refuge and all listing for plant are state designations. Of the total listed animal species, 17 are federally listed. However, 7 of these species (American alligator, Kemp's ridley sea turtle, Hawksbill sea turtle, Atlantic salt marsh snake, snail kite, Audubon's crested caracara, and roseate tern) either have a special listing (i.e., alligator) or have rarely been recorded on the refuge. This brings the actual number of state or federally-listed species that presently occur on the refuge to 41; 10 federal and 31 state species (excludes alligator; includes 28 plant species) (Table 2). There are 10 federally and 3 state listed animal species (13 total state or federal) that presently occur on the refuge. A total of 93 species that presently occur on the refuge have a federal or state designation (i.e., T, E, BCC, SSC, or C). Annotated species records of rare sightings (16 species) are included on this list, however, these rare species may not actually be a functional component of the wildlife community on the refuge and may only be the results of incidental sightings. Additionally, rare nonfederally listed species, such as the Florida black bear, Limpkin, Roseate tern, and others are also listed but may have limited distribution or activity on the refuge. Species that are rare or have only had incidental sightings are footnoted to this effect. They are removed from the final calculation.

There are 55 animal species designated as species of Special Concern by state or federal agencies (designated BCC or SSC). There are 33 plant species listed by the state as Threatened, Endangered, or Commercially Exploited. Included in the list are 22 additional plant species that have special designations (e.g., UR, FNAI, CITES, or FCREPA). Some plant species may have both a state and special designation.

Table 1. State or federally designated plants and animals that have been recorded on Merritt Island National Wildlife Refuge.

Species	**Federal**				**State**			**Commercially Exploited Plants**
	E	T	BCC		E	T	SSC	C
Fishes	0	0	0		0	0	0	0
Amphibians	0	0	0		0	0	1	0
Reptiles	4	4	0		5	2	3	0
Birds	2	5	42		3	8	12	0
Mammals	1	1	0		1	2	1	0
Plants	0	0	0		17	11	0	5
Total Recorded	**7**	**10**	**42**		**26**	**23**	**17**	**5**

Table 2. Number state and federally threatened and endangered species that presently occur on the refuge.

T & E Species Presently Occurring	Fish	Amphibians	Reptiles	Birds	Mammals	Plants	TOTAL
Number of Federal	0	0	4	4	2	0	10
Number of State and Federal	0	0	4	7	2	28	41

Table 3. Listed species of the Merritt Island National Wildlife Refuge.

Scientific Names	Common Names	Agency Status			
		FWC	FWS	FCREPA	FNAI
Amphibians (1)					
Rana capito	Gopher frog	SSC	*	T	G3G4S3
Reptiles (10)					
Alligator Mississippiensis	American alligator [1]	SSC	T(S/A)	*	G5S4
Caretta caretta	Loggerhead	E	T	T	S3
Chelonia mydas	Green turtle	E	E	E	S2
Dermochelys coriacea	Leatherback	E	E	R	S2
Lepidochelys kempi	Kemp's ridley [3, 5]	E	E	E	S1
Eretmochelys imbricata	Hawksbill [3, 5]	E	E	E	S1
Gopherus polyphemus	Gopher tortoise	SSC	*	T	S3
Pituophis melanoleucus mugitus	Florida pine snake [4]	SSC	*	SSC	G5T3S3
Nerodia clarkii taeniata	Atlantic saltmarsh snake [2, 5]	T	T	E	G4T1S1
Drymarchon couperi	Eastern indigo snake	T	T	SSC	G4T3S3
Birds [6, 7] (69)					
Spizella pusilla	Field sparrow	*	BCC	*	*
Ammodramus henslowii	Henslow's sparrow [5]	*	BCC	*	*
Aimophila aestivalis	Bachman's sparrow	*	BCC	*	G3S3

Scientific Names	Common Names	Agency Status			
		FWC	FWS	FCREPA	FNAI
Passerina ciris	Painted bunting	*	BCC	*	G5S3
Sturnella magna	Eastern meadowlark	*	BCC	*	*
Dolichonyx oryzivorous	Bobolink	*	BCC	*	*
Dendroica discolor	Prairie warbler	*	BCC	*	G5T3S3
Dendroica pensylvanica	Chestnut-sided warbler	*	BCC	*	*
Lymnothylpis swainsonii	Swainson's warbler [5]	*	BCC	*	*
Vireo altiloguus	Black-whiskered vireo	*	BCC	R	G5S3
Lanius ludovicianus	Loggerhead shrike	*	BCC	*	*
Cistothorus platenis	Sedge wren	*	BCC	*	*
Hylocichla mustelina	Wood thrush	*	BCC	*	*
Catharus fuscescens	Veery	*	BCC	*	*
Colaptes auratus	Northern flicker	*	BCC	*	*
Aphelocoma coerulescens	Florida scrub-jay	T	T	T	G2S2
Aramus guarauna	Limpkin [5]	SSC	BCC	SSC	G5S3
Charadrius melodus	Piping plover	T	T	E	G3S2
Botaurus lentiginosus	American bittern	*	BCC	*	*
Ixobrychus exilis	Least bittern	*	BCC	SSC	G5S4
Egretta caerulea	Little blue heron	SSC	*	SSC	G5S4
Egretta rufescens	Reddish egret	SSC	BCC	R	G4S2
Egretta thula	Snowy egret	SSC	*	SSC	G5S3
Egretta tricolor	Tricolored heron	SSC	*	SSC	G5S4
Eudocimus albus	White ibis	SSC	*	SSC	G5S4
Polyborus plancus audubonii	Audubon's crested caracara [5, 7]	T	T	T	G5S2LTLT
Falco peregrinus	Peregrine falcon	E	*	E	G4S2
Rosthrhramus sociabilis	Snail kite [5, 7]	E	E	E	G4G5T2S2
Elanoides forficatus	Swallow-tailed kite	*	BCC	T	G5S2

Scientific Names	Common Names	Agency Status			
		FWC	FWS	FCREPA	FNAI
Circus cyaneus	Northern harrier	*	BCC	*	*
Grus canadensis pratensis	Florida sandhill crane	T	*	T	G5T2T3S2S3
Haematopus palliates	American oystercatcher	SSC	*	T	G5S2
Mycteria Americana	Wood stork	E	E	E	G4S2
Gavia immer	Common loon	*	BCC	*	*
Pelecanus occidentalis	Brown pelican	SSC	BCC	T	G4S3
Laterallus jamaicensis	Black rail	*	BCC	R	G4S2
Rynchops niger	Black skimmer	SSC	*	SSC	G5S3
Sterna antillarum	Least tern	T	BCC	T	G4S3
Sterna dougallii	Roseate tern [5]	T	T	T	G4S1
Chilidonias niger	Black tern	*	BCC	*	*
Tyto alba	Barn owl	*	BCC	*	*
Asio flammeus	Short-eared owl	*	BCC	*	*
Haliaeetus leucocephalus	Bald eagle	T	T	T	G4S3
Caprimulgus carolinensis	Chuck-will's-widow	*	BCC	*	*
Puffinus Iherminieri	Audubon's shearwater [5]	*	BCC	*	*
Fregata magnificens	Magnificent frigatebird [5]	*	BCC	T	G5S1
Melanerpes erythrocephalus	Red-headed woodpecker	*	BCC	*	*
Falco sparverius paulus	Southeastern American kestrel [5]	T	BCC	T	G5T4S3
Dendroica petechia (only gundlachi sub spp.)	Yellow warbler	*	BCC	R	G5T4S3
Dendroica dominica	Yellow-throated warbler	*	BCC	*	*
Numenius phaeopus	Whimbrel	*	BCC	*	*
Ammodramus maritimus	Seaside sparrow	SSC	BCC	SSC	G4TS

Scientific Names	Common Names	Agency Status			
		FWC	FWS	FCREPA	FNAI
Calidris canutus	Red knot	*	BCC	*	*
Calidris pusilla	Semipalmated sandpiper	*	BCC	*	*
Limnodromus griseus	Short-billed dowitcher	*	BCC	*	*
Sterna nilotica	Gull-billed tern	*	BCC	*	G5S2
Sterna hirundo	Common tern	*	BCC	*	*
Casmerodius albus	Great egret	*	*	SSC	*
Nycticorax nycticorax	Black-crowned night-heron	*	*	SSC	*
Nycticorax violacea	Yellow-crowned night- heron	*	*	SSC	*
Plegadis falcinellus	Glossy ibis	SSC	*	SSC	*
Accipiter cooperii	Cooper's hawk	*	*	SSC	*
Recurvirostra americana	American avocet	*	*	SSC	*
Sterna fuscata	Sooty tern [5]	*	*	SSC	*
Sterna maxima	Royal tern	*	*	SSC	*
Sterna sandvicensis	Sandwich tern	*	*	SSC	*
Sterna caspia	Caspian tern	*	*	SSC	*
Picoides villosus	Hairy woodpecker [5]	*	*	SSC	*
Cictothorus palustris	Marsh wren	SSC	*	SSC	*
Mammals (6)					
Peromyscus polionotus niveiventris	Southeastern beach mouse	T	**T**	**T**	**G5T1S1**
Podomys floridanus	Florida mouse	SSC	*	T	G3S3
Trichechus manatus	West Indian manatee	E	E	E	G2S2
Ursus americanus floridanus	Florida black bear [5]	T	*	T	G5T2S2
Neofiber alleni	Round-tailed muskrat	*	*	SSC	*
Mustela frenata peninsulae	Florida weasel [5]	*	*	R	*

Plants [8] (38)					
Asclepias curtissii	Curtiss milkweed	*	E	*	G3, S3
Avicennia germinans	Black mangrove	*	*	SSC	*
Calamovilfa curtissii	Curtiss reedgrass	*	T	*	G1G2,S1S2
Calopogon multiflorus	Many-flowered grass pink	*	E	*	*
Chamaesyce cumulicola	Sand dune spurge	*	E	*	G2,S2
Chrysophyllum oliviforme	Satinleaf	*	T	*	*
Encyclia tampensis	Butterfly orchid	*	C	*	*
Epidendrum canopseum	Greenfly orchid	*	C	*	*
Harrisella filiformis	Threadroot orchid	*	T	*	*
Hexalectris spicata	Crested coralroot	*	E	*	*
Lantana depressa var. *floridana*	East coast lantana	*	E	*	G2T2, S2
Lechea cernua	Nodding pinweed	*	T	*	G3, S3
Lechea divaricata	Pine pinweed	*	E	*	G2, S2
Lilium catesbaei	Catesby lily	*	T	*	G4, S3
Myrcianthes fragrans	Nakedwood	*	T	*	G4T3, S3
Nemastylis floridana	Celestial lily	*	E	*	G2, S2
Ophioglossum palmatum (= *Cheiroglossa palmata)*	Hand fern	*	E	E	G5, S2
Opuntia stricta	Shell mound prickly-pear	*	T	*	*
Osmunda cinnamomea	Cinnamon fern	*	C	*	*
Osmunda regalis var. *spectabilis*	Royal fern	*	C	*	*
Pavonia spinifex	Yellow hibiscus	*	*	*	G4G5, S2S3
Peclumula plumula (=Polypodium plumula)	Plume polypody	*	E	*	*
Peperomia humilis	Peperomia	*	E	*	G5, S2
Peperomia obtusifolia	Florida peperomia	*	E	*	G5, S2

Scientific Names	Common Names	Agency Status			
		FWC	FWS	FCREPA	FNAI
Persea borbonia var. *humilis*	Scrub bay	*	*	*	G3, S3
Pogonia ophioglossoides	Rose pogonia	*	T	*	*
Pteroglossaspis ecristata (= Eulophia ecristata)					
	False coco	*	T	*	G2G3, S2
Remirea maritima (=Cyperus pedunculatus)					
	Beach-star	*	E	*	*
Rhizophora mangle	Red mangrove	*	*	SSC	*
Scaevola plumieri	Scaevola	*	T	*	*
Sophora tomentosa	Necklace pod	*		*	G4, S3
Spiranthes laciniata	Lace-lip ladies'-tresses	*	T	*	*
Tephrosia angustissima var. curtissii	Narrow-leaved hoary pea; coastal hoary pea	*	E	*	G1T1, S1
Tillandsia fasciculata	Common pine	*	E	*	*
Tillandsia utriculata	Giant wild pine; giant air plant	*	E	*	*
Verbena maritima (= Glandularia maritima)	Coastal vervain	*	E	*	G2, S2
Verbena tampensis (=Glandularia tampensis)	Tampa vervain	*	E	*	G1, S1
Zamia umbrosa (= Zamia pumila)	East coast coontie	*	C	T	*

1 (S/A) means species was listed due to similarity of appearance with the American crocodile. The species is not listed in regards to regulatory actions of Section 7 of the Endangered Species Act and is not in danger of becoming extinct (D. Palmer, FWS, personal communication)
2 Within species home range area, not officially recorded on the Refuge (Moler 1992, Blihovde 1996, Seigel and Seigel 2000).
3 see Ehrhart (1983
4 R. Seigel (personal communication)
5 Species which have been recorded on the Refuge but are rarely seen. These species may not be a functional component of the vertebrate wildlife on the refuge
6 US Fish and Wildlife Service, 2002
7 Merritt Island NWR, unpublished data
8 Plants list after Schmalzer et al. 2002
9 Florida Natural Area Inventory. 2002

Appendix 1: FNAI - Florida Natural Areas Inventory Ranking and Status Definitions

UPDATED OCTOBER 2002

Florida Resources and Environmental Analysis Center
1018 Thomasville Road, Suite 200-C
Tallahassee, Florida 32303
Phone: (850) 224-8207 http://www.fnai.org/data.cfm

FNAI GLOBAL RANK DEFINITIONS

G1 = Critically imperiled globally because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.

G2 = Imperiled globally because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.

G3 = Either very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.

G4 = Apparently secure globally (may be rare in parts of range)

G5 = Demonstrably secure globally

GH = Of historical occurrence throughout its range, may be rediscovered (e.g., ivory-billed woodpecker)

GX = Believed to be extinct throughout range

GXC = Extirpated from the wild but still known from captivity or cultivation

G#? = Tentative rank (e.g., G2?)

G#G# = Range of rank; insufficient data to assign specific global rank (e.g., G2G3)

G#T# = Rank of a taxonomic subgroup such as a subspecies or variety; the G portion of the rank refers to the entire species and the T portion refers to the specific subgroup; numbers have same definition as above (e.g., G3T1)

G#Q = Rank of questionable species - ranked as species but questionable whether it is species or subspecies; numbers have same definition as above (e.g., G2Q)

G#T#Q = Same as above, but validity as subspecies or variety is questioned.

GU = Due to lack of information, no rank or range can be assigned (e.g., GUT2).

G? = Not yet ranked (temporary)

FNAI STATE RANK DEFINITIONS

S1 = Critically imperiled in Florida because of extreme rarity (5 or fewer occurrences or less than 1000 individuals) or because of extreme vulnerability to extinction due to some natural or man-made factor.

S2 = Imperiled in Florida because of rarity (6 to 20 occurrences or less than 3000 individuals) or because of vulnerability to extinction due to some natural or man-made factor.

S3 = Either very rare and local throughout its range (21-100 occurrences or less than 10,000 individuals) or found locally in a restricted range or vulnerable to extinction from other factors.

S4 = Apparently secure in Florida (may be rare in parts of range)

S5 = Demonstrably secure in Florida

SH = Of historical occurrence throughout its range, may be rediscovered (e.g., ivory-billed woodpecker)

SX = Believed to be extinct throughout range

SA = Accidental in Florida, i.e., not part of the established biota

SE = An exotic species established in Florida may be native elsewhere in North America

SN = Regularly occurring, but widely and unreliably distributed; sites for conservation hard to determine

FEDERAL LEGAL STATUS

Provided by FNAI for information only.
For official definitions and lists of protected species, consult the relevant federal agency.

Definitions derived from U.S. Endangered Species Act of 1973, Sec. 3. Note that the federal status given by FNAI refers only to Florida populations and that federal status may differ elsewhere.

LE Endangered: species in danger of extinction throughout all or a significant portion of its range.
LT Threatened: species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.
E(S/A) Endangered due to similarity of appearance to a species which is federally listed such that enforcement personnel have difficulty in attempting to differentiate between the listed and unlisted species.
T(S/A) Threatened due to similarity of appearance (see above).
PE Proposed for listing as endangered species.
PT Proposed for listing as threatened species.

C Candidate species for which federal listing agencies have sufficient information on biological vulnerability and threats to support proposing to list the species as endangered or threatened.
XN Nonessential experimental population.
MC Not currently listed, but of management concern to U.S. FWS.
N Not currently listed, nor currently being considered for listing as endangered or threatened.

STATE LEGAL STATUS

Provided by FNAI for information only.
For official definitions and lists of protected species, consult the relevant agency.

Animals: Definitions derived from "Florida's Endangered Species and Species of Special Concern, Official Lists" published by Florida Fish and Wildlife Conservation Commission, 1 August 1997, and subsequent updates.

LE Endangered: species, subspecies, or isolated population so few or depleted in number or so restricted in range that it is in imminent danger of extinction.
LT Threatened: species, subspecies, or isolated population facing a very high risk of extinction in the future.
LS Species of Special Concern is a species, subspecies, or isolated population which is facing a moderate risk of extinction in the future.
PE Proposed for listing as endangered.
PT Proposed for listing as threatened.
PS Proposed for listing as species of special concern.
N Not currently listed, nor currently being considered for listing.

Plants: Definitions derived from Sections 581.011 and 581.185(2), Florida Statutes, and the Preservation of Native Flora of Florida Act, 5B-40.001. FNAI does not track all state-regulated plant species; for a complete list of state-regulated plant species, call Florida Division of Plant Industry, 352-372-3505 or see:
http://www.doacs.state.fl.us.

LE Endangered: species of plants native to Florida that are in imminent danger of extinction within the state, the survival of which is unlikely if the causes of a decline in the number of plants continue; includes all species determined to be endangered or threatened pursuant to the U.S. Endangered Species Act.
LT Threatened: species native to the state that are in rapid decline in the number of plants within the state, but which have not so decreased in number as to cause them to be endangered.
PE Proposed for listing as endangered.
PT Proposed for listing as threatened.
C Commercially Exploited
N Not currently listed, nor currently being considered for listing.

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[9] **Explanations and definitions to the ranking system were copied from the Florida Natural Areas Inventory (FNAI) website. For additional information on FNAI species status and ranking, please contact FNAI or see http://www.fnai.org/data.cfm.**

Literature Cited:

Anonymous. Birds: Merritt Island National Wildlife Refuge. Brochure, unknown date.

Blihovde, William Boyd. 1996. Distribution of the *Nerodia clarkii* Complex in Volusia, Brevard, and Indian River Counties, Merritt Island National Wildlife Refuge Complex and Canaveral National Seashore. Unpublished report to Merritt Island National Wildlife Refuge.

Ehrhart, Llewellyn M. 1983. Marine turtles of the Indian River Lagoon system. *Florida Scientist*, Vol. 46.

Florida Fish and Wildlife Conservation Commission. 1997. *Florida's Endangered Species, Threatened Species and Species of Special Concern: Official List.* Florida Game and Fresh Water Fish Commission.

Florida Natural Areas Inventory. 2002. List of Vertebrates. Unpublished data.

Humphrey, S.R. (ed.). 1992. *Rare and Endangered Biota of Florida: Volume I, Mammals.* University Press of Florida, Gainesville, Florida. 392 pp.

Moler, P.E. (ed.). 1992. *Rare and Endangered Biota of Florida: Volume III, Amphibians and Reptiles.* University Press of Florida, Gainesville, Florida. 291 pp.

Office of Migratory Bird Management. 1995. *Migratory Nongame Birds of Management Concern in the United States: The 1995 List.* U.S. Fish and Wildlife Service, Washington, D.C. 22 pp.

Schmalzer, P.A., T.E. Foster and B.W. Duncan. 2002. *Revised Flora and List of Threatened and Endangered Plants for the John F. Kennedy Space Center Area, Florida.* NASA Technical Memorandum NASA/TM-2002-211175. Kennedy Space Center, Florida. 75 pp.

Seigel, Richard A. and Nadia A. Seigel. 2000. Inventory and Monitoring of Herpetological Communities on the Kennedy Space Center/Merritt Island National Wildlife Refuge/Canaveral National Seashore: Annual Report. Unpublished report to Merritt Island National Wildlife Refuge. Southeastern Louisiana University, Hammond, Louisiana.

Sullivan, D.J. 2004. *Florida's Endangered Species, Threatened Species, and Species of Special Concern.* Florida Fish and Wildlife Conservation Commission. 6 pp.

U.S. Fish and Wildlife Service. 2002. *Birds of Conservation Concern 2002.* Division of Migratory Bird Management, Arlington, Virginia. 99 pp. [Online version available at http://migratorybirds.fws.gov/reports/bcc2002.pdf]

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Appendix E. – Appropriate Use and Compatibility Determinations

Merritt Island 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:

- Six wildlife-dependent recreational uses - As defined by the National Wildlife Refuge System Improvement Act of 1997, the six wildlife-dependent recreational uses (hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation) are determined to be appropriate. However, the refuge manager must still determine if these uses are compatible.

- Take of fish and wildlife under state regulations - States have regulations concerning 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 following 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:

- 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: Merritt Island National Wildlife Refuge

Use: Bicycling

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Spiegrann Date: 10/05/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Commercial Services

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Souhrann Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Commercial Fishing (phase out use)

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth LaBranche Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Beekeeping (phase out use)

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sobczanski Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island 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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanfacon Date: 10/5/07

A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Astronomy

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanbrann Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Organized Group Camping

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanzone Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Noncommercial Plant Collection

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanfacon Date: 10/5/07

A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Interim Management of Citrus Groves

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanbrano Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Feral Hog Control

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Souzeau Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Forest Management – Commercial Timber Harvest

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?	✓	
(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?	✓	

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** ✓ **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** ✓

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Souheaan Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: All-terrain Vehicles

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?		✓
(c) Is the use consistent with applicable executive orders and Department and Service policies?		✓
(d) Is the use consistent with public safety?		✓
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(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?		✓
(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?		✓

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** ✓ **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**____

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanfilippo Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Boating (Airboats and Personal Watercraft)

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?		✓
(c) Is the use consistent with applicable executive orders and Department and Service policies?		✓
(d) Is the use consistent with public safety?		✓
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(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?		✓
(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?		✓

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** ✓ **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**_____

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Souhrann Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Horseback Riding

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?		✓
(c) Is the use consistent with applicable executive orders and Department and Service policies?		✓
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(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?		✓
(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?		✓

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** ✓ **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**_____

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanzeann Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Jogging

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(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?		✓
(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?		✓

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** ✓ **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** ____

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Imbiano Date: 10/5/07
A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Model Airplanes

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?		✓
(c) Is the use consistent with applicable executive orders and Department and Service policies?		✓
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(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?		✓
(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?		✓

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** ✓ **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**____

Refuge Manager: Ron Hight Date: 9/27/07

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: Elizabeth Sanfiamo Date: 10/5/07

A compatibility determination is required before the use may be allowed.

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Merritt Island National Wildlife Refuge

Use: Segways

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?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?		✓
(c) Is the use consistent with applicable executive orders and Department and Service policies?		✓
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(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?		✓
(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?		✓

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** ✓ **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**____

Refuge Manager: Ron Hights Date: 9/27/07

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: Elizabeth Imbsweiler Date: 10/5/07
A compatibility determination is required before the use may be allowed.

Merritt Island National Wildlife Refuge Compatibility Determinations

The Fish and Wildlife Service reviewed several uses for compatibility during the comprehensive planning process for Merritt Island National Wildlife Refuge. Descriptions and anticipated impacts of each of these uses are addressed separately. However, the Uses through Other Applicable Laws, Regulations and Policies sections, the Literature Cited section, the Public Review and Comment section, and the Approval of Compatibility Determinations section apply to each use. If one of these uses is considered outside of the Comprehensive Conservation Plan for Merritt Island National Wildlife Refuge, then those sections become part of that compatibility determination.

Uses

Several uses were evaluated to determine their compatibility with the mission of the Refuge System and the purposes of the refuge: (1) waterfowl hunting; (2) upland game hunting; (3) fishing; (4) wildlife observation and photography; (5) environmental education and interpretation; (6) bicycling; (7) commercial services; (8) commercial fishing; (9) beekeeping; (10) research; (11) astronomy; (12) organized group camping; (13) noncommercial plant collection; (14) interim management of citrus groves; (15) feral hog control; and (16) forest management/commercial timber harvest.

Refuge Name: Merritt Island National Wildlife Refuge

Establishing and Acquisition Authorities: Migratory Bird Conservation Act; North American Wetlands Conservation Act

Refuge Purposes: Due to its nature as an overlap of the Kennedy Space Center, National Aeronautics and Space Administration and its unique location and resources, the refuge has two traditional purposes, as well as an additional purpose stemming from legislation that created a unit of the National Park Service. Recognizing the high migratory bird benefits served by the lands and waters of the refuge, the Service administratively designated Merritt Island National Wildlife Refuge in 1963 under the provisions of the Migratory Bird Conservation Act, outlining a primary purpose of these lands and waters:

> *"... for use as an inviolate sanctuary, or for any other management purpose, for migratory birds."*
>
> 16 USC §715d (Migratory Bird Conservation Act)

Further reading of the Migratory Bird Conservation Act also recognizes benefits to other species, including those designated as threatened or endangered:

> *"... to conserve and protect migratory birds ... and other species of wildlife that are listed ... as endangered species or threatened species and to restore or develop adequate wildlife habitat."*
>
> 16 USC §715i (Migratory Bird Conservation Act)

The refuge's primary purpose applies to all lands and waters managed by the refuge, regardless of when they were added to the refuge. Since the refuge has management agreements with NASA and the State of Florida, lands and waters under those management agreements are also subject to the conditions of those agreements.

In 1995, under the authority of the North American Wetlands Conservation Act, the refuge and its partners began purchasing additional lands and waters in the northwest corner of the refuge, the Turnbull Creek area:

> *"(1) to protect, enhance, restore, and manage an appropriate distribution and diversity of wetland ecosystems and other habitats for migratory birds and other fish and wildlife in North America; (2) to maintain current or improved distributions of migratory bird populations; and (3) to sustain an abundance of waterfowl and other migratory birds consistent with the goals of the North American Waterfowl Management Plan and the international obligations contained in the migratory bird treaties and conventions and other agreements with Canada, Mexico, and other countries."*
>
> 16 USC §4401(2)(b) (North American Wetlands Conservation Act)

This secondary purpose applies only to those lands and waters of the Turnbull Creek area of the refuge. However, the primary purpose also applies to the lands and waters of the Turnbull Creek area. Again, since the refuge has management agreements with the State of Florida for lands and waters in the Turnbull Creek area, those lands and waters are also subject to the conditions of those agreements.

Congruent to the discussion of the traditional purposes of the refuge is the congressional enabling legislation in 1975 that established Canaveral National Seashore as a unit of the National Park Service. Congress established the Seashore partially on new lands and waters and partially as an overlay of NASA's Kennedy Space Center on lands and waters that were already being managed as part of Merritt Island National Wildlife Refuge. In the legislation, Congress outlined that the majority of the overlay portion of the Seashore would be managed as a refuge. The overlay area encompasses approximately 34,345 acres and includes southern Mosquito Lagoon. The Seashore was established "... to preserve and protect the outstanding natural, scenic, scientific, ecologic, and historic values ... and to provide for public outdoor recreation use and enjoyment of the same ... the Secretary shall retain such lands in their natural and primitive condition, shall prohibit vehicular traffic on the beach except for administrative purposes, and shall develop only those facilities which he deems essential for public health and safety" [16 USC 459(j)]. This language applies much as a Wilderness designation might apply, making this a secondary purpose for the 34,345 acres in the overlap area.

National Wildlife Refuge System Mission: 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."*

Public Review and Comment: Following the initial gathering of information, a Notice of Intent to prepare a CCP for the refuge was published in the Federal Register on August 26, 2002. The Service also placed ads in local newspapers, posted information on the refuge's web site regarding upcoming meetings and how to submit comments, posted meeting information in the local community (e.g., at local shops, at the refuge's Visitor Center, and at the local libraries), and sent out flyers announcing the public meetings. An open house at the refuge's Visitor Center kicked off the public scoping phase on September 21, 2002. Over 180 people attended the open house which was followed by three public scoping meetings: October 23, 2002 in south Merritt Island with 31 attendees; October 28, 2002 in New Smyrna Beach with 17 attendees; and October 29, 2002 in Titusville with 55 attendees. During September and October 2002, 10 CCP related articles appeared

in three local papers: Florida Today, Orlando Sentinel, and Press Tribune. One article appeared in November 2002 to review the wide range of plan comments submitted to the Service. During public scoping, over 1,600 written comments were submitted by individuals and organizations spanning 49 states and 11 countries. Two planning updates kept the public informed of the progress of the plan. Follow up meetings were scheduled in 2004 to address the public's concerns specific to Mosquito Lagoon: April 29, 2004 in Titusville with 65 attendees; May 12, 2004 in New Smyrna Beach with 25 attendees; November 8, 2004 in Titusville with 7 attendees; and November 22, 2004 in New Smyrna Beach with 32 attendees.

Several outreach activities occurred in advance of public review and comment on the DCCP and EA. In March 2006, over 1,400 postcards were mailed out to individuals, organizations, businesses, and governmental agencies to allow them to request copies of the DCCP and EA. About 100 responded, requesting copies. And over 75 additional copies of the DCCP and EA were distributed from the refuge's Visitor Center. The refuge briefed key governmental agencies: Kennedy Space Center, National Aeronautics and Space Administration; Florida Fish and Wildlife Conservation Commission; Canaveral National Seashore, National Park Service; and Cape Canaveral Air Force Station and Patrick Air Force Base, U.S. Air Force. Press releases were sent out to 15 newspapers, including three area papers: Florida Today, Daytona Beach News-Journal, and the Orlando Sentinel. Two news articles on the CCP appeared before public review and comment. [Throughout the planning process numerous articles appeared in Florida Today, Star Advocate (of Florida Today), Daytona Beach News-Journal, the Orlando Sentinel, Florida Sportsman, Wilderness, Coastal Angler, Eastern Fly Fishing, Florida Wing Beats (Florida Ducks Unlimited newsletter), and HabiChat (newsletter of Merritt Island Wildlife Association).] The Notice of Availability of the DCCP and EA was published in the Federal Register on December 27, 2006.

The public review and comment period for the DCCP and EA for Merritt Island National Wildlife Refuge opened on December 27, 2006 and closed on February 26, 2007. A few comments were received after the deadline. Written comments were submitted by 22 members of the general public, three state government agencies, three area businesses, three researchers or research entities, and one organization. Comments were also submitted through the State of Florida's clearinghouse, representing comments from four state government agencies. Comments were submitted by two federal agencies: Kennedy Space Center, National Aeronautics and Space Administration and Canaveral National Seashore, National Park Service. The government agencies submitting comments during the public review and comment period included: Florida Fish and Wildlife Conservation Commission, Division of Historical Resources of the Florida Department of State, St. Johns River Water Management District, Florida Department of Environmental Protection, and Florida Department of Transportation. The proposed activity was determined by the State of Florida to be consistent with the Florida Coastal Management Program. Appendix J summarizes the comments received during the public review and comment period and the Service's Response to those comments.

Description of Use: *Waterfowl Hunting*

Waterfowl hunting has been identified as a priority wildlife-dependent activity under the National Wildlife Refuge System Improvement Act and is a traditional use at Merritt Island National Wildlife Refuge. The initial interagency agreement between NASA and the Service named waterfowl hunting as an activity that would continue as a condition of the agreement. This wildlife-dependent recreational use is supported by boating; therefore, boating impacts which are associated with the waterfowl hunting program are also considered in this review.

Waterfowl hunting is permitted on approximately 36,000 acres of the refuge's over 140,000 acres. Waterfowl hunting is being proposed in the Turnbull Creek area marshes. The remainder of the refuge is closed to hunting to protect other migratory birds, nongame birds, and endangered species; provide opportunities for nonconsumptive recreational uses, such as wildlife viewing and photography; and provide a sanctuary for waterfowl. Hunting areas include the open waters of Mosquito Lagoon and the Indian River Lagoon, as well as 25 of the refuge's 76 impoundments. The 2,945-acre Pole and Troll zones in Mosquito Lagoon will alter historic waterfowl hunter access in part of one hunt area, but will help benefit waterfowl and other migratory birds and lessen impacts to submerged aquatic plants from prop scarring.

Waterfowl hunting is allowed in four areas of the refuge (i.e., hunt areas 1–4) in accordance with state regulations and seasons. In addition to state regulations, several refuge regulations apply, which are paraphrased in this list:

- Hunting is allowed only three days per week (i.e., Wednesday, Saturday, and Sunday) from one half hour before sunrise until 1:00 p.m.
- Entry into the refuge cannot begin earlier than 4:00 a.m.
- A general Merritt Island Refuge Hunt Permit for Ducks and Coots is required.
- A quota permit is required for hunt areas 1 and 4 during the months of November and December. A fee is charged for the quota permit.
- Hunters are required to have completed a state-certified hunter safety course and to carry proof of completion on their person while hunting.
- Hunting is not allowed within 15 feet of any dike.
- Airboats and jet skis are not permitted.

Quota permits are issued through a telephone call-in reservation system prior to the beginning of the waterfowl hunt season. Hunters may pay for the permits by mail or in person. Leftover and unclaimed quota permits are available to walk-in customers. The quota permit program is designed to maintain high quality hunting conditions, providing for limits to the number of hunting parties in each impoundment of the quota areas. The quota limits were developed by providing one hunting party per 40 acres in those quota areas. Further, each hunting party is limited to no more than four hunters per group.

Access to the hunting areas is primarily by boat, since access is limited and only a few areas allow foot access. Currently, the refuge has no restrictions on the type of boat, horsepower, or motor type. Depending on the hunt area, size of impoundment, or water conditions, hunters generally access the hunting areas with nonpowered boats, such as canoes, or with motorized boats, such as small (i.e., 8- to 16-foot) flat-bottomed boats with outboard motors or go-devils. The open waters of Mosquito Lagoon can be hazardous during windy weather conditions and for safety reasons, most hunters in Hunt Area 3 use slightly larger flat-bottomed boats, up to 18 feet, to access this area.

The best hunting is usually found in the impoundments. The refuge has made efforts to provide launch sites into each impoundment open to waterfowl hunting. This is not only convenient to the hunter, but helps prevent damage to the dike's bank and vegetation. Hunt Area 3 is the exception to this rule, and hunters who hunt in the beach impoundments on the east side of Mosquito Lagoon must pull over the dike.

Water level management in the impoundments is an important aspect of refuge management. The strategy is to begin holding water in the impoundments designated for waterfowl management in late summer for the production of desirable waterfowl aquatic plants. As the season progresses, the refuge has some ability to hold water to create the proper balance to fulfill the dual requirements for waterfowl and hunters. Achieving optimum water level conditions for the diverse range of wildlife species that use the impoundments and visitors engaged in priority recreational activities constitute one of the greatest management challenges for the refuge. Each user group, it seems, prefer different water level conditions and, on occasion, vandals pull riser boards, which drain the impoundments. To prevent visitors from tampering with the riser boards, the refuge has designed a locking mechanism aimed at preventing unwanted removal of riser boards.

Availability of Resources: Operation and maintenance funds to support waterfowl hunting are taken from the refuge's annual budget, which is adequate to sustain the program at the current level. Funds are needed annually to mow, grade, and fix roads open to waterfowl access; replace gravel on hunter access roads; paint, repair, and replace signs; develop and print brochures; and issue permits. One Refuge Ranger, one Refuge Biologist, one Biological Science Technician, one Administrative Assistant, and two law enforcement officers spend at least one month a year managing the waterfowl hunt. These salaries come out of the refuge's operating budget and are adequate to sustain the program at current levels.

Anticipated Impacts of Use: Anticipated impacts were identified and evaluated based on best professional judgment and published scientific papers, as well as by analyzing 30 years of refuge hunt data. Numerous studies have documented the inverse relationship between the number of waterfowl using an area and hunting intensity (Reichholf 1973; Arctander et al. 1984; Madsen et al. 1992, as cited by Fox and Madsen 1997; Wolder 1993). Boating, walking, and shooting undoubtedly impact the distribution of and use by bald eagles, but waterfowl carcasses that become available during the hunting season may be beneficial for bald eagles and other scavenging species. The greatest potential adverse impact related to waterfowl hunting may be from boating impacts. Boating has been shown to alter distribution, reduce use of particular habitats by waterfowl and other birds, alter feeding behavior, and cause premature departure from areas. Impacts of boating can occur even at low densities, given the ability of powerboats to cover extensive areas in a short amount of time, the noise they produce, and their speed (Sterling and Dzubin 1967; Bergman 1973; Speight 1973; Skagen 1980; Korschgen et al. 1985; Kahl 1991; Bauer et al. 1992; Dahlgren and Korschgen 1992).

Feeding patterns and the nutritional status of waterfowl has also been shown to be impacted by hunting. Hunting can cause birds to change feeding locations (Cronan 1957; Thornburg 1973; Madsen 1995); feed more at night (Thornburg 1973; Morton et al. 1989a; Morton et al. 1989b); reduce the amount of time spent feeding (Cronan 1957; Thompson 1973; Thornburg 1973; Paulus 1984; Korschgen et al. 1985; Morton et al. 1989a); and feed in lower quality habitat (Kahl 1991). Other factors, including road access, hunter densities, and distribution and amount of high quality sanctuary, can impact waterfowl and nontarget species (Skagen 1980; Bauer et al. 1992). Thirty years of data at the refuge generally support these findings.

The literature suggests that the main impact of waterfowl hunting on wildlife and the wetlands of the refuge is not the direct mortality of waterfowl from hunters, but the associated impacts related to boating. Boating impacts wildlife due to noise and speed, and significantly increases access to more parts of the marsh (i.e., hunters accessing by boat can disturb more birds than walk-in hunters).

As a strategy to reduce motor boat impacts, the refuge has taken several actions. Perhaps the biggest factor and one over which the refuge has no control is that about half of the refuge is within the restricted area of Kennedy Space Center and is closed to motorized boating. This area serves as a sanctuary for migratory birds and other species. The only portion of the south half of the refuge that is open to the public is the Banana River and most of it is a no motor zone and is not open to hunting. Within the hunting area, a portion of Hunt Area 3 is designated as a Pole and Troll Zone. This is a management strategy to improve the quality of fishing and to reduce prop scarring. Although not specifically aimed at reducing waterfowl hunting impacts, this action could benefit waterfowl by reducing disturbance to waterfowl, while also reducing impacts to submerged aquatic grasses. These actions will be monitored to determine their effectiveness in maintaining waterfowl and other wildlife populations.

Disturbance by hunters to other recreational activities is not considered a problem due to the limited number of days and hours during which the refuge is open to hunting. This, coupled with the availability of quality wildlife viewing areas outside of the hunting area, indicates that visitors engaged in nonconsumptive wildlife recreation are generally not impacted by waterfowl hunting. Wildlife viewing and photography areas, such as Black Point Wildlife Drive, serve as additional sanctuaries from hunting. Hunting may actually improve wildlife viewing on the Wildlife Drive, since hunting pressure in surrounding marshes probably shifts waterfowl to the sanctuary found along the Wildlife Drive.

The refuge has taken numerous actions to reduce hunting pressure. Implementing quota hunt permits, limiting the number of days that the refuge is open to hunting, closing roads from November through March annually, and implementing the Pole and Troll zones are all actions taken to help sustain migratory bird populations. If waterfowl populations begin declining or other wildlife impacts occur, additional actions can be taken, such as implementing additional closed areas, increasing the size of the pole and troll zones, or adding other motor boat restrictions.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: To ensure compatibility of hunting activities on the refuge, the following stipulations are necessary in addition to state regulations:

- Hunting is allowed only three days per week (i.e., Wednesday, Saturday, and Sunday) from one half hour before sunrise until 1:00 p.m.
- Entry into the refuge cannot begin earlier than 4:00 a.m.
- A general Merritt Island Refuge Hunt Permit for Ducks and Coots is required.
- A quota permit is required for hunt areas 1 and 4 during the months of November and December. A fee is charged for the quota permit.
- Hunters are required to have completed a state-certified hunter safety course and to carry proof of completion on their person while hunting.
- Hunting is not allowed within 15 feet of any dike.
- Airboats and jet skis are not permitted.

As necessary, the Service will implement additional regulations to address waterfowl hunting. In the future, it may be necessary to focus additional management actions to maintain high quality waterfowl habitat in the sanctuary as a strategy to help sustain waterfowl populations. Other strategies such as restricting motor boat use in some impoundments for hunting or scouting, establishing additional seasonal sanctuaries, implementing quotas in nonquota hunt areas, extending the requirement for quota permits into January, reducing the number of days open to hunting, implementing noise or speed restrictions on boats, are additional measures the refuge could use to sustain waterfowl populations.

Justification: Hunting is a priority wildlife-dependent use under the National Wildlife Refuge System Improvement Act. Waterfowl hunting, as described, was determined to be compatible, in view of the potential impacts that hunting and the supporting activities (e.g., boating) can have on the Service's ability to achieve the purposes and goals of the refuge, because: (1) hunter densities and use levels are relatively low during most days the refuge is open to hunting, (2) sufficient restrictions have been established to ensure that an adequate amount of high-quality feeding and resting habitat would be available to accommodate the needs of waterfowl and other wetland birds using the refuge, and (3) sufficient opportunities are available for other priority wildlife-dependent recreation during the waterfowl season.

Mandatory 15-Year Re-evaluation Date: 09/27/2022

Description of Use: *Upland Hunting*

Hunting has been identified as a priority wildlife-dependent activity under the National Wildlife Refuge System Improvement Act. With the implementation of the comprehensive conservation plan, the Service will take the steps necessary (e.g., develop needed regulations and publish the appropriate Federal Register notice) to open the refuge to upland hunting for deer and feral hogs in a portion of the refuge's upland habitat in cooperation with the state. This will provide additional opportunities for a priority recreational activity and help to reduce the feral hog population on the refuge. Implementing the upland hunt will first require preparing a hunt plan; posting appropriate notice in the Federal Register; and establishing regulations in Title 50, Code of Federal Regulations.

Upland hunting for white-tailed deer and feral hogs will be designated in the area north of Haulover Canal on approximately 6,083 acres of the refuge's over 140,000 acres. A quota will be established for the number of hunters. The remainder of the refuge will remain closed to upland hunting to minimize conflicts with other priority uses and for Kennedy Space Center security reasons. The area north of Haulover has the highest deer population. The upland game hunt will be conducted in cooperation with the Florida Fish and Wildlife Conservation Commission.

Availability of Resources: The details for administering the program have not been determined. It is assumed that a quota permit will be charged for the hunting opportunity to cover the costs of managing the program. Funds would be needed annually to mow, grade, and fix roads and parking areas open to hunter access; maintain signs; and print leaflets. The selection process for permits will likely be processed through the existing state system. Management of the program has a biological, administrative, maintenance, and law enforcement component. Partnering with the state will help provide the needed components.

Anticipated Impacts of Use: Anticipated impacts were identified and evaluated based on best professional judgment and published scientific papers. Many of the impacts associated with upland hunting are similar to those considered for other public use activities, such as waterfowl hunting and wildlife viewing and photography, with the exception of direct mortality to game species, short-term changes in the distribution and abundance of game species, and unrestricted travel through the hunt area. Direct mortality can impact isolated, resident game species populations by reducing breeding populations to a point where the isolated population can no longer be sustained. This can result in localized extirpation of isolated populations.

The hunt would be conducted in upland habitats; therefore minimal disturbance to migratory birds is anticipated. Use of lead shot could be allowed for deer and feral hogs, but considering the separation between the upland hunt and wetland habitat, the ingestion of lead shot by migratory birds should be minimal. The walk-in hunters would use existing fire breaks and roads for access. No soil compaction or vegetation disturbance is expected. Parking would occur in temporary sites designated along existing fire lines. Hunting would not occur within 1,500 feet of any active eagle nest.

The refuge has an active hog removal program where the permittees trap and remove feral hogs in four geographic areas of the refuge. The area proposed for the upland hunt would be located in the northern geographic hog trapping zone. The primary intentions of feral hog hunts would be to increase pressure on this population and assist in the population control of this unwanted species. Upland hunting for feral hogs would help reduce the hog population in this area, while also reducing the availability of hogs for the feral hog trapping permittee. This activity would assist the refuge in the control of this species.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: Several stipulations will be necessary to ensure compatibility of this use. Additional stipulations may be added, as the program is developed with the state. Known stipulations are listed:

- The hunt will be conducted in accordance with state regulations and seasons.
- The methods of hunting to be considered include primitive weapons, archery, and shotguns.
- Only white-tailed deer and feral hogs will be hunted in the designated area.
- Quota hunt permits will be issued.
- Hunting densities no greater than one hunting party per 100 acres will be allowed.
- The number of deer permitted to be taken will be based on annual population estimates.
- Check stations will be used to collect hunt data and to monitor the quality of the hunt.
- Vehicle access and parking will be limited and confined to existing fire lanes and unimproved roads.
- Climbing spikes and permanent stands will not be permitted.
- Off road vehicles or ATVs will not be permitted.
- Liberal bag limits or extended seasons may be established for feral hogs as part of a wider effort to eliminate this nonnative species.
- No flagging or trail marking will be permitted.

Upland hunting would have little impact on other visitor activities. The Pine Flatwoods Trail is proposed in the area north of Haulover Canal. Two boat ramps and several waterfowl hunter and fishing access roads also traverse through the area proposed for upland hunting. A closed area for hunters will be established to provide at a safe buffer distance around all public use facilities.

Justification: Hunting is a priority wildlife-dependent use under the National Wildlife Refuge System Improvement Act. Upland hunting, as described, was determined to be compatible, in view of the potential impacts that hunting can have on the Service's ability to achieve purposes and goals of the refuge, because: (1) hunter densities and use levels will be relatively low during days the refuge is open to hunting, (2) sufficient restrictions have been established to ensure that an adequate amount of high-quality habitat would be available to accommodate the needs of deer and other wildlife using the refuge, and (3) sufficient opportunities are available for other priority wildlife-dependent recreation during the upland hunt season.

Mandatory 15-Year Re-evaluation Date: 09/27/2022

Description of Use: *Fishing*

Fishing has been identified as a priority wildlife-dependent activity under the National Wildlife Refuge System Improvement Act and is a traditional use at the refuge. The initial interagency agreement between NASA and the refuge named fishing as an activity that would continue. This wildlife-dependent recreational use is supported by boating; therefore, boating impacts which are associated with fishing are also considered in this review.

Fishing is permitted on approximately 46,000 of the refuge's 140,000 acres. The remainder of the refuge is contained within the restricted area of the Kennedy Space Center and is closed to fishing. This large closed area serves as a sanctuary from fishing activities to protect fish, along with other wildlife. Fishing areas include the open waters of Mosquito Lagoon, the Indian River Lagoon, and Banana River, as well as 32 of the refuge's 76 impoundments and several freshwater borrow pits.

Fishing is allowed in accordance with state regulations. Additionally, the refuge has implemented refuge-specific fishing regulations which can be updated annually in Title 50 of the Code of Federal Regulations. The following list serves as a summary of the refuge-specific fishing regulations:

- A refuge sportfishing permit is required.
- Fishing is allowed only during daylight hours.
- Night fishing from boats is allowed under a valid special Sport Fishing Permit in the open waters of the refuge (i.e., Mosquito Lagoon, Indian River Lagoon, and the Banana River) and night boat launching is permitted from Bair's Cove, Beacon 42, and the BioLab boat ramps.
- Fishing, crabbing, and boat/canoe/kayak launching is not permitted from Black Point Wildlife Drive or from any side road or dike connected to Black Point Wildlife Drive, except L Pond Road.
- Motorized vessels are not permitted in the Banana River within the posted No Motor Zone. This includes any vessel having an attached or nonattached internal combustion or electric trolling motor capable of use.
- Vessels may not operate internal combustion engines in either of two Pole and Troll zones, except in the posted channels. Vessels drafting more than 12 inches at rest may not enter a Pole and Troll Zone.

- Airboats, personal watercraft, or hovercraft are not allowed.
- Harvesting of horseshoe crabs is prohibited.
- Fishermen and crabbers must attend their lines.

Both saltwater and freshwater fishing is available, but the estuarine fishing opportunities in Mosquito Lagoon, Indian River Lagoon, and Banana River are by far the largest component of the fishing program. Because of the associated wildlife and habitat impacts of boats, regulations have been developed to reduce impacts from boats. In addition to the regulations listed above, slow speed and no wake zones have been established in several locations, in addition to the No Motor Zone in Banana River, for the protection of manatees.

With the advent of tunnel-hull flatboats, jack plates and jet-foot devices, outboard-powered boats, and jet boats, many boats can now operate at fast speeds in shallow water. With these developments, fishing boats now present the potential to disturb foraging and loafing waterbirds in shallow water habitats. Outboard-powered boats also have the potential to cause impacts to the soft lagoon bottom and the submerged aquatic plants. Over the last 20 years these impacts have been increasing, along with the number of anglers using the lagoon waters of the refuge. Over the last 20 years the number of sport fishermen has increased from 25,000 to 151,000 annual visitors. The combination of increased anglers and improved boat designs has increased impacts in the shallow water flats of the estuary, impacting the quality of the fishing experience. The development of the Pole and Troll zones in two of the most severely impacted shallow water flats in Mosquito Lagoon is an adaptive strategy to allow a quality priority wildlife-dependent use to continue, as well as to help reduce wildlife disturbance and submerged aquatic plant impacts.

Fishing by boat represents the largest percentage of fishermen, but bank fishing opportunities are available from Haulover Canal and from numerous other locations where anglers fish from the bank or fish by wading in the water. Several freshwater borrow pits and drainage ditches provide limited freshwater fishing opportunities. A common issue associated with bank fishing is litter.

Availability of Resources: Operation and maintenance funds to support fishing are taken from the refuge's annual budget, which is adequate to sustain the program at the current level. Funds are needed annually to mow, grade, and fix roads, parking lots, and boat ramps open to fishing; replace gravel on roads leading to boat ramps; paint, repair, and replace signs; and develop and print brochures. One ranger, two law enforcement officers and several maintenance workers spend up to two months a year managing the fishing program. These salaries come out of the refuge's operating budget, which is adequate to sustain the existing program.

Funding for the improvements outlined in the comprehensive conservation plan is not currently available. For example, the cost to post the two Pole and Troll zones is about $60,000. If the Pole and Troll zones were expanded, additional funding would be necessary. Funding would also be needed for road and parking improvements, restrooms, bank fishing improvements, and freshwater fishing improvements. With the implementation of the comprehensive conservation plan, a fee will be charged for a sportfishing permit (e.g., $5 weekly or $20 annually in 2007), which is projected to generate approximately $193,000 per year. Eighty percent of this revenue source will remain at the refuge and will be used to fund sport fishing improvements identified in the comprehensive conservation plan.

Anticipated Impacts of Use: Anticipated impacts were identified and evaluated based on best professional judgment and published scientific papers, as well as by analyzing 30 years of refuge fishing data. Overfishing has been known to cause ecological extinction of certain fish species and precedes all other human disturbance (Jackson et al. 2001). In recent history, overfishing in Florida has led to the decline of certain species such as redfish and sea trout. But, today the state monitors

fish populations and has set seasons, slot and size limits, and total bag limits for most sport fish, making the likelihood of overfishing depleting fish stocks minimal. The closed areas of the refuge also serve to recharge local waters. Stevenson and Sulak (2001) tagged 3,358 estuarine sport fish in the restricted area of the refuge and documented adult sport fish movement to surrounding waters. Collectively, the state fishing regulations and the extensive fishery recharge afforded by the Kennedy Space Center restricted area should minimize the likelihood of fish stocks declining on the refuge.

Wildlife responds differently to boats based on their size, speed, the amount of noise they make, and how close the crafts get to wildlife. Boats increase the access of visitors to areas not open to most other visitors, thus having a greater potential to cause wildlife disturbance if not managed properly. The speed and manner in which a boat approaches wildlife can influence wildlife responses. Rapid movement directly toward wildlife frightens them, while movement away from or at an oblique angle to the animal is less disturbing (Knight and Cole 1995). Dahlgren and Korschgen (1992) categorized the following human activities in order of decreasing disturbance to waterfowl:

1. Rapid overwater movement and loud noise (e.g., power boating, water skiing, and aircraft);
2. Overwater movement with little noise (e.g., sailing, wind surfing, rowing, and canoeing);
3. Little overwater movement or noise (e.g., wading and swimming); and
4. Activities along shorelines (e.g., fishing, birdwatching, hiking, and traffic).

Hume (1976, as cited by Dahlgren and Korschgen 1992) observed a similar differential response of waterfowl to human activities. Common goldeneyes often flew when people on the shore approached within 100 or 200 meters, but settled elsewhere on the water. A single sailing dingy was sufficient to cause more than 60 common goldeneyes to take flight and for most to leave the vicinity within a few minutes. Remaining birds then flew up each time the boat approached to within 300 to 400 meters and generally left the area within an hour. The appearance of a powerboat caused instantaneous flight by most birds. If the boat traversed the length of the reservoir, all remaining birds left within minutes. Hume reported that waterfowl abundance decreased over time as a result of the increased frequency of boating.

In Germany, Bauer et al. (1992) concluded that boating pressure on wintering waterfowl had reached such a high level that it was necessary to establish larger sanctuaries and stop water sports and angling from October to March. Likewise, on numerous occasions Thornburg (1973) observed boaters causing mass flights of diving ducks on the Mississippi River. He believed that increased boating could pose a serious threat to the continued use of the area by great numbers of migratory waterfowl. Thornburg (1973) concluded that eventually restrictions on boating activity may be necessary and that establishing a sanctuary should be considered.

Rodgers and Schwikert (2002) compared the flushing distance of three species of birds in response to a slow versus fast approach using the same outboard-powered boat. A fast approach resulted in significantly larger flush distances for brown pelicans, anhingas, and great egrets. They concluded that waterbird staging areas along migratory corridors and frequently used foraging sites of resident birds merit protection from human activity. In another study Rodgers and Smith (1997) recommended that the establishment of 150-meter buffer zones around colonial bird rookeries would help minimize disturbance. Increasing the predictability of boating patterns to help wildlife habituate to nonthreatening human disturbance can also be accomplished by establishing well-marked routes of travel.

Boating has been shown to alter distribution, reduce use of particular habitats by waterfowl and other birds, alter feeding behavior, and cause premature departure from areas. Impacts of boating can occur even at low densities, given the ability of powerboats to cover extensive areas in a short amount of time,

the noise they produce, and their speed (Sterling and Dzubin 1967; Bergman 1973; Speight 1973; Skagen 1980; Korschgen et al. 1985; Kahl 1991; Bauer et al. 1992; Dahlgren and Korschgen 1992).

Because the quality of fishing is better within the refuge, tournament fishermen originating from a tournament outside the refuge travel into refuge waters. Tournaments have become big businesses and can substantially increase the level of fishing activity in the refuge. This can have negative impacts on other sport fishermen, wildlife, and habitat.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: Fishing is allowed on the refuge in accordance with state regulations. In addition, the refuge has the following listed sportfishing regulations, which are paraphrased:

- A refuge sportfishing permit is required
- Fishing is allowed only during daylight hours.
- Night fishing from boats is allowed under a valid special Sport Fishing Permit in the open waters of the refuge (i.e., Mosquito Lagoon, Indian River Lagoon, and the Banana River) and night boat launching is permitted from Bair's Cove, Beacon 42, and the BioLab boat ramps.
- Fishing, crabbing, and boat/canoe/kayak launching is not permitted from Black Point Wildlife Drive or from any side road or dike connected to Black Point Wildlife Drive, except L Pond Road.
- Motorized vessels are not permitted in the Banana River within the posted No Motor Zone. This includes any vessel having an attached or nonattached internal combustion or electric trolling motor capable of use.
- Vessels may not operate internal combustion engines in either of two Pole and Troll zones, except in the posted channels. Vessels drafting more than 12 inches at rest may not enter a Pole and Troll Zone.
- Airboats, personal watercraft, or hovercraft are not allowed.
- Harvesting of horseshoe crabs is prohibited.
- Fishermen and crabbers must attend their lines.

Boating impacts wildlife due to noise and speed, as well as from increased access to more parts of the lagoon (i.e., boats can disturb more birds than bank fishing). Most of the southern half of the refuge (except for a portion of the Banana River) is closed to the public and serves as a sanctuary. Most of the portion of the Banana River open to the public is restricted to nonmotorized boats. Within the 21,000-acre Mosquito Lagoon, the refuge has established two Pole and Troll zones as a management strategy to improve the quality of fishing and to reduce prop scarring. If the Pole and Troll zones prove to be effective, additional zones may be expanded to other shallow water habitats of the refuge. This action is anticipated to benefit waterfowl and other shallow water foraging and loafing birds by reducing the disturbance from powerboats. Channels are embedded within the Pole and Troll zones which provide a predicable route of travel for motorized boat travel and should reduce wildlife impacts. Closed area buffers are posted around colonial bird rookeries as an additional protection to sensitive wildlife areas. Manatee speed zones have been established in Mosquito Lagoon north of Haulover Canal. The area west of the Intracoastal Waterway channel is a Slow Speed/No Wake zone and the area east of the Intracoastal Waterway is posted for 35 mph daytime

and 25 mph nighttime speed limits. Haulover Canal is designated as a Slow Speed/Minimum Wake zone. Monitoring will help the Service to determine the effectiveness of refuge management actions in maintaining migratory birds, endangered species, and other wildlife populations on the refuge.

The refuge has little control over fishing tournaments which originate off the refuge. However, the staff will work with the organizers of these events to educate them to the impacts boating can have on wildlife, discuss limiting the size of the tournament, and brief them on refuge regulations.

It is anticipated that Kennedy Space Center's restricted area (which serves as a sanctuary); the 10,000-acre No Motor Zone; the 2,945 acres of Pole and Troll zones, which include posted running channels; and the Slow Speed/Minimum Wake, Idle Speed, and posted speed zones designed to protect manatees will be adequate to sustain migratory bird and endangered species populations and adequate stocks of fish, and provide for a quality fishing experience which has little impact on other visitors. If wildlife populations suffer as a result of fishing activities, the quality of fishing declines, or other wildlife impacts occur, additional Pole and Troll zones or manatee zones may be established and/or additional motor boat restrictions may be implemented. The refuge will modify or eliminate any use with unacceptable impacts.

Justification: Fishing is a priority wildlife-dependent use under the National Wildlife Refuge System Improvement Act. Fishing, as described, was determined to be compatible, in view of the potential impacts that fishing and its supporting activities (e.g., boating) can have on the Service's ability to achieve the purposes and goals of the refuge, because: (1) fishing densities and use levels are relatively low during most days; (2) sufficient restrictions have been established to ensure the protection of manatees and that an adequate amount of high quality feeding and resting habitat would be available to accommodate the needs of waterfowl, migratory birds, and other resident birds using the refuge; and (3) sufficient opportunities are available for other priority wildlife-dependent recreation.

Mandatory 15-Year Re-evaluation Date: _____09/27/2022____

Description of Uses: *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. Commercial photography or videography, if allowed, would be covered under the Commercial Services compatibility determination and would require a special use permit by the refuge with specific restrictions.

Wildlife observation and photography may occur during daylight hours throughout all open areas of the refuge and on Kennedy Space Center bus tours within restricted portions of the Space Center. Posted with closed area signs, certain portions of the refuge are closed to protect wildlife, while other areas are closed to support Space Center operations. Improvements for wildlife viewing and photography have been made at Black Point Wildlife Drive, the manatee observation deck, along hiking trails, and at other locations to provide exposure to different refuge habitat types and diverse flora and fauna. In addition, numerous refuge dikes and roads are open year-round or seasonally to provide different wetland or upland habitats for wildlife viewing. Although no photography blinds currently exist on the refuge, two wildlife viewing blinds are planned for Black Point Wildlife Drive. Restrooms and other improvements are planned on the Wildlife Drive to support wildlife observation and photography.

Approved forms of access for wildlife viewing and photography include driving licensed vehicles, hiking, and motorized and nonmotorized boats. Certain areas may be closed to specific forms of transportation. Motor boat restriction zones are in place in several locations to provide protection for manatees, to increase the quality of fishing opportunities, and/or to limit prop damage. Bicycles are not allowed on hiking trails and will be allowed only on designated routes.

Refuge brochures and maps will provide the public with the locations of visitor facilities.

Availability of Resources: Operation and maintenance funds to support wildlife viewing and photography are taken from the refuge's annual budget, which is adequate to sustain the program at the current level. Funds are needed annually to mow, grade, and fix roads open to the public; replace gravel on the Wildlife Drive and other public roads; fix, repair, and replace boardwalks and trails; paint, repair, and replace signs; and develop and print brochures. Up to three equipment operators, two rangers, and two law enforcement officers spend up to one month managing this program (7 staff months).

Funding is not currently available to fully support all the planned wildlife observation and photography improvements identified in the comprehensive conservation plan. To support the program and make improvements, the Merritt Island Wildlife Association, in cooperation with other partners, has currently pledged $76,455 and is pursuing additional fund-raising opportunities. In addition, a fee will be established on Black Point Wildlife Drive and is projected to generate approximately $200,000 per year. These funds will help offset program costs. Other refuge staff, volunteers, and the Merritt Island Wildlife Association also support these uses.

Anticipated Impacts of Uses: This section is to critically and objectively evaluate the potential effects that wildlife observation and photography could have on the wildlife, habitat and other public use activities based on available information and best professional judgment. Each activity has the potential to have impacts, but the focus is to minimize impacts to within acceptable limits. This is based on the impacts at the existing and projected level of use.

Short-term Impacts: Impacts associated with wildlife observation activities can be divided into two categories, based on whether the activity occurs within or outside of a vehicle. In general, activities that occur outside of vehicles tend to increase disturbance potential for most wildlife species (Klein 1993; Gabrielson and Smith 1995; Burger 1981; Pease et al. 2005). Wildlife observation trails and pullouts along the Black Point Wildlife Drive have a greater potential for disturbing wildlife species. Among wetland habitats, out-of-vehicle approaches can reduce time spent foraging and can cause waterbirds 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). Bicycling and people walking causes more disturbances to waterfowl than vehicles (Pease et al. 2005).

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 some 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).

Boating impacts on wildlife can be classified based on the form of boating activity (Korschgen and Dahlgren 1992; Knight and Cole 1995); the season of use (Burger 1995); and species tolerance to the activity (Jahn and Hunt 1964). For example, motorboat activity likely has more disturbances on wildlife than nonmotorized boat travel because motorboats produce a combination of movement and noise (Knight and Cole 1995). Even canoes can cause disturbance based on the ability to access shallower areas of the marsh (Speight 1973). However, compared to motorboats and airboats, canoe travel appears to have the least disturbance (Jahn and Hunt 1964).

Long-term Impacts: Considering the high level of use and variety of activities occurring at the refuge, appropriate solutions to minimize impacts need to be developed and monitored. For example, during the fall migration and overwintering season, wildlife observation, photography, environmental education, interpretation, and waterfowl hunting are all occurring simultaneously and are at the highest levels of the year. Techniques to limit disturbance must be evaluated, implemented, and monitored. This stems from the hypothesis that prolonged and extensive disturbance may cause migratory birds to abandon the wetlands most disturbed by humans and winter elsewhere. Current public use may not be at a level to cause this shift, but anticipated increases relative to the expansion of the population and growth of visitor opportunities could result in seasonal shifts in migratory bird use of the refuge's wetland habitats.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: By design, wildlife observation and photography should have minimal wildlife and habitat impacts. However, as use increases, wildlife impacts are more likely to occur. Evaluation of the sites and programs will be conducted annually to assess 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 will be necessary to change the activity or the program, move the activity or program, or eliminate the program.

Stipulations that may be employed include the following:

- Establishing buffer zones that minimize disturbance around sensitive areas and establishing additional no-entry zones.
- Vegetation that effectively conceals visitors and provides cover for birds can help minimize impacts of people in busy areas like Black Point Wildlife Drive.
- Impacts from wildlife viewing and photography can be reduced by providing observation blinds.
- The establishment of stay-in-your-vehicle zones could further reduce disturbance on the Wildlife Drive.

- Rerouting, modifying, or eliminating activities which have demonstrated direct wildlife impacts should also be employed.
- Education is critical for making visitors aware that their actions can have negative impacts on birds.
- Establishing well-marked trails where human use is more predictable will lessen wildlife impacts.

Justification: Wildlife observation and photography are priority public uses of the National Wildlife Refuge System. Providing quality, appropriate, and compatible opportunities for these activities contributes toward fulfilling the provisions of the National Wildlife Refuge System Improvement Act. Wildlife observation and photography would provide excellent forums for promoting increased awareness, understanding, and support of refuge resources and programs and of the Service. The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. At the current level of visitation, these wildlife-dependent uses would not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the refuge.

Mandatory 15-Year Re-evaluation Date: _____09/27/2022____

Description of Uses: *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 onsite staff-led or teacher-led environmental education programs; offsite teacher-led classroom programs; teacher workshops; and interpretation of wildlife, habitat, other natural features, and/or management activities occurring on 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 have been identified in the National Wildlife Refuge System Improvement Act as priority public use activities, provided they are appropriate and compatible with the purposes for which the refuge was established.

The comprehensive conservation plan identifies an expansion of the environmental education program to a curriculum-based program that focuses on habitat diversity. Over time the program would grow to provide a diverse range of onsite staff-led education programs. The programs will explore various habitats of the refuge (i.e., lagoon waters, wetlands, scrub, and pine flatwoods), leading to a better understanding of the value of these habitats to fish and wildlife resources, the human influence on the ecosystem, and the importance of these resources to society. The refuge has developed facilities to support the program and will be developing curricula that allow students to explore and experience these habitats firsthand.

The proposed interpretation program strives to increase awareness and understanding of the refuge's natural features, habitat diversity, wildlife, human history, and refuge management activities. The comprehensive conservation plan calls for minor changes, such as adding new signs, revising brochures, and developing new interpretive panels and kiosks. The plan also calls for more extensive improvements such as developing the pine flatwoods trail and the Huntington Road trail, making improvements at the manatee observation deck, developing an interpretive wildlife viewing area near the Kennedy Space Center visitor center, and adding a guided tram-type tour.

Except for the improvements near the Space Center, proposed changes in the environmental education and interpretive program are planned for areas currently open to the public. Current interpretive sites include the visitor center, Black Point Wildlife Drive, Oak and Palm Hammock trails, Cruickshank Trail, Scrub Ridge Trail, and the manatee observation deck. The refuge uses the Sendler Educational Outpost as the focal point for education programs. New educational programs will use several sites in the vicinity of the Outpost, including various lagoon waters, marshes, scrub, and pine sites. Supervised activities will encourage the exploration of the environment, but efforts will be made to return any collected item to the habitat from which it came in an unharmed condition.

Availability of Resources: Annual refuge operation and maintenance funds support the Visitor Service program and activities. The development of proposed facilities is contingent upon successfully locating a funding source. Costs for improvements identified in the comprehensive conservation plan will typically come from the Merritt Island Wildlife Association, the Fish and Wildlife Foundation, other grants or endowments, and refuge budget increases under the Refuge Operating Needs System. The Merritt Island Wildlife Association is annually supplementing the environmental education and interpretive programs by $10,000. A portion of the proposed fee money generated from Black Point Wildlife Drive, approximately $100,000 annually, can also be used for improvements in the interpretive and educational programs. Refuge staff, such as interpretive rangers, volunteers, and the Merritt Island Wildlife Association, provides the staffing for these uses.

Anticipated Impacts of Uses: Environmental education primarily occurs at the Sendler Education Outpost and surrounding areas. The expansion of the program, as proposed, would increase disturbance in several new sites; however, impacts would be considered short-term and discrete due to the low anticipated frequency of use and ability to move sites to a new area if the habitat showed signs of impacts. Vegetation trampling, altering structure and species composition, and temporal wildlife impacts to species would be at a minimal level. This unavoidable impact associated with running the environmental educational program is acceptable.

Impacts associated with interpretive activities generally occur at developed facilities such as the visitor center, trails, boardwalks, Wildlife Drive, manatee deck, or other improved facilities. Adding the new interpretive sites will have some wildlife or habitat impacts. The pine flatwoods trail would use an existing fire break and only minimal clearing will be required for a parking lot (about one tenth of an acre). The preferred route for the tram tours would use an existing railroad track and about two tenths of an acre of clearing would be required for a parking lot. The planned observation tower for visitors at the Kennedy Space Center would be located adjacent to State Route 405 and most improvements (e.g., parking lots and a kiosk) would be located in a previously cleared and disturbed area. The tower and tower trail would be located near some wetlands, but the footprint of the tower and trail will be in uplands where impacts are minimal.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: While anticipated impacts are expected to be minimal, stipulations are required to ensure that wildlife resources are adequately protected. The environmental education program activities will avoid sensitive sites and sensitive wildlife populations. Built into all curriculums will be a section on wildlife etiquette. Environmental education programs and activities will be held at or near established facilities where impacts may be minimized. Evaluations of

sites and programs should be conducted annually to assess if objectives are being met and that the natural resources are not being adversely impacted.

Impacts associated with interpretive programs are also anticipated to be minimal. One overarching aspect of the interpretive program is to build understanding and appreciation for the refuge and its natural resources. As use increases, wildlife disturbances are unavoidable, but through interpretive materials (e.g., brochures, signs, and kiosk panels) proper wildlife etiquette will be stressed. Education is critical for making visitors aware that their actions can have negative impacts on wildlife. Interpretive activities and programs will be conducted at developed sites where impacts can be minimized. Wildlife impacts on Black Point Wildlife Drive will be carefully monitored. If impacts are detected, adaptive strategies will be developed, such as stay-in-your-vehicle zones, to lessen wildlife disturbance. Annual evaluations will be conducted to assess if objectives are being met and that the natural resources are not being adversely affected.

The refuge will modify or eliminate any use that results in unacceptable impacts.

Justification: Environmental education and interpretation represent two priority wildlife-dependent recreational activities listed under the National Wildlife Refuge System Improvement Act. Environmental education and interpretation are used to encourage all citizens to act responsibly in protecting natural resources. They are tools the refuge can use to build understanding, appreciation, and support for the refuge and the National Wildlife Refuge System. Resources required to run the programs are minimal and are built into the refuge's operation and maintenance budget. Identified improvements will not be developed until adequate staff and budget are available to develop and operate them. As long as stipulations to ensure compatibility are followed, the programs should remain compatible with the purposes of the refuge. At such time that the monitoring program identifies unacceptable wildlife impacts are occurring, the refuge will modify the activity to minimize or eliminate the impacts.

Both programs allow the education of the public on the missions of the Service and Refuge System and on the refuge purposes. They highlight the areas that are most in line with the refuge's management philosophy proposed under the comprehensive conservation plan. Considering the minimal anticipated impacts through 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.

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Description of Use: *Bicycling*

While not one of the six priority wildlife-dependent recreational uses listed in the National Wildlife Refuge System Improvement Act, bicycling is a mode of transportation currently used to facilitate wildlife observation. Bike riding is also included in the compatibility determination for Wildlife Observation and Photography. This compatibility determination provides additional guidance on this specific use. As proposed, bike riding would occur only on designated roads and trails. This use occurs all year.

Availability of Resources: Operation and maintenance funds to support wildlife viewing are taken from the refuge's annual budget, which is adequate to sustain the program at the current level. Funds are needed annually to mow, grade, and fix roads open to the public; replace gravel on the Wildlife Drive and other public roads; fix, repair, and replace boardwalks and trails; paint, repair, and replace signs; and

develop and print brochures. The refuge will seek outside funding, grants, and partnerships to fund the development of the bicycle paths planned in the comprehensive conservation plan.

Anticipated Impacts of Use: A critical and objective evaluation of the potential effects that bicycles could have on the wildlife, habitat, and other public use activities is based on available information and best professional judgment. Although bicycling has the potential to have impacts, the focus is to minimize impacts. This is based on the impacts at the existing and projected level of use.

Bicycling may be an appropriate form of transportation to view wildlife and has been approved in specific locations. However, bicycle riding takes several forms. For example, mountain biking, according to the International Mountain Bicycling Association, is the sport of riding bicycles off paved roads. It requires endurance and bike handling skills and is performed on dirt roads, fire breaks, access roads, and public trails. According to the Association, the sport is broken down into several categories: cross country, downhill, street, dirt jumping, and free riding. Several aspects of mountain biking are more similar to trail running than to regular bicycling (Wikipedia 2005).

Although wildlife viewing may be an incidental aspect of the mountain biking activity, it is not considered the main purpose or intent. Mountain bikers, joggers, and all-terrain vehicle riders may enjoy the outdoor setting found at the refuge, but the activity may conflict with other wildlife-dependent recreation activities, may disturb migratory birds, and is not specifically aimed at viewing wildlife. Therefore, mountain biking, along with other similar sport activities such as jogging, is not permitted.

Other forms of bike riding may be appropriate. The intent of some bike riders is wildlife viewing and several bicycle trails are planned in the comprehensive conservation plan. Bicycle riders are not permitted to ride on refuge hiking trails. This activity disturbs other trail users and will be eliminated from hiking trails and eventually from the Wildlife Drive.

Short-term Impacts: Wildlife disturbance relative to bicycle riding has been poorly studied with most references using other activities such as walking, hiking, and operating vehicles and their impacts on wildlife; therefore, bicycle impacts are inferred (unless noted). As noted in the Wildlife Observation and Photography compatibility determination, impacts associated with wildlife observation activities can be divided into two categories, based on whether the activity occurs within or outside of a vehicle. In general, activities that occur outside of vehicles (including bicycling) tend to increase the disturbance potential for most wildlife species (Klein 1993, Gabrielson and Smith 1995; Burger 1981; Pease et al. 2005). Out-of-vehicle activities along wildlife observation trails and pullouts along the Black Point Wildlife Drive have the greatest potential for disturbing wildlife species. Among wetland habitats, out-of-vehicle approaches can reduce time spent foraging and can cause waterbirds 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 out-of-vehicle activities such as walking require longer periods of time to cover the same distance. Similarly, walking on wildlife observation trails tends to displace birds and can cause localized declines in species richness and abundance (Riffell et al. 1996).

A study conducted at Back Bay National Wildlife Refuge indicated that jogging and bike riding in an open habitat, such as marshes where the activity is highly visible to wading birds, shorebirds, and waterfowl, is disruptive. As a result, marsh birds in open areas flee from joggers and bike riders (Laskowski 1999). Wildlife may receive different cues from different modes of transportation, since wildlife do not flee as readily from cars, perhaps because the person is hidden in the vehicle and not perceived as a threat (Klein 1983). A 2005 study at Back Bay National Wildlife Refuge (Pease et al. 2005) compared five different human activities (motorized tram, slow-moving truck, fast-moving truck, bicyclist, and pedestrian) in relation to waterfowl disturbance. The study found that people walking and biking disturbed waterfowl more than vehicles.

Long-term Impacts: Considering the high level of use and variety of activities occurring at the refuge, appropriate solutions to minimize impacts need to be developed. For example, during the fall migration and overwintering season, wildlife observation, photography, environmental education, interpretation, and waterfowl hunting are all occurring simultaneously and are at the highest levels of the year. Techniques to limit disturbance must be evaluated, and implemented and monitored. This stems from the hypothesis that prolonged and extensive disturbance may cause migratory birds to abandon the wetlands most disturbed by humans and winter elsewhere. Current use may not be at a level to cause this shift, but anticipated increases relative to the expansion of the population and the growth of visitor opportunities could result in seasonal shifts in migratory bird use of the refuge's wetland habitat. Bicycling would add to the level of disturbance, especially in wetland habitats, and strategies need to be implemented to limit wildlife impacts.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: All forms of wildlife observation should have minimal wildlife and habitat impacts. However, bicycling can cause wildlife impacts in open wetland areas, can increase wildlife impacts, and can disrupt other individuals viewing wildlife. Bicycles will not be permitted on established hiking trails. Bicycling on Black Point Wildlife Drive has not reached a level where disturbance is occurring to wildlife or other individuals participating in wildlife observation. However, as use on Black Point Wildlife Drive increases, bicycling could become a greater disruption to wildlife or other visitors. Three bike paths are proposed in the comprehensive conservation plan, and as soon as the first bike path is developed, bicycling will be discontinued on Black Point Wildlife Drive. Evaluation of bike riding on bike paths and other roads open to biking will be conducted annually to assess if objectives are being met, if habitat impacts are within a tolerable range, 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, move the activity or program or eliminate the program.

Stipulations that might be employed include those listed as follows:

- Establishing buffer zones that minimize disturbance around sensitive areas and establishing additional no entry zones.
- Vegetation that effectively conceals visitors and provides cover for birds can help minimize impacts of people.
- Impacts from wildlife viewing can be reduced by providing observation blinds.
- The establishment of stay in your vehicle zones could further reduce disturbance on the Wildlife Drive.
- Techniques specific to bicycling will include: re-routing, modifying, or eliminating bicycle riding activities which have demonstrated direct wildlife impacts in open wetland habitats.
- Education is critical for making bicycle riders aware that their actions can have negative impacts on birds.
- Establishing well-marked bike trails where this use is allowed and contained.

Justification: Bicycling to observe wildlife facilitates priority public uses of the National Wildlife Refuge System. Providing opportunities for these activities contributes toward fulfilling provisions of the National Wildlife Refuge System Improvement Act. Wildlife observation from bicycles in areas

where there are few impacts to wildlife would provide an appropriate mode of transportation for promoting increased awareness, understanding, and support of refuge resources and programs. The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. At the current level of visitation, bicycling does not seem to conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the refuge.

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Description of Use: *Commercial Services*

While not one of the six priority wildlife-dependent recreational uses named in the National Wildlife Refuge System Improvement Act, commercial services support wildlife viewing, interpretation, hunting, and fishing and they assist the refuge in providing quality wildlife-dependent recreational activities. The refuge authorizes commercial services through the issuance of special use permits. For the purpose of this document, the term "commercial" is defined as a permittee that charges a client a fee for a program or service to generate a profit. This does not include individuals who perform these services for no fee, not-for-profit groups, schools, colleges, or other governmental agencies.

This activity provides recreational and educational opportunities for the public who desire a quality wildlife-dependent experience, but who may lack the necessary equipment, skills, knowledge, ability, or resources to obtain it themselves. Commercial services on the refuge include motor vehicle tours; boat, canoe and kayak tours; and guided sportfishing and hunting trips. Except for the fee charged to the customer by the commercial provider, the impacts associated with these activities are no different than other activities, which are already occurring on the refuge. The named activities covered by this compatibility determination are similar to the activities covered by the interpretation, wildlife observation, waterfowl hunting, and fishing determinations, but this compatibility determination provides additional guidance specific to commercial services.

As proposed, most commercial services would be permitted in the open areas of the refuge under a special use permit. If the activity occurs in Mosquito Lagoon or north of State Route 402 and east of State Route 3, the permit is administered through an Incidental Business Permit with Canaveral National Seashore. Mosquito Lagoon is an area that is contained within the boundary of both the Seashore and the refuge. The arrangements for the incidental business permits have been developed to avoid the need for redundant permits from the Seashore and the refuge and to maintain uniformity of regulations, procedures, and guidelines between the two Department of Interior agencies. Interpretive training and further guidelines may be developed and required in the future. No administrative facilities for the providers of these commercial services will be located on the refuge.

Availability of Resources: This program cost to refuge operations includes, but is not limited to, development and review of policy and procedure; administration of annual permits (e.g., addressing inquires, screening applicants, checking on insurance, and issuing permits); and enforcement and monitoring of permit holders. However, the size and scope of the program and number of permits issued will have to be balanced with the permit fee. One factor is that Canaveral National Seashore currently administers the Commercial Fishing Guide program, which is the largest component of commercial services. Existing facilities, such as boat ramps and other infrastructure, are adequate to accommodate this use at existing levels.

Anticipated Impacts of Use: To date, the largest single component of the commercial services program is guided fishing trips. Sportfishing from boats is a use that has increased dramatically over the last 20 years. Boating, especially power boating, has been shown to cause numerous wildlife impacts (see the Fishing and Waterfowl Hunting compatibility determinations). With the popularity and growth of sport fishing, commercial fishing guides obtaining permits in the refuge have shown a similar level of growth (from 0 fishing guide permits in 1985 to over 70 in 2005). The main difference between most sports fishermen and fishing guides is the level of fishing activity. Although data is unavailable to support this, informal observations at boat ramps and contacts by refuge law enforcement officers indicate that many commercial fishing guides provide guide services on the refuge several times per week, compared to most individual sport fishermen who are seen much less frequently. This infers that a relatively small number of commercial fishing guides have the potential to cause much more wildlife disturbance or impact other individuals engaged in priority recreation activities than the same number of sport fishermen. The refuge cannot separate the impacts of fishing guides from recreational fishermen on wildlife, sport fishing, or other users.

Currently no permits are issued to hunting guides. Although only one permit is currently issued to a kayak outfitter, over the past five years several other permits have been issued to kayak guides and to one motorboat tour operator. Each year the refuge issues several permits to motor vehicle tour guides.

Guided tour activities may conflict with other refuge visitors. For example, commercial tours will use the same areas as other visitors engaged in wildlife observation, kayaking, hunting, and angling. Unregulated, commercial operations could adversely affect the safety of other visitors and the quality of their experience, and could contribute to wildlife disturbance.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: Commercial operators shall be permitted only in the areas open to the public. Seasonal or permanent closures in certain areas may be imposed on commercial operators if the level of use becomes excessive, conflicts occur with other users engaged in priority wildlife-dependent recreation, or wildlife impacts occur. In the future, interpretive training and other stipulations may be required of commercial operators to help the refuge achieve its outreach and educational objectives.

The refuge is implementing a number of strategies to address the quality of sport fishing and impacts from boaters in the shallow waters of Mosquito Lagoon. Included are strategies to cap commercial fishing guides at current levels. For planning purposes the current level is defined as any guide who holds a permit between October 1, 2003 and September 30, 2005. There are approximately 70 permit holders currently. With the completion of the comprehensive conservation plan, no additional new permits will be issued to commercial fishing guides unless a current permit holder fails to renew.

Fees charged for special use permits are based on the duration of the permit. A one-time permit (good for one visit) is $50. The fee for annual commercial use permits is $250. *The permit structure changed in January 2006 when the permit changed from a two-year permit for $250 to an annual permit issued in January for $250.* These fees are anticipated to be increased as the cost for administering the program increases.

Commercial service providers follow all refuge regulations along with additional special conditions stipulated in their permits. The special conditions listed below are common to most commercial service providers:

- The permittee will provide proof of general liability insurance in the amount of $300,000.
- The permittee will provide proof of a state charter license and/or Coast Guard Captain's license.
- The provider will supply the refuge with his/her fee schedule charged per client.
- The provider will supply the refuge with the number of trips provided per year (this will include the number of clients).
- The vessels used by fishing guides will be required to bear the annual guide permit decal.

All conditions of special use permits must be met. A special use permit may be revoked for failure to comply with the conditions or for repeat violations of refuge regulations.

Motor vehicle tours are allowed on all public roads throughout the refuge, except that busses are not allowed on dikes such as Black Point Wildlife Drive. Participants of tours may use the visitor center and auditorium, but this use must be scheduled in advance. Additional fees may be charged for the use of the Sendler Educational Outpost pavilion or restroom and prior approval is required to use these facilities.

Boat, canoe, and kayak tours may use all designated launch sites. Tour routes will be approved in the permit.

Guide fishing trips may fish in the waters of Mosquito Lagoon, Indian River Lagoon, and Banana River in accordance with refuge and state regulations. Commercial fishing guides will be capped at current levels.

Guide hunting trips may use existing hunt areas. All refuge hunting regulations and quota permit requirements apply.

Justification: Commercial operations support wildlife observation, interpretation, fishing, and waterfowl hunting. They provide recreational and educational opportunities for the public who desire a quality wildlife-dependent experience, but who may lack the necessary equipment, skills, knowledge, ability or resources to obtain it themselves. Providing opportunities for these activities would contribute toward fulfilling provisions of the National Wildlife Refuge System Improvement Act. The stipulations outlined above should minimize potential impacts relative to wildlife/human interactions. At the current level of visitation, commercial operations would not conflict with the national policy to maintain the biological diversity, integrity, and environmental health of the refuge.

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Description of Use: *Commercial Fishing*

Harvesting commercial resources from the marine environment has been a historic use on the refuge well before the refuge was established. The activity included fishing with large nets and net boats. That activity was banned in the early 1990s by a state referendum. The commercial fishing activities that remain on the refuge include crabbing using crab pots; clamming using rakes; fishing using hook and line; fishing using throw nets; and bait fishing using throw nets. Currently these activities are allowed under a commercial harvest permit. Approximately 70 individuals are currently under permit. Due to the proximity of Canaveral National Seashore and its regulatory responsibility, it was determined in 1999 that a joint permit was the most appropriate means to administer the program.

Availability of Resources: The permitting process requires the review of boat registration, saltwater products license, and photo identification to renew each permit. The permits expire on September 30 of each year. Administrative oversight is required to process the permits and handle the fees collected. In addition, catch logs must be maintained by the permittee and are subject to review. Law enforcement officers are required to ensure that permittees adhere to their special permit conditions. For instance, water areas are closed seasonally to commercial harvest. Currently the refuge has sufficient funds from the permits to support the program. However, resources are not sufficient to monitor the specific environmental impacts.

Anticipated Impacts of Use: Inherent impacts result from the operation of motorized boats in the marine environment, which include motor exhaust, disturbance to wildlife, turbidity of the water, and alteration of the marine bottoms. More specific impacts include the by-catch in crab pots of diamond-backed terrapins and other organisms. In addition, derelict traps that have been abandoned or moved by storms continue to catch and kill many organisms. Manatees have also become entangled in the float lines of the pots and suffered loss of appendages or death. Clamming with rakes or tongs can disturb or destroy marine grasses if conducted in the wrong area. Raking also adds to the turbidity of the water, which can impact seagrass growth. The level of recreational fishing from the shore and from boats is steadily increasing. At some point, direct competition will occur between the recreational and commercial fishing efforts.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: The number of permits issued for commercial fishing will be capped at the current level and the commercial fishing program will sunset in 2018 with the end of all permits by October 1, 2018. For planning purposes the current level is defined as any valid permit issued between October 1, 2003 and September 30, 2005. In addition, the permits will not be sold or transferred to anyone other than an immediate family member (i.e., father, son, daughter, mother, brother, or sister). Through attrition the number of permits will decline over time. Based on ongoing research by state and federal manatee recovery teams on the design of crab pots with escape mechanisms for manatee, crabbers will be required to implement new designs or modifications. They will also be required to recover more derelict traps. More water areas with shallow water and sensitive bottoms may be closed to commercial fishing. Special conditions in the permits will help minimize impacts from these uses. Fees are anticipated to increase to ensure the costs associated with the program are covered.

Justification: The refuge recognizes the family dependence on being watermen over the history of this local area. In order to allow a long transition of family businesses and to not place undue hardship on these families and their business, this phased approach is fair and equitable. The families will be required to adhere to more and more special conditions of the permits and permit cost increases.

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Description of Use: *Beekeeping*

Beekeeping is a use which historically supported the growing of citrus crops on refuge lands both before and after establishment of the refuge. As the acreage of citrus on the refuge has declined, beekeeping has continued and beekeepers now rely not only on citrus, but also on palmetto, maple, Brazilian pepper, and other plants for their honey crops. Beekeeping is currently allowed under special use permit. Beekeepers are selected by competitive bid with each beekeeper restricted to a maximum of 10 apiary sites. Permits are for five years and are renewed annually. If a beekeeper fails to pay for his sites, the sites are re-bid and awarded to other beekeepers. There currently are eight permitted beekeepers and 50 apiary sites on the refuge.

Availability of Resources: On an annual basis, permits are issued, funds are collected, and NASA badges are obtained for permittees with apiary sites within Kennedy Space Center's security area. If a permittee does not pay for his sites, refuge staff administers a new competitive bidding process for the available apiary sites. During the life of the permits, refuge staff occasionally inspects apiary sites and addresses access issues. Currently there are sufficient funds in the refuge's operations budget to administer the beekeeping program. Resources are not sufficient to monitor the specific environmental impacts of beekeeping activities.

Anticipated Impacts of Use: Approximately 12 acres of habitat are maintained as cleared apiary sites. There is probably some minor disturbance to wildlife caused by work at the apiary sites, but this is minimal because beekeepers visit the sites on an infrequent basis. Bees from the apiary sites pollinate exotic plants (e.g., Brazilian pepper), which may enhance the spread of these exotic plants on the refuge.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: The number of permits issued for beekeeping and the number of apiary sites will be capped at the current level and the beekeeping program will sunset in 2016 with the removal of all apiary sites and the end of all permits by October 1, 2016. For planning purposes, the current level is defined as permit holders and apiary sites in effect from January 2005 through December 2005. Permits will not be issued to anyone other than the 8 current permit holders and permits will not be transferable. If a current permit holder fails to pay for his sites, the sites will be made available through the bidding process to the remaining current permit holders under the maximum of 10 sites per permittee stipulation. Any site not receiving bids will be eliminated from the program. Once a current permit holder is dropped from the program due to nonpayment, he

or she will not be allowed to reenter the program at a future date. From 2007 forward, all beekeepers will keep the apiary sites they currently hold under permit. The only competitive bidding will be for sites made available due to nonpayment by a beekeeper.

Beekeepers will also be required to adhere to special conditions outlined in special use permits. These conditions address payment of fees, responsibility for apiary equipment, NASA security clearances, restrictions due to NASA operations, refuge fire operations, apiary site maintenance, apiary site conditions, and protection of listed species.

Justification: Beekeeping is a commercial use that does not contribute to the achievement of the refuge purposes or the mission of the National Wildlife Refuge System. The Service's Southeast Region guidance indicates that beekeeping typically will not be allowed on refuges, the only exception being the use of bees as sentinels for wildlife or public health reasons. In light of this, the refuge intends to eliminate beekeeping. However, the refuge recognizes the investment beekeepers have in their businesses. The refuge also recognizes the dependence current beekeepers have on the refuge apiary sites and acknowledges that, for many beekeepers, other suitable sites are not available within a reasonable driving distance. In order not to place undue hardship on these beekeepers and their businesses, the phased approach to eliminating beekeeping outlined in the Stipulations section above was selected as fair and equitable.

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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, nonprofit 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 NASA and its contractors. 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. All research activities will be overseen by the refuge biologist and refuge manager. The refuge has established a Refuge Research Policy (Number 9, dated July 19, 2005) that provides guidance for the refuge's research program.

Availability of Resources: The refuge currently has an onsite eight-room dormitory building to support researchers and students. As resources become available, the comprehensive conservation plan outlines the addition of an updated dormitory facility and recreational vehicle pads in the maintenance compound area. The refuge maintains geographic information system databases and a library of pertinent biological texts, published scientific and biological papers, reports, and reprints. 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. 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 significant, 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). Projects that are fish and wildlife management-oriented, which will provide needed information to refuge operation and management, will receive priority consideration and will even be solicited.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed 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 to the refuge updating the refuge on research activities, progress, findings, 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 the 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 important benefits to the refuge and to the natural resources supported by the refuge. Supporting management, 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 of the refuge and the mission of the National Wildlife Refuge System.

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Description of Use: *Astronomy*

To support the Kennedy Space Center workforce, the Service has allowed a group of amateur astronomers to use a site on the north end of the refuge on certain nights for astronomy purposes. The group simply sets up telescopes in a designated site to view the skies. The group uses the site approximately eight nights a year. The group size is limited to 25 individuals. Applicants must obtain a special use permit from the refuge before commencement of this activity.

Availability of Resources: The activity is conducted under a special use permit issued biannually. There is no current charge for the permit. No facilities are required, nor are any alterations of habitat required for this activity. Each event requires notification to the refuge. Since the area is closed to public use at night, notification of the use must be coordinated with refuge and Space Center law enforcement. Staff involvement is limited to permit processing and monitoring.

Anticipated Impacts of Use: There are no long-term measurable impacts from this activity. The designated site is in an upland community, away from any concentrated bird activity. The site already has some human use since it contains a fenced cemetery. Some minor short-lived soil compaction may occur.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: Participants must obtain a special use permit from the refuge. The special use permit will contain specific conditions of approval. A special use permit may be revoked at any time for noncompliance or for any violations. The group size is limited to 25 individuals and no fires are permitted. The frequency of eight nights per year is an acceptable level of use. If a dramatic increase in use is requested, or if multiple organizations request to use the site, a reevaluation will be necessary.

Justification: Kennedy Space Center is the primary launch site for spacecraft in this country. As such, Space Center administration attempts to nurture individual employee interest in the exploration of space. In addition, providing a variety of recreational opportunities is also part of the total employee experience at the Space Center. As an overlay of the Space Center, the refuge cooperates with this effort. No long-term impacts are anticipated from this activity.

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Description of Use: *Organized Group Camping*

The refuge has provided an unimproved camping site for the Boy Scouts of America and the Girl Scouts of America for many years. This opportunity is provided as support for a 1985 national cooperative agreement with the Boy Scouts. Each camping event is covered by a special use permit. An average of 23 troops representing 550 individuals uses the site annually. Most of the use avoids the hot summer months. The refuge coordinates the placement of portable restrooms for each event. In recent years the Merritt Island Wildlife Association has funded the construction of an open pavilion and permanent restrooms at the site. These actions were in support of the refuge's environmental education program. The pavilion is used by the scouts at no cost. If they desire to use the permanent restrooms, a $25 cleaning fee is required. The troops are required to accomplish conservation projects, such as litter pickup, during their stay on the refuge.

Other organized groups outside of the scouts have requested the use of the camping area. The refuge has resisted expansion of the opportunity due to logistical and monitoring workload requirements.

Availability of Resources: Operation and maintenance costs for this program are taken from the 1262 maintenance account, the 1263 visitor services account, and 1264 law enforcement account of the refuge's budget. Maintenance workers mow the site periodically. They also trim trees and brush. Refuge rangers coordinate the special use permit, order the portable restrooms, monitor compliance, notify Kennedy Space Center security, and ensure the conservation project is accomplished. The refuge's operating budget is adequate to sustain this program at the current level of use.

Anticipated Impacts of Use: The camping site is not located in an area of intensive bird use. It is an upland site with no impacts to wetlands. Some minor soil compaction and vegetation trampling do occur associated with the use. No impact to gopher tortoises or their burrows is expected. Fires are restricted to an approved fire pit.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: Applicants must obtain a special use permit from the refuge. This use must have a conservation basis supporting the missions of the Service and Refuge System, the purposes and goals of the refuge, and the six priority wildlife-dependent recreational uses of the Refuge System. A conservation project assisting the refuge must be a part of the requirements. A sanitary system must be in place to support the activity.

Justification: The Boy Scouts and Girl Scouts have a conservation unit within their programs. Few places are available for a truly wild, but safe camping experience. The Service has a broad national agreement to work with these scouting groups; therefore, as long as the impacts are minimized and the refuge has adequate funds and staff to support this activity, it could continue.

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Description of Use: *Noncommercial Plant Collection*

Plant collection for noncommercial purposes involves collecting, gathering, or using plant materials from refuge lands for individual, noncommercial, personal purposes that is incidental and nondestructive in nature. All plant collection (i.e., plant material, dead or alive, exotic or native) activities must be covered under a special use permit. Activities for incidental plant collection include small amounts of materials that may be used by hunters for the building of temporary blinds; small amounts of already downed or previously cut trees for firewood; or small amounts of plant material used for personal, individual purposes. Each request for the collection of plant materials will be evaluated independently. Requests for collections or actions to collect plants that will adversely impact any state or federally protected species will not be allowed. Similarly, no collections will be allowed in areas that will disrupt fish and wildlife or their habitats, and/or in areas that will adversely impact public use or public use facilities. All plant collection requests and collection activities will be overseen by the refuge ranger, refuge biologist, and refuge manager.

Availability of Resources: Other than the administration of associated special use permits, no refuge resources are required for this use.

Anticipated Impacts of the Use: Generally, adverse impacts from plant collections are minimal. Occasionally, slight or temporary disturbances may occur (e.g., minor noise associated with cutting of firewood). However, these impacts are not significant, they are not permanent, and they are far less upsetting than ordinary refuge operations (e. g., mowing of roads, controlling exotic plant species, and cutting trees to clear roads). All plant 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 the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: To ensure that plant collection activities are compatible, the refuge requires that a special use permit be obtained before any collection activity may occur. All plant collections will adhere to established refuge and Service policies on collecting specimens (Director's Order Number 109) and stipulations from Director's Order Number 109 will be inserted as a special condition in all special use permits. All plant collection requests 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 will contain conditions under which the collections must be conducted. The refuge will deny permits for plant collections that are determined to be detrimental to the resource or to be in conflict with the purposes of the refuge and the mission of the National Wildlife Refuge System. The refuge will deny permits for plant collections that are determined to negatively impact protected species or that interfere with or detract other refuge programs. All plant collection activities are subject to the conditions of their permits and may be revoked at any time for any violations.

Justification: Some plant collection activities may benefit the refuge by removing exotic species or unwanted downed material that may be obstructing access or that may be inconsequential to refuge operations. Allowing limited and supervised plant collection or removal within the scope of this determination may support some refuge projects and partnerships. Otherwise, plant collection activities at current levels are few and have minimal impacts.

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Description of Use: *Interim Management of Citrus Groves*

When NASA acquired the land that is now the refuge, approximately 2,500 acres of citrus groves existed. Under the refuge's agreement with the Kennedy Space Center, the refuge is responsible for citrus grove management. At first, the owners previous to NASA were allowed to continue to farm the groves. After several years, the groves were leased to commercial citrus interests. To facilitate administration of the citrus contracts, the groves were divided in groups of between 250 and 350 acres in size. In the late 1980s, the refuge entered into a Memorandum of Understanding (MOU) with the Kerr Center for Sustainable Agriculture in an attempt to find ways of growing citrus with less chemical inputs than is the normal practice. The Kerr Center worked with the citrus contractors to reduce the amounts of pesticides and to find more efficient ways of applying fertilizer. The contractors paid for this work through what was known as Clean Up and Improvement funds, a contract obligation. This continued until the mid-1990s when economic conditions forced the contractors to give up their operations.

NASA took over most of the grove operations for two years while the Kerr Center, under a modified MOU, operated one of the grove groups. NASA eventually returned all of the groves to the refuge. At that time the refuge again revamped the MOU with the Kerr Center. The Kerr Center, which soon became the Florida Research Center, was to farm as many of the groves as they deemed economical. They were to use the revenue from these groves to develop environmentally friendly, economically viable citrus practices called the Sustainable Citrus Program. The knowledge thus gained would then be exported to other citrus growers along the east coast of Florida. Hopefully, these growers would use these new techniques, thereby reducing the citrus industry's contribution to nonpoint source pollution in the Indian River Lagoon system.

As a part of the now renamed Florida Research Center's grove management program, the less economically desirable blocks of citrus were allowed to go fallow. The abandoned groves were those on poor soil, with low value juice oranges and some grapefruit. The fallow groves soon became overgrown with Brazilian pepper and other exotics.

The overall goal for citrus on the refuge, as described in the refuge's comprehensive conservation plan, is to eventually eliminate groves on the refuge. Under the plan, some of the land occupied by the groves would be restored to native habitat. Several restoration projects have been proposed in the comprehensive conservation plan and the habitat management plan. Other lands are designated to be returned to NASA as sites for future facilities. The groves currently being farmed are likely be allowed to go fallow unless one of two situations occur. The first would be the formation of a new partnership to determine the costs and methodology of restoring groves to native habitat. In this case, proceeds of the groves would be used to fund the study and, hopefully, to fund the restoration of all remaining grove areas to some sort of native vegetation. The other possibility would be to use the grove areas for some other uses such as alternative fuels production. As in the previous scenario, partnerships would be used to accomplish this activity. The fate of the uneconomical groves that are already fallow is for them remain fallow until opportunities for restoration or use by NASA become apparent. .

Availability of Resources: All of the citrus field and research operations are performed by the Florida Research Center. At the present time a portion of the time of one staff member is dedicated to overseeing the grove operations. Other staff members are involved in obtaining security clearance from NASA for workers in the groves inside the Kennedy Space Center security zone. The comprehensive conservation plan does not specifically identify an individual position to oversee the management of the citrus groves.

Anticipated Impacts of the Use: Citrus farming has the potential to spread exotic plants and to contribute to nutrient and pesticide pollution to the Indian River Lagoon system and other waters in and around the refuge. However, the MOU with the Florida Research Center tasks it with developing citrus culture methods that reduce these very risks. The Florida Research Center monitors the water coming off the grove areas, where practically no contamination has been detected under their program.

The Florida Research Center also controls exotic plants in the farmed groves and along their perimeters. If the groves are left unmanaged until they can be restored, these areas would have a greater potential for negative impacts on refuge habitats and wildlife than they would if management of them was continued by the Florida Research Center or a similar organization. This agreement with the Florida Research Center is scheduled to expire in 2008.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: The farming of the citrus groves should be continued under a MOU similar to the one now in force. Farming practices should minimize the used of pesticides and use innovative methods of fertilization, such as foliar feeding. Pesticides will be applied only when a Pesticide Use Proposal has been approved for that chemical. Pesticide Use Proposals will be developed annually in accordance with current Service policy. Monitoring of the runoff from the groves should be continued to track possible contamination of surface water from chemical applications. Frequent communication between the grove operator and the refuge must be done to ensure that sustainable agricultural practices are being used, that new technology is being employed where feasible, and that impacts are minimized.

Justification: As conducted under the MOU, interim citrus farming does not detract from or materially interfere with the purposes of the refuge. As an interim practice, citrus farming serves refuge goals in that invasive exotic plants are controlled on over 700 acres with little or no cost to the refuge. And the potential exists for wider-ranging environmental benefits from citrus research conducted on the refuge. If the sustainable citrus culture techniques being developed on the refuge can be exported to citrus growers along the east coast of Florida, then the levels of overall runoff pollution in the Indian River Lagoon system can be reduced. Left fallow and with little or no funding to support restoration to native habitats, citrus groves on the refuge would serve to grow and spread exotic plants on the refuge.

Mandatory 10-Year Re-evaluation Date: 09/27/2017

Description of Use: *Feral Hog Control*

Feral hogs are one of the most abundant exotic animals on the refuge. They are present in nearly all refuge habitats. Feral hogs cause considerable damage and impacts to native wildlife and habitats. The refuge has historically used trappers to annually remove about 2,500 feral hogs from the refuge. Under the current feral hog control program, four trapping units are assigned to four agent trappers and their helpers under special use permits. Trappers are permitted to remove feral hogs from the refuge through the use of live traps and trail dogs.

The feral hog control program supplements other refuge activities to control hogs, including the proposed upland deer and feral hog hunt program, which is outlined in the comprehensive conservation plan and in the Upland Game Hunting compatibility determination. Under the sea turtle protection program, refuge staff and permittees focus special attention on removing hogs from the beach and dune system to limit hog predation of sea turtle nests.

The comprehensive conservation plan outlines increasing the removal of feral hogs to 4,000 animals annually for three years, evaluating the feral hog population after this time, and adjusting the target take accordingly to reduce the feral hog population on the refuge and to limit impacts to native wildlife and habitats.

Availability of Resources: The current level of refuge funding is adequate to support the feral hog removal program as it is described in the refuge's comprehensive conservation plan and habitat management plan. Funding is used for staff time and, occasionally, to purchase shelled corn for baiting traps. Staffing at the current level is also adequate to administer the feral hog removal program. Management staff administers permits and checks for permit compliance. Administrative staff prepares pass cards for trappers and obtains NASA security badges as needed. Law enforcement officers monitor permit compliance and compliance with applicable laws and regulations.

Anticipated Impacts of Use: Minor, short-term, and discrete increased disturbance to native wildlife may be caused by trapping and trail dog activities. Native wildlife such as raccoons, opossums, and wild turkey may occasionally feed on corn used for bait at trap sites. The potential for disturbance to the visiting public does exist; however, most trapping and trail dog activities take place in areas closed to the public or at night to limit disturbance.

Determination (check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility:

- Feral hog removal permits will be issued for five years and renewed annually, subject to successful performance during the prior year by the agent trapper.
- Agent trappers will furnish all labor, equipment, and supplies required to accomplish the effective capture and removal of hogs from the refuge.
- Possession of firearms is prohibited.
- All captured hogs will become the property of the trapper and will be disposed of in accordance with local, state, and federal laws. All hogs must be removed from the refuge alive.
- Period of use, time of entry, route of travel, and techniques used are subject to approval by the refuge manager.
- Hog trapping and capture will be restricted during daylight hours in the vicinity of Black Point Wildlife Drive, Oak Hammock and Scrub Jay trails, and other public use areas.
- All agent trappers and helper trappers will be required to pass a refuge background check. Individuals with wildlife violations, felony violations, trespass violations, a pattern of repeated misdemeanor violations, and other similar violations will not be permitted.
- Agent trappers will be required to operate a specified number of traps for at least nine days each month from October through April.
- Agent trappers will be required to submit reports each month outlining the number of hogs captured and the number of traps operated each month.
- Agent trappers must provide the refuge with detailed personal information for each helper trapper and must provide detailed information on all vehicles to be used for feral hog removal.
- Trappers required to work in Kennedy Space Center's security area will be required to meet and maintain security requirements for NASA badging.

Justification: Feral hog removal and the resulting reduction of the refuge feral hog population help reduce habitat disturbance, competition between feral hogs and native wildlife for food resources, native wildlife mortality, safety hazards due to hog and car collisions, and property destruction caused by rooting activities. Without this feral hog removal program, an unrealistic amount of refuge staff time would be required to reduce the feral hog population to the level achieved by the current removal program.

Mandatory 10-Year Re-evaluation Date: 09/27/2017

Description of Use: *Forest Management – Commercial Timber Harvest*

Merritt Island National Wildlife Refuge has used commercial timber harvesting to support its forest and woodland management program for twenty years under the refuge's Upland Habitat Management Plan (Adrian et al. 1982) and the Forest and Upland Habitat Management Plan (Adrian 1991). Under the refuge's comprehensive conservation plan, timber harvesting will continue to be used in forest and woodland stands where the trees are merchantable.

Timber harvesting will be used to help achieve several of the goals and objectives outlined in the comprehensive conservation plan. Included in these are the provision of nesting substrate for the bald eagle (*Haliaeetus leucocephalus*), the improvement of habitat for the Florida scrub-jay (*Aphelocoma coerulescens*), the creation of diversity in the landscape, and the maintenance of ecological integrity. The strategies and techniques for each of these are discussed in detail in the current habitat management plan, which was developed as a step-down plan of the comprehensive conservation plan.

Periodically, the refuge's timbered areas will be assessed as to their ability to meet habitat requirements. When it is necessary to remove part or all of a stand of trees, a prospectus will be prepared and the sale offered to commercial harvesting operations. Two general methods of choosing the trees will be used. The first is to mark the individual trees that are to be removed. This method is usually used where the purpose of the harvest is to create a range of stand densities throughout the forest. In this case, a relatively small portion of the stand is removed and is most applicable where the objective is to create eagle nesting habitat or where more diversity in the forest is desired. The other method of choosing trees to be harvested is logger selection, which can be used when it is necessary to remove either the entire stand or the majority of it. With the logger selection method, the commercial operator is given the number of stems per acre that are to be left on the site, along with some size and form parameters. He is then allowed to select the trees that are cut as he works through the stand. The most likely use of this method is to reduce trees in areas where the shrub layer would provide habitat for the Florida scrub-jay. Although this method reduces the amount of pre-harvest work by eliminating marking, it requires closer monitoring of the logging operation.

Commercial timber harvesting may also be used to protect the health of the forests and woodlands. In this scenario, pockets of trees infested with insects or disease would be removed to prevent the spread of these pathogens throughout the area.

Availability of Resources: In order to effectively use timber harvesting to achieve refuge goals and objectives, personnel on the refuge's staff need to be knowledgeable in forest ecology. They must also have an awareness of the capabilities and limitations of timber harvesting operations. At the present time, such staffing is available. The comprehensive conservation plan provides for staffing at both the technical and professional level to meet this requirement in the future

Anticipated Impacts of the Use: Harvesting operations can have a major impact on the shrub layer of forests. The equipment used in these endeavors crushes and breaks many of the plants as trees are felled and skidded to the loading docks. However, the understory quickly recovers. Within a year, much of the shrub layer has grown back. The removal of some of the stems opens up the understory and allows easier access by the wildlife that lives there. Often times, the herbaceous layer responds positively to the removal of the overstory and portions of the shrub layer. This can create important foraging opportunities although they are short lived.

Soil compaction and disruption of local drainage can also be an important negative side effect of logging operations. These can be mitigated by selecting proper sites for loading areas, varying skid trails and avoiding operations during wet periods.

Noise level of the equipment and chainsaws will cause some minor disruption or displacement of wildlife.

Determination (Check one below):

	Use is Not Compatible
X	Use is Compatible, with the Listed Stipulations

Stipulations Necessary to Ensure Compatibility: All commercial timber harvesting operations will be carried out under a special use permit. Conditions of the sale will be specified in the permit and will depend on the purpose of the harvest, the characteristics of the site, current policy, and safety of refuge and Kennedy Space Center employees and visitors. The permit should also address any specific requirements of the Space Center.

While checking on harvest operations, refuge staff will be aware of present and forecasted weather conditions. Should soil moisture reach a point where excessive damage is being done to the site operations will be shut down until conditions improve. Refuge staff will also check for damage to the residual stand and will make operators aware of any problems as soon as they are detected.

Justification: The forest management actions, proposed in the comprehensive conservation plan and described in the habitat management plan, are in accordance with Service guidelines for the protection, management, and enhancement of wildlife populations and habitats on the refuge. The habitat for the bald eagle and the Florida scrub-jay, both federally threatened species, will require periodic manipulation if recovery goals are to be met. The timber harvest will also help meet goals of maintaining upland habitat diversity and will help maintain the ecological integrity of the refuge landscape.

Mandatory 10-Year Re-evaluation Date: 09/27/2017

Literature Cited:

Adrian, F.W., R.C. Lee, Jr. and J.E. Sasser. 1982. *Upland Management Plan for Merritt Island National Wildlife Refuge.* Merritt Island National Wildlife Refuge, Titusville, Florida. 64 pp.

Adrian, F.W. 1991. *Forest and Upland Habitat Management Plan, Merritt Island National Wildlife Refuge.* Merritt Island National Wildlife Refuge, Titusville, Florida. 22 pp.

Arctander, P., J. Fjeldsa and A. Jensen. 1984. Sejlads med lufpudebade, jagt og andre forstyrrelser af jugle of sealer ved Saltholm jaj-september 1984. Milljoministeriet, Fredningsstyrelsen, Denmark.

Bauer, H. G., H. Stark, and P. Grenzel. 1992. Disturbance factors and their effects on water birds wintering in the western parts of Lake Constance. *Der Ornithologische Beobachter* 89: 81-91.

Bergman, R. D. 1973. Use of southern boreal lakes by post-breeding canvasbacks and redheads. *Journal of Wildlife Management* 37: 160-170.

Burger, J. 1995. Beach recreation and nesting birds. Pages 281-295 in T.L. Knight and K.J. Gutzwiller, eds., *Wildlife and Recreationists: Coexistence through Management and Research.* Island Press, Washington, D.C. 372 pp.

Burger, J. 1981. The effects of human activity on birds at a coastal bay. *Biological Conservation* 21: 231-241.

Cronan, J.M. 1957. Food and feeding habits of the scaups in Connecticut waters. *Auk* 74(4): 459-468.

Dahlgren, R. B. and C.E. Korschgen. 1992. *Human Disturbance of Waterfowl: An Annotated Bibliography.* Resource Publication 188, U.S. Fish and Wildlife Service, Washington D.C. 62 pp.

Dobb, E. 1998. Reality check: the debate behind the lens. *Audubon,* January-February 1998.

Fox, A.D. and J. Madsen. 1997. Behavioral and distributional effects of hunting disturbance on waterbirds in Europe: Implications for refuge design. *Journal of Applied Ecology* 34: 1-13.

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 Recreationists: Coexistence through Management and Research.* Island Press, Washington, D.C. 372 pp.

Hume, R.A. 1976. Reaction of goldeneyes to boating. *British Birds* 69: 178-179.

Jackson, Jeremy B.C., Michael X. Kirby, Wolfgang H. Berger and Karen A. Bjorndal. 2001. Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293(5530): 629-638.

Jahn, L.R, and R.A. Hunt. 1964. *Duck and Coot Ecology and Management in Wisconsin.* Wisconsin Conservation Department, Technical Bulletin No. 33. 211 pp.

Kahl, R. 1991. Boating disturbance of canvasbacks during migration at Lake Poygan, Wisconsin. *Wildlife Society Bulletin* 19: 242-248.

Klein, M.L. 1993. Waterbird behavior responses to human disturbances. *Wildlife Society Bulletin* 21: 31-39.

Knight, R.L. and D.N. Cole. 1995. Wildlife response to recreationists. Pages 71-79 in R.L. Knight and K.J. Gutzwiller, eds., *Wildlife and Recreationists: Coexistence thorough Management and Research.* Island Press, Washington, D.C. 372 pp.

Korschgen, C.E. and R.B. Dahlgren. 1992. *Human Disturbance of Waterfowl: Causes, Effects and Management.* U.S. Fish and Wildlife Service Leaflet 13.2.15. 7 pp.

Korschgen, C.E., L.S. George and W.L. Green. 1985. Disturbance of diving ducks by boaters on a migrational staging area. *Wildlife Society Bulletin* 13: 290-296.

Laskowski, H., T. Leger, J. Gallegos and F. James. 1993. Behavior Response of Greater Yellowlegs, Snowy Egrets and Mallards to Human Disturbance at Back Bay National Wildlife Refuge. Unpublished report #51510-01-92. U.S. Fish and Wildlife Service, Washington, D.C. 25 pp.

Madsen, J. 1995. Impacts of disturbance on migratory waterfowl. *Ibis* 137: S67-S74.

Madsen, J., E. Bogebjerg, J.B. Kristensen, J. Frikke and J.P. Hounisen. 1992. Forsogsreservat Ulvshale-Nyord: Baggrundsundersogelser efteraret. 1985 til foraret 1989. *Danmarks Miljoundersogelser Fagilig Rapport* 47: 1-57.

Morton J.M. 1995. Management of human disturbance and its effects 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 Edition. Environmental Management Committee, Atlantic Flyway Council Technical Section, and Delaware Division of Fish and Wildlife. Dover, Delaware. 1114 pp.

Morton, J.M., A.C. Fowler and R.L. Kirkpatrick. 1989a. Time and energy budget of American black ducks in winter. *Journal of Wildlife Management* 53: 401-410.

Morton, J.M., R.L. Kirkpatrick, M.R. Vaughan and D.F. Stauffer. 1989b. Habitat use and movements of American black ducks in winter. *Journal of Wildlife Management* 53: 390-400.

Paulus, S.L. 1984. Activity budgets of nonbreeding gadwalls in Louisiana. *Journal of Wildlife Management* 48: 371-380.

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.

Reichholf. J. 1973. Begrundung einer okologischen Strategie der Jagd auf Enten. Anzeiger Ornitholghishes Gessellschafte Bayern 12: 237-247.

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.

Rodgers, J.A., Jr. and H.T. Smith. 1997. Buffer zone distances to protect foraging and loafing waterbirds from human disturbances in Florida. *Wildlife Society Bulletin.* 25(1): 139-145.

Rodgers, J.A., Jr. and S.T. Schwikert. 2002. Buffer zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboard-powered boats. *Conservation Biology* 16(1): 216-224.

Skagen, S.K. 1980. Behavioral response of wintering bald eagles to human activity on the Skagit River, Washington. Pages 231-241 in R.L. Knight, G.T. Allen, M.V. Stalmaster and C.W. Servhenn, eds., *Proceedings of the Washington Bald Eagle Symposium.* The Nature Conservancy, Seattle, Washington.

Speight, M.C.D. 1973. Outdoor recreation and its ecological effects: A bibliography and review. *Discussion Papers in Conservation No. 4.* University College of London, England. 35 pp.

Sterling, T. and A. Dzubin. 1967. Canada goose molt migrations to the Northwest Territories. *Transactions of the North American Research Conference* 32:367-369.

Stevenson, Phillip W. and Kenneth Sulak. 2001. Egress of adult sport fish from an estuarine reserve within Merritt Island National Wildlife Refuge, Florida. *Gulf of Mexico Science* 2: 77-89.

Thompson, D. 1973. Feeding ecology of diving ducks on Keokuk Pool, Mississippi River. *Journal of Wildlife Management* 37: 367-381.

Thornburg, D.D. 1973. Diving ducks movement on Keokuk Pool, Mississippi River. *Journal of Wildlife Management* 37: 382-389.

Wikipedia. 2005. Mountain Biking. Accessed at http://en.wikipedia.org/wiki/Mountain.biking.

Wolder, M. 1993. *Disturbance of Wintering Northern Pintail at Sacramento National Wildlife Refuge, California.* M.S. Thesis, Humbolt State University, Arcata, California. 62 pp.

Approval of Compatibility Determinations:

The signature of approval covers all the compatibility determinations considered within the Comprehensive Conservation Plan for Merritt Island National Wildlife Refuge. If one of the descriptive uses is considered for compatibility outside of the plan, the approval signature becomes part of that determination.

Signature:

Ron Hight 6/19/08

Refuge Manager Date

Review:

Pamela Hess 6/20/08

Regional Compatibility Coordinator Date

Review:

Holly Jakobiaut 6/24/08

Acting Refuge Supervisor Date

Concurrence:

7-1-08

Regional Chief
National Wildlife Refuge System
Southeast Region

Date

Appendix F. - Habitat Management Plan

For a copy of the Habitat Management Plan for Merritt Island National Wildlife Refuge, please contact the refuge at 321.861.0667; by e-mail at MerrittIslandCCP@fws.gov; or through standard mail: P.O. Box 6504, Titusville, FL 32782-6504.

To view or print a copy, please visit http://www.fws.gov/southeast/planning/, select Draft Documents, and scroll down to Merritt Island National Wildlife Refuge.

Appendix G. - Visitor Services Plan

For a copy of the Visitor Services Plan for Merritt Island National Wildlife Refuge, please contact the refuge at 321.861.0667; by e-mail at MerrittIslandCCP@fws.gov; or through standard mail: P.O. Box 6504, Titusville, FL 32782-6504.

To view or print a copy, please visit http://www.fws.gov/southeast/planning/, select Draft Documents, and scroll down to Merritt Island National Wildlife Refuge.

Appendix H. - Consultation and Coordination

INTRODUCTION

The comprehensive planning process for Merritt Island National Wildlife Refuge involved a wide range of participants from federal, state, and local governments; universities and other researchers; private nonprofit groups; and the friends of the refuge, Merritt Island Wildlife Association, as well as a wide variety of local residents, local businesses, concerned citizens from all over the country, local schools, universities, and state and national organizations. Outreach efforts by the refuge and news coverage by the media have spread across the country. The list of participants, beyond those individuals and organizations providing comments during the public scoping process, includes the Core Planning Team, the Wildlife and Habitat Management Review Team, the Public Use Review Team, the Wilderness Review Team, the Intergovernmental Coordination Planning Team, and other parties.

CORE PLANNING TEAM

The Core Planning Team included representatives from the Service (i.e., from the refuge and the Division of Ecological Services) and the Florida Fish and Wildlife Conservation Commission. The team met as a whole to review all of the issues, determine the priority issues, and identify potential solutions or approaches. A subset of the Core Planning Team, consisting of the refuge's staff, developed the draft plan and environmental assessment, based on the information and direction provided by the Core Planning Team.

Merritt Island National Wildlife Refuge, U.S. Fish and Wildlife Service

- Fred Adrian, Forester
- Cheri M. Ehrhardt, AICP, Natural Resource Planner
- Marc Epstein, Refuge Biologist
- Ron Hight, Project Leader
- Ralph Lloyd, Deputy Refuge Manager
- James Lyon, Biological Science Technician
- Dorn Whitmore, Supervisory Refuge Ranger

North Florida Ecosystem Field Office, Ecological Services, U.S. Fish and Wildlife Service

- John Kasbohm, former Fish and Wildlife Biologist

Florida Fish and Wildlife Conservation Commission

- Dennis David, Regional Director
- Richard Paperno, Research Biologist, Florida Marine Research Institute
- Steve Rockwood, Waterfowl Biologist

WILDLIFE AND HABITAT MANAGEMENT TEAM

Organized by staff at the Merritt Island National Wildlife Refuge Complex, the Wildlife and Habitat Management Review Team included a core group of Service staff with invited participants. The invited participants included local and regional experts, researchers, and individuals with intimate knowledge of and expertise of the resources of the refuge. These participants included representatives from the Service, Kennedy Space Center (NASA), Canaveral National Seashore (NPS), National Marine Fisheries Service (NOAA), U.S. Geologic Survey, Florida Fish and Wildlife

Conservation Commission, St. Johns River Water Management District, Brevard County, Brevard Mosquito Control District, Marine Resources Council, and several universities. The Wildlife and Habitat Management review was conducted in two parts during July and September of 2001.

Core Group – Merritt Island National Wildlife Refuge, U.S. Fish and Wildlife Service

- Fred Adrian, Forester
- Lisa Earnest, former Biological Science Technician
- Sandy Edmondson, former Cooperative Fish and Wildlife Student
- Cheri M. Ehrhardt, AICP, Natural Resource Planner
- Marc Epstein, Refuge Biologist
- Ron Hight, Project Leader
- Ralph Lloyd, Deputy Refuge Manager
- Gary Popotnik, former Biological Science Technician
- Dorn Whitmore, Supervisory Refuge Ranger

Invited Participants - Uplands

- Roger Boykin, Fire and Law Enforcement Coordinator, Southeast Regional Office, U.S. Fish and Wildlife Service
- Laura Brandt, Senior Refuge Biologist, ARM Loxahatchee National Wildlife Refuge, U.S. Fish and Wildlife Service
- Tim Breen, Regional Nongame Biologist, Florida Fish and Wildlife Conservation Commission
- Mickey Heitmeyer, Gaylord Memorial Laboratory, University of Missouri
- Chuck Hunter, Nongame Migratory Bird Biologist, Division of Migratory Birds, Southeast Regional Office, U.S. Fish and Wildlife Service
- Mike Legare, Wildlife Biologist, Dynamac Corporation/Kennedy Space Center
- Paul Schmalzer, Plant Ecologist, Dynamac Corporation/Kennedy Space Center
- Keith Watson, Nongame Migratory Bird Biologist, Division of Migratory Birds, Southeast Regional Office, U.S. Fish and Wildlife Service

Invited Participants - Beach, Wetlands, and Estuarine Systems

- James Bohnsack, Research Biologist, Southeast Fisheries Science Center, National Marine Fisheries Service
- Frank Bowers, Chief, Division of Migratory Birds, Southeast Regional Office, U.S. Fish and Wildlife Service
- Ron Brockmeyer, Environmental Specialist, St. Johns River Water Management District
- Jaime Collazo, Assistant Unit Leader, North Carolina State University, Fish and Wildlife Cooperative Research Unit, U.S. Geologic Survey
- Robert Day, Indian River Lagoon Program, St. Johns River Water Management District
- Jim Egan, Executive Director, Marine Resources Council
- Lew Ehrhart, Professor, University of Central Florida
- Leigh Fredrickson, Professor, Gaylord Memorial Laboratory, University of Missouri
- Grant Gilmore, Research Scientist, Dynamac Corporation/Kennedy Space Center
- Carlton Hall, Dynamac Corporation/Kennedy Space Center
- Garth Herring, Graduate Research Assistant, North Carolina State University
- Wilson Laney, Coordinator, South Atlantic Fisheries Management Council, U.S. Fish and Wildlife Service
- Mike Legare, Wildlife Biologist, Dynamac Corporation/Kennedy Space Center
- Rich Paperno, Research Biologist, Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission

- Steve Rockwood, Waterfowl Biologist, Florida Fish and Wildlife Conservation Commission
- Philip Stevens, Fisheries Biologist, U.S. Geological Survey, University of Florida
- John Stiner, Resource Specialist, Canaveral National Seashore, National Park Service
- Eric Stolen, Wildlife Biologist, Dynamac Corporation/Kennedy Space Center
- Scott Taylor, Biologist, Brevard Mosquito Control District
- Robert Virnstein, Environmental Scientist, St. Johns River Water Management District
- Keith Watson, Nongame Migratory Bird Biologist, Division of Migratory Birds, Southeast Regional Office, U.S. Fish and Wildlife Service
- Conrad White, Supervisor, Natural Resources Management Office, Brevard County Florida
- Blair Witherington, PhD, Sea Turtle Beach Nesting Index Coordinator, Florida Marine Research Institute, Florida Fish and Wildlife Conservation Commission

VISITOR SERVICES REVIEW TEAM

The Visitor Services Review Team consisted of Service staff from the Southeast Regional Office and other refuges, as well as staff from the National Park Service and the Florida Fish and Wildlife Conservation Commission. The Public Use Review for the refuge was conducted in March 2002.

U.S. Fish and Wildlife Service

- Tom Comish, Refuge Manager, Sunkhaze Meadows National Wildlife Refuge
- Cheri M. Ehrhardt, AICP, Natural Resource Planner, Merritt Island National Wildlife Refuge Complex
- Ron Hight, Project Leader, Merritt Island National Wildlife Refuge Complex
- Richard Mattison, Architect, Division of Refuges, Southeast Regional Office
- Kay McCutcheon, Park Ranger, Santee National Wildlife Refuge
- Ray Paterra, Public Use Specialist, White River National Wildlife Refuge
- Garry Tucker, Acting Chief, Division of Visitor Services and Outreach, Southeast Regional Office
- Dorn Whitmore, Supervisory Refuge Ranger, Merritt Island National Wildlife Refuge Complex

National Park Service

- Norah Martinez, former Chief Ranger, Canaveral National Seashore

Florida Fish and Wildlife Conservation Commission

- Joni Ellis, former Conservation Education Specialist

WILDERNESS REVIEW TEAM

The Wilderness Review Team involved staff from the Merritt Island National Wildlife Refuge Complex.

Merritt Island National Wildlife Refuge, U.S. Fish and Wildlife Service

- Cheri M. Ehrhardt, AICP, Natural Resource Planner
- Ron Hight, Project Leader
- Gary Popotnik, former Biological Science Technician

INTERGOVERNMENTAL COORDINATION PLANNING TEAM

The participants of the Intergovernmental Coordination Planning Team included local, state, and federal governmental field staff representatives involved with the resources at the local and regional levels, including representatives from the U.S. Fish and Wildlife Service; National Aeronautics and Space Administration; National Park Service (Canaveral National Seashore); National Oceanic and Atmospheric Administration (National Marine Fisheries Service); U.S. Air Force (Cape Canaveral Air Force Station); Florida Fish and Wildlife Conservation Commission; Florida Department of Environmental Protection; Florida Division of Forestry; St. Johns River Water Management District; Brevard County; Brevard Mosquito Control District; and the City of Titusville.

Although they did not generally attend the meetings of the Intergovernmental Coordination Team, a variety of other governmental representatives were kept informed throughout the process and provided input to the team, including the Miccosukee Tribe; National Aeronautics and Space Administration; U.S. Air Force; National Oceanic and Atmospheric Administration; U.S. Army Corps of Engineers; Florida Fish and Wildlife Conservation Commission; Florida Department of State; Florida Division of Forestry; Florida Department of Community Affairs; Florida Department of Environmental Protection; Florida Inland Navigation District; St. Johns River Water Management District; Brevard County; Volusia County; and the cities of Titusville, Oak Hill, and New Smyrna Beach.

U.S. Fish and Wildlife Service

- Fred Adrian, Forester, Merritt Island National Wildlife Refuge Complex
- Cheri M. Ehrhardt, AICP, Natural Resource Planner, Merritt Island National Wildlife Refuge Complex
- Marc Epstein, Refuge Biologist, Merritt Island National Wildlife Refuge Complex
- Ron Hight, Project Leader, Merritt Island National Wildlife Refuge Complex
- Steve Johnson, former Refuge Operations Specialist, Merritt Island National Wildlife Refuge Complex
- John Kasbohm, former Fish and Wildlife Biologist, North Florida Ecosystem Field Office, Ecological Services
- Ralph Lloyd, Deputy Refuge Manager, Merritt Island National Wildlife Refuge Complex
- Richard Meyers, former Refuge Operations Specialist, Merritt Island National Wildlife Refuge Complex
- Gary Popotnik, former Biological Science Technician, Merritt Island National Wildlife Refuge Complex
- Glen Stratton, Forestry Technician, Merritt Island National Wildlife Refuge Complex
- Dorn Whitmore, Supervisor, Refuge Ranger, Merritt Island National Wildlife Refuge Complex

National Aeronautics and Space Administration

- Mario Busacca, Environmental Management, Kennedy Space Center
- Chris Fairey, former Spaceport Services Director, Kennedy Space Center
- Sue Gaines, Lead, Master Planning, Kennedy Space Center
- John Halsema, Director, External Affairs, Kennedy Space Center
- Scott Kerr, Director of Spaceport Services, Kennedy Space Center
- Bill Knott, PhD, Chief Scientist, Kennedy Space Center
- Pete Nicolenko, National Test Director, Kennedy Space Center

- Renee Ponik, Planner, Master Planning, Kennedy Space Center
- Burton Summerfield, Director, Occupational Health and Environmental Division, Kennedy Space Center
- Leila Taylor, Real Property Officer, Kennedy Space Center
- Joel Wells, External Affairs, Kennedy Space Center
- Spencer Woodward, NASA Test Director, Launch and Landing, Kennedy Space Center

National Park Service

- Timothy Morgan, former Chief Park Ranger, Canaveral National Seashore
- Bob Newkirk, former Superintendent, Canaveral National Seashore
- John Stiner, Resource Specialist, Canaveral National Seashore

National Oceanic and Atmospheric Administration

- George Getsinger, Ecologist, National Marine Fisheries Service

U.S. Air Force

- Jack Gibson, Deputy Range/Base Engineer, Cape Canaveral Air Force Station
- Robin Sutherland, Cape Canaveral Air Force Station

Miccosukee Tribe

- F.K. Jones, Wildlife Director

Florida Fish and Wildlife Conservation Commission

- Dennis David, Regional Director
- Richard Paperno, Research Biologist, Florida Marine Research Institute
- Steve Rockwood, Waterfowl Biologist
- Blair Witherington, PhD, Sea Turtle Beach Nesting Index Coordinator, Florida Marine Research Institute

Florida Department of Environmental Protection

- Keith Fisher, Manager, St. Sebastian River Buffer Preserve
- Steve Williams, Environmental Specialist, St. Sebastian River Buffer Preserve

Florida Division of Forestry

- John Koehler, Orlando District Manager
- Mike Kuypers, District Manager, Bunnell District
- Bill Scaramellino, Forest Area Supervisor

St. Johns River Water Management District

- Ron Brockmeyer, Environmental Specialist
- Robert Day, Environmental Scientist, Indian River Lagoon National Estuary Program
- Peter Henn, Land Manager
- Michelle Reiber, Supervising Regulatory Scientist
- Troy Rice, Director, Indian River Lagoon National Estuary Program
- Robert Virnstein, Environmental Scientist

Brevard County

- Anne Birch, Manager, Environmentally Endangered Lands Program
- Marsha Cantrell, Manager, Park Support Services

- Ray Mojica, Environmentally Endangered Lands Program
- Donna Oddy, Natural Resources
- Cheryl Paige, Parks and Recreation
- Betty Salter, Parks and Recreation

Brevard Mosquito Control District

- Jim Hunt, Director
- Chris Richmond

City of Titusville

- Wes Hoaglund, Planner
- Dean Pettit, Chairman, Titusville Environmental Commission

Appendix I. - List of Preparers

Merritt Island National Wildlife Refuge, U.S. Fish and Wildlife Service

- Fred Adrian, Forester
- Cheri M. Ehrhardt, AICP, Natural Resource Planner
- Marc Epstein, Refuge Biologist
- Ron Hight, Project Leader
- Ralph Lloyd, Deputy Refuge Manager
- James Lyon, Biological Science Technician
- Dorn Whitmore, Supervisory Refuge Ranger

Appendix J. Public Involvement

SUMMARY OF PUBLIC SCOPING

Following the initial gathering of information, the Service published a notice of intent to prepare a Comprehensive Conservation Plan and Environmental Assessment (CCP/EA) for Merritt Island National Wildlife Refuge in the *Federal Register* on August 26, 2002. The Service also placed advertisements in local newspapers, posted information on the refuge's website regarding upcoming public meetings and how to submit comments, posted meeting information in the local community (at local shops, at the refuge's visitor center, and at local libraries), and sent out flyers announcing the public meetings. An open house was held at the refuge's visitor center on September 21, 2002, to kick off the public scoping phase. More than 180 people attended the open house, which was followed by three public scoping meetings: one on October 23, 2002, in south Merritt Island with 31 attendees; one on October 28, 2002, in New Smyrna Beach with 17 attendees; and another on October 29, 2002, in Titusville with 55 attendees.

During September and October 2002, ten articles on the refuge's planning process appeared in three local newspapers: *Florida Today*, *Orlando Sentinel*, and *Press Tribune*. One article appeared in November 2002 to review the wide range of public comments submitted to the Service. During this public scoping, the Service received more than 1,600 written comments from individuals and organizations spanning 49 states and 11 countries. Two planning updates kept the public informed of the Service's progress on the plan. Four follow-up meetings were held in 2004 to address the public's concerns specific to Mosquito Lagoon: one on April 29, 2004, in Titusville with 65 attendees; one on May 12, 2004, in New Smyrna Beach with 25 attendees; another on November 8, 2004, in Titusville with 7 attendees; and a final one on November 22, 2004, in New Smyrna Beach with 32 attendees.

The Service then began the task of reviewing all the issues raised, including internally and from the public, organizations, businesses, local and state government agencies, and other federal agencies. The Draft CCP/EA was then developed based on those issues determined to be of the highest priority for the refuge to address during the 15-year life of the CCP/EA.

In preparation for public review and comment, in March of 2006 the Service mailed more than 1,400 postcards to those entities on the refuge's CCP mailing list to notify them of the coming availability of the Draft CCP/EA for public review and comment, and to allow interested parties to request copies of the document. Information was also posted at the refuge's visitor center and on its website. The Service also published a notice of availability of the Draft CCP/EA in the *Federal Register* on December 27, 2006. From November 2004 to February 2007, no fewer than 15 articles appeared in various publications regarding the Draft CCP/EA, including the *Daytona Beach News-Journal*, *Florida Today*, *Ducks Unlimited Newsletter*, *Florida Sportsman*, *Wilderness*, and *Habi-Chat* (newsletter of the Merritt Island Wildlife Association). The document was also made available at the refuge's visitor center and on the Internet. More than 100 copies of the document were mailed from the Service's Southeast Regional Office in late December 2006–early January 2007 to those who had requested copies. Subsequent to this initial mailing, numerous paper (hard copy) and compact disk (CD) copies of the Draft CCP/EA were distributed from the refuge.

DRAFT PLAN COMMENTS AND SERVICE RESPONSES

The Draft CCP/EA for Merritt Island National Wildlife Refuge was made available for public review and comment for a period of 60 days, beginning on December 27, 2006, and closing on February 26, 2007. A few comments were received after the deadline. The Service received written comments from 22 members of the general public, three state government agencies, three area businesses, three researchers or research entities, and one organization. Comments were also received through the State of Florida's clearinghouse, representing four state government agencies. Two federal agencies, the Kennedy Space Center (National Aeronautics and Space Administration) and Canaveral National Seashore (National Park Service) also submitted comments. The state government agencies that submitted comments during the public review and comment period included the Florida Fish and Wildlife Conservation Commission; Division of Historical Resources of the Florida Department of State; St. Johns River Water Management District; Florida Department of Environmental Protection; and Florida Department of Transportation. The proposed plan was determined by the State of Florida to be consistent with the Florida Coastal Management Program.

In accordance with the requirements of the National Environmental Policy Act, the Service responded to substantive comments. For the 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. On the other hand, a comment such as "We love the refuge" would not be considered substantive.)

The comments received 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; Alternatives; References; Notification of Public Review and Comment Period; and Minor Corrections. Comments on like topics were grouped together. The Service's responses to the comments are provided by category. The page numbers referenced relate to the original page numbers in the Draft CCP/EA that was released for public review and comment.

WILDLIFE AND HABITAT MANAGEMENT

Impoundment Management

Comments: Four comments addressed impoundment management on the refuge. One citizen focused on the management of water levels and favored a return to pre-1990s conditions in the impoundments, with more water and less management. This commenter especially noted that Area 3 is void of ruppia and chara.

Another citizen expressed concerns regarding the Shiloh impoundments, and stated that this area has changed drastically since the 1960s. Although freezes have had an impact, the commenter felt that the opening of the dikes to the Indian River Lagoon served as a catalyst that has all but eliminated the aquatic plants above and below the water in these impoundments.

A third commenter suggested improving waterfowl food quality in Shiloh 1, Shiloh 2, and BioLab.

The Florida Fish and Wildlife Conservation Commission (FWC) supported the characterization of the refuge's impounded wetlands as an appropriate balance of wetlands to be managed for fish and wildlife resources, mosquito control, and hydrologic reconnection or full restoration. Further, the targeted objectives will place an increased emphasis on management of selected impoundments to maximize habitat management potential for these species. Connecting strategic impoundments to allow for the exchange of fish biomass avoids conflicts with management of other impoundments for waterfowl or wading birds. These management actions will also provide exceptional recreational opportunities for hunting and viewing wildlife, supporting tourism that is so important to the local community and to Florida's economy.

Service Response: The refuge manages its impoundments with two main functions: migratory birds and aquatic resources (see the refuge's Habitat Management Plan, Chapter IX [Appendix F]). The refuge accomplishes both of these functions while also providing for mosquito control needs in Brevard and Volusia counties. Reconnecting impoundments to the estuary has had significant impact on the species composition and plant diversity in the impoundments for the benefit of aquatic resources (fisheries). See also the wetlands initiative (Cahoon et al. 2004).

The vegetative components of Area 3 are driven by rainfall. If the refuge misses significant amounts of rainfall in the early summer, then the Area 3 impoundments do not produce aquatic plants for waterfowl.

Wetlands – Sediment Accretion

Comment: The St. Johns River Water Management District expressed a concern regarding sediment accretion and the need for long-term monitoring.

Service Response: See page 138 of the Habitat Management Plan (Appendix F). In addition, the refuge supports long-term monitoring of marsh loss and accretion through the SET stations following the Cahoon et al. (2004) protocol. The refuge's Habitat Management Plan was amended to reflect this addition.

Interior Wetlands

Comment: One citizen specifically addressed the CCP's section on Interior Wetlands (page 99, 4.e). This section needs to provide more emphasis on (a) the negative impact that fire suppression has had on swale habitats (Schmalzer et al. 1999); (b) the impacts of feral hogs; and (c) the impacts of creation of firebreaks that sometimes run into or around these wetlands. We have seen several cases where firebreaks have been built through freshwater swales, significantly altering the hydrology of the swale for years and perhaps decades. Given the importance of these habitats to overall patterns of biodiversity on the site (Seigel and Pike 1993), this section needs additional attention and expansion.

Service Response: These comments are addressed in the CCP and Habitat Management Plan (see Wildlife and Habitat Management Objective 4.e(1) and in Appendix F, HMP, Chapter IX). The Service is actively involved with reversing the impacts of previous fire suppression throughout the refuge, and including the swale habitats. Feral hogs are a major impact on swale marshes, and the refuge has a very aggressive removal program with professional trappers. The refuge does recognize that some firebreaks may alter the hydrology of certain habitats, but the refuge mitigates for that impact as much as possible by reducing the amount of firebreaks to the minimum, and installing culverts under firebreaks as needed.

Feral Hog Control

Comments: Three comments addressed enhanced feral hog damage and control on the refuge.

One individual submitted an article by Robert C. Belden of the FWC, regarding enhancing feral hog control through planned hunts.

A second commenter stated that the CCP understates the impacts of feral hogs, inadequately conveying the urgency of this problem. Data from various studies on amphibians and reptiles on the refuge indicate that feral hogs are severely impacting the few remaining natural freshwater wetlands/swales and have been shown to cause local extinction of some ecologically important species (Seigel and Pike 2003). This comment suggested that the current levels of hog harvest are too low, that the proposed target of 4,000 is barely sufficient, and that the refuge should conduct a more detailed study of the impacts of feral hogs on the refuge ecosystem to better target specific areas of impact for hog removal.

The third comment came from Canaveral National Seashore, National Park Service, which addressed the feral hog discussion on page 91 under Wildlife and Habitat Management Objective 3.b(1):

> Page 91, Feral Hogs: Another significant impact of feral hogs is to fragile freshwater swales, especially during periods of drought. These swales are crucial habitat for over 35 amphibian and reptile species, including several rare amphibian species recorded from only single swales (Seigel et al. 2002). Hog rooting could lead to local extinction of several of these species.

Service Response: These comments are addressed in the CCP and HMP under Visitor Services Objective 2.b(1), which describes the refuge's work with the Florida Fish and Wildlife Conservation Commission to develop a deer and feral hog hunt program. Further, the proposed removal target of 4,000 hogs over three years is sufficient to reduce the population. The implementation of required trap nights by the permittees over the last two years has reduced the overall population. The take recorded by the permittees has actually declined in 2004 and 2005 to less than 2,000 hogs. The key is persistent pressure to keep the population low. The implementation of a hunting program and persistent pressure by the permittees will be sufficient to protect these wetlands. Any trouble spots can be identified to the refuge for additional action. The refuge recognizes the negative impact of hogs on these habitats, and the refuge's feral hog control program is working to address the issue. (See also Appendix F, HMP, C2-1).

Waterfowl in Mosquito Lagoon

Comment: One citizen expressed concern about the lack of bluebills and other ducks in Mosquito Lagoon. This comment focused on fishing pressure as the cause of disturbance and decline of rafting duckings in Mosquito Lagoon.

Service Response: This comment is addressed in the CCP and HMP (see Wildllife and Habitat Management Objective 2.a(2), and also in Chapter 9 of the HMP.

Fisheries

Comments: Two comments addressed the fisheries on the refuge. One citizen was a fishing guide who supported saving the fishery from total collapse, even if it hurts the income of commercial users (e.g., fishing guides).

The other comment, submitted by Canaveral National Seashore, National Park Service, specifically addressed the strategies under Wildlife and Habitat Management Objective 4.c(1):

> Page 97, Strategies (Fisheries): Another good strategy would be to coordinate with the Seashore to assess boating use patterns and impacts throughout Mosquito Lagoon (refuge and Seashore) to protect vulnerable fish spawning and juvenile nursery areas.

Service Response: The CCP, Habitat Management Plan, and Visitor Services Plan all work toward protecting the important fisheries of the refuge, including recommended actions addressing wildlife, habitat, visitor services, and refuge administration. Wildlife and Habitat Management Objective 4.c(1) specifically calls for a baseline inventory of the refuge's estuarine fisheries resources.

Red Drum Fishery in Mosquito Lagoon

Comment: One citizen suggested that the refuge work with the Florida Fish and Wildlife Conservation Commission (FWC) to make all or part of Mosquito Lagoon a catch and release only fishery for red drum. At a minimum, the commenter suggested making the area south of Haulover Canal a catch and release only area for red drum. Further, the commenter suggested that the refuge work with FWC to initiate red drum population studies over multiple years to assess the status and trends of the population, including a tagging program to track movements of Mosquito Lagoon's red drum. These activities were suggested to help limit the decline of red drum in Mosquito Lagoon due to fishing pressure, especially pressure from fishing tournaments.

Service Response: These comments are addressed in the CCP and Habitat Management Plan (see Wildllife and Habitat Management Objective 4.c(1), and Chapter IX in the HMP). The refuge currently supports a FWC fisheries monitoring program in Mosquito Lagoon.

Seagrass Beds

Comment: One commenter stated that habitat protection is the key to the long-term quality of the estuaries. Further, he supported doing whatever is necessary to justify and fund additional pole and troll zones to help recover seagrass beds and improve the fisheries.

Service Response: This comment is addressed in the CCP and in more detail in the Habitat Management Plan and Visitor Services Plan under Wildlife and Habitat Management objectives 4.b(1) and 4.b(2) and under Visitor Services Objective 3.a(1). Figure 3.4 in the Visitor Services Plan depicts the Tiger Shoals and WSEG Boat Ramp pole and troll zones.

Habitat Restoration

Comments: One individual supported the proposed planting and management of upland trees and hardwoods and the restoration of orange groves. The NASA commented that it wanted to emphasize the importance of continuing the coordinated efforts detailed in the Habitat Management Plan for both scrub and wetland restoration projects.

Service Response: These comments are addressed in the CCP and in more detail in the Habitat Management Plan under Wildlife and Habitat Management objectives 1.b(1), 2.e(1), 4.f(1), 4.h(1), and 4.h(2).

Citrus Groves

Comments: Five comments addressed citrus groves on the refuge: one suggesting mismanagement of the groves; one clarifying the role of citrus groves for wildlife; one opposing citrus grove activities on the refuge; one suggesting keeping the historical groves; and the NASA expressing particular interest regarding the active citrus groves.

One commenter stated that the refuge has destroyed and mismanaged the groves, destroying grove income. This commenter further stated that when NASA purchased the property, the citrus groves would be maintained and leased to grove operators.

One individual submitted five references supporting the use of citrus groves by as many as 24 species of birds and the use of citrus groves as suitable breeding habitats for songbirds and doves:

Lohrer, F.E. 1991. Winter bird population studies. 33. Mature citrus orchard. J. Field Ornithol. 62:26.

Lohrer, F.E. 1991. Breeding bird census. 98. Mature citrus orchard. J. Field Ornithol. 62:87.

Lohrer, F.E. 1990. Winter bird population studies. 28. Mature citrus orchard. J. Field Ornithol. 61:20.

Mitchell, M.C., L.B. Best, and D.L. Fischer. 1995. Bird abundance in Florida citrus groves. Fla. Field Nat. 23: l-9.

Mitchell, M.C., L.B. Best, and J.P. Gionfriddo. 1996. Avian nest-site selection and nesting success in two Florida citrus groves. Wilson Bull. 108(3): 573-583.

This commenter also submitted two corrections in the documents in relation to the citrus groves, as follows:

> An incorrect statement is made on the last sentence of page 272. It states, “Citrus farming has the potential to *‘spread exotic plants’* and to contribute to nutrient and pesticide pollution to the Indian River Lagoon system and other waters in and around the refuge.” Two edits are needed here. The first is the word “Conventional” should precede “Citrus farming” as the first word of the sentence, because conventional programs use phosphorus fertilizers and a full range of pesticides while the “Sustainable Citrus Program” in place since 1998 does not. Secondly, since both conventional and sustainable citrus programs use herbicides and mowing to control weeds, it is very doubtful that either program would spread exotic plants since they are actively controlled. The deletion of *‘spread exotic plants’* also makes the opening sentence in the first paragraph on page 273 more logical and consistent.

> On page 272, the second paragraph, fifth sentence, should have the published name of the "friendly citrus culture program, '*named the Sustainable Citrus Program*,' that would be economically valuable" inserted. This program named as such has been published within the annual reports to the refuge since 1998 and in various trade journals and numerous public presentations over the last decade. Nowhere in the CCP is it named and at least insertion at this location would seem to be appropriate. Likewise, it would be equally appropriate to insert the same on page 101, last paragraph, at the end of the fourth sentence to read, "a nonprofit organization, to manage some of the citrus areas *'using their Sustainable Citrus Program'*. " This is justified since significant funds derived from the crop returns were used to validate and demonstrate this worthy program. Additionally, this is important to communicate the program name since part of the goals of the refuge was to foster the use of the Sustainable Citrus Program by citrus growers along the Indian River Lagoon, thereby reducing the entry of pollutants into the Indian River Lagoon (see the Justification section on page 273).

An opposing commenter stated that the continued practice of maintaining citrus groves is incompatible with the refuge's purposes and the mission of the National Wildlife Refuge System:

> The practice of citrus farming materially detracts from and interferes with the purpose of the refuge by facilitating the introduction and spread of exotic plants such as Brazilian pepper, occupying vast tracts of land intended to be restored to native habitat, and through environmental damage and water pollution resulting from the foliar applications of pesticides and fertilizers.

Another commenter suggested retaining some of the citrus groves, possibly those south of SR 402. These could be managed by state agricultural representatives as a research/experimental site.

The NASA stated that it looks forward to partnering efforts to identify options for the citrus groves if current operations are discontinued in July 2008.

Service Response: The citrus groves do provide some habitat for passerine birds. However, since citrus farming is not compatible with the refuge's long-term objectives and the groves will eventually be phased out, this point is moot.

The comment that citrus farming does not have the potential to spread exotic plants is in error. Even though there is a concerted effort to control exotic plants in a citrus operation, there is a very real possibility that seeds, rhizomes and other parts of exotic plants can be spread to other parts of the refuge by equipment.

The CCP was updated to reflect the following points:

> Page 101, last paragraph, fifth sentence was changed to read, "The Florida Research Center's mission was to develop more environmentally benign methods for growing citrus which became the Sustainable Citrus Program."
>
> Page 272, second paragraph, fifth sentence was changed to read, "They were to use the revenue from these groves to develop environmentally friendly, economically viable citrus practices called the Sustainable Citrus Program."

Comments noted regarding compatibility, continued operation of citrus groves, and future use of groves by NASA. The refuge recognizes that the continued practice of citrus farming is not in line with the goals and objectives of the CCP. As discussed under Wildlife and Habitat Management Objectives 4.h(1) and 4.h(2), the refuge will assess the ultimate disposition of the groves, with the hopes of restoring some of the area to native habitat. Other options could involve working with NASA and other partners to use the grove areas for various purposes.

Scrub-jay Habitat

Comment: One citizen supported restoring the orange groves and using controlled burns to create scrub-jay habitat.

Service Response: This comment is addressed in the CCP and in more detail in the Habitat Management Plan under Wildlife and Habitat Management objectives 1.a(1), 1.a(2), 4.h(1), and 4.h(2).

Spoil Islands

Comment: One individual supported the proposed activities to enhance and restore spoil islands to support wading bird breeding and roosting.

Service Response: This comment is addressed in the CCP and in more detail in the Habitat Management Plan under Wildlife and Habitat Management objectives 4.a(1), 4.a(2), 4.a(3), 4.a(4), 4.a(5), and 4.a(6).

Wood Storks

Comment: One citizen supported habitat restoration and management for wood storks.

Service Response: This comment is addressed in the CCP and in more detail in the Habitat Management Plan under Wildlife and Habitat Management Objective 1.f(1).

Mottled Ducks

Comments: Two comments supported mottled duck management and protection. One citizen suggested a moratorium on the hunting of mottled ducks. Another supported the proposed target of 250 breeding pairs of mottled ducks on the refuge to help the population.

Service Response: The Service is working with the Florida Fish and Wildlife Conservation Commission regarding mottled ducks on the refuge. Mottled ducks are addressed under the priority issues for the refuge to address in the CCP and under Wildlife and Habitat Management objectives 2.a(3), 4.a(3), and 4.a(4) in the CCP and in more detail in the Habitat Management Plan.

Manatee Population

Comment: One citizen suggested that a reasonable number of manatees should be determined for the refuge to support a healthy population. This citizen stated that overgrazing by manatees has destroyed a large number of seagrass flats, negatively impacting fish and birds that use those areas. The commenter further stated that a viable number of manatees should be restricted to the closed confines of the NASA-secured areas, away from the general public.

Service Response: Manatees move along the coastal waters during various seasons of the year. It is not feasible to restrict their movements to NASA-secured areas. Population levels are addressed under Wildlife and Habitat Management Objective 1.e(1) in the CCP and the HMP.

Southeastern Beach Mouse

Comment: Canaveral National Seashore, National Park Service, suggested a clarification regarding the location and extent of the southeastern beach mouse:

> Page 68, first paragraph, third full sentence: The statement seems to say that the southeastern beach mouse is only found on the refuge. The refuge may have the largest population; however, the mouse also occurs at the Seashore, Cape Canaveral Air Force Station, and a couple of other areas as well.

Service Response: The CCP has been updated to clarify the role of the refuge with respect to the southeastern beach mouse. Page 68, first paragraph, fourth sentence was revised to read, "The refuge provides core habitat for the southeastern beach mouse, and may serve as a source population for reintroduction of this species to former habitats. "

Herpetological Species

Comment: Canaveral National Seashore, National Park Service, addressed herpetological species as follows:

> Page 91, Feral Hogs: Another significant impact of feral hogs is to fragile freshwater swales, especially during periods of drought. These swales are crucial habitat for over 35 amphibian and reptile species, including several rare amphibian species recorded from only single swales (Seigel et al. 2002). Hog rooting could lead to local extinction of several of these species.
>
> Page 101, Strategies: May want to include reducing hog impacts to freshwater swales and associated herptofauna, through targeted control efforts (see comment on Page 91 above).

Service Response: Comments noted. The refuge's Habitat Management Plan (Appendix F) was updated on page 166, third paragraph, third sentence to read, "They also root extensively in shallow seasonally flooded wetlands, including sensitive swale wetlands."

Global Warming and Sea Level Rise

Comments: Two comments were submitted addressing climate change issues. One individual stated that the Draft CCP/EA must consider the threat of global warming and take appropriate actions to mitigate its effects; and that the CCP gives only scant treatment of this issue and proposes no actions to address these threats. Further, the CCP fails to consider that global warming could increase storm intensity (Erwin et al. 2004); negatively change the refuge's ecologically important diverse plant species (Browder et al. 2005); alter the spread of invasive species (Ogden et al. 2005); increase drought-induced fires (Twilley et al. 2001); transition intertidal marshes into subtidal marshes (Galbraith et al. 2002); shift marshes and beaches inland (Field et al. 2001); and further imperil already threatened and endangered species. The Service is required to address the impacts of global warming under §668dd(e)(2)(E), §668dd(a)(4)(B), Secretarial Order 3226 (January 19, 2001), and House Concurrent Resolution 398. By not sufficiently addressing global warming, the Service will not be able to adequately manage and protect Merritt Island National Wildlife Refuge.

This individual provided comments on how coastal Florida habitats, mammals, birds, reptiles, fisheries, and invasive species could be affected by global warming and offered recommendations for management of the refuge, as listed below:

Upland Plants
Global warming should be included when determining the appropriate matrix of upland vegetative communities necessary to support native wildlife diversity.

Woody/Oak Species
Global warming throughout the next 100 years is expected to have serious negative effects on native woody plant species (Crumpacker et al. 2001). Many woody plant species in the Florida Upper Peninsula, including Merritt Island NWR, are at their southern range boundaries in the eastern United States. Populations of southern red oak and other woody species could suffer immense loss with only a one degree Celsius temperature increase, especially if the increase is greater in winter than other seasons or accompanied by a 20% decrease in annual precipitation (Crumpacker et al. 2001). As global warming decreases temperate woody plant species' fitness, invasion by aggressive native and nonnative plant species could become increasingly problematic (Crumpacker et al. 2001).

It is not likely that subtropical species will move the necessary distance over the next 100 years without human assistance (Crumpacker et al. 2001). Future research is necessary since plants should only be translocated into conservation areas following rigorous experimental design, monitoring, and analysis (Crumpacker et al. 2001).

Fire Management
If dry conditions and time between rainfalls increase as expected with global warming, the risk of fires will increase (Twilley et al. 2001). Also, if conditions become drier, savannahs and grasslands may expand and take over forests (Twilley et al. 2001). As temperature rises, trees will lose some of their capacity to absorb and store carbon (Twilley et al. 2001). Ironically, the CCP/EA (page 184) notes that absorbing carbon is the most important thing the refuge does to mitigate climate change.

Freshwater Habitats and Interior Wetlands
Freshwater habitats will likely be affected by sea level rise (SLR) and rising temperatures. Increased temperature could increase evaporation of freshwater habitats (Twilley et al. 2001). If saltwater invades freshwater habitats due to SLR, vegetation with low salt tolerance, such as the sabal palm would be decimated (Twilley et al. 2001). Interior wetlands should be managed with SLR in mind, especially since restoring natural hydrology to the wetlands could help mitigate the effects of climate change (Parkinson et al. 2006).

Estuarine Wetlands
SLR may alter the depth and width of estuaries (Kennedy et al. 2002). Bottom friction is important in controlling hydrodynamics in shallow estuaries that are strongly wind-driven, so changes in bottom area (width or depth) will have negative effects on the estuaries' energy dissipation (Kennedy et al. 2002). Further research is necessary concerning SLR and the estuaries within Merritt Island NWR.

Sea Grass
Seagrasses are marine flowering plants that provide crucial ecological services, including carbon production and export, nutrient cycling, sediment stabilization, enhanced biodiversity, trophic transfers to adjacent habitats, essential habitat for a variety of marine wildlife, and food sources for green sea turtles and manatees (Orth et al. 2006). High light requirements and low taxonomic diversity make seagrasses especially susceptible to global warming and anthropogenic influences that directly alter their physical attributes, such as boat propellers, or change water clarity, such as sediment runoff, invasive species and algal blooms (Orth et al. 2006).

Sensitive temperate and tropical seagrass populations decreased almost tenfold over the last 40 years (Orth et al. 2006). This was likely due to a combination of biological, environmental, and extreme climatological events (all of which are expected to increase due to global warming), including dune migration, sediment deposition, SLR, increased temperature, and eutrophication (Orth et al. 2006). The CCP/EA should include climate change as a stressor where it discusses threats to seagrass beds (CCP/EA page 94).

In some cases, restoration projects could be feasible, but many seagrass species can not be successfully transplanted and restored (Orth et al. 2006). Since seagrass loss is a symptom of larger problems, conservation plans must identify and solve problems at local scales (Orth et al. 2006). Increased research and modeling should be used to identify the most vulnerable areas so that conservation and management can determine the most cost-effective ways to conserve seagrass.

Manatees
Scientists believe that a widespread bloom of the dinoflagellate red tide organism *Gymnodinium breve* killed 39 manatees in the lower Caloosahatchee River and nearby waters of southwestern Florida in 1982 (O'Shea et al. 1991). The abnormally large number of deaths could have occurred because manatees arrived in the area from a nearby winter aggregation site earlier than normal and unusually high salinities could have facilitated inshore spread of the red tide bloom (O' Shea et al. 1991). An unusual number of manatee deaths in 1996 and 2003 were also linked to red tides (Barnes 2005). Toxic algal blooms and other events caused by eutrophication and runoff could increase with global warming and flooding. Along with increased runoff, warmer water could contribute to the intensity, duration, and extent of toxic algal and cyanobacteria blooms (Twilley et al. 2001).

Manatees are not as specialized as dugongs (who depend on seagrass for nourishment) and have adapted to a diverse herbivorous diet of freshwater and marshy vegetation, including seagrass (MacFadden et al. 2004). Even though they are not entirely dependent upon seagrass, Florida manatees primarily rely on the seagrasses they undoubtedly coevolved with, particularly *Syringodium filiforme*, *Halodule wrightii*, and *Thalassia testudinum* (Lefebvre et al. 2005). Further research is necessary to understand the relationship between seagrass ecology and manatee behavior so that the carrying capacity of important feeding sites does not decline as a result of lower seagrass population numbers (Lefebvre et al. 2005).

Southeastern Beach Mouse
The section of the CCP/EA discussing management of the southeastern beach mouse is one of the few places in the document that acknowledges SLR. SLR, erosion, and storms have already altered, and could continue to transform southeastern beach mouse habitat (CCP/EA page 81). However, we are concerned that the Service does not suggest any plans that could mitigate the impacts of SLR on southeastern beach mouse habitat. We recommend further research as well as a consultation with

USFWS Ecological Services and other partners to develop appropriate management actions to conserve the species in the face of rising sea levels. The CCP has been updated on page 81 to reflect concerns about sea level rise on the beach mouse.

Florida Scrub-jays

Breininger et al. (1999) found that hurricanes increase the extinction risk of coastal Florida scrub-jay populations. Global warming could further endanger Florida scrub- jays with increased storm intensity and frequency.

In wild areas without supplemented human food sources, scrub-jays eat many energy-rich acorns (Fleischer et al. 2003). Fleischer et al. (2003) hypothesized that individuals that forage and handle more food breed earlier, suggesting that foraging efficiency might be a perceptual cue for breeding. Scrub-jay breeding schedules rely heavily on nutritious food, so it will be necessary to determine through further research whether climate change will negatively affect their food sources (mainly acorns, lizards, and frogs).

Florida scrub-jays are susceptible to inadequate fire management and fire suppression (Breininger et al. 1999; Breininger et al. 2006). Further research is necessary regarding the best scrub fire management as global warming increases drought and fluctuating fire regimes as expected.

According to Root (1998), present habitat will not support Florida scrub-jay populations for the next 60 years, especially since the populations are currently small and unlikely to survive a major epidemic or catastrophe. The best ways to overcome future population declines are to increase connectivity between populations and acquire and/or restore additional scrub habitat to optimal conditions (Breininger et al. 1999; Root 1998). Further research should determine how global warming could affect scrub habitat, since it characteristically occurs on well-drained sites with low nutrient levels and periodic fires, all of which could be affected by climate change.

Sea Turtles

Sea turtles may suffer losses due to many consequences of global warming (other than hurricanes that are discussed in the CCP/EA page 79), including beach erosion, sea level rise, and rising temperatures. Loss of nesting habitats caused by beach erosion could further endanger the Kemp's Ridley, hawksbill, and loggerhead sea turtles (Twilley et al. 2001; Wood et al. 2000). Loggerhead sea turtle hatchling success decreases when inundation from rising sea water and/or extensive rainfall increase sand moisture levels above 25% (Wood et al. 2000). The CCP has been updated on page 79 to reflect concerns about sea level rise.

Warmer sea surface temperatures have been correlated with earlier and shorter loggerhead sea turtle nesting periods, which will likely lead to fewer egg clutches oviposited per nesting season (Pike et al. 2006). Since there is no evidence that oviparous species such as loggerhead sea turtles will adapt to the warmer temperatures, climate change will likely continue to contribute to the their decline (Pike et al. 2006).

Biologists link rising air temperatures to the greater incidence of female hatchlings observed in loggerhead and green turtle populations in recent years, a dangerous reproductive trend for the threatened species (Morreale et al. 1982; Mrosovsky et al. 1992). Southern United States loggerhead sea turtle populations are predicted to suffer from further female-biased sex ratios as temperature increases one degree Celsius and extreme levels of egg mortality with an increase of three degrees Celsius (Hawkes et al. 2007). Increased emphasis should be placed on preserving suitable nesting habitats that are important for male hatchling production (Hawkes et al. 2007).

For example, since dark sand is typically warmer than light sand, beach nourishment projects, the majority of which use darker sand, should be ceased in areas that sea turtles use to nest (Hawkes et al. 2007).

Change detected at Merritt Island NWR may not be enough to inform management decisions. A comprehensive program throughout refuges along the Atlantic coast will be able to discern population level changes in abundance or distribution of sea turtles. The FWS should work closely with other owners and managers of coastal habitat on the Atlantic, particularly the National Park Service. This will help fulfill the FWS requirement "to monitor the status and trends of fish, wildlife, and plants in each refuge" (16 U.S.C. §668dd).

Eastern Indigo Snake
Eastern indigo snakes are found in the vicinity of xeric pine-oak sandhills inhabited by gopher tortoises and are listed under the Endangered Species Act (ESA) as threatened species (Stevenson et al. 2003). Possible increased loss of pine habitat, due to increasing hurricanes and drought-induced fires could further decrease populations (Gibbons et al. 2000; Gilliam et al. 2006).

While the CCP/EA mentions that eastern indigo snakes are frequently killed by vehicles, the chosen alternative (page 164) provides "no active management." This is a glaring oversight. As climate change alters snake habitat, additional protection and management of current controllable threats will be necessary. Alternative B in the CCP/EA (page 164) would help decrease snake road mortality by working with the Kennedy Space Center (KSC) to shift traffic times to coordinate with snake movement, increase law enforcement, decrease illegal poaching, and conduct additional research and monitoring. We find Alternate B more appropriate than the selected alternative to manage the nonclimatic stressors affecting this threatened species, including road mortality and illegal take.

American Alligators
American alligators are vulnerable to high levels of water salinity (Davis et al. 2005). Since sea level rise could cause saltwater influx into freshwater areas, global warming impacts should be incorporated into the evaluation that will be used to decide whether alligator hunts will be feasible on Merritt Island NWR (CCP/EA at 173).

Fisheries
The CCP/EA (page 96) discusses declining horseshoe crab numbers and the migratory birds that rely on their eggs for sustenance. We recommend further research about climate change effects on timed ecological events (such as horseshoe crab spawning and shorebird migration), as well as the effects of a horseshoe crab harvest on bird population numbers.

Invasive Species
Exotic species have already invaded Florida. Climate change will exacerbate the issue, either directly or indirectly favoring these highly opportunistic species (Twilley et al. 2001). Frequent disturbance from fires and storms could weaken native species and favor the spread of invasive species already present on Merritt Island NWR, such as Australian pine, paper bark melaleuca, Brazilian pepper, water hyacinth, and the Southern pine bark beetle (Ogden et al. 2005; Twilley et al. 2001).

Building Design
Development planning involving elevated buildings has been successfully implanted in New Jersey and South Carolina (Neumann et al. 2000). We recommend that all attempts be made to incorporate global warming into the refuge office building plans that are described in the CCP/EA

page 127. In addition, refuge infrastructure should be planned and designed to anticipate increased hurricane frequency and intensity. Infrastructure design and equipment procurement should emphasize the most energy efficient option available to reduce greenhouse gas emissions.

Environmental Education

Environmental education and interpretation are priority public uses of the refuge system and when compatible, support the refuge system's mission by building public understanding and support for wildlife conservation. According to the FWS General Guidelines for Wildlife Dependent Recreation (605 FW 1, *Service Manual*), recreational uses should provide "an opportunity to make visitors aware of resource issues, management plans, and how the refuge contributes to the Refuge System and Service mission."

The CCP/EA discusses environmental education curriculum objectives that are import to Merritt Island NWR on page 118. As described above, global warming poses a significant threat to the biological integrity and mission of the refuge. It is incumbent upon the FWS to ensure the public is informed about the climate-driven changes occurring to the wildlife they have come to enjoy and learn about at Merritt Island NWR. The FWS should develop brochures, interpretive panels, websites, and education programs that include the vulnerabilities of the refuge's resources to climate change.

For example, mangroves, salt marshes, and coral reefs receive three-fold to 100-fold more media coverage in the *New York Times*, *National Geographic* and *New Scientist*, even though the ecological services provided by the combination of seagrass and algal beds are greater (Costanza et al. 1997). To help overcome a large disconnect between available information and public awareness, Merritt Island staff should raise the public's awareness by incorporating seagrass issues into educational programs.

Summary Recommendations for Incorporating Global Warming in the CCP/EA

- The impacts of global warming on the refuge's wildlife and habitat must be included throughout the CCP/EA.
- The FWS should consider the present and future impacts global warming when developing objectives and management actions in the CCP/EA. In the face of uncertainty, the FWS should be building natural resilience to global warming by focusing resources to reduce nonclimate-related ecological threats.
- FWS should convene a panel of experts to assist Merritt Island NWR and other coastal refuges in developing adaptation strategies for coastal marshes and other habitats.
- FWS should establish a sea turtle monitoring and research network with other Atlantic coast refuges and other agencies to detect population changes associated with global warming.
- The CCP/EA should include comprehensive research on and monitoring of the impacts of global warming and their relation to nonclimatic stressors to ecological systems and management actions including:
    - Upland habitat shifts
    - Changes in fire regime
    - How fresh and saltwater marshes respond to global warming
    - Changes in seagrass habitat and the relationship to manatee populations
    - How southeastern beach mouse responds to sea level rise
    - Changes in the timing of ecological events, including horseshoe crab spawning and shorebird migration

- Global warming should be incorporated into refuge infrastructure design and planning.
- Global warming should be incorporated into the refuge's environmental education and interpretation programs.

Another commenter stated that the documents did not sufficiently address the issue of sea level rise in relation to wetlands management and sustainability of wetlands, as follows:

If, as the literature and data from MINWR suggest, areas of wetland with management-impacted emergent vegetation are not accreting at a rate that can keep pace with sea level rise, then this type of management may not be sustainable. In fact, areas without emergent vegetation examined during the Wetlands Initiative at MINWR were losing elevation. This may have wide-ranging implications for your plan, specifically regarding sustainability of management, impacts to soil processes, and carbon sequestration. All proposed alternative plans need to address this issue. To the extent that the intensity of management or the acreage under management changes, there will be differences in sustainability, soils, and carbon among alternatives. At minimum, this should be a critical area of monitoring. The SET stations, installed for the Wetlands Initiative, are still in place and could be monitored over time to keep track of accretion rates.

Service Response: The Service's responses to the above comments are as follows:

The CCP/EA Must Consider the Impact of Global Warming: The CCP has been updated to reflect concerns about global warming and climate change as follows: Under the Ecological Threats and Problems discussion on page 16, third paragraph; and in the discussion on scrub habitat under Wildlife and Habitat Management Objective 1.a(1) on page 74, fifth paragraph. The refuge recognizes the vulnerability of its infrastructure and habitats to climate change which could result in sea level rise, warmer environmental temperatures, less or more rainfall, and an increase in tropical storm activity. As part of a barrier island complex formed during the Pleistocene and Holocene periods, some change is constant.

The highest land elevation of the refuge is approximately 10 feet above mean sea level. Although the hurricanes of 2004–2005 in Florida did not make direct landfall on the refuge, considerable damage was experienced due to wave action within the shallow lagoons, wave action from the Atlantic Ocean, and tropical storm-force winds. Fish were literally swimming down the paved roads. In 1998, extreme dry conditions burned 70,000 acres in Florida with the refuge having several large wildfires. A serious killing frost has not occurred since 1990.

The fact that the refuge is a barrier island surrounded by a shallow brackish lagoon does not offer many options for dealing with long-term climate change. The CCP recognizes that much more monitoring and research is necessary to evaluate and respond appropriately. NASA has a huge investment in their infrastructure located within the refuge. The refuge will partner with both the Kennedy Space Center and Canaveral National Seashore to reformat the existing monitoring program and add other partners to meet this monitoring need.

Upland Plants: Upland plants are addressed in the CCP and HMP (see Chapter II and Wildlife and Habitat Management Objectives 1.a(1),1.b(1),1.d(1),2.e(1),and 4.f(1) in the CCP and Chapters 4, 5 and 7 in the HMP). Merritt Island NWR is not located in the Florida Upper Peninsula. Its location can better be defined as being in the east central region of Florida. The climate is classified as subtropical. The vegetation on the refuge is a mix of temperate and warm climate species. It is felt that if any temperate plants drop out of the system due to warming of the climate, plants favored by higher average temperatures will be able to populate the area.

Three species of trees found on the refuge make up the vast majority of the forest canopy: live oak (*Quercus virginiana*), south Florida slash pine (*Pinus Elliottii* var. *densa*) and cabbage palm (*Sabal palmetto*). It is felt that the influence of global warming on these species over the life of the CCP will be negligible. The range of live oak extends to the southern tip of Florida (W.R. Harms, 1990). It would be reasonable to assume that even with some increase of temperature, over the next 15 years this species would continue to thrive. With south Florida slash pine, one finds that the refuge is located in the northern portion of its range which extends to the Florida Keys (R.E. Lohrey and S.V. Kossuth, 1990). In this case, the species would survive and even larger temperature increase than live oak and still be viable. As is the case with south Florida slash pine, the refuge is at the northern limits of the species range. Cabbage palms can be found in Cuba and the Bahamas. Global warming trends over the next several decades would not be expected to affect this species viability on the refuge. Interestingly enough, the species mentioned, southern red oak (*Quercus falcata*), does not occur on the refuge as its range is too far north. Minor canopy species such as American elm (*Ulmus americana*) and pignut hickory (*Carya glabra*) may well be affected by a rise in average temperatures.

Some midstory species will most likely not be affected by warming trends, while others may well be removed from forest stands. Naked wood (*Myrcianthes fragrans*) is a subtropical native species that will most likely survive. Red mulberry (*Morus rubra*), on the other hand, is near the southern end of its range and may well be affected by an increase in temperature.

The principal understory species on the uplands of the refuge are saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), gallberry (*Ilex glabra*) and species of *Lyonia*. The range of saw palmetto, gallberry and wax myrtle includes the entire state of Florida and global warming influences over the life of the CCP should not cause concern. Some of the Lyonia species can be found in the Caribbean and likewise should survive temperature increases, while others are at the southern end of their range and may be adversely affected by warming (USDA 2007).

The possibility of fires increasing as the climate becomes warmer and dryer can be mitigated by the refuge's fire management program (Adrian 2003). The use of prescribed fire to manage fuels is discussed under Refuge Administration Goal 1a, Unwanted Wildland Fire (page 126 of the CCP). The use of prescribed fire is also discussed in detail in the Habitat Management Plan (HMP) as one of the tools used to manage the shrublands (Chapter IV, Section C-1, page 51) and pine flatwoods (Chapter V, Section C-1, page 75). The possibility of climate change opening up the landscape fits with the refuge's desire to mimic the less forested scenario that was present prior to fragmentation and fire exclusion as discussed in the CCP Wildlife and Habitat Management Objective 1(a), page 73 and Chapter I of the HMP, pages 3 and 4. The CCP has been altered on page 74 to reflect some thoughts on the effects of global warming and climate change on the scrub ecosystem.

The refuge is developing a monitoring plan designed to determine first-order fire effects. While the primary objective of the plan is to monitor the effects of the prescribed burning program, it can also give valuable information on many aspects of the vegetation in the upland communities on the refuge. These data can be used to monitor changes in the makeup of the upland vegetative communities, some of which may be the result of climatic changes. As part of this monitoring program, fire behavior and fire weather are recorded during burns. The refuge also records fire behavior information during wildfires. The occurrence of wildfires on the refuge has been recorded in detail since 1981. These combined data sets can help determine if, in fact, fires are increasing in numbers and intensity as the result of climate change.

There is also an extensive database of weather data collected at Kennedy Space Center. This information dates back to the 1960s. These records may be extremely valuable in determining the actual changes in temperature, rainfall and atmospheric moisture that occur here. The refuge will work with NASA to collate and analyze these data.

Freshwater Habitats and Interior Wetlands, Estuarine Wetlands: These are addressed in the CCP and HMP (see Wildlife and Habitat Management Objective 4.e(1) in the CCP and Chapter 8 in the HMP). Merritt Island NWR is engaged in an aggressive wetland restoration program within both the freshwater and saline systems. Under Wildlife and Habitat Management Goal 4, Interior Wetlands Objective 4(e), ditch plugging and restoring hydroperiod are critical elements. The St. Johns River Water Management District has hired an ecologist to assist in the design of various proposed projects. While there is much speculation on the effect of sea level rise (SLR) on various habitats, it is generally accepted that intact and functional ecological systems are the most resilient to changes, and have the greatest ability to persist. For example, ditches and canals that connect saline and freshwater systems are well documented to have the deleterious effect of increasing the release of carbon to the atmosphere by volatilizing organic materials on the canal bank and within the hydrologic zone of influence (Kevin Moorhead and Mark Brinson, 1995). By restoring the natural hydrology, i.e. filling in the ditches, Merritt Island NWR is restoring wetland systems, while at the same time, making those wetlands more resilient to sea level rise. Merritt Island NWR has an active and progressive program of research partnerships and welcomes the opportunity to monitor the impact of sea level rise on all of our ecological processes, and to determine where real, positive impacts can be made through management of the landscape.

Seagrass: Comments noted. These are addressed in the CCP and HMP (see Wildlife and Habitat Management Objective 4.b(1) in the CCP and Chapter 8 in the HMP). Merritt Island NWR agrees with the author of this letter on all points related to the vulnerability of seagrass beds. Merritt Island NWR is currently supporting two research projects on seagrasses; one looking at the impacts of prop scars, and a second mapping the current distribution of seagrass beds. A troll and pole zone of approximately 2,200 acres was established in Mosquito Lagoon in 2006 to reduce damage to sea grass beds. If this proves effective, more zones will likely be established.

Manatees: Manatees are addressed in the CCP and HMP (see Wildlife and Habitat Management Objective 1.e(1) in the CCP and Chapter 8 in the HMP). Further research is necessary with regard to manatee foraging impacts and their relationship to aquatic plants. Additionally, continued research is necessary to document the impacts of invasive exotic plants and their role in manatee nutritional requirements.

Southeastern Beach Mouse: This species is addressed in the CCP and HMP (see Wildlife and Habitat Management Objective 1.d(1) in the CCP and Chapter 7 in the HMP). Recent research indicates that the southeastern beach mouse has some affinity for upland scrub habitats that are in an early successional state and that have a component of open sandy habitats. While this does not diminish the potential impact of sea level rise on the species, it does indicate that it may be slightly more flexible with regard to habitat selection.

Florida Scrub-jay: The Florida scrub-jay is addressed in the CCP and HMP (see Wildlife and Habitat Management Objective 1.a(1) and 1.a(2) in the CCP and Chapter 4 in the HMP). There are four Scrub Reserve Units (SRUs) on the refuge (Breininger et al. 1996). Each SRU can support a subpopulation of Florida scrub-jays. The refuge intends to manage these landscapes using a variety of techniques to provide habitat for the maximum number of scrub-jays. By maintaining viable jay populations throughout the length of the refuge, the possibility of a single storm or other event impacting all of the scrub-jays would be reduced.

The refuge also plans to increase the connectivity between subpopulations. This includes not only those jays within the refuge boundaries, but also jay populations on Cape Canaveral Air Force Station to the east and Canaveral National Seashore to the north. Unfortunately, connection of refuge jay populations with populations on the Brevard County Florida mainland is not likely (Breininger et. al. 1996). The connectivity between Florida scrub-jay populations is discussed under Wildlife and Habitat Management Objective 1(a), page 73 of the CCP and in more detail in the HMP in Chapter 4.

The monitoring activities concerning fire occurrence and fire behavior, along with the availability of long-term weather data, are discussed above. This information is a good start toward understanding the effects of climate change on fire management as it relates to Florida scrub-jay habitat management. The refuge plans to work with NASA and other partners to develop research programs to investigate this and other aspects of environmental change as it would affect scrub-jays and other wildlife.

Since 1990, the effects of elevated carbon dioxide (CO_2) (EC) levels in the atmosphere on the refuge's scrub ecosystem have been investigated. This study is a cooperative effort between the Smithsonian Environmental Research Center, NASA, Dynamac Corporation, and later the Department of Energy. The results of the investigation suggest that EC can alter nitrogen cycling (Hungate et al. 2006) and the distribution of other soil nutrients (Johnson et al. 2003). In addition, there is the possibly of EC increasing the ability of scrub ecosystems to sequester anthropologic carbon (Hymus et al. 2003). It was also discovered that photosynthetic capacity was affected by EC, although this varied among the several species of scrub oaks (Ainsworth 2002). Li (2007) also suggests that the sequestering of carbon will be increased in scrub vegetation. In addition, he theorizes that elevated CO_2 levels in the atmosphere could help scrub oak ecosystems survive the consequences of the effects of increased greenhouse gasses, including the increased frequency of droughts. The CCP has been updated on page 74 to reflect this information.

Sea Turtles: Sea turtles are addressed in the CCP and HMP (see Wildlife and Habitat Management Objective 1.c(1) in the CCP and Chapter 8 in the HMP). The Service does monitor the regional and global trends of these populations, most notably through the efforts of the Service's sea turtle coordinator. Merritt Island NWR supports the idea of coordinated monitoring and research throughout the individual species ranges and not just at the local level.

Eastern Indigo Snake: Under the key topic Wildlife Impacts from Vehicle Collisions, Alternative D states the Service's concern for all species impacted by roadways. The Service proposes to increase the enforcement of speed regulations, close roads that can be closed at night, oppose any new road construction, and monitor road kill data geographically. If the refuge has the opportunity to influence the staging or timing of Kennedy Space Center (KSC) employees, it will do so.

Merritt Island NWR and the KSC have partnered to educate the 15,000+ employees that drive the refuge roads during their daily commute to work at KSC. Road signs, educational materials, and newsletter campaigns have been initiated to reduce the impact of road mortality on all species on Merritt Island NWR. While the eastern indigo snake is not "actively" managed under Alternative A, the species is managed as a component of the refuge's intact habitats, benefiting from prescribed fire, wetland restoration, and maintaining the largest unfragmented habitats possible.

American Alligator: The Visitor Services Plan (CCP Appendix G) was updated on page 27. The CCP was also updated on page 117. Merritt Island NWR will evaluate incorporating the impact of global warming on its population of American alligators and the proposed harvest of the species.

Fisheries/Migratory Birds: These are addressed in the CCP and HMP (see Fish and Wildlife Habitat Management Objective 4.c(1), and Chapter 8 in the HMP). Merritt Island NWR welcomes the opportunity to support research on one of its most important trust species, migratory birds. The refuge solicits research proposals and will continue to provide support to researchers, and partner with the U.S. Geological Survey's Biological Research Division, universities, and nongovernmental organizations to conserve migratory birds at the local, regional, flyway, continental, and global scales. This includes the authors' comments of looking at impacts of fisheries changes (prey) and changes on other trust species.

Invasive Species: The refuge outlines its exotic plant control program in Wildlife Habitat and Management Objective 3.a(1), pages 90–91 of the CCP. Exotic plant control is also addressed in the HMP in Chapter 9. It is possible that the effects of global warming could increase the spread of some species of exotic plants. The most likely candidates for this increase would be *Melalueca* and Brazilian pepper. The periodic surveys described above will help establish baseline of present infestation and should also help determine if rates of infestation are increasing. The CCP was modified on page 91 to reflect possible influences from climate change.

Building Design: This comment is addressed under Refuge Administration Objective 1.b(1). The major structure proposed in the CCP is a replacement office building. Due to recent storm damage funding, the office structure is under construction. It is designed by NASA engineers to withstand 140 mph winds and has been elevated. All structures planned for the future will be planned in this way.

Environmental Education: The Visitor Services Program has been updated on page 118 to reflect the inclusion of global warming as a topic in the environmental education, interpretive, and outreach programs. The long-term goal of the refuge's environmental education program is to develop educational curriculums that meet Florida's Comprehensive Assessment Test (FCAT) requirements. As changes occur in FCAT standards, changes will be made in the environmental education program. The program is intended to be dynamic and will evolve and change. The refuge can and should include global topics such as global warming in its curriculum when it is relevant to the refuge and a subject covered by FCAT.

Roadways and Roadkill

Comment: One citizen suggested that additional solutions should be incorporated into the CCP to help minimize wildlife mortality on refuge roads. Proposed traffic management solutions included diversions, stop signs, and speed bumps (Mumme et al. 2000).

Service Response: This issue is addressed under Wildlife and Habitat Management Objective 4.i(1), which will look into a variety of methods to minimize wildlife mortality on refuge roads.

Proposed Closure of SR 406 from Dusk to Dawn

Comments: Two comments were submitted regarding the closure of SR 406 from SR 3 to SR 402 from dusk to dawn. One supported this closure, while the other opposed it.

One citizen supported the closure to limit wildlife impacts from road collisions. Seigel et al. (2002) showed that this area has perhaps the highest occurrence of road collisions on the refuge, especially for amphibians and reptiles. Further, this commenter stated that since alternative routes exist, the closure represents benefits for wildlife, while creating minimal inconvenience for local residents.

Another citizen opposed the closure. The commenter felt that this would be an inconvenience for NASA employees commuting to and from work and for participants in night fishing activities from Haulover Canal, just to limit the roadkill of opossums and raccoons.

Service Response: This issue is addressed under Wildlife and Habitat Management Objective 4.l(1), which will look into a variety of methods to minimize wildlife mortality on refuge roads, including closing SR 406 from SR 3 to SR 402 from dusk to dawn. Authorized traffic will continue to be able to travel on SR 402 and SR 3. Permit holders wishing to access Haulover Canal from Titusville would follow that route.

Contaminants

Comments: One commenter suggested a clarification regarding contaminants, as follows:

> Page 93, paragraph 1: There are locations of PCB contamination on Kennedy Space Center, but it is not a product of shuttle launches. Zinc is found in increased levels near the shuttle pads (Schmalzer et al. 1993) apparently derived from pad structures. We have found that formerly agricultural soils have higher levels of copper, zinc, chromium, and manganese than similar soils that had not been farmed (Schmalzer et al. 2001).
>
> Schmalzer, P.A., C.R. Hall, C.R. Hinkle, B.W. Duncan, W.M. Knott III, and B.R. Summerfield. 1993. Environmental monitoring of space shuttle launches at Kennedy Space Center: the first ten years. American Institute of Aeronautics and Astronautics Conference Paper AIAA93-0303. 16 pp.
>
> Schmalzer, P.A., M.A. Hensley, and C.A. Dunlevy. 2001. Background characteristics of soils of Kennedy Space Center, Merritt Island, Florida: selected elements and physical properties. Florida Scientist 64:161-190.

Service Response: The CCP was updated on page 92 last paragraph, last sentence to read, "Several Superfund sites have been identified at Cape Canaveral and zinc and PCB contamination is documented on refuge property."

Tank Island

Comment: One commenter supported the efforts to protect the important wading bird nesting habitat associated with Tank Island as consistent with Florida Department of Environmental Protection and Florida Fish and Wildlife Conservation Commission strategies.

Service Response: Comment noted. This is addressed under Resource Protection Objective 2.c(1).

RESOURCE PROTECTION

Land Acquisition in the Turnbull Area

Comment: One citizen expressed concern regarding the acquisition of land in the Turnbull area. This citizen wished for this property to remain in private hands.

Service Response: Comment noted. The Service's policy is to acquire property from willing sellers.

Cultural Resources

Comment: The Florida Department of State commented that continued coordination is necessary to preserve and protect the important cultural resources of the refuge.

Service Response: Comment noted. The Service is committed to working with the state to preserve and protect these resources.

Bill's Hill

Comments: Canaveral National Seashore, National Park Service, expressed some comments on Resource Protection Objective 2.a(1), as follows:

> Page 107, Bills Hill Area: In three of the four alternatives developed for the Seashore's draft General Management Plan, some use of the Bill's Hill area is proposed. As outlined in our meeting with partners, including the Merritt Island National Wildlife Refuge staff, in June 2006, these alternatives range from hiking trails to a visitor center/headquarters facility. This property was transferred to the National Park Service by NASA in 1975 "for the purpose of establishing such facilities as are needed for administration of the Seashore, for the construction of the principal visitor center and for central access to the Seashore." The National Park Service currently uses prescribed fire to reduce hazardous fuels and to improve protected species habitat in this area, is conducting herpetological studies there and uses the area to access cultural resource areas. The National Park Service will not consider transferring the property to the refuge.

Service Response: Comments noted. The Bill's Hill area is addressed in Resource Protection Objective 2.a(1).

VISITOR SERVICES

Visitor Services in General

Comment: One citizen suggested keeping public use and waterfowl hunting open to users as these programs currently exist, without the proposed changes.

Service Response: Comment noted. The Service evaluated four management alternatives in the EA. Alternative A, the No Action alternative, would continue programs and activities at levels similar to existing programs and activities. Based upon the analysis in the EA, Alternative D was determined to best serve the purposes, vision, and goals of the refuge and the mission of the Refuge System. Alternative D was then selected as the proposed action.

Fees

Comments: Several comments were submitted regarding the implementation of fees on the refuge. Three citizens supported the implementation of fees in general; three opposed the implementation of fees in general; one addressed the Golden Age Passport; four supported fees for certain user groups and opposed fees for other user groups; one only opposed fees for Black Point Wildlife Drive; and two supported only fees for participants fishing on the refuge.

One citizen requested that the Golden Age Passport be honored when fees are implemented for Black Point Wildlife Drive.

One individual supported increasing fees for hunting and fishing uses, supported a nominal fee for volunteer-led tours, and opposed fees for Black Point Wildlife Drive. This commenter suggested that the refuge have a voluntary donation for Black Point Wildlife Drive, where the Merritt Island Wildlife Association or a volunteer could process the donations, easing the burden on refuge staff.

Another citizen supported fees for hunting and fishing participants, a small fee for other refuge activities, a $15 fee for senior lifetime passes, and no fees for children under 18.

One commenter opposed fees for Black Point Wildlife Drive, but supported fees for participants in hunting and fishing activities.

Another individual opposed fees for Black Point Wildlife Drive, but suggested that snowbirds be charged a fee.

One citizen supported the implementation of a reasonable fee (as proposed) for fishing on the refuge. Another commenter also supported the proposed fishing fees.

One commenter said that he would be happy to pay a $20 annual fee for the continued privilege of driving through Black Point Wildlife Drive to help maintain the refuge.

Another individual supported a $20 annual fee for the refuge and further suggested also charging a daily fee for those infrequent visitors.

One commenter suggested higher fees: $5 for a daily pass, $20 for a weekly pass, and $100 for an annual pass.

An opposing commenter stated that fees for Black Point Wildlife Drive would discourage local visitors from using the Drive.

One citizen opposed any fee, tax, or tariff on any activities on the refuge, since it is federal lands supported by tax dollars. With the implementation of fees, this commenter felt that the public was being charged twice.

Another opposing commenter felt that federal taxes were already being used to support the refuge and that user fees would just be used to expand staff.

In addition to already receiving federal tax dollars, another citizen opposed fees for other reasons, including that a fee would be unfair for those who are financially disadvantaged.

Service Response: All comments on the subject of fees were noted. Both the CCP and the refuge's Visitor Services Plan have been updated. Fees are discussed in the CCP and in more detail in the Visitor Services Plan under Visitor Services objectives 13.a(1), 13.b(1), 13.c(1), and 13.d(1). During the public scoping phase of the planning process, the implementation of fees was brought up and supported by several members of the public. The CCP was changed on page 124 and the Visitor Services Plan was changed on pages 86 and 87 to reflect that the refuge will honor the America the Beautiful Federal Recreation Lands Passes (formerly known as Golden Age, Golden Eagle, and Golden Access Passes).

Eliminate Hunting and Trapping

Comments: Several comments were submitted regarding hunting. Most of the commenters supported hunting activities on the refuge, while one opposed hunting.

One citizen stated that fewer than 4% of the 30 million annual visitors to national wildlife refuges hunt or trap. The commenter further stated that these activities should be eliminated from refuges.

Other individuals opposed the elimination or reduction of waterfowl hunting from the refuge.

Service Response: Hunting is discussed in the CCP on pages 112–117 and in more detail in the Visitor Services Plan under Visitor Services objectives 2.a (1), 2 a (2), 2.b (1) 2.b (2), 2.b (3), and 2.c., pages 21–28. Hunting is identified as a priority wildlife-dependent activity under the National Wildlife Refuge System Improvement Act and is a traditional use at Merritt Island NWR. The initial interagency agreement between NASA and Merritt Island NWR named "waterfowl hunting" as an activity that would continue as a condition of the agreement. Refuge-specific hunting regulations have been established which limit the areas, days, and times open to hunting, and minimize impacts to other wildlife-dependent activities. There are no plans to open the refuge to trapping.

The Service evaluated four management alternatives in the EA. Alternative A, the No Action alternative, would continue programs and activities at levels similar to existing programs and activities. Based upon the analysis in the EA, Alternative D was determined to best serve the purposes, vision, and goals of the refuge and the mission of the Refuge System. Alternative D was then selected as the proposed action.

Waterfowl Hunting – Quota Hunt System

Comments: Several comments were submitted supporting and opposing the refuge's existing quota hunt system. Two citizens supported it; one individual opposed it; one commenter suggested changing over to the the Florida Fish and Wildlife Conservation Commission's Total Licensing System (TLS) (managed by the state) or eliminating it altogether; and one citizen supported it, but suggested that the concentration of hunters was still too intense.

One citizen noted that none of the problems related to duck hunting have been addressed by the existing waterfowl quota hunt system, which created new problems. He further suggested the elimination of the waterfowl quota hunt system and the development of a refuge-wide permit fee of $50 and a required class to educate hunters on problems and regulations. He also suggested increased communication between the hunters and refuge management and law enforcement.

An opposing citizen supported the current quota hunt system on the refuge.

Another commenter supported the quota hunt system and suggested expanding it to other areas, creating an automated quota hunt procurement system over the Internet, and closing roads to limit other public access.

One individual suggested either changing the quota system to TLS or eliminating it altogether. An elimination of the quota hunt system would make Areas 2 and 3 less crowded. Further, with the elimination of the quota hunt system, the refuge could institute a hunting fee for all hunters.

One commenter supported the current quota hunt system, but felt that the concentration of hunters is still too intense in some areas, such as Area 1. This citizen supported further limitations of hunter permits or the development of some method of dividing the areas to limit the number of hunt parties setting up in range of each other.

Service Response: Procedures for administering refuge hunts are continually being evaluated and updated in the annual hunting regulations when changes are needed to protect migratory birds or regulate or protect the public. Currently, the refuge is working with the Florida Fish and Wildlife Conservation Commission (FWC) to allow refuge quota hunt permits to be administered and sold through the Commission's Total Licensing System (TLS). This will replace the refuge's telephone call-in system (used since 2000) with the FWC's computerized TLS permit system. The refuge phone-in quota permit system has gained in popularity over the years and in recent years the phone lines have remained busy for the entire call-in period. This has been a source of frustration to hunters. Some hunters report they never get a permit and it has been a common complaint that they call continuously for the entire call-in period and never get through. Other agencies that offer waterfowl hunting quota permits also use the TLS system, such as the South Florida Water Management District. Switching to the TLS system will standardize the quota permit procedures statewide, streamline the permit procedure, link it with all other waterfowl quota permits sold, and reduce the amount of time required by individuals to obtain a quota hunt permit. Many hunters have requested this change and it will be an upgrade to the refuge's current telephone system.

The refuge made this change on pages 21 and 25 of the Visitor Services Plan to reflect that quota waterfowl hunting permits will be sold through the TLS.

Waterfowl Hunting – Expansion

Comments: One citizen supported and one opposed expanding waterfowl hunting into the Turnbull Creek area. The latter opposed expanding waterfowl hunting into the Turnbull Creek area because it would represent increased opportunities for trespass onto their property.

Service Response: The open waters of the Indian River Lagoon and the navigable waters of Turnbull Creek and other creeks in this area have always been open to waterfowl hunting under state regulations. There is very limited waterfowl habitat in the Turnbull Creek area and this opening merely continues a use, albeit limited, which has always existed.

Waterfowl Hunting – Number of Days

Comment: One citizen suggested limiting waterfowl hunting to two days per week (to Wednesdays and Saturdays).

Service Response: The refuge has made at least one change to the number of days open to hunting over the years (reducing it from five to three). The refuge will continue to evaluate and adjust the program as needed to manage waterfowl populations and limit impacts to other visitor programs as needed annually. This could include reducing the number of hunt days per week the refuge is open; however, at this point, the refuge does not feel reducing the number of days open to two is necessary.

Waterfowl Hunting – Conflict with Space Coast Birding Festival

Comment: One individual suggested that instead of suspending hunting during the Space Coast Birding Festival, that the refuge then designate an alternative weekend to help limit conflicts between these user groups.

Service Response: The Space Coast Birding and Wildlife Festival occurs over a five-day period (Wednesday–Sunday) during the fourth week in January. Currently refuge hunts occur three half days per week, and mirrors the state season which usually runs from late November through January. Waterfowl seasons in Florida are established by the Atlantic Flyway Council and the Florida Fish and Wildlife Conservation Commission. The refuge has the authority to close the hunt during the festival, but not to offer additional hunting opportunities outside the state season. In other words, there are no opportunities to move to another date in February after the festival is over. However, in the future, the refuge will consider closing the refuge hunt for the three days during the festival. This change was made on on page 24 of the Visitor Services Plan.

Waterfowl Hunting – Blinds

Comment: One commenter suggested that nonnative plant species be banned as materials allowable for blinds (e.g., Brazilian pepper).

Service Response: This level of detail is not provided in the CCP or the Visitor Services Plan. This information is provided in the refuge's annual hunting regulations. The current regulations read, "Temporary blinds may be constructed of natural vegetation." The refuge will amend its waterfowl hunt regulations to read, "Temporary blinds may be constructed of <u>native</u> vegetation."

Waterfowl Hunting – Kayak/Walk-In Only Areas

Comment: One individual suggested the development of kayak/walk-in only areas with limited permits to enhance the hunting and outdoor experience.

Service Response: Comment noted.

Waterfowl Hunting – Law Enforcement

Comment: One citizen supported an increased law enforcement presence during waterfowl hunting to help ensure that all users are abiding by the law.

Service Response: The refuge concurs. Section V Objective 17 on pages 94 and 95 of the Visitor Services Plan identifies the need for two additional law enforcement officers.

Waterfowl Hunting – Shell Limit

Comment: One commenter opposed the possibility of a refuge shell limit for the 2007–2008 waterfowl season, since some hunters might not dispatch crippled ducks to ensure they have shells available to meet bag limits.

Service Response: Neither the CCP nor the Visitor Services Plan goes into this level of detail. Changes in shell limits will be addressed through annual updates in the waterfowl hunting regulations and is planned to be implemented during the 2007–2008 waterfowl season.

Waterfowl Hunting – Education

Comment: One citizen felt that increased hunter education was needed.

Service Response: The refuge supports an increase in hunter education and will add a strategy on page 22 of the Visitor Services Plan to reflect this change.

Alligator Hunting

Comments: Two comments supported alligator hunting. One of these comments supported alligator hunting on a limited basis during the state-wide alligator season.

The East Central Florida Aquatic Preserves Office under the Florida Department of Environmental Protection requested to be involved in discussions related to the implementation of alligator hunting on the refuge.

Service Response: Visitor Services Objective 2.c(1) found on page 117 of the CCP and page 27 of the Visitor Services Plan outline the feasibility of an alligator hunt on the refuge. The Service will work with partners such as the Florida Fish and Wildlife Conservation Commission and Florida Department of Environmental Protection in evaluating such a hunt.

Deer and Feral Hog Hunting

Comments: Two citizens supported the proposed deer and feral hog hunt program. One of these commenters suggested relocating hogs within NASA's security area to the area north of Haulover Canal. Further, he suggested that hog hunting be allowed until at least March and that no quota hunt permit should be required for hog hunting after the deer season.

Service Response: Deer and feral hog hunting are addressed in the CCP and in more detail in the Visitor Services Plan under Visitor Services objectives 2.b(1), 2.b(2), and 2.b(3) and Figure 25.

Boating Impacts

Comments: Several commenters noted the impacts of boating activities on refuge resources, including damaging seagrasses, contributing to shoreline erosion, disturbing waterfowl and other wildlife, spooking redfish, and disturbing other users. One citizen focused on the impacts of boat use in relation to compounding the impacts of global warming. This commenter suggested future research into whether boat use in the refuge could add to the negative impacts incurred by climate change.

Service Response: Motorized boating is authorized to support two priority wildlife-dependent uses, fishing and hunting, and is discussed in the CCP and in more detail in the Visitor Services Plan under Visitor Services objectives 3.a, 3.b, and 3.c. Fishing and hunting are identified as priority wildlife-dependent activities under the National Wildlife Refuge System Improvement Act. Refuge-specific fishing and hunting regulations have been established which limit the areas and times open to fishing and hunting and minimize impacts to other wildlife-dependent activities. Objective 3.a addresses the establishment of Pole and Troll zones and was developed specifically to reduce wildlife impacts and the damage to seagrasses from motorboats and improve the quality of fishing. Although not specifically stated in the objective, a side benefit of Objective 3.a may result in fewer disturbances to waterfowl, minimize disturbance to redfish schools, and reduce shoreline erosion.

Limiting the Size and Horsepower of Boats

Comments: Two comments were submitted regarding limiting the size and horsepower of boats. One citizen believed it was unacceptable to have no limits on the type of boat, horsepower, or motor type allowed to access the refuge, and called for limits to boating if boating is causing impacts to refuge resources.

Another citizen opposed such limits, stating that it would be a financial hardship to commercial fishing guides who have already invested in their flats boats and motors. He further stated that if restrictions were instituted, the current fishing guide permit holders should be grandfathered into the new system. He also felt that current speed restrictions were sufficient, and suggested that it might be illegal to limit the speeds in the Intracoastal Waterway.

Service Response: Horsepower limits were considered during the public scoping and planning process and were dismissed as a practical means to reduce wildlife and seagrass impacts in estuarine waters. Objective 3.a describes the implementation of Pole and Troll zones as a preferred alternative to address impacts from motorboats. Motorboat impacts occur primarily in shallow waters where there is a correlation between horsepower size and width and/or depth of the prop scars, with larger motors causing more severe impacts. However, horsepower size becomes irrelevant if the motor is not in use. Boats operating within the boundary of a Pole and Troll zone would have their motors turned off. The implementation of the Pole and Troll zones has received widespread public support and would result in less economic hardship to boaters. If horsepower limits were enacted, it would require most boaters to re-power their boats.

Ban Out-of-State Boaters

Comment: One citizen suggested banning all out-of-state boaters from refuge waters.

Service Response: The Service does not have the authority to ban out-of-state boaters.

Mosquito Lagoon Closure

Comments: Three individuals submitted comments requesting the closure of Mosquito Lagoon. One commenter suggested closing Mosquito Lagoon south of Haulover Canal from November through the end of February. Another citizen suggested closing Mosquito Lagoon south of Haulover Canal from November to February to fishing boats, since the fishing pressure is disturbing rafting ducks. A third individual suggested closing Mosquito Lagoon from Haulover Canal south to about T-27-A from November 1 to February 1 to reestablish duck populations and use of this area.

Service Response: Closures in Mosquito Lagoon were considered during public scoping but the implementation of the Pole and Troll zones was considered a better long-term solution. Both the Kennedy Space Center security area and the No Motor zone in the Banana River provide large motorboat-free zones, yet waterfowl populations have not shifted or increased in these areas. Declining waterfowl populations in Florida may be part of a larger trend unrelated to boating disturbance and adding additional closed areas may not achieve the desired objective. The implementation of the Pole and Troll zones is an adaptive approach to address habitat and wildlife impacts from motorboats and improving the quality of sportfishing. Monitoring the Pole and Troll zones is part of the plan and if the zones are not achieving the stated objectives, other alternatives such as seasonal closures can be considered.

Mosquito Lagoon Pole and Troll Zones

Comments: Supporting and opposing comments were submitted regarding the Pole and Troll zones in Mosquito Lagoon. Four citizens supported the zones and one opposed them. One commenter suggested creating another pole and troll zone, while another citizen suggested greatly expanding the zones.

One citizen opposed the Pole and Troll zones as a fix to limiting disturbance to rafting waterfowl, since the waterfowl are found in the deeper waters and the Pole and Troll zones are in the more shallow waters.

Another citizen suggested that the designated pole and troll zone is a good idea, providing angler access while preserving the flats, allowing for undisturbed fishing activities, and protecting seagrass. This citizen further stated that another pole and troll zone should be developed in the southern end of Mosquito Lagoon, south of the Middle Grounds/Whale's Tail. He offered detailed recommendations for this new zone as follows:

- Mark access channels around the Middle Grounds and into Eddy Creek.
- Provide an access channel down the western side of the flat south of the Middle Grounds for about ½-mile (the exact channel length can be determined better with maps and GPS coordinates).
- Consider making all the shallow seagrass-covered flats inside the bar on the eastern and western sides of Mosquito Lagoon as pole and troll areas with access channels to traditional backcountry areas or occasional access channels to reach very large flats that can only be reached by very long pole or troll runs.

One individual stated that habitat protection is the key to the long-term quality of the estuaries, and further supported doing whatever is necessary to justify and fund additional pole and troll zones to help recover seagrass beds and improve the fisheries.

One citizen supported the existing Pole and Troll zones, but suggested that the two northern entrance markers be moved about 10 yards to the right to the deepest part of the bank.

Another citizen that supported the Pole and Troll zones suggested extending these zones to encompass the entire eastern shoreline of the existing zone, south to the Whale's Tail area, 500 yards from the entire shoreline.

Service Response: As mentioned above, the establishment of the Pole and Troll zones is an adaptive approach to address the rate of growth in flats fishing, the declining quality of sportfishing, and the increase in seagrass impacts. Before new pole and troll zones are established, the Service intends to assess the success of the current zones in achieving the refuge's stated objectives. If they prove successful in improving the quality of sportfishing and reducing prop scarring and wildlife impacts, as indicated in the plan, additional pole and troll zones may be established if funding and the workforce is available to implement the expanded zones.

Mosquito Lagoon – Seasonal Closures

Comment: One citizen opposed any seasonal closure of the southern end of Mosquito Lagoon for migratory birds. The commenter stated that such a closure would concentrate the fishing pressure into a much smaller area, resulting in over-harvesting in some areas and creating an imbalance of viable fishing spots. This citizen also felt that such a seasonal closure should not be considered for something as trivial as a small number of migratory birds.

Service Response: The primary purpose of the refuge is migratory birds. Seasonal closures during the winter months to protect migratory birds could be a viable option to reduce boating impacts; however, other closed areas of the refuge in the Kennedy Space Center Restricted Area or the No Motor zone do not appear to be attracting waterfowl. In lieu of closures, the Service developed two experimental Pole and Troll zones as a means to reduce boating impacts and allow two priority wildlife-dependent recreational activities (hunting and fishing) to continue. As mentioned above, additional pole and troll zones south of Haulover Canal could be considered in the future

Dummit Cove Closure

Comment: One commenter suggested changing the complete closure of the Dummitt Cove waterway to a seasonal closure, allowing for public access from December through March since the manatees are not present in these colder months.

Service Response: The establishment of the Slow Speed zone to protect manatees is a joint effort between the State of Florida and the U.S. Fish and Wildlife Service and both agencies establish Slow Speed zones for manatee protection. Within the refuge there exists a mix of state and federal manatee zones. The Slow Speed zone referred to in Dummitt Cove is a state zone and is not subject to control by the refuge.

Fishing Guides

Comments: One commenter opposed capping the number of fishing guides on the refuge and felt that more guides mean more money for the refuge; would increase the number of trained, certified, and insured users; and would allow for the refuge to regulate these activities on the refuge. He further stated that if the refuge capped the number of guides, nonpermitted guides would simply use off-refuge boat ramps and use the refuge anyway.

Another citizen supported reducing or capping the number of fishing guides as an action that was long overdue. Instead of capping the guides at the current level of 70, he suggested reducing the number of permitted fishing guides to around 40. Further, the commenter felt that the fishing guide permits should be allowed to be willed to an immediate family member.

A third individual felt that commercial fishing guides should not personally gain from public resources and that they should be excluded from the refuge.

Service Response: The refuge's Commercial Fishing Guide Program, Objective 13.d, is addressed in the CCP on page 125 and in the Visitor Services Plan on pages 90 and 91. The refuge works in conjunction with Canaveral National Seashore to administer this program. Sportfishing has become one of the fastest-growing recreational activities on the refuge and fishing, like other activities, may cause habitat and wildlife impacts. It has been difficult to evaluate the impacts of commercial fishing guides and separate it from impacts generated by recreational (nonguided) sport anglers. However, fishing guides are a commercial activity and subject to Seashore and refuge regulations. Should the

number of commercial guides be allowed to increase indefinitely? Should commercial fishing guides be allowed to fish seven days per week? What is the correct number of fishing guides that should be allowed under permit? Do commercial fishing guides impact recreational sport anglers? These and other questions will be analyzed during the five-year moratorium outlined in the Visitor Services Plan and a long-term plan for administering the commercial guide program will be developed.

Banana River No Motor Zone

Comment: One individual focused on the Banana River No Motor zone, and asked why the security zone east of the channel was still in place. He suggested increased access to these waters for the public.

Service Response: The security zone located east of the channel in the Banana River was initiated by the U.S. Air Force and remains in place for reasons of national security. Increased access into the Banana River No Motor zone is addressed in the CCP and in the Visitor Services Plan. The Service proposes a new public canoe launch into the Banana River No Motor zone at Hall Road to increase public access into this waterway [this comment is addressed in the CCP – see Figure 23, Visitor Services Goal 3, and Visitor Services Objective 4.c(1); and this comment is addressed in more detail in the Visitor Services Plan (Appendix G) – see Figure 4.2 and Visitor Services Objective 4.c(1)].

Fishing Tournaments

Comments: Four comments opposed fishing tournaments on the refuge, even those that originate from off the refuge.

One individual stated that the CCP has failed to adequately address the big problem of fishing tournaments originating off the refuge. Although the tournament is off the refuge, the participants use the refuge's waters. The problem is that these tournament participants are not recreational anglers, but are competitive anglers who have the main aim of winning money and prizes; and they can triple the number of users on refuge waters. Further, there are several dozen tournaments being held every year in the surrounding communities. The strategies proposed in the CCP and Visitor Services Plan will be completely ineffective at addressing this problem. There is no purpose served by allowing this activity to continue. This activity conflicts with recreational anglers, increases water turbidity, damages seagrasses, harasses shoreline birds and waterfowl, and endangers manatees.

Another citizen urged the elimination of fishing tournaments due to their exploitation of the resources and behavior of the participants. This commenter suggested that if these tournaments could not be eliminated, that the refuge then collect a tournament fee of 10% of the value of all the prizes offered in the tournament.

A third citizen stated that fishing tournament activities should be banned from the refuge. This commenter further suggested that someone on the staff was benefiting by allowing these activities to continue. These tournaments make up more than just the tournament weekend with heavy fishing pressure beginning two weeks before an event. Hundreds of fishermen do more prop-scarring damage in two weeks than the rest of the fishermen do throughout the entire season of recreational fishing. Fishing tournaments have a high and unacceptable rate or mortality of redfish.

Service Response: Comments noted. Well-planned fishing tournaments can promote recreational fishing opportunities on refuges and be a source of conservation information and education for the angler. The Service allows tournament fishing in the refuge when it makes a determination that the event is compatible with refuge purpose(s) and the Refuge System mission. When issuing special use permits for fishing tournaments, refuge managers must consider the potential disturbance to

wildlife and habitat and conflicts with other refuge visitors. The refuge uses techniques such as limiting the number of participants, zoning areas for tournament fishing, limiting the number of tournament events, and enforcing speed limits to plan successful tournaments. At this time, all tournaments originate outside the boundary of the refuge, therefore the refuge must consult state fish and wildlife conservation agencies and other conservation partners when considering and developing permit conditions for tournament fishing events. The refuge will continue to work with the State of Florida to manage fishing tournaments and manage tournaments under Special Use Permits.

Fishing – Daily Boat Quota

Comment: One citizen suggested the implementation of daily limits or quotas on the number of boats allowed on the refuge.

Service Response: This solution is not practical at Merritt Island NWR. Boat quotas may be a workable management approach on a refuge which controls all boat access. However, there are numerous open water access points on three bodies of water from which boats can enter the refuge. It would be difficult and impractical to implement daily quotas on boats with current staff and budgets. The refuge has implemented Slow Speed zones, No Motor zones, and Poll and Troll zones as management actions to mitigate the impact of boats, and believes these are better approaches to the management of boat use in refuge waters.

Freshwater Fishing

Comment: One citizen supported the development of freshwater fishing opportunities on the refuge. He suggested that the refuge manage different ponds with different management focuses (e.g., handicapped access pond, largemouth bass pond, and panfish pond). This citizen further suggested that a public school, the International Game Fish Association, or other organization might help fund such projects.

Service Response: This comment is addressed in the CCP on page 117 and in more detail on pages 40–42 in the Visitor Services Plan under Visitor Services Objective 3.c(1) and Figure 23. As stated in the plan, the refuge has limited freshwater fishing opportunities and funding to develop the program. The refuge is looking for partners to develop freshwater fishing opportunities and would be willing to consider these suggestions if partner(s) could be found to fund and implement these management actions.

Airboats and Air Propulsion Vehicles

Comment: One citizen supported the ban on airboats, but suggested that air propulsion vehicles be allowed if they met sound standards (e.g., 25-horsepower outboard), since air propulsion is friendlier to aquatic grasses.

Service Response: Airboats have always been banned from refuge waters based on compatibility issues. Noise is one concern, but even with lower noise levels, airboats may create other wildlife impacts. Airboats have the ability to run in very shallow water, mud flats, or salt marshes with emergent vegetation and can access portions of the refuge not readily accessible to other user groups. The wildlife impacts and disturbances associated from this use would be substantial. In addition to wildlife and habitat impacts, airboats will conflict with other priority wildlife activities. Permitting airboats with lower noise levels will not be considered a valid use.

Mud Motors

Comment: One commenter suggested banning mud motors (or "go devils") from refuge waters, since they cause damage to aquatic grasses and flats.

Service Response: Air-cooled outdrive motors fall under several brand names, such as Go Devil and Mud Motor. These motors have been used on the refuge for more than ten years and during that time the refuge staff has seen their numbers and horsepower size increase. Refuge managers are beginning to observe impacts to submerged aquatic vegetation or the substrate in some impoundments and lagoon locations, which are believed to be associated with this type of motor. The refuge is currently evaluating these impacts. If the refuge determines they are the source of the problem, their use will be addressed through amendments in the Hunting or Fishing Regulations which are updated annually.

Bicycle Trails

Comments: Two comments addressed bicycle trails. One citizen supported the development of bicycle trails on the refuge, and stated that these trails could be closed during part of the year to limit disturbance and minimize impacts to wildlife.

Canaveral National Seashore, National Park Service, suggested that a sentence be added regarding bicycle trails, as follows:

> Page 120, third paragraph: Add sentence about working with Canaveral National Seashore and the City of Titusville to provide a bike trail from Titusville through the refuge to Playalinda Beach.

Service Response: This comment is addressed in the CCP on pages 114, 118, and 120 and in more detail in the Visitor Services Plan under Visitor Services objectives 4.b(1) and 7.a(7) and in Figure 23, pages 45 and 62. The Visitor Services Plan, page 66, already indicates that the refuge will work with Canaveral National Seashore, Kennedy Space Center, and the City of Titusville to establish a bike trail that terminates at the Seashore.

Canoe and Kayak Trails

Comments: Two comments addressed canoe and kayak trails. One individual supported the development of kayak trails on the refuge, as long as they are properly mapped and marked. Canaveral National Seashore, National Park Service, suggested that Visitor Service Objective 4.c(1) be expanded to include connecting to canoe/kayak trails north of the refuge to be developed by the Seashore.

Service Response: Canoe/kayak trails are addressed on page 118 in the CCP and in more detail in the Visitor Services Plan under Visitor Services objectives 4.c(1) and 4.c(2) and Figure 23 on pages 48–62. A new objective has been added on page 118 of the CCP and page 48 of the Visitor Services Plan which indicates the refuge and Seashore will work on connecting their respective canoe trials. The following was added: "Objective 4.c.3. Within five years of plan approval, the refuge will work with Canaveral National Seashore to connect refuge and Seashore canoe trails."

Environmental Education

Comment: One commenter supported the increase in environmental education and awareness.

Service Response: Environmental education is addressed in the CCP and in more detail in the Visitor Services Plan under Visitor Services objectives 5.a(1), 5.a(2), 5.a(3), 5.a(4), 6.a(1), 6.b(1), 6.b(2), 6.c(1), 6.c(2), 6.d(1), 6.e(1), 6.f(1), 7.a(1), 7.a(2), 7.a(3), 7.a(4), 7.a(5), 7.a(6), 7.a(7), 7.a(8), 8.a(1), 8.b(1), and 10.c(1), pages 53–81.

Outreach

Comment: Canaveral National Seashore, National Park Service, commented that both the refuge and the Seashore needed to increase awareness within the local community of the resources and missions of both the refuge and the Seashore.

Service Response: Comment noted.

Law Enforcement Goal

Comments: Two comments addressed law enforcement officers on the refuge. One citizen suggested that four officers are insufficient for 24/7 protection for the refuge and its resources. This commenter suggested that reserve officers be employed, much like what the Florida Fish and Wildlife Commission uses.

Canaveral National Seashore, National Park Service, supported Visitor Services Goal 11, but noted that it will be hard to attain without major funding increases.

Service Response: Comments noted.

REFUGE ADMINISTRATION

Funding

Comments: Two comments addressed funding. One citizen stated that without adequate funding, the refuge will have a challenge in implementing the CCP. Another citizen supported the funding needed to implement the plan.

Service Response: The Service will pursue the goals and objectives outlined in the CCP as funding and staffing allow. The Service will continue to work with partners to pursue shared goals and objectives in order to accomplish the projects and activities outlined in the CCP.

Commercial Crabbing and Clamming

Comments: Two comments addressed commercial fishing activities. One individual opposed the elimination of commercial crabbing and clamming from the refuge, and suggested that the refuge instead regulate the amount of harvest. The other citizen supported the sunset of commercial fishing activities.

Service Response: Under the Service's compatibility policy, only those uses that meet the requirements of compatibility can occur on national wildlife refuges. During the review of those uses appropriate and compatible for the refuge, the Service determined that commercial fishing activities, including commercial crabbing and clamming, could only be determined to be compatible if these uses were to be phased out from the refuge. In essence, these uses do not meet the requirements necessary to be allowed to occur on the refuge.

NASA Landing and Recovery Area

Comment: One citizen opposed the refuge giving back land to the NASA for a landing and recovery area, since it would destroy many acres of habitat and would be a great disturbance to wildlife.

Service Response: The refuge is an overlay of NASA's Kennedy Space Center (see Figure 3 in the CCP and the discussion of the refuge's history and purposes in Chapter II of the CCP). Management by the Service of Kennedy Space Center lands and waters is based upon an agreement between NASA and the Service, where space operations have priority. Since the lands and waters are owned by NASA, NASA has the authority to take certain lands and waters out of the management agreement and out of refuge management.

DeBerry Fish Camp

Comments: The DeBerry Fish Camp commented on several portions of the plan, how it is pursuing similar objectives on its adjacent 90 acres, and how it could play a role in supporting shared goals and objectives (e.g., law enforcement, water quality, and cultural resources).

Service Response: The Service welcomes and is committed to working with a multitude of partners, including adjacent landowners, to accomplish the refuge's stated goals and objectives. Without these partnerships, the Service would not be able to address many of the issues facing refuges and wildlife.

Staffing

Comments: Four comments addressed staffing of the refuge. One individual supported the additional staffing called for in the CCP; one supported adding two law enforcement officers and increasing law enforcement presence on the water; and a third citizen opposed the hiring of additional officers, stating that they were not needed.

The fourth commenter stated that all of the existing and proposed staff members are way overpaid for their jobs, and suggested that salaries be reduced for existing staff.

Service Response: Based upon the purposes, vision, and goals of the refuge and based upon the analysis in the EA, the Service developed an organizational chart with identified positions to enable implementation of the actions outlined in the CCP and attainment of the identified goals and objectives. The proposed staffing is outlined under Refuge Administration Objective 1.d(1) and in Figure 27.

Incidental Business Permit Fees

Comment: One commenter stated that the increase in incidental business permit fees to $250 per year was unacceptable, since that item was up for review in the Draft CCP/EA and should not have been implemented before the plan was finalized.

Service Response: Canaveral National Seashore is the lead agency in administering the Incidental Business Permit program and the refuge and Seashore meet regularly to discuss changes in the program. The Seashore periodically adjusts the fees based on increases in administrative costs, including the cost for law enforcement and other factors. In January 2006, during the development of the CCP, Canaveral National Seashore met with the refuge and requested a fee increase. The refuge concurred with the request because it felt it was justified and the CCP was not to be completed until late 2007.

NASA Security Airboat Use

Comment: One commenter suggested that airboat use by NASA Security should be banned immediately. This citizen stated that these airboats are disturbing wildlife; are heard from seven or more miles away over the water; travel within 100 yards of every shoreline along the Mosquito Lagoon and northern Indian River Lagoon, and at high speeds; spook fish; and disturb people fishing. Since airboat use is not allowed on the refuge by the public, it should not be allowed by NASA.

Service Response: Under the Service's agreement with NASA for the lands and waters managed as part of the refuge, NASA retains certain rights, authorities, and jurisdictions for its lands and waters. This includes all security operations.

Titusville Bridge

Comment: One citizen stated that it looked like the bridge on SR 406 connecting Titusville to the Parrish Park boat ramp was under the jurisdiction of the refuge and that all future bridge work should only be conducted during January and February, when there would be less impact to people using this roadway.

Service Response: The SR 406 bridge is not part of the refuge, nor is it under refuge jurisdiction. However, NASA's railroad bridge, north of SR 406, is within the refuge's management boundary. The maps clearly show that the refuge boundary is close to the eastern shoreline of the Indian River Lagoon at SR 406. The Service does not control when bridge work is conducted. Further, January and February are high use times where the refuge's highest visitation occurs between the months of November and March.

Beekeeping

Comment: One individual stated that beekeeping operations on the refuge for the purposes of pollination or honey production were incompatible with the purposes of the refuge. This commenter felt that the proposed sunset of beekeeping activities on the refuge by 2018 failed to address the compatibility issues of this use.

Service Response: The CCP and associated compatibility determination were updated to reflect a new sunset date of 2016 (see page 135 in the CCP and pages 266–267 in the compatibility determination). This comment is addressed under Refuge Administration Objective 3.b(1). The beekeeping program predated the refuge, since it was used to support the active citrus grove operations of the time. Initially it was not under the control of the refuge under the Service's management agreement with NASA. Now that this use is under refuge management control, the Service has determined that it needs to be phased out from the refuge. The elimination of citrus groves in 2008 [see Wildlife and Habitat Management objectives 4.h(1) and 4.h(2) in the CCP and in the Habitat Management Plan] and the aggressive Brazilian pepper control program will likely accelerate the closure of the beekeeping program. The sunset date has been shortened to 2016,

which will allow current beekeepers to transition off the refuge without undue financial hardship. The Beekeeping Compatibility Determination has been edited to more accurately reflect the current status of beekeeping activities on the refuge.

Dormitory Facility

Comment: One commenter supported the need for construction of a dormitory facility for researchers, interns, volunteers, and firefighters on the refuge, allowing for a large amount of vital research to be conducted on the refuge.

Service Response: This comment is addressed under Refuge Administration Objective 1.b(3).

Future Permits

Comment: The State of Florida advised that some of the proposed management activities may require future permitting. Further, it stated that it is expected that the proposed activities will have a net positive environmental benefit.

Service Response: The Service is committed to working with all governmental partners and complying with all applicable permit requirements.

Intergovernmental Cooperation

Comments: Canaveral National Seashore, National Park Service, suggested that Refuge Administration Objective 2.a(3) be modified to be reciprocal and that an additional strategy be added regarding environmental education and public outreach. The seashore also addressed Refuge Administration Objectives 2.a(3) and 2.a(4) as follows:

> Page 132, Objective 2.a (3), first sentence: The objective should be reciprocal. Coordination should not only make refuge goals and objectives an important component of planning and implementing operations at the Seashore, <u>but also</u> Seashore goals are an important component of planning and implementing operations at the refuge. This is particularly important for management of cultural resources in the joint area, control of exotic species, and protection of aquatic resources in Mosquito Lagoon.
>
> Page 133, Strategies for Objective 2.a (3): A good one to add would be to meet regularly with Seashore interpretive staff to expand opportunities to provide environmental education and public outreach.
>
> Page 133, Objective 2.a (4), Strategies: Agree with having annual meetings between the refuge, Seashore, and Florida Fish and Wildlife Conservation Commission to ensure consistency between laws and regulations applied in Mosquito Lagoon.

Service Response: The CCP was updated on page 132 to reflect the importance of joint coordination for planning and implementation of operations. The CCP was also updated on page 133 to add that the refuge and Seashore interpretive staff should meet annually.

ALTERNATIVES

Alernative D

Comments: Four comments specifically supported Alternative D as the proposed action, while two of them each offered modifications.

One citizen stated that Alternative D was the best option on the table, but also stated that a blend of Alternatives C and D would be more desirable with an emphasis toward migratory bird management.

Another citizen supported Alternative D as the most beneficial for the refuge, but suggested changes. The commenter opposed the development of four slow speed/idle speed zones in Mosquito Lagoon, Banana River, and Indian River Lagoon.

Service Response: All comments were noted. The Service evaluated four management alternatives in the EA. Based upon that analysis, Alternative D was determined to best serve the purposes, vision, and goals of the refuge and the mission of the Refuge System.

Alternative A

Comments: Two comments supported Alternative A as the proposed action. One citizen supported Alternative A, but with increases similar to Alternative C in relation to waterfowl.

Service Response: Comments noted. The Service evaluated four management alternatives in the EA. Based upon that analysis, Alternative D was determined to best serve the purposes, vision, and goals of the refuge and the mission of the Refuge System.

Brevard County Vote

Comment: One citizen suggested that the comments should be compiled and the residents of Brevard County would vote on the proposed future management of the refuge.

Service Response: Although located in Brevard County and Volusia County, Merritt Island National Wildlife Refuge is part of the National Wildlife Refuge System and is a national resource supported by federal funding. A local vote on resources of national and international importance would be inappropriate. The refuge is managed by the U.S. Fish and Wildlife Service, which is an agency of the U.S. Department of Interior. The Service makes management decisions based upon a variety of federal laws, treaties, and policies supported by the government of the United States.

References to be Included in the Documents

Comments: Two comments provided additional references for the CCP and Habitat Management Plan (HMP). One commenter suggested the addition of five references regarding avian populations within citrus groves.

Avian Populations within Citrus Groves:

Lohrer, F.E. 1991. Winter bird population studies. 33. Mature citrus orchard. *Journal of Field Ornithology* 62:26.
Lohrer, F.E. 1991. Breeding bird census. 98. Mature citrus orchard. *Journal of Field Ornithology* 62:87.
Lohrer, F.E. 1990. Winter bird population studies. 28. Mature citrus orchard. *Journal of Field Ornithology* 61:20.
Mitchell, M.C., L.B. Best, and D.L. Fischer. 1995. Bird abundance in Florida citrus groves. *Florida Field Naturalist* 23: l-9.
Mitchell, M.C., L.B. Best, and J.P. Gionfriddo. 1996. Avian nest-site selection and nesting success in two Florida citrus groves. *Wilson Bulletin* 108(3): 573-583.

Service Response: The refuge plans to discontinue citrus farming; therefore, the citations related to citrus farming do not provide relevant long-term information.

Comments: Numerous additional comments provided more references on a variety of topics in the CCP and HMP, as outlined below with the Service's responses for each:

CCP page 23, paragraph 1; and Habitat Management Plan, page 18, paragraph 3: The reference to Schmalzer, Hensley and Dunlevy (2001) deals with soils. The reference for groundwater should be Schmalzer and Hensley (2001). The conclusions are similar for both soils and groundwater.

Schmalzer, P.A. and M.A. Hensley. 2001. Background characteristics of groundwater in the surficial aquifer of Kennedy Space Center, Merritt Island, Florida. *Florida Scientist* 64: 250-273.

Service Response: Both the CCP and HMP have been updated to include the above correct citation.

CCP page 34, Planted Scrub Oak: A reference for this project is Schmalzer et al. (2002):

Schmalzer, P.A., S.R. Turek, T.E. Foster, C.A. Dunlevy, and F.W. Adrian. 2002. Reestablishing Florida scrub in a former agricultural site: Survival and growth of planted species and changes in community composition. *Castanea* 67:146-160.

Service Response: The CCP was updated to reflect this citation.

CCP page 35, Florida Scrub-jay: There is uncertainty in the population estimate of Florida scrub-jays on MINWR (Johnson et al. 2006):

Johnson, F.A., T. Beech, R.M. Dorazio, M. Epstein and J. Lyon. 2006. Abundance and detection probabilities of Florida scrub-jays at Merritt Island National Wildlife Refuge using spatially replicated counts. Draft Report, USFWS, Division of Migratory Bird Management, Gainesville, Florida. 16 pp.

Service Response: The CCP has been updated; page 35, last paragraph, second sentence was revised to read, "Although there is some uncertainty concerning the specific numbers (Johnson et al. 2006), it is believed that the refuge is the site of the second largest population (about 550 family groups) …"

CCP page 38, Eastern Indigo Snake: A published reference here is Breininger, Legare, and Smith (2004):

Breininger, D.R., M.L. Legare and R.B. Smith. 2004. Eastern indigo snakes (*Drymarchon couperi*) in Florida: Influence of edge effects on population viability. Pages 299–311 in H. R. Akçakaya, M. Burgman, O Kindvall, P. Sjorgren-Gulve, J. Hatfield, and M. McCarthy, eds., *Species Conservation and Management: Case Studies.* Oxford University Press.

Service Response: The CCP has been updated to include this citation.

CCP page 76, paragraph 4: There is uncertainty in the population estimate for Florida scrub-jays on MINWR (Johnson et al. 2006).

Service Response: The CCP has been updated; page 76, paragraph 4, last sentence now reads, "While this population meets the stated goal, there is some uncertaintly (Johnson et al. 2006), and it would be preferable to support as many jay families as the habitat would allow."

HMP page 41, 4h, last bullet: The historical vegetation on old grove sites was determined in a study of historical vegetation of the Indian River Lagoon basin (Duncan et al. 2004). In addition to the summary maps published in that paper, topographic quadrangle scale maps are available.

Duncan, B.W., V.L. Larson, and P.A. Schmalzer. 2004. Historic landcover and recent landscape change in the North Indian River Lagoon Watershed, Florida. *Natural Areas Journal* 24:198-215.

Service Response: The HMP has been updated to include this citation.

HMP page 46, Planted Oak Scrub: A reference for this project is Schmalzer et al. (2002):

Schmalzer, P.A., S.R. Turek, T.E. Foster, C.A. Dunlevy, and F.W. Adrian. 2002. Reestablishing Florida scrub in a former agricultural site: survival and growth of planted species and changes in community composition. *Castanea* 67:146-160.

Service Response: The HMP has been updated to include this citation.

HMP page 48: There exists considerable uncertainty in the scrub-Jay population estimate for Merritt Island NWR (Johnson et al. 2006).

Service Response: The HMP has been updated to reflect this information and the citation.

HMP page 52, Planting: A reference is as above (HMP page 46, Schmalzer et al. 2002).

Service Response: The HMP has been updated to reflect this citation.

HMP page 56, paragraph 1: There is substantial variability in the growth rates of scrub between different sites and among different types of scrub (Schmalzer 2003; Schmalzer et al. 2003).

Schmalzer, P.A. 2003. Growth and recovery of oak-saw palmetto scrub through ten years after fire. *Natural Areas Journal* 23:5-13.

Schmalzer, P.A., T.E. Foster, and F.W. Adrian. 2003. Responses of long-unburned scrub on the Merritt Island/Cape Canaveral barrier island complex to cutting and burning. In: Proceedings of the Second International Wildland Fire Ecology and Fire Management Congress, American Meteorological Society. Published on CD ROM and at http://www.ametsoc.org.

Service Response: The HMP has been updated to reflect this information and citation.

HMP page 142, paragraph 4: Parkinson et al. (2006) found that some impounded wetlands had experienced sufficient substrate erosion that, if reconnected, would flood to a sufficient depth as to preclude revegetation. Possible loss of sediment during decades of impoundment needs to be considered in restoration planning.

Parkinson, R.W., R.R. DeLaune, C.T. Hutcherson, and J. Stewart. 2006. Tuning surface water management and wetland restoration programs with historic sediment accumulation rates: Merritt Island National Wildlife Refuge, East-Central Florida, U.S.A. *Journal of Coastal Research* 22:1268-1277

Service Response: The CCP was updated on page 83 and the HMP on page 122 to include this information.

Citation Missing from Reference List

Comment: One commenter noted that a citation was missing from the list of references: Tooms 2001 on page 80 of the CCP.

Service Response: The reference to Tooms was found to be invalid and was removed.

NOTIFICATION OF PUBLIC REVIEW AND COMMENT PERIOD

Insufficient Notice Provided

Comment: One citizen stated that the public was provided insufficient notice that the Draft CCP/EA was out for public review and comment.

Service Response: In addition to the required *Federal Register* notices, numerous articles, postings, and mailings helped keep the public up to date on the progress of the planning process for the Draft CCP/EA for Merritt Island National Wildlife Refuge. The Service also developed a mailing list to keep interested parties informed. More than 1,500 people were placed on the refuge's CCP mailing list.

Following the initial gathering of information, a Notice of Intent to prepare a CCP was published in the *Federal Register* on August 26, 2002. The Service also placed ads in local newspapers, posted information on the refuge's web site regarding upcoming meetings and how to submit comments, posted meeting information in the local community (e.g., at local shops, at the refuge's visitor center, and at local libraries), and distributed flyers announcing the public meetings. An open house held on September 21, 2002, at the refuge's visitor center kicked off the public scoping phase. More than 180 people attended the open house, which was followed by three public scoping meetings: one on October 23, 2002, in south Merritt Island with 31 attendees; one on October 28, 2002, in New Smyrna Beach with 17 attendees; and another on October 29, 2002, in Titusville with 55 attendees. During September and October 2002, 10 CCP-related articles appeared in three local papers: *Florida Today*, *Orlando Sentinel*, and *Press Tribune*. One article appeared in November 2002 to review the wide range of CCP comments submitted to the Service. During public scoping, the Service received more than 1,600 written comments from individuals and organizations spanning 49 states and 11 countries. Two planning updates kept the public informed of the progress of the CCP. Follow up meetings were held in 2004 to address the public's concerns specific to Mosquito Lagoon: one on April 29, 2004, in Titusville with 65 attendees; one on May 12, 2004, in New Smyrna Beach with 25 attendees; one on November 8, 2004, in Titusville with 7 attendees; and a final one on November 22, 2004, in New Smyrna Beach with 32 attendees.

The Service then began the task of reviewing all the issues raised, including internally and from the public, organizations, businesses, local and state government agencies, and other federal agencies. The Draft CCP/EA was developed for the refuge based on those issues determined to be of the highest priority for the refuge to address during the 15-year life of the plan.

In preparation for public review and comment, in March of 2006 the Service mailed over 1,400 postcards to those entities on the refuge's mailing list to notify them of the coming availability of the Draft CCP/EA for public review, and to allow interested parties to request copies of the document. Information was also posted at the refuge's visitor center and on its website. As required and as part of the normal process, the Service published a Notice of Availability of the Draft CCP/EA for Merritt Island National Wildlife Refuge in the *Federal Register* on December 27, 2006. From November 2004 to February 2007, no fewer than 15 articles appeared in various publications regarding the Draft CCP/EA, including the *Daytona Beach News-Journal*, *Florida Today*, *Ducks Unlimited Newsletter*, *Florida Sportsman*, *Wilderness*, and *Habi-Chat* (newsletter of the Merritt Island Wildlife Association). The documents were also made available at the refuge's visitor center and on the Internet. Over 100 copies of the documents were mailed from the Service's Southeast Regional Office in late December 2006–early January 2007 to those who had requested copies. Subsequent to this initial mailing, numerous paper (hard copy) and compact disk (CD) copies were distributed from the refuge.

Insufficient Review Time Allotted

Comment: One individual stated that the review period for the Draft CCP/EA was short.

Service Response: The Service normally provides a 30-day period for public review and comment on a Draft CCP/EA. Under the Coastal Zone Management Act, this review period is extended to 60 days for areas falling within the coastal zone. The public review and comment period for the Draft CCP/EA for Merritt Island National Wildlife Refuge was 60 days, beginning on December 27, 2006, and closing on February 26, 2007.

MINOR CORRECTIONS

CCP Typos, Clarifications, and Minor Corrections

Comment: One commenter submitted numerous typos, clarifications, and minor corrections for the CCP, as outlined below. The Service's responses follow each:

Page 19, paragraph 4: Typo "…considerable staff time was spent …" (not spend).

Service Response: This correction was made in the CCP.

Table 1: There are a number of spelling and capitalization mistakes in scientific names of plants. All scientific names should be italicized or underlined. Genus names should be capitalized and species names in lowercase (e.g., *Spartina bakeri-Distichlis spicata* tidal herbaceous alliance).

Hardwood hammock *Quercus virginiana-Sabal palmetto.*
Upland coniferous forest: *Serenoa* (not senora).
Planted pine: *Pinus elliotti* tropical forest alliance.
Australian pine: *Casuarina*

Service Response: These corrections were made in Table 1 of the CCP.

Page 31, Wetland Hardwood Forests and Woodlands: *Ulmus americana* Association.

Service Response: Correction made.

Page 31, Mesic Hardwood Forests and Woodlands (spelling): *SABAL PALMETTO*, *Myrcianthes fragrans.*

Page 32, Xeric Hardwood Forest (spelling): *Quercus geminata.*

Page 32, Pine Forests and Woodlands, Upland Coniferous Forests (spelling): *SERENOA*.

Page 33, Shrubland Communities (spelling): *QUERCUS MYRTIFOLIA*.

Page 34, Australian Pine (spelling): *CASUARINA.*

Service Response: Spellings corrected.

Table 2 (spellings): *Bauhinia variegata, Imperata cylindrica, Pueraria montana.* Earpod tree is *Enterolobium contortisiliquum.*

Service Response: These spellings were corrected in Table 2.

Page 80, paragraph 4: Typo “sea turtle” (not se).

Service Response: Spelling corrected.

Page 92, paragraph 5: The sentence “As adjacent landscapes and habitat …” is confusing and probably should be reworded.

Service Response: The confusing sentence was deleted.

Page 101, paragraph 1: “Long-term monitoring has provided considerable …” (not a considerable). Capitalize *Osteopilus*.

Service Response: Corrections made.

Page 118, Objective 5.a(4): The Brevard County Environmentally Endangered Lands Program is engaged in some similar environmental education programs. It would be advantageous to share information.

Service Response: Comment noted.

Additional Clarifications

Comments: The St. Johns River Water Management District provided a number of additional clarifications and comments, as outlined below with the Service’s responses following each:

Page 5, Relationship to State Partners: The SJRWMD has some form of interest in approximately 640,000 acres of land (through ownership, management, or conservation easement rights). More than 260,000 acres of the SJRWMD lands that occur with the Upper St. Johns River Basin (immediately adjacent to IRL and the Refuge), and further acquisitions are planned.

Service Response: Comments noted. The CCP was updated on page 5 to reflect these changes.

Page 17, last paragraph, second to last sentence, regarding marsh management and sea level rise: Critical Issue! Good inclusion. This is more than just a suggestion, however. There are many studies in the literature confirming the link with healthy emergent vegetation and long term sustainability of wetlands. In addition, this premise is support by direct measurements made at MINWR. This issue should be reflected throughout. In these systems (with low inorganic sediment input), accretion is driven by plant material (carbon) being incorporated into the sediments. It is the only way for these wetlands to maintain there position relative to sea level. This means it is critical both for sustainability of the wetlands and carbon sequestration. Measurements of carbon incorporation (as below ground biomass production) into the

sediments were also made during the recent Wetlands Initiative at MINWR. Monitoring of wetland sediment elevation should be a critical task to evaluate the sustainability of any management strategy implemented in these systems. The goals of the N. Florida Ecosystem Team all talk about protecting habitats and Goal 3 specifically speaks of wetlands.

Service Response: Comments noted.

Page 68, Impounded Wetlands, regarding marginal management potential for fisheries: This still says that if they are not good for wildlife management, then we will consider something else. Can it be said that effective fisheries management is being done in these impoundments if there is no determination based on fisheries "management potential?" It was my impression that this descision making process was to include more than just wildlife management. The list could include (1) suitability for fisheries management, (2) susceptibility to wetland loss (subsidence/sea level rise…see above), (3) adjacency to the Lagoon, (4) potential to provide migratory bird benefit in an open/restored condition, (5) existing open water within the impoundment, etc.

Service Response: Comments noted.

Page 69, Herring 2003 citation: Herring (in Wetlands Initiative Report and via personal communication) also said that scaup primarily use open estuarine habitats and do not occur in large numbers within the impoundments.

Service Response: Comment noted.

Page 83, second paragraph, first sentence: Is this still the breakdown? This looks like it did in the early versions of the Habitat Management Plan.

Service Response: Comment noted. This is the current plan.

Page 83, second paragraph, fourth sentence: Please clarify, what does this mean? Maintain flooding to preserve SAV? Maintain flooding to prevent emergent vegetation from establishing? Or does this mean that impoundments would be left open and emergent vegetation encourage so that the wetland would survive sea level rise?

Service Response: This sentence means that the impoundments are managed for habitat that supports a species goal.

Page 83, Objective 2.a(1): As above … Is this still the breakdown of acreage? Seems like it is still very high.

Service Response: This is the current acreage.

Page 83, Objective 2.a(1), Strategies, first bullet: Does this mean structures at both ends of culverts?

Service Response: This sentence says that the refuge will manage water levels for migratory birds as appropriate.

Page 84, Objective 2.a(1), Strategies, fourth bullet: Has this number of diving ducks been documented in the wetlands? Aren't most scaup found in the open Lagoon?

Service Response: This is the refuge objective. Within the life of the plan the objective will be evaluated.

Page 96, third paragraph, sixth sentence: This is a little confusing … the sciaenids are the FIRST three species … not the latter.

Service Response: The CCP was updated on page 96 to reflect this change.

Page 96, third paragraph, last sentence: For many estuarine species, wetlands are a critical larval and juvenile habitat. Access is critical.

Service Response: Comment noted.

Page 98, Objective 4.d(3), Strategies, last bullet: This sounds like a great idea. This could be very valuable and we would be happy to collaborate (and fund).

Service Response: Comments noted.

Page 98, Objective 4.d(4): Can do. This is a perfect project for us to fund. Not limited to Mosquito Lagoon.

Service Response: Comments noted.

Page 133, Objective 2.a(4): The FWC FIM program should be mentioned. Coordination with the Coastal/Marine habitats restoration folks should be prominent … Jeff Beal.

Service Response: Comments noted.

Page 133, Objective 2.a(5): Sounds good to me. We have many areas of mutual interest. New items for them (and us) to include fisheries work with FWRI's FIM and seagrass (prop scars, transects, and mapping).

Service Response: Comments noted.

Page 141, last bullet: Our three-year contract with FWRI's FIM program is exactly this item.

Service Response: Comment noted.

Page 141, suggested additional bullet: Perhaps add a bullet …Resume the monitoring of wetland elevations relative to sea level rise to determine best management options for long-term sustainability of wetlands areas and their targeted functions.

Service Response: Comment noted.

Page 156. First paragraph, sentences two through five: What happened to fisheries management of impoundments? How can a diversity alternative not list fisheries as a priority … only birds?

Service Response: Comments noted.

Page 156, second paragraph, second to last sentence: Sounds great … partners and funding ready. Is this the fisheries component?

Service Response: This is the fisheries component in the Wildlife Diversity Alternative.

Page 172, Waterfowl Hunting Opportunities row, Alternative D column: Why increase hunting in this alternative? How does this fit with diversity and habitat focus?

Service Response: The statement indicates that all activites would be increased., i.e. additional quota areas, additional law enforcement, etc.

Page 173, Upland Game Hunting Opportunities row, Alternative B column: Why would feral hog hunting not benefit T&E species … turtles, habitats …? The Table on Page 190 lists a positive for upland hunting of feral hogs for Alternative B.

Service Response: This is in response the current practice of hog control by trapping.

Page 173, Estuarine Fishing Opportunities row, Alternative D column: If flats fishing impacts T&E (Alternative B) and migratory birds (Alternative C), why would you encourage flats fishing under diversity and habitat (proposed action)? Would restrictions be included?

Service Response: These alternatives include independent actions. Restrictions are listed in Column D.

Page 175, Number of Interpretive Trails row, Alternative D column: As long as they don't impact diversity or habitats (including management such as fire).

Service Response: Comment noted.

Page 181, Relationship with St. Johns River Water Management District, State of Florida row, Alternative A column: Is this really still the case? We currently have a contract in place to fund restoration activities and temporary staff funded to help with restoration planning.

Service Response: Comment noted.

Page 184, Climate Change, first paragraph, last sentence and second paragraph: This is contradicted by statements in this document (see page 17 and comment RB2 above). If continued burning and wildlife management inhibit wetland accretion, less carbon is sequestered. In addition, if this management is applied long term and emergent wetlands are lost permanently, the capacity to sequester carbon is also lost. This is not an issue that is neutral for all alternatives. The reduction in waterfowl-focused management in Alternative B would potentially benefit carbon sequestration. Conversely, the increased focus on migratory birds and waterfowl in Alternative C potentially reduce carbon sequestration.

Service Response: Comments noted.

Page 184, Soils: See comment above … accretion in wetlands is soil formation.

Service Response: Comment noted.

Page 184, Water Quality, Wetlands, and Floodplains: See above … management can have negative impacts.

Service Response: Comment noted.

Page 185, Alternative A, second paragraph: See previous comments … this may not be true for the vast tidal wetland component of the refuge.

Service Response: Comment noted.

Page 186, Alternative B, second paragraph: Reduced intensity of waterfowl management and impoundment restoration are positive for soils.

Service Response: Comment noted.

Page 186, Alternative C, second paragraph, second sentence, managing habitats: See previous comments. Increasing Wildlife/Aquatic Management of impoundments would potentially negatively impact soils and soil-forming processes.

Service Response: Comment noted.

Page 186, Alternative C, second paragraph, second sentence, remainder of sentence: Good. If restoration allows soil-forming processes to function without impact, this should be positive.

Service Response: Comment noted.

Page 186, Alternative C, last paragraph, first sentence: Lagoon fisheries resources will likely be negatively impacted by the increased management intensity focused on migratory birds

Service Response: Comment noted.

Page 187, Alternative D, second paragraph, second sentence, managing habitats: See comments regarding Alternative A … net loss for soils in wetland areas.

Service Response: Comment noted.

Page 187, Alternative D, second paragraph, second sentence, remainder of sentence: Good.

Service Response: Comment noted.

Page 193, Waterfowl Hunting Opportunities row, Alternative D column: Why would expanding waterfowl hunting into an area that was not hunted previously be a benefit to wildlife and habitat diversity?

Service Response: The EA was updated to reflect that the effect of this change would be neutral.

Comments: Canaveral National Seashore, National Park Service, also provided additional clarifications and comments as outlined below. The Service's responses follow each:

Page 8, first paragraph, last sentence: The area east of the beach road is not in the refuge/Seashore overlap area. Through agreement with the refuge, the Seashore maintains four areas at Playalinda Beach along the west side of the road: the Eddy Creek boat launch/dock/parking area and parking areas 11–13.

Service Response: Comments noted. The statement in question reads, "Generally the Seashore manages …"

Page 44, Cultural Resource Protection paragraph: The Seashore is responsible for cultural resource management in the joint management area.

Service Response: The CCP was updated to reflect this clarification. This fact is stated earlier in the document on page 8.

Page 54, Figure 11: The Seashore-managed area between the road to the Playalinda Beach and the NASA railroad tracks is designated an inholding. To many people, that would imply private holdings rather than management by another federal agency.

Service Response: For the purposes of the CCP and in the framework of the land status for the refuge, this area is designated as an inholding in that it is not owned or managed by the Service. Figure 3 on page 11 clearly outlines the intricate management agency picture for this area and shows that it is under management by Canaveral National Seashore.

Page 69, last paragraph: In 2006, the Seashore visited each recorded site in the joint management area to complete a condition assessment and accurately recorded each location with GPS. This will assist in monitoring efforts.

Service Response: Comments noted.

Page 78, last paragraph: Since annual sea turtle nest totals fluctuate so widely and are out of our control, do you want to have a goal involving number of nests deposited?

Service Response: The sea turtle numbers listed in the objective are the target population numbers, providing a framework, but not the measure of success or failure. The key portions of this objective are the elements that are more under the control of refuge management: the 6.3 miles and the high-quality condition.

Page 90, second paragraph, third sentence: The statement about working with the Seashore to control exotic plants is an excellent one. Joint funding proposals and treatment strategies will greatly enhance exotic plant control efforts of both agencies.

Service Response: Comments noted. Both the refuge and the Seashore are committed to making progress in the control of exotic, invasive, and nuisance species.

Habitat Management Plan Typos, Clarifications, and Minor Corrections

Comments: One commenter submitted numerous typos, clarifications, and minor corrections for the Habitat Management Plan (see Appendix F), as outlined below. The Service's responses follow each:

HMP pages xii–xiv: The titles of figures, tables, and appendices should be left-justified, not centered.

Service Response: The HMP's table of contents was corrected to reflect these changes.

HMP, Table 1. Typos regarding scientific names of plant species:

Wetland shrub-scrub-saltwater: *BORRICHIA FRUTESCENS*
Oak scrub: *QUERCUS, Serenoa.*
Planted oak scrub: *Serenoa*
Hardwood Hammock: *SABAL*.
Upland hardwood forest: *SABAL.*
Upland coniferous forest: *Serenoa*
Planted pine: *PINUS ELLIOTTII*.
Australian pine: *CASUARINA*.

Service Response: These corrections were made in Table 1.

HMP page 27, paragraph 6: Capitalize *Osteopilus.*

HMP page 41, Typo: *Sabal palmetto.*

HMP page 45, Oak Scrub and Scrubby Flatwoods. Italicize: *Quercus geminata-Quercus myrtifolia-Serenoa repens* Association.

HMP page 45, Palmetto Scrub. Italicize: *Serenoa repens-Ilex glabra-Lyonia* spp. Association.

Service Response: Corrections made.

HMP page 53, paragraph 3: The Joint Base Operations Contract will be ending (on Sept. 30, 2008), and NASA and the Air Force will return to having separate base operation contracts. How this affects the fire notification system will have to be determined.

Service Response: The HMP was updated to reflect this change.

HMP page 59, Specific Management Projects: Something seems out of place with the first sentence.

Service Response: Revision made. The first part of the Specific Management Projects now reads: Several specific management projects have been identified. Most involve the conversion of other vegetation types to scrub lands.

HMP page 61, paragraph 1: The restoration site south of Haulover Canal was cut in 2005 and burned in January 2006.

Service Response: The HMP was updated to reflect this change.

HMP pages 70 to 72: Italicize species scientific names used in Associations (e.g., *Acer rubrum-Ulmus americana* Association).

Service Response: The scientific names on pages 70–72 were italicized as suggested.

HMP page 70, Hardwood Hammock, spelling: *Myrcianthes fragrans*.

HMP page 71, Upland Coniferous Forests, spelling: *SERENOA.*

Service Response: Both spellings were corrected.

HMP page 78, paragraph 5: The Joint Base Operations Contract will be ending (on Sept. 30, 2008), and NASA and the Air Force will return to having separate base operation contracts. How this affects the fire notification system will have to be determined.

Service Response: The HMP was updated to reflect this change.

HMP page 79, paragraph 3: Something is missing. "In addition to the operation factors discussed above, there **are** …"

Service Response: Correction made.

HMP page 111, paragraph 3: *Spartina bakeri* is not typically a dune species. The *Spartina* occurring on dunes in this region is *Spartina patens*. The rationale for proposing mechanical chopping and fire of dune strand habitat is not explained. The transition from grass dominated dunes to shrub dunes is related to dune stabilization and succession. The loss of grassy dunes in recent years has not been due to fire exclusion and succession but to erosion of the grassy fore dunes by hurricanes and other storms.

Service Response: The HMP was corrected to include Beach Grass (*Panicum amarum*) on page 111, and the offending sentences were removed.

HMP page 123, paragraph 1: Italicize *Ruppia.* Spelling *Scirpus (*not Scurpus).

HMP page 126, Figure 21: The Mathews et al. reference is 1980, not 1908.

HMP page 136, last line: Spelling *Setaria* (not Setria).

HMP page 141, paragraph 1: Spelling *Setaria.*

HMP page 158, paragraph 1: Spelling *Imperata cylindrica*.

Service Response: Corrections made.

HMP pages 159–160, Table 6, spellings: *Bauhinia variegata, Imperata cylindrica, Pueraria montana.* Earpod tree is *Enterolobium contortisiliquum.*

Service Response: Corrections made.

HMP page 168: Two exotic insects that damage native, rare plants are spreading in the region and may affect Merritt Island NWR in the near future.

The exotic cactus moth *Cactoblastis cactorum* (Lepidoptera: Pyralidae) has been found in the South Beaches region of Brevard County near the Archie Carr National Wildlife Refuge (Nichole Strickler, Brevard County Environmentally Endangered Lands Program, personal communication). This moth is a threat to prickly pear (*Opuntia* spp.) and other cacti. *Opuntia stricta* is listed by Florida as Threatened.

The bromeliad weevil *Metamasius callizona* (Chevrolat) has been found at the Enchanted Forest Sanctuary in northern Brevard County (Judy Gregoire, Brevard County Environmentally Endangered Lands Program, personal communication). This insect is a threat to the air plants *Tillandsia utriculata* and *Tillandsia fasciculata*, both listed as Endangered by the State of Florida.

Service Response: The HMP was updated on page 168 to reflect these changes.

HMP Appendix G-212, #3, Unit 1: Update expected completion of CCP from 2005.

Service Response: Correction made.

Visitor Services Plan Typos, Clarifications, and Minor Corrections

Comments: One commenter submitted numerous typos, clarifications, and minor corrections for the Visitor Services Plan (VSP) (see Appendix G).

VSP page 20, paragraphs 6 and 7: Have the changes proposed for 2006 taken place or have they been delayed?

Service Response: Comment noted.

VSP page 41, paragraph 5: Some recent improvements to Black Point Wildlife Drive have been completed or are nearing completion (Habi-Chat, Winter 2006). Are these reflected in this discussion?

Service Response: Comment noted.

VSP page 45, paragraph 1: The hammock area on Huntington Road, acquired by the Brevard County Environmentally Endangered Lands Program and the State of Florida, is a sensitive environment and supports (or supported when acquired) a substantial population of a rare plant (*Glandularia tampensis*, also know as *Verbena tampensis*), listed as Endangered by the State of Florida. This needs to be considered when planning any parking or trail development.

Service Response: The VSP was updated to reflect this information.

VSP page 49, Objective 5.a(4): Networking should include the Brevard County Environmentally Endangered Lands Program, which is engaged in some environmental education projects that are similar.

Service Response: The VSP was updated to reflect this change.

Appendix K. - Finding of No Significant Impact

Merritt Island National Wildlife Refuge
Comprehensive Conservation Plan
Brevard and Volusia Counties, Florida

Introduction
The U.S. Fish and Wildlife Service proposes to protect and manage certain fish and wildlife resources in Brevard and Volusia Counties, Florida, through the Merritt Island National Wildlife Refuge. An Environmental Assessment was prepared to inform the public of the possible environmental consequences of implementing the Comprehensive Conservation Plan for Merritt Island National Wildlife Refuge. A description of the alternatives, the rationale for selecting the preferred action, the environmental effects of the preferred action, 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 Section B, Environmental Assessment.

Alternatives
In developing the Draft Comprehensive Conservation Plan and Environmental Assessment for Merritt Island National Wildlife Refuge, the Fish and Wildlife Service evaluated four alternatives. The Service adopted Alternative D, the "Proposed Action," as the comprehensive conservation plan for guiding the direction of the refuge for the next 15 years. The overriding concern reflected in this plan is that wildlife conservation assumes first priority in refuge management, and wildlife-dependant recreational uses are allowed if they are compatible with wildlife conservation. Wildlife-dependent recreation uses (hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation) will be emphasized and encouraged.

Alternative A. No Action Alternative
Alternative A represents no change from current management of the refuge. Under this alternative, the refuge would continue to maintain 550 Florida scrub-jay family groups across 15,000 acres; 11–13 nesting pairs of bald eagles; and 6.4 miles of sea turtle nesting beaches. Visitor services and facilities would continue similar to past refuge activities. No active management currently or in the future would address resource protection issues. Coordination and partnerships with various agencies would not reach their potential.

Alternative B. Threatened and Endangered Species
Alternative B expands refuge management for the needs of threatened and endangered species. The refuge would aggressively manage for Florida scrub-jays, restoring and maintaining 19,000–20,000 acres in optimal condition to support 900 family groups. Habitat management activities would support and expand the number of nesting pairs of bald eagles to 20, with increased protection of nest sites and development of artificial nesting platforms. Visitor access would be limited and certain hunt areas would be reduced. The visitor experience would be focused on the visitor center with less field opportunities. Resource protection would be focused only on those habitats supporting threatened and endangered species. Coordination would take on a more adversarial approach to protect key species.

Alternative C. Migratory Birds
Alternative C focuses refuge management actions on the needs of migratory birds. Current management activities for threatened and endangered species would remain the same or would be

decreased. The refuge would manage intensively for waterfowl, increasing the acres of impounded wetlands managed to over 16,000 acres and annually support targets of 250 breeding pairs of mottled ducks, 60,000 scaup, 25,000 dabbling ducks, and 38,000 other diving ducks. The refuge would also intensively manage for shorebirds, increasing to over 5,000 acres the areas of impounded wetlands set aside for their use. Waterfowl hunting would be eliminated on the refuge. Estuarine waters would be closed to boating activity. Coordination would take on a more adversarial approach over impoundment management and reduced public use.

Alternative D Wildlife Diversity (Proposed Action)
Alternative D, the Service's proposed alternative, takes a more landscape view of the refuge and its resources, focusing refuge management on wildlife and habitat diversity. The refuge would support 500–650 Florida scrub-jay family groups with 350-500 territories in optimal condition across 15,000–16,000 acres. With active management, the refuge would support 11–15 nesting pairs of bald eagles; maintain 6.3 miles of sea turtle nesting beaches; and maintain 100 acres of habitat for the southeastern beach mouse. Manatee-focused management would be reestablished on the refuge. Several impoundments would be managed for wood storks. The refuge would manage 15,000–16,000 acres of impounded wetlands for waterfowl. Over 2,500 acres of wetlands would be managed for shorebirds and another 1,500 acres would have a wading bird focus. An increased effort to control exotic plants and animals would be made. Coastal islands would be restored. There would be an increase in environmental education with emphasis on diversity of habitats and global warming. Coordination and partnerships would be enhanced.

Selection Rationale
Alternative D is selected for implementation because it directs the development of programs to best achieve the refuge purpose and goals; emphasizes a landscape approach to land management; 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 significant 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 comprehensive conservation plan. Habitat management, population management, land conservation, and visitor service management activities on Merritt Island National Wildlife Refuge would result in increased migratory bird utilization; better habitat for threatened and endangered species; enhanced habitat diversity; restoration of agricultural lands and impounded marshes; reduction of the impacts of exotic species; and would enhance opportunities for wildlife-oriented recreation and environmental education. These effects are detailed as follows:

1. Migratory waterfowl, shorebird and wading bird use on the refuge would improve due to the impoundment management program. The refuge would manage 15,000 to 16,000 acres of impounded wetlands for migratory waterfowl. In addition, 2,500 acres of impoundments would be managed for migratory shorebirds and 1,500 acres for wading birds. For neotropical migrants, the refuge would conduct habitat enhancements and would support research to determine their usage and habitat requirements on the refuge.

2. In the arena of threatened and endangered species, the refuge would support 500–600 Florida scrub-jay families with 350–500 territories in optimal condition. Population and habitat monitoring for this species would increase. By actively managing the pine flatwoods and creating and conserving future potential eagle nest tree stands, the refuge would support 11–15 nesting pairs of bald eagles. Over six miles of beach would be maintained for sea turtle nesting. The refuge would also manage 100 acres for the southeastern beach mouse by enhancing and restoring beach, dune and transitional scrub habitat. For the wood stork, the refuge will increase the prey base, develop artificial nest structures, and manage three impoundments specifically for wood stork foraging.

3. Habitat diversity would be enhanced through the use of timber management, mechanical treatment of scrub, the application of prescribed fire, and the elimination of citrus groves. The restoration of 200 acres of groves to native habitat will increase both mesic and xeric habitat acres. The restoration of 1,200 acres of impounded marshes by removing dikes will result in a more natural ecotone between the uplands and the estuary. This will improve the fishery resource, and result in a more efficient exchange of nutrients between the marsh areas and the open lagoons. Furthermore, the refuge will evaluate and restore altered freshwater swales to more historic vegetation.

4. The refuge would increase management actions regarding controlling and eliminating exotic, invasive and nuisance species. The refuge would pursue grants from partners to control exotic plants. Exotic plants would be controlled on 30 percent of the refuge annually, and specific exotic plant species would be eliminated. Feral hog removal would be increased to at least 4,000 per year.

5. Managing visitor use in a proactive manner will provide the public with opportunities to enjoy both consumptive and nonconsumptive wildlife-dependent activities while keeping disturbance at a minimum. An active environmental education program will inform the public on the importance of the refuge, and increase their awareness of the need for active management and conservation practices.

Potential Adverse Effects and Mitigation Measures

Wildlife Disturbance

Disturbance to wildlife at some level is an unavoidable consequence of any public use program, regardless of the activity involved. Obviously, some activities innately have the potential to be more disturbing than others. The management actions to be implemented have been carefully planned to avoid unacceptable levels of impact.

As currently proposed, the known and anticipated levels of disturbance of the management action are considered minimal and well within the tolerance level of known wildlife species and populations present in the area. Implementation of the public use program would take place through carefully controlled time and space zoning and routing of roads and trails to allow large areas where wildlife can be isolated from human activity. All hunting activities (season lengths, bag limits, number of hunters) would be conducted within the constraints of sound biological principles and refuge-specific regulations established to restrict illegal or nonconforming activities. Monitoring activities through wildlife inventories and assessments of public use levels and activities would be used, and public use programs would be adjusted as needed to limit disturbance.

User Group Conflicts

As public use levels expand across time, some conflicts between user groups may occur. Programs would be adjusted, as needed, to eliminate or minimize these problems and provide quality wildlife-dependent recreational opportunities. Experience has proven that time and space zonings, such as establishment of separate use areas, use periods, and restricting numbers of users, are effective tools in eliminating conflicts between user groups.

Effects on Adjacent Landowners
Implementation of the management action would not impact adjacent or inholding landowners. The refuge's primary "adjacent land owner" is the Kennedy Space Center. The agreement with the Space Center provides for consultation between the two parties on land use issues. The main area where access to private inholdings and land acquisition is a concern would be the Turnbull area. Essential access to private property would be allowed through the issuance of special use permits. Future land acquisition is limited to inholdings within the Turnbull area and would occur on a willing-seller basis only. The management action contains neither provisions nor proposals for land acquisition in other areas.

Land Ownership and Site Development
As noted above, proposed acquisition efforts by the Service are limited. Acquisition of inholdings in the Turnbull area would result in very minor changes in land and recreational use patterns. Any impacts to future economic development by the private sector would also be small. Potential development of access roads, dikes, control structures, and visitor parking areas could lead to minor short-term negative impacts on plants, soil, and some wildlife species. Since most of the proposed facilities and trails are on already disturbed sites, these negative effects will be minimal

The management action is not expected to have significant adverse effects on wetlands and floodplains, pursuant to Executive Orders 11990 and 11988.

Coordination
The management action has been thoroughly coordinated with all interested and/or affected parties. Parties contacted include:

- All affected landowners
- Congressional representatives
- National Aeronautics and Space Administration
- National Park Service
- U.S. Air Force
- Miccosukee Tribe
- Seminole Tribe
- Governor of Florida
- Florida Fish and Wildlife Conservation Commission
- Florida State Historic Preservation Officer
- Florida Division of Forestry
- Florida Department of Environmental Protection
- St. Johns River Water Management District
- Brevard Count Environmentally Endangered Lands Program
- Brevard Mosquito Control District
- Brevard County Commission
- City of Titusville
- Interested citizens through public meetings, mailings and comments

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 following factors (40 C.F.R. 1508.27), as addressed in the Environmental Assessment for Merritt Island 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 183 through 184 and 187).

2. The actions will not have a significant effect on public health and safety (Environmental Assessment, page 185).

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 183 through 184 and 187).

4. The effects on the quality of the human environment are not likely to be highly controversial (Environmental Assessment, pages 183 through 187).

5. The actions do not involve highly uncertain, unique, or unknown environmental risks to the human environment (Environmental Assessment, pages 184 through 185).

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 183 through 198).

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 158 through 182).

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, page 183).

9. The actions are not likely to adversely affect threatened or endangered species, or their habitats (Environmental Assessment, pages 187 through 189).

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 143 through 144).

Supporting References

U.S. Fish and Wildlife Service. 2006. Draft Comprehensive Conservation Plan and Environmental Assessment for Merritt Island National Wildlife Refuge, Brevard and Volusia Counties, Florida. U.S. Department of the Interior, Fish and Wildlife Service, Southeast Region.

Document Availability

The Environmental Assessment is Section B of the Draft Comprehensive Conservation Plan for Merritt Island National Wildlife Refuge and was made available in December 2006. Additional copies are available by writing: Merritt Island National Wildlife Refuge, Post Office Box 6504 Titusville, FL 32780-6504.

Sam D. Hamilton Regional Director	9/27/07 Date