

IV. ENVIRONMENT CONSEQUENCES

Chapter III describes four alternatives for achieving the vision of Hobe Sound National Wildlife Refuge. These alternatives are: Alternative 1, Maintain Current Management; Alternative 2, Ecosystem Emphasis; Alternative 3, Biological Emphasis; and Alternative 4, Public Use Emphasis. The purpose of this chapter is to identify, describe, and analyze the impacts that would result from implementing each of the management alternatives. Alternative 1 is used as the baseline to which the other three alternatives are compared. Because of the general nature of the assessment and the lack of numerical or quantitative information regarding refuge resources, impacts are often expressed in relative terms.

The planning team evaluated the impacts of each alternative on the following topics: (1) physical environment; (2) biological environment; (3) cultural and historic resources; (4) recreation and environmental education and interpretation; (5) socioeconomic environment; and (6) unavoidable impacts.

Direct, indirect, and cumulative impacts are described, where applicable for each alternative. Direct impacts are those that occur immediately or occur at the same place and time. Indirect impacts are those foreseeable effects that occur later in time. Cumulative impacts are a series of individual, seemingly minor effects that may accumulate to create major problems over a period of time.

Effects on Physical Environment

To assist in this analysis, the impacts on the physical environment were further subdivided into major categories of soil, hydrology, water quality, air quality, noise, aesthetics, and facilities.

Soils

The soils will be positively affected under Alternative 1. Sand renourishment efforts would continue at regular intervals. Sea oats would be planted along small sections of the beach as plants are donated and labor is available. These plantings would stabilize the dunes.

Alternatives 2 and 3 would have minor cumulative negative impacts on soils. Soil compaction is not likely to occur in the soft Paola sands of the refuge; however, heavy equipment used to mimic natural disturbance, control exotic plants, and contour the beach could have that effect. Short-term erosion would occur within the scrub vegetation as it is set back to a younger successional stage by fire or mechanical disturbance. However, using small controlled burns on the Mainland Tract would prevent the chance of soil sterilization caused by very hot wildfires. Long-term effects from beach renourishment and dune stabilization projects would have a positive effect on the soils of the Jupiter Island Tract.

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*"Jupiter Island lay
dormant, visited
only by Indians
intermittently and
by mosquitos
incessantly."*

Joseph V. Reed

Under Alternative 2, spoil sites on the Jupiter Island Tract would be restored to mangrove wetlands. To accomplish this, mounds would be leveled to a few inches above the mean high tide line. While there would be a significant impact to the soil of these sites, this action would nearly restore the original elevation and subsequent soil profile of the site. Furthermore, this action would result in significant benefits to native plant and animal communities.

Under Alternative 4, increased foot traffic on new and extended foot trails would be expected to have a negligible impact on soil erosion. However, construction of an office/visitor center would result in a minor loss of soil. Under all alternatives, efforts would be made to minimize soil erosion and degradation including installation of board walks in sensitive areas and foot bridges over wetlands using environmentally sensitive materials. Beach renourishment would continue under Alternative 4. Long-term impacts associated with beach renourishment are unknown. Exploration and excavation of archaeological sites might increase soil erosion, especially near slopes along the Indian River Lagoon.

Hydrology

A continuation of the existing management would have no effect on hydrology.

In Alternatives 2 and 3, mosquito impoundments would be reconnected through the possible construction of water control structures. Water levels would be managed for fish, wading birds, and control of biting insects. Water would be held and released seasonally, thus directly affecting the local hydrology of those portions of the barrier island. This action would create tidal wetlands, where now only seasonally moist soils exist. Restoring the functional value of wetlands would have a positive impact on fish, aquatic invertebrates, and the vegetative communities and a negative effect on exotic plants, specifically Brazilian pepper and Australian pine, since these species cannot tolerate submersion in brackish water.

Currently, spoil sites support stands of Australian pines and Brazilian peppers. These mounds are surrounded by salt-tolerant mangrove wetlands. The Australian pines and Brazilian peppers require fresh water for existence. They derive this water from a lens that forms just above the saltwater table within the mound. As these spoil sites receive precipitation, the less dense fresh water soaks into the soil and floats on top of the more dense salt water. To restore these spoil mounds to mangrove wetlands, Alternatives 2 and 3 propose to level them to a few inches above mean high tide. Although the effects of this action would alter the hydrology of the sites, the direct, indirect, and cumulative impacts would be positive for the natural community.

No adverse effects to hydrology would result from the implementation of Alternative 4.

"When the dredge came down the Indian River, he had no difficulty persuading the dredge master (with permission from the War Department) to place the fill from the dredge in his swamp-which thereupon became high and fertile land."

Permelia Reed

Water Quality

Under Alternative 1, the cumulative effects of long-term herbicide use for exotic plant control could result in a slight decrease in water quality in localized areas, specifically in areas prone to exotic plant infestation. With proper application, no leaching of chemicals into water bodies would be expected.

Currently, the mosquito control district of Martin County aerially applies insecticides on the refuge, when necessary, to help control mosquito populations. This insecticide, although approved for use, could have direct, indirect, and cumulative negative effects on aquatic micro- and macro-invertebrates within and in the Indian River Lagoon.

Under all alternatives, beach renourishment would continue until such time as new technology is developed that equally slows or halts the erosion process. The renourishment process requires dredging the Intracoastal Waterway or Atlantic Ocean floor, then transferring the sand in a slurry of water and sediment via pipe to the beach. One method of dredging uses, what is in effect, a large vacuum which pulls sediment directly from the bottom and pipes the slurry directly to the beach. This method has short-term negative effects on water quality in the near-shore environment. However another method uses a clam shell drag-line to dig the sediment from the bottom, lifting it out of the water and releasing it into a barge. From here the material is transported by barge to a pumping station where the barge is unloaded by another clam shell drag-line and deposited into a hopper, where it is then pumped through a pipe to the beach. Water quality impacts are more widespread and longer lasting with even the most efficient equipment using this technique. Water quality at the delivery site (the beach front) is directly impacted using either technique, as the sediment is discharged directly into the surf. The impacts are usually confined to the immediate area and last only during the renourishment period. Near-shore, hard bottom habitats may be affected.

The water quality may be temporarily impacted in the Indian River Lagoon with the reconnection of the mosquito impoundments. Best management practices would be implemented to avoid exceeding water quality standards.

Under Alternatives 2 and 3, organic debris resulting from logging and/or prescribed fire may directly effect water turbidity levels in the immediate area, for a limited time. However, the activity would not occur near water as a 100-foot buffer would be left undisturbed. Siltation caused by run-off of the logged or burned areas would temporarily impact the water quality in the Indian River Lagoon and the few freshwater wetlands. Within a few weeks of such land disturbance, herbaceous plants and ground cover would re-sprout and again function as soil stabilizers.

Under Alternatives 2 and 3, the refuge would work with the U.S. Coast Guard, Florida Fish and Wildlife Conservation Commission,

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"Today, the island is almost completely masked out by a seemingly solid, high hedge of Casuarinas. These trees were not planted until 1916; prior to that time one could have viewed the island in an unbroken sweep."

Joseph V. Reed

and Jupiter Island Public Safety - Marine Units to help enforce restrictions on the speed and wake of vessels traveling within manatee zones in the Intracoastal Waterway and along the refuge boundary. This action would not only positively affect manatee, mangrove, and sea grass populations, but would increase the water quality of the Indian River Lagoon as a result of lower turbidity levels.

Under Alternative 4, an increasing amount of trail-use-associated trash and debris might cumulatively impact the water quality in the tidal and freshwater wetland areas. Attempts would be made to minimize the effects by providing trash receptacles at board walks and bridges in sensitive areas, and a volunteer group would be asked to pick up trash on trail-roving duty.

The construction of a boat dock at Peck Lake, under Alternative 4, would increase boat traffic in the area. The resulting increase in gasoline and diesel powered engines would have a negative effect on both water and air quality in the immediate area of the Indian River Lagoon.

Air Quality

Under Alternative 1, air quality would have a temporary negative effect if a wildfire occurred in the scrub community. Under Alternatives 2 and 3, the use of prescribed fire and logging as tools to restore the sand pine/scrub oak community would have direct short-term negative impacts on air quality. As specified by the prescription, fire would only be used with favorable wind speed and direction, although impacts to air quality on lands adjacent to U.S. Highway 1 and on Jupiter Island are of concern. Under Alternative 4, the increased automobile and boat traffic to the refuge could result in minor localized increases in emissions.

Noise/Traffic

Under all alternatives, increases in noise from traffic are expected, as are increases in road kill. In addition, under Alternatives 2 and 3, a short-term increase in noise level would be expected while using equipment for land management activities.

Aesthetics

Under Alternative 1, little change of visual quality would be expected. The unsightly facilities at the headquarters and beach parking lot would continue to degrade the visitor and employee experience. Without scrub pine restoration the chance of wildfire increases. As demonstrated by the wildfire of 1971, much of the Mainland Tract of the refuge was blackened.

Under Alternatives 2 and 3, smaller prescribed fires conducted after mature sand pine removal and timed to encourage quick regeneration would reduce the effects on visual quality. Fires could be controlled to provide a vegetative buffer along U.S. Highway 1 and the Indian River Lagoon.

Alternatives 2 and 3 call for the removal of Australian pines along the Indian River Lagoon. To many people, these tall trees have aesthetic value. They provide perches and nesting cavities for birds such as the osprey. However, the importance of their control and removal from significant areas is necessary to the health of the sand pine scrub community. Planting of appropriate native vegetation in their place would counteract some of the negative visual effects.

Under Alternatives 2 and 4, newly created and extended nature trails, including the construction of an elevated observation tower on the Island and an overlook of the Indian River Lagoon on the scrub trail, would provide visitors with more opportunities to enjoy the visual beauty of the refuge.

Facilities

Under Alternative 1, there is no doubt that the files and equipment in the existing facilities would be heavily damaged by the next major storm. The seriousness of the situation can no longer be minimized or discounted.

Under Alternatives 2 and 4, several facilities would be constructed: an office/visitor center at or near the location of the existing building; a fee booth and interpretive area, as well as a composting toilet possibly with running water and a changing room at the beach access area; and an observation tower along the mangrove/beach trail. These actions would result in positive benefits to refuge facilities.

Implementation of Alternative 3 would adversely affect facility upgrades with emphasis placed on restoration of land for plants and wildlife. Existing facilities at Peck Lake would be removed.

Effects on Biological Environment

Vegetation

Under Alternative 1, the lack of adequate control of exotic vegetation would result in the continued degradation of natural communities. The refuge would continue to rely on the services of maintenance workers who have many other duties, and private contractors hired with funds received from grants to control the spread of exotics. Support is insufficient from A.R.M. Loxahatchee National Wildlife Refuge to control the spread of exotics. Under Alternative 2, exotic plants would be aggressively controlled to achieve 50 percent removal within 15 years, resulting in an accumulative positive impact on native vegetation. The plan would encourage volunteer support and agreements with local plant nurseries to promote plantings of native species. Fifty percent of the spoil sites would be converted to mangrove wetlands. Under Alternative 3, 90 percent of exotic plants would be eliminated from the refuge within 15 years. Native communities would be restored and all spoil sites would be converted to either upland hardwood hammocks or removed to restore tidal influences. Alternatives 2 and 3 would positively affect the native vegetative communities directly, indirectly, and cumulatively.

Under Alternative 4, less emphasis and resources would be committed to vegetation enhancement. Primary control would be accomplished through the use of volunteers and grants. Limited funds would be allocated for exotic plant removal, however, native plants would be grown in a volunteer nursery and used in limited restoration efforts. At the same time, efforts would still be made to partner with local nurseries to encourage native species plantings and donations of plants to the refuge. The positive impacts from the implementation of Alternative 4 would be less significant than with Alternatives 2 or 3.

Increased numbers of visitors raise the possibility that new exotic species would be introduced into the area when visitors do not comply with requests to stay on marked trails. Other negative impacts associated with increased public use would result from the extension, creation, and maintenance of nature trails that require the clearing of non-sensitive vegetation along their length.

Sand Pine Scrub Community

Under Alternative 1, limited management of the community would continue. Negative indirect and cumulative effects would result. Attempts would be made to burn or mechanically disturb the community, but there would be inadequate knowledge gained or applied. The refuge would continue to suppress wildfires and monitor for diseases within the stand. Eventually, the community would either succumb to wildfire, creating a very serious public safety hazard, but setting it back to an early, healthy state, or continue to age past senescence and be replaced with a scrub oak hammock. Species diversity would be compromised, and endemic sand pine scrub species (including 14 protected species) could be extirpated. Under Alternative 1, there would be limited management of the sand pine scrub community. Exotic plant control would continue on a sporadic basis. As a result, the health of the scrub community would continue to decline over time.

Under Alternatives 2 and 3, removal of exotic plants in the disturbed areas would minimize the need to constantly maintain these areas to prevent their spread. Contractors would be used throughout the year to control Australian pine, Brazilian pepper, Old World climbing fern, mahoe, rosary pea, and others. Trails would be cut into greatly disturbed areas to facilitate plant removal. In addition, these trails would provide opportunities for wildlife observation and photography. This intensive exotic removal program would have a positive effect on the biotic community.

The indirect and cumulative effects of fire or mechanical clearing would restore health to this aging scrub community. Initially, Alternatives 2 and 3 would have a negative direct effect on the scrub community, since most of the native plants (or at least the above-ground portions) in the project area would be disturbed either by fire or mechanical treatment. Fire or mechanical disturbance would have a direct effect on individual plants and to species that require a late seral stage, however, managing this community

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Lichen
USFWS Photo

for earlier succession would have overall indirect and cumulative, positive effects.

Some of the scrub habitat (approximately 50 acres) under both Alternatives 2 and 3, would be spared from fire and/or mechanical disturbance. This area would serve the few species, such as lichens (*Cladonia*), that require older growth and act as refugia for wildlife during fire and mechanical treatment elsewhere on the refuge.

Under Alternative 4, exotic plants (e.g., Australian pine, Brazilian pepper and Old World climbing fern) would be removed from the scrub community along U.S. Highway 1 and the Indian River Lagoon—areas which are easily visible by the public. This removal would result in a positive direct effect. However, cumulative effects of removal would be less significant.

Coastal Strand Community

Under Alternatives 1 and 4, the effects of passive management would continue to threaten the health of the community. Without maintenance and the replanting of native plants (e.g., sea oats, sea purslane, and railroad vine), while at the same time controlling the spread of exotic species (e.g., Australian pine, Brazilian pepper, and *Scaevola*), the dune would continue to erode.

Under Alternatives 2 and 3, native species would be planted on the foredunes and backdunes. Sand fence installed according to turtle safe guidelines would be evaluated to foster dune accretion. This action would increase the area of potential habitat for the vegetative community. Regulations protecting the dune from visitor impacts would be strictly enforced. More signs notifying visitors to stay off the dune would be placed along its length. Fire and mechanical disturbance would be used, where appropriate, to control exotic plants and maintain the native community. It is expected that these treatments would eliminate 95 percent of the exotic plants.

Picnic pavilions would be constructed at the beach access area under Alternative 4. During construction, the pavilions would have negative effects on dune vegetation. The increase in trash and food scraps, as a result of additional public use, would directly impact the biological environment. Birds might entangle themselves in food containers, plastic materials may be ingested by sea turtles, an increase in feral animals would result, and wildlife might become dependent upon food scraps in the trash. Increased numbers of visitors on the beach would result in added human/wildlife conflicts. Alternative 4 is anticipated to have no negative impacts on the coastal strand community.

Mangrove Wetlands

Under Alternatives 1 and 4, minimal efforts would be extended to enhance the mangrove community. As a consequence, there would be little impact to this community. As mentioned above, extended and newly created nature trails developed under Alternative 4 would impact a small percentage of individual plants. Boardwalks

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*Margo Stahl & Dawn Greenly
during prescribed burn
USFWS Photo*

and bridges would be installed to minimize the impact of erosion. Minimal efforts would be extended to enhance the community. Erosion to the shoreline and associated mangrove habitat would continue to increase from boat wakes.

Positive direct, indirect, and cumulative impacts would result with the implementation of Alternatives 2 and 3. Under Alternatives 2 and 3, efforts would be made to work with boat users to evaluate a slow speed/minimum wake zone in the Intracoastal Waterway along the length of the refuge. This action would slow or reduce the erosion process to the mangrove community, thus creating a positive indirect and cumulative impact. Red mangroves would be planted in areas that are the most prone to erosion. Installation of water control structures and pumps in old mosquito control impoundments would restore healthy mangrove wetlands. This action would create an additional 200 acres of exotic-free mangrove wetlands on the Island and potentially increase the numbers of fish species and wading birds utilizing the wetlands.

Alternative 3 calls for the conversion of 50 percent of all spoil sites on the island to mangrove wetlands. This would increase the area of biologically productive mangrove wetlands by 50 acres and at the same time reduce the identical acreage of exotic plants.

Under all alternatives, cooperation with the Environmental Learning Center and the Marine Resources Council would continue in order to study the effectiveness of mangrove planting techniques.

Wildlife

Under Alternative 1, impacts from mammalian predators (e.g., raccoons, armadillos, foxes and coyotes and feral cats), ghost crabs, fish crows, sea gulls, and snakes on sea turtle and least tern nests would continue at the existing level. Predators would be controlled through contracts with the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS), and would continue at the current level. For all the alternatives, new methods of excluding predators would be evaluated in terms of humaneness and feasibility; if these methods meet these criteria, they would be adopted by the refuge.

Under Alternatives 2 and 3, additional resources and funding would be committed to ensure that sea turtle hatching success is increased to 90 percent. Animals identified as primary nest predators would be removed from the population (see predator control plan for methods and materials) and improved techniques and excluding devices would be evaluated and applied, if appropriate. Alternatives 2 and 3 are anticipated to result in positive, cumulative impacts for protected coastal species.

The impacts of the actions contained in Alternative 4 would be similar to those of Alternative 1. However, in addition to volunteer staff, refuge staff could be used to assist with predator control activities. The expected increase in public visitation in response to

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implementation of Alternative 4 could affect the number of traps and the methods used.

Public Use Effects on Sea Turtles

Under Alternative 1, the current level of visitor use has minimal impact on sea turtle nesting. Currently, very few sea turtle nests are disturbed by visitors. Pets, such as dogs, are often left off their leashes (in violation of refuge regulations); thus, these pets may disturb sea turtle nests by digging over the egg chamber.

On the other hand, implementation of Alternative 2 would require strict enforcement of refuge regulations concerning unconfined

domestic animals. Domestic animals would be prohibited under Alternative 3.

Alternatives 2 and 3 limit the negative impacts of public use activities on sea turtles.

Under Alternative 4, pets would continue to be permitted under current regulations. However, with the increase of visitor use associated with the implementation of Alternative 4, the cumulative negative impacts would be greater. Night-time turtle walks could be conducted on the refuge according to the Florida Department of Environmental Protection's permitting regulations.

These, as well as other night-

time public use activities such as star gazing and camping, would negatively affect turtle nesting.



*Least terns
USFWS Photo*

Public Use Effects on Shorebirds

Throughout the United States, the increasing number of beachgoers and anglers is having negative effects on shorebird populations. Recent refuge surveys suggest an impact on the nesting success of the least tern. In 1999, not only humans, but pets (specifically dogs) were suspected of contributing to nesting failure in the Peck Lake area. Unconfined dogs pose a threat to resting and feeding shorebirds. Beside the potential for capture, the cumulative effects of repeated flushing result in a significant loss of energy; energy reserves are a requirement for successful migration.

At Hobe Sound Refuge, under Alternative 1, disturbance to shorebird feeding and resting would continue and, in addition, injuries and death to shorebirds would continue to occur due to discarded fishing tackle.

Under Alternative 2, an educational program would be developed to inform the public about areas to be closed to protect nesting colonies, should this action be needed. Prior to the nesting season, the public would be alerted to the location of least tern nesting sites, and early in the nesting season, the refuge would step up its law enforcement presence, including enforcement of existing animal leash laws. Should this prove inadequate, owners would be denied access with pets during the nesting season. Some of the negative effects associated with public visitation would be mitigated by the implementation of a more aggressive predator control program.

Least tern nesting would be positively affected under Alternative 3. Public use of the refuge beach would be restricted to the area located south of the Peck Lake cross-over trail during the nesting season. As under Alternative 2, Alternative 3 would provide a more aggressive predator control program to enhance the least tern nesting success.

Under Alternative 4, the Peck Lake visitor use area would be developed to include additional facilities, including a boat dock, a composting toilet, and an access to the mangrove trail and observation tower. The increased use associated with these developments would directly, indirectly, and cumulatively negatively affect the nesting efforts of least terns in that area.

Beach renourishment, which involves the transfer of sand from off-shore sites, would continue under each alternative. Sand renourishment, implemented properly, is beneficial to sea turtles, least terns, and other shorebirds, since beach habitat is temporarily restored. The effects of renourishment on wildlife would continue to be monitored. Beach renourishment does have some negative effects on sea turtles. Escarpments as great as 5 feet generally form the first winter after completion of the renourishment project. In some instances, escarpments are leveled by winter storms. In other instances, they remain well into the season and function to deter sea turtles from nesting. Although the contractor is required to till the deposited sand prior to the next turtle nesting season, the substrate is likely to become very compact as it settles. This compaction hinders and can, in some cases, prevent sea turtles from excavating the egg chamber. The long-term effects of various renourishment substrates on sea turtle nesting are being researched.

The effects on near-shore habitat and Indian River Lagoon River bottom habitat need to be further researched. Cooperative agreements with other resource protection agencies such as the Florida Department of Environmental Protection and Florida Fish and Wildlife Conservation Commission would be pursued to help prevent human nest predation under all alternatives.

Protected Scrub Species

Under Alternatives 1 and 4, the sand pine scrub community on the Mainland Tract would either eventually mature into a xeric hardwood forest without sand pines, or be consumed by wildfire (Myers 1990). These alternatives would have major negative indirect and

cumulative impacts and minor negative direct impacts to scrub jays, scrub lizards, gopher tortoises, gopher frogs, indigo snakes, florida mice, pine snakes, and sand skinks. All of these listed species prefer the younger stages of the sand pine scrub community.

Alternatives 2 and 3 would have major positive indirect and cumulative impacts for all scrub species of management concern on the refuge. Habitat for all of these species would be restored to preferred natural conditions. See the Sand Pine Scrub Habitat Restoration Plan 2000 (available upon request).

The following addresses the impacts associated with the Sand Pine Scrub Habitat Restoration Plan implemented under Alternatives 2 and 3.

Gopher tortoise (*Gopherus polyphemus*)
State of Florida Species of Special Concern

A comprehensive survey for gopher tortoise burrows is anticipated and several known burrows have already been identified. Gopher tortoise ingress and births are expected to increase sub-

stantially over the next 5-10 years in response to comprehensive scrub restoration efforts. Currently, most of the tract is not suitable for the gopher tortoise because of dense sand pine canopy, overgrown scrub oak midstory, and the remnants of mulch from earlier site preparation. Gopher tortoises could colonize within 2 years of the treatment.



*Marked nest
USFWS Photo*

Eastern indigo snake
(Drymarchon corais couperi)
*Federal and State of Florida
Threatened Species*

Eastern indigo snakes would benefit from an increase of gopher tortoise burrows,

which are expected to arise after harvest and burning of sand pine. Harvest and burning, which fosters the growth of herbaceous plants, would also increase the number of rodents available as a food source for this snake. By seeking refuge in nearby burrows, the eastern indigo snake would likely avoid direct effects from the associated mechanical treatment and prescribed fire.

Florida scrub jay (*Aphelocoma coerulescens*)
Federal and State of Florida Threatened Species

Restoration of sand pine scrub would expand the amount of suitable habitat for the Florida scrub jay from 0 to nearly 50 acres within the first 10 years following treatment. The majority of the research suggests that 50 acres should provide habitat for at least 2 nesting

colonies. Families of scrub jays are known to occur in the adjacent Jonathan Dickinson State Park. The created habitat would provide dispersal opportunities for maturing juveniles.

Florida gopher frog (*Rana capito*)

State of Florida Species of Special Concern

Although the sand pine habitat contains no standing fresh water, there are a few low-lying wetland areas within the scrub that could provide suitable breeding habitat for the gopher frogs. Enhanced tortoise habitat would indirectly benefit the gopher frog which uses the burrow provided by the tortoise. Equipment used for harvesting and roller chopping or mechanical shredding could have a negative, but limited, effect on gopher frogs.

Florida mouse (*Peromyscus floridanus*)

State of Florida Species of Special Concern

Similar to the Florida gopher frog, the Florida mouse is also expected to benefit from the implementation of Alternatives 2 and 3. This species, which inhabits scrub vegetation, prefers younger stands (Fernald 1989). Following a fire, populations of this species are highest in early successional stages of scrub vegetation (Humphrey 1992). While an increase in acorn production and open canopy should benefit this species, it has not been found on Hobe Sound Refuge (Gilligan 1999, unpub. data) in spite of intensive surveys. The equipment used for land preparation could have a slight negative effect on the species. However, it would likely retreat into burrows or loose sand.

Florida pine snake (*Pituophis melanoleucus mugitus*)

State of Florida Species of Special Concern

This species is a frequent resident of gopher tortoise burrows (Fernald 1989). It prefers disturbed scrub and sandy habitats and, within 2 or 3 years following harvest, an early successional habitat could become suitable for the snake. Thus, restoration of pine scrub is expected to be beneficial to this species. A visual survey was conducted for this species on the refuge by Gilligan in 1999 and no individuals were found. However, the pine snake has been observed near the U.S. Highway 1 corridor in the sand pine scrub community of the adjacent Jonathan Dickinson State Park (Noel 2000, personal observation).

Scrub lizard (*Sceloporus woodi*)

State of Florida Rare Species

Currently, the scrub lizard is commonly found in the refuge sand pine habitat. Since this species thrives in areas containing numerous patches of open, unvegetated sand with high sunshine levels (Fernald 1989), the lizard should indirectly benefit from these alternatives. The scrub lizard should be able to avoid heavy equipment and retreat into loose sand during the burn phase of the project.

Under Alternatives 2 and 3, restoration of the mainland coastal ridge to earlier successional stages would have moderate negative direct impacts to all scrub species of management concern occurring on the refuge. Individuals of some species may be killed during heavy

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*Manatee
USFWS Photo*

equipment use and during prescribed burns due to extreme heat. Populations of other species, especially those that share burrows with gopher tortoises, may only incur loss of habitat or food. Many species commonly retreat to subterranean burrows to escape the heat and flames of fire. Forested buffers excluded from mechanical harvest and prescribed fire would serve as wildlife refugia during these events.

Under Alternative 2, indicator and trust species populations would be inventoried prior to and at regular intervals following mechanical or prescribed fire treatments. Under Alternative 3, populations of all endemic scrub species on the refuge would be carefully monitored. With this information, management treatments on species populations could be measured and adjusted over time to increase effectiveness.

West Indian manatee

Although manatees are found in waters adjacent to the refuge boundary, jurisdiction of waters and submerged lands is held by the State of Florida. However, the Service, as authorized by the Endangered Species Act of 1973, and the Marine Mammal Protection Act of 1972, is the primary federal agency responsible for the protection and recovery of manatees.

Under Alternative 1, there would be status quo protection for manatees. No additional protection from vessel collisions would be afforded, and seagrass beds and water quality would not be monitored or protected by refuge personnel. Education would be provided to school groups and the visiting public by the Hobe Sound Nature Center, Inc.

Under Alternatives 2 and 3, the refuge would work closely with other agencies and the boating public to place greater emphasis on reducing vessel speed and wake along the refuge boundary; and with the Florida Inland Navigation District to keep manatee zone signs posted along the Intracoastal Waterway. The refuge would also coordinate with the Florida Fish and Wildlife Conservation Commission, Marine Division and the Jupiter Island Public Safety Department, Marine Units to enforce the existing speed restrictions.

The above actions would reduce the number of vessel collisions and disturbance to manatees, and assist in the reduction of water turbidity levels. Suspended sediment, caused by excessive high speed vessel traffic, eventually settles to the river bottom covering vegetation (e.g., seagrass beds) and hard bottom habitats. Boater compliance and decreased boat speed and wake would reduce negative direct, indirect, and cumulative impacts to manatees.

Water control structures (culverts) are second only to vessel collisions as the leading cause of manatee mortality (Whitehead 1999, oral communication). To minimize these negative effects, water control structures in the mosquito impoundments would be constructed to be manatee friendly. In addition, these structures would be constructed with pressure sensitive gates, which would not continue to close if an object was contacted.

Under Alternative 4, partnerships with state and county resource protection agencies would be maintained to promote public awareness of manatees. With an increase in boat traffic, collisions with manatees in the Indian River Lagoon could be more frequent, resulting in permanent injuries and death.

Migratory Birds (excluding shorebirds)

The refuge provides wintering habitat and stopover habitat for a variety of migratory birds. Some of the more common migratory birds that use the refuge are small songbirds that stop over in the scrub and in hammocks; wading birds and osprey that feed in the Indian River Lagoon and mangrove wetlands; peregrine falcons, kestrels and hawks; blue-gray gnatcatchers, and gray catbirds.

The level and duration of use on the refuge by migratory birds would probably decline as exotic plants overtake the diverse and biologically important hammocks, as a consequence of Alternative 1. However, under alternatives 2 and 3, active management of the sand pine scrub community and hammock restoration would likely result in greater species diversity and abundance.

Use of prescribed burning would have a direct but short-term negative effect on bird population levels because of decimation or displacement of insect populations. However, the long-term effects would be positive. Early successional scrub would provide greater numbers of insects; small mammals; and increased quantities of seeds, berries, and acorns. After scrub restoration, snags would remain on which raptors and passerines could perch and on which woodpeckers and wood ducks could nest. Exotic plants would be removed from freshwater wetlands and hardwood hammocks would provide more suitable habitat for birds. Reduced boat speed and wake in the Intracoastal Waterway would attract greater numbers of wading birds that feed along the shores and in the mangrove swamps. The Indian River Lagoon would also support greater numbers of diving ducks and loons. Reduced boat speed would allow aquatic vegetation to reestablish which would support greater populations of bird prey.



*Shorebirds
USFWS Photo*

Under Alternative 4, increased visitor traffic on existing trails and the introduction of human disturbance on newly created trails would temporarily displace migratory bird populations on the refuge. Wading birds would avoid the shorelines that are more heavily used by visitors and fishermen.

Under all alternatives, there would also be some positive cumulative effects on migratory birds as a whole. New partnerships with organizations such as Audubon Society and Ducks Unlimited and participation in multinational efforts such as the Partners-in-Flight Initiative would seek to identify population trends and assist in management decisions. Using volunteers, supervised by a refuge biologist, to complete weekly bird surveys on the newly created trails and overlooks would help the refuge monitor populations and identify new species within the communities. This information would be incorporated into a regional database and used to make sound management decisions for populations and habitats.

Other Wildlife (not including species targeted by the predator control program)

Under Alternatives 1 and 4, many plants and animals would be negatively affected as the pine scrub community approaches mature forest. As described above, most species adapted to life in the scrub are dependent on early succession. Species of snakes, lizards, and small mammals prefer little to no canopy in numerous open unvegetated patches of sand in order to thrive. Although every attempt would be made to restore the sand pine scrub habitat under Alternatives 1 and 4, funding and personnel availability would likely be inconsistent. Much of the sand pine community may be left to age and eventually die and would not benefit native wildlife species. Efforts to avoid catastrophic wildfire would be implemented on an as needed basis.

Barrier island and Indian River Lagoon habitats support populations of bobcats, pelicans, and fish crows. These species would not likely benefit from Alternatives 1 and 4. No biological enhancements would be made to support non-trust species.

Under Alternatives 2 and 3, the continuation of well-designed and implemented beach renourishment projects, reduced vessel speeds in the Intracoastal Waterway, water quality, seagrass bed monitoring, exotic plant removal, and mosquito control impoundment restoration would positively affect most species of wildlife. Enhancements to the biological communities would be primarily directed at trust species, but all flora and fauna would be considered prior to any action taken. Many of the trust species serve as indicator species that reflect the health of the biotic community. Therefore, in principle, if management activities were directed toward promoting ideal conditions for these species, other populations would benefit as well.

Effects on Cultural and Historic Environment

Under all four alternatives, historical and archaeological sites would be protected under federal ownership, as defined in the National Historic Preservation Act of 1966, as amended through 1992 (P.L. 89-665) [NHPA], the Archaeological Resources Protection Act of 1979 (P.L.96-95) [ARPA], the Native American Grave Protection and Repatriation Act of 1990 (P.L.101-601), and the implementing regulations authored by the Advisory Council on Historic Preservation, the Department of the Interior, and the National Park Service. However, the degree of protection, as well as the opportunities to conduct scientific research and to interpret past cultures, vary between each alternative.

Archaeological and related scientific investigations on the refuge have been limited to the Fryman, Miller, and Swindell 1980 project-specific archaeological survey and Russo's 1999 testing of the Joseph Reed Mound. The lack of a comprehensive refuge-wide archaeological survey hampers the Service's ability to effectively meet its cultural resource management responsibilities. Such a survey would provide a site predictive model based on the region's

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cultural history, known site distribution, oral history interviews, historic documents, historic land-use patterns, topography, geomorphology, soils, hydrology, and vegetative patterns.

Under Alternative 1, cultural resource management would be limited to those investigations required for compliance with Section 106 of the NHPA, ARPA-permitted investigations, and ARPA-related investigations of illicit looting and collecting. Data relating to the refuge's hydrological regime, geomorphology, changing vegetation patterns, and past cultural land-use patterns would be garnered only through reviews of existing technical literature and not through focused scientific investigations. Other efforts, such as erosion control of the Joseph Reed Mound, and the interpretive and educational opportunities would be virtually non-existent due to the lack of personnel, facilities, and funds.

Alternative 2 would represent a balanced management approach to the refuge's natural and cultural resources. To accomplish the goals of this alternative, scientific investigations such as plant and animal inventories, geographic information system analysis and mapping, archaeological investigations, and geomorphic studies would be necessary tools. The databases generated from these investigations would enhance the refuge's ability to monitor and protect cultural resources under its jurisdiction. Under Alternative 2, a refuge-wide comprehensive archaeological survey would be conducted. This survey would generate a site predictive model. The resulting technical report would provide specific recommendations for future research and site protection measures.

One of the focal points of the environmental education program would be to provide increased public awareness of the region's past cultural histories, the fragility of archaeological sites, and the nature of human-habitat interactions. Ties with the current-day Miccosukee and Seminole nations are further encouraged in Alternatives 2 and 4, particularly for input into the management of sites important to these groups, as well as an opportunity to educate others about their history and use of resources present within the refuge. Partnerships with universities and other pertinent entities to conduct archaeological research would be actively pursued and fostered.

Alternative 3 would place a limit on public use and instead focus on an intensive biological management approach. Decisions would be made utilizing sound biological and wildlife principles, as well as past and ongoing investigations. This alternative would provide an opportunity to conduct archaeological investigations that incorporate a range of other disciplines. The objective would be to provide information regarding the refuge's habitats and changes due to human-habitat interactions. However, like Alternatives 1 and 4, no comprehensive archaeological survey of the refuge would be conducted. Archaeological investigations would be limited to those necessary for compliance with Section 106 of the NHPA. Such an approach curtails the refuge's effectiveness for managing the cultural resources under its jurisdiction and passes on an excellent

opportunity to understand the long-term dynamics of the refuge's habitats. Protection of archaeological sites might improve due to active investigations, as well as closure of large areas to the public.

Alternative 4 could be the most destructive to cultural resources due to the construction of public use-associated facilities such as boardwalks, observation towers, photo blinds, and restrooms. Although, increased visitation could lead to opportunities for education about past cultures and habitats, it might also lead to an increased site loss due to illicit looting and unpermitted collecting.

Effects on Recreation and Environmental Education and Interpretation

Fishing

Under Alternative 1, there would be no effect on fishing access. Under Alternatives 2 and 4, fire breaks along the Mainland Tract would be upgraded to offer fishing, canoeing, and kayaking access points to the Indian River Lagoon, if the Florida Department of Transportation would grant right-of-way privileges along U.S. Highway 1. The increased use associated with upgrading these trails would also remedy the constant maintenance associated with reopening the fire breaks.

Under Alternative 3, no new trails would be provided for access to the Indian River Lagoon. Restoration of the mosquito control impoundments on the barrier island would provide a greater number of fish species, but access would remain difficult.

Wildlife Observation and Photography

Under Alternative 1, opportunities for wildlife observation and photography would remain constant.

Under Alternatives 2 and 4, the extension of existing and creation of new wildlife trails would provide greater opportunities for the public to passively enjoy wildlife on the refuge. An observation tower would be constructed on the new mangrove/beach trail which would allow visitors to view three natural communities, namely, mangrove wetlands, coastal strand, and the Indian River Lagoon. A fixed mounted telescope would be provided for wildlife viewing from the tower. An extension of the scrub trail would be constructed under Alternatives 2 and 4 as an overlook that would provide additional viewing opportunities of the Indian River Lagoon. Existing recreational uses of the refuge would continue under Alternative 3, except that pets would no longer be permitted. No resources would be allocated for expanding additional recreational opportunities.

Under Alternative 4, photo blinds and additional interpretive kiosks would be provided along the scrub and mangrove trails. Providing covered shelters and overlooks along the beach and Indian River Lagoon would positively affect visitor use under Alternative 4. However, the increased refuse and feeding of wildlife associated with picnicking would ultimately impact wildlife populations including gulls, terns, land crabs, sea turtles, raccoons, armadillos, and fish crows.

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Swimming, surfing, shelling, sun bathing, walking, photography, and painting would continue to be permitted activities on the barrier island under all alternatives. Hiking, fishing, photography, painting, and wildlife observation would continue to be permitted activities on the Mainland Tract under all alternatives, unless temporary beach closure is necessary to protect nesting shorebirds under Alternatives 2 and 3.

Environmental Education and Interpretation

Under Alternative 1, no changes would occur to the existing environmental education curriculum. The Hobe Sound Nature Center would continue to provide all education and interpretive services. The refuge and the Nature Center would pursue funding for a new Nature Center building.

Under Alternatives 2 and 4, the refuge would assume a larger role in environmental education and interpretation responsibilities. A refuge ranger and volunteers would work with the Nature Center

and its staff to expand programs and to provide more information to visitors.

Ranger guided tours would be conducted on the beach and scrub trails. Current facilities would be refurbished and informational kiosks would be updated. Positive direct, indirect, and cumulative impacts would be expected from an expanded program.

Under Alternative 4, in-service training for teachers would be provided at the refuge. An interactive web site would be created and updated by refuge staff. A satellite downlink for distance learning would be initiated for area schools. The impact would be positive for educational programs in the area, as well as for those programs via the Internet.

Under Alternative 3, no additional resources would be directed toward environmental education and interpretation. The Nature Center would continue to take all responsibility for this activity and limited space would be available for expansion.

Effects on Socioeconomic Environment

Ecotourism

An economic impact analysis of the effects of ecotourism on communities surrounding national wildlife refuges highlights the substantial



*ATV tracks on sand
USFWS Photo*

benefits visitors bring to the local economy (Laughland and Caudhill 1997). Ecotourism effects, which included lodging, meals, gasoline, and ancillary purchases, were in the millions of dollars.

Alternative 4, with a significantly expanded public use program, would benefit the local economy the most. No change of current conditions would occur under Alternative 1. Alternative 2 would provide more positive impacts than Alternative 3 due to the increased public use program.

Research shows that "a wildlife refuge in an increasingly urbanized and congested region can generate community benefits for regional inhabitants. This community amenity can be reflected in higher land values, particularly for properties nearby." (Kerlinger 1995).

Tax Revenue

The refuge currently contains over 1,000 acres. Federal lands are not subject to state or local taxes or assessments. However, under the Refuge Revenue Sharing Act, the Service makes annual payments to Martin County to offset the loss of property tax revenues. In June 2001, a Revenue Sharing check in the amount of \$41,338 was presented to the Martin County Commission on behalf of the refuge. Refuge Revenue Sharing Act payments for owned and acquired lands are based upon the greatest of the following three formulas: (1) 3/4 of 1 percent of the fair market value of the lands acquired in fee title; (2) 25 percent of the net refuge receipts collected, or (3) 75 cents per acre of the lands acquired in fee title. The Refuge Revenue Sharing Act also requires that Service lands be appraised every 5 years to ensure that payments to local governments remain equitable. Funding for Refuge Revenue Sharing Act payments are derived from all revenues received from refuge products, such as timber fees, grazing fees, permit fees, oil and gas royalties, and leases. If these funds are not sufficient to make full payments to the counties, Congress is authorized under the Act to appropriate funds to make up the shortfall. In the past, Congress has not fully appropriated funds to enable full payments to be made, and the counties have received a pro-rata reduction in their Refuge Revenue Sharing Act disbursement.

In addition to the Revenue Sharing Act proceeds, approximately \$20,000 in state sales tax revenue is currently generated from local businesses patronized by refuge visitors (1996). Alternatives 2 and 4 should produce a moderate increase in sales tax impacts. In a relative sense, the local impact could be significant. It is important to note that increased refuge visitation would likely come from local residents, and local residents do not contribute as much to the local economy on a per visit basis. Alternative 3 would have a minor negative impact on local sales tax.

Unavoidable Impacts

Under Alternative 1, continual natural aging of the sand pine scrub community and loss of habitat for associated species would result in incremental adverse impacts, including the potential for wildfire.

Exotic plants would continue to severely reduce the biological function of all native communities under Alternative 1.

The refuge, without the Indian River Lagoon within its boundaries, would not directly have the ability to establish vessel speeds and control wakes to protect adjacent mangrove communities, seagrass beds, or manatee populations. Lack of funding support from Congress to implement the preferred alternative will result in indirect and cumulative negative effects on all wildlife species dependent upon the refuge for adequate habitat and food supply. If worst case sea level rise scenarios come about, impacts to the refuge boundaries and its resources are expected to be significant and unavoidable.

Effects Common to Alternatives

Health and Safety Effects

Wildfires could have a significant negative impact on human health and safety. There is a chance of increased health effects associated with smoke from prescribed fire under Alternatives 2 and 3. Management of the sand pine scrub habitat would decrease the chance of catastrophic wildfire and thereby have a significant positive impact on the safety of adjacent human communities.

Regulatory Effects

As indicated in Section 1 of the Draft Comprehensive Conservation Plan, the Service must comply with a number of federal laws, executive and administrative orders, and policies in the development and implementation of management actions and programs. The alternatives would not lead to a violation of these laws and orders.

Effects on Surrounding Lands

Under Alternatives 1 and 4, a less aggressive approach would be implemented to control exotic plants. These populations would continue to serve as a seed and dispersal source for adjacent private landowners and public natural areas such as Jonathan Dickinson State Park and St. Lucie Inlet Preserve State Park.

Without managing the over mature sand pine scrub habitat on the refuge, a wildfire would likely occur and threaten adjacent forested lands. Under Alternatives 2 and 3, mosquito impoundments would be restored to functional wetlands, providing biological control over biting insects and reducing the need for aerial pesticide application on neighboring lands.

The disjointed nature of the existing boundary hinders control of invasive exotic species, prescribed burning, and control of predators while fostering encroachment and fugitive dumping. Thus, the refuge must acquire lands on a willing-seller basis immediately

adjacent to its existing boundary to consolidate its boundary and enhance management actions on existing refuge lands.

Uncertainty of and Future Action Effects

Real estate prices continue to soar in Martin County. Lands that presently buffer the refuge, identified for acquisition into the refuge system, may ultimately succumb to developmental pressures without an aggressive private lands partnership and land acquisition priority.

Cumulative Effects

Cumulative effects on the environment result from incremental effects of a proposed action when these are added to other past, present, and reasonably foreseeable future actions. While cumulative effects may result from individually minor actions, they may be viewed, as a whole, to be significant over time.

The implementation of the alternatives includes actions relating to facility development, wildlife habitat and population management, resource protection, public use, and administrative programs. These actions would have both direct and indirect effects (e.g., facility development results in increased public use, which increases littering, noise, and vehicular traffic); however, the cumulative negative effects of these actions over the 15-year planning period would not be significant and are far outweighed by the anticipated positive impacts.

Mitigation Measures

Described below are the measures used to mitigate and minimize potential adverse effects resulting from the implementation of the preferred alternative.

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. All preferred alternative public use activities contained in this document have been carefully planned to avoid unacceptable levels of impact.

As currently proposed, the known and anticipated level of disturbance of the preferred alternative is not considered significant but can be managed to reduce impacts to known wildlife species and populations present in the area. Providing access for fishing opportunities allows the use of a renewable natural resource without adversely impacting other resources.

General wildlife observation (e.g., photographing, painting, walking, and accessing canoes/kayaks) activities may result in minimal disturbance to wildlife. If impacts from the expected additional visitor uses are determined to be above the acceptable threshold for wildlife, those uses would be discontinued or rerouted to other, less sensitive areas.

The expanded environmental education and interpretation program would slightly affect wildlife populations as a result of direct interaction and observation. The benefits to the ecosystem resulting from a more educated public would far outweigh any negative effect, in the form of disturbance to individual organisms.

Initial disturbance to wildlife and habitat would occur during the construction of new facilities such as the education center/office, beach restroom, boardwalk trails, law enforcement boat ramp, and observation platform. Short-term negative effects to air quality, noise, and soils within the project site would be expected and measures to protect the environment would be taken. Allowing these recreational opportunities would help to maintain and build public support for the refuge.

Monitoring activities through wildlife inventories and assessments of public use levels and activities would be conducted, with minor adverse impacts to resources expected. These public use activities would be adjusted, as needed, to limit disturbance to acceptable levels. No dogs (or other pets) would be allowed off leash on the refuge because of their potential to cause disturbance to wildlife. Excluding pets from the refuge is a likely possibility in the future if violations of the leash law continue to occur.

Water Quality Disturbance

Implementation of best management practices to avoid erosion of soils into water bodies would be implemented.

User Group Conflicts

As public use levels increase, unanticipated conflicts between user groups could occur. Programs would be adjusted, as needed, to eliminate or minimize each problem and provide high quality, appropriate, and compatible wildlife-dependent recreational opportunities. Experience has proven that time and space zoning (e.g., establishment of separate use areas, use periods, and limits on the numbers of users) is an effective tool in eliminating conflicts between user groups.

Under the preferred alternative, wildlife observation, photography, walking, shelling, sunbathing, surfing, and swimming would occur on the refuge beach or in adjacent state controlled waters. Despite the 3.5 miles of beach, conflict between the beach users occurs already on certain days when fishing is exceptional, surf is high, and solar radiation is ideal. A beach zoning option may be proposed to address conflicts in the future.

With roughly 9 miles of shoreline on the mainland along the Indian River Lagoon, conflicts between users (e.g., those participating in fishing, snorkeling, and diving; environmental education for school groups, scout groups, and summer camp students participating in aquatic programs) are not anticipated.

Effects on Adjacent Landowners

Implementation of the preferred alternative is not expected to negatively affect adjacent landowners. The positive impacts would include higher property values, reduced risk of wildfire, less intrusion of invasive exotic plants, increased opportunities for viewing wildlife, and a more aesthetically pleasing view.

Some impacts that may occur are a higher frequency of trespass onto adjacent private lands by refuge visitors, temporary smoke from prescribed fires, and noise associated with traffic. The refuge would take every measure to prevent these impacts by clearly marking refuge boundaries, carefully preparing and conducting prescribed fires, and maintaining existing parking facilities at the beach access area.

Land Ownership and Site Development

Proposed land acquisition efforts by the Service would result in changes in land and recreational use patterns, since all uses on national wildlife refuges must meet compatibility standards. Most of the lands identified in the proposed acquisition boundary is currently undeveloped. The lands selected for acquisition would be maintained in a natural state; managed for native wildlife populations; and opened to wildlife compatible public use, if feasible. This leads to a concern related to strategic growth. Significant land acquisition should be considered within the context of sea-level rise. Land prices in this area are significant and will continue to rise. From the standpoint of strategic growth, this highlights the need to consider the threat posed by sea-level rise to the long-term sustainability of the refuge and its purposes.

Potential development of the buildings, trails, and other improvements could lead to minor short-term negative impacts on plants, soil, and some wildlife species. Efforts would be made to use recycled products and environmentally sensitive treated lumber when building the boardwalks and observation towers. The environmental education/office building would be re-constructed in such a way as to be aesthetically pleasing to the community and to avoid any additional impact to native plant communities. All operations would comply with the requirements of Section 404 of the Clean Water Act, National Historic Preservation Act, and other applicable regulations.

Short-Term Uses Versus Long-Term Productivity

The proposed habitat protection and management program is dedicated to maintaining the long-term productivity of refuge habitats. Benefits to long-term productivity far outweigh any short-term uses. The key is finding that threshold where public uses do not degrade or interfere with refuge resources. Short-term losses of visual aesthetics and visitor use after a prescribed burn do not compare to the long-term benefits of prescribed fire for many trust species, and for the reduced probability of catastrophic wildfire. Restricted speeds in the Intracoastal Waterway would limit recreational activity in a discreet location balanced against the area's long-term ability to sustain viable populations of manatees, seagrass beds,

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and mangroves. The construction of a wildlife trail and observation tower on the barrier island would have short-term negative impacts on the mangrove and coastal strand communities, but the educational value and associated public support gained from the visitors' experience would have long-term benefits for the entire ecosystem.