FINAL
ENVIRONMENTAL ASSESSMENT FOR THE BEDDOWN AND FLIGHT OPERATIONS OF UNMANNED AIRCRAFT SYSTEMS AT CAPE CANAVERAL AIR FORCE STATION, FLORIDA

U.S. Department of Homeland Security

U.S. Customs and Border Protection

Office of Air and Marine

Washington, D.C.

In cooperation with

U.S. Air Force

Cape Canaveral Air Force Station

JULY 2011

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **JUL 2011**	2. REPORT TYPE	3. DATES COVERED **00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE **Environmental Assessment for the Beddown and Flight Operations of Unmanned Aircraft Systems at Cape Canaveral Air Force Station, Florida**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Science Applications International Corporation,1710 SAIC Drive,McLean,VA,22102**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**515**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

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FINAL

FINDING OF NO SIGNIFICANT IMPACT for the Beddown and Flight Operations of Unmanned Aircraft Systems (UAS) at Cape Canaveral Air Force Station, Florida U.S. Customs and Border Protection Air and Marine

The mission of CBP Air and Marine (CBP A&M), the world's largest law enforcement air force, is to protect the American people and Nation's critical infrastructure through the coordinated use of integrated air and marine forces to detect, interdict and prevent acts of terrorism and the unlawful movement of people, illegal drugs and other contraband toward or across the borders of the United States.

This specialized law enforcement capability allows CBP A&M to make significant contributions to the homeland security efforts of DHS, as well as to those of Federal, State, local, and tribal agencies. To accomplish this mission, CBP A&M utilizes over 700 pilots and 267 aircraft including the use of unmanned aircraft systems (UASs), over 130 mariners and over 200 vessels.

An Environmental Assessment (EA) was prepared in compliance with provisions of the National Environmental Policy Act (NEPA) of 1969 as amended (42 U.S.C. 4332, et seq.), the Council on Environmental Quality's (CEQ) NEPA implementing regulations at 40 Code of Federal Regulation (CFR) Part 1500 et seq., and DHS's Environmental Planning Management Directive 5100.1.

The EA was prepared to present and evaluate the Proposed Action and alternatives, including the No Action Alternative. Resources addressed in the EA include land use, geology and soil, hydrology and groundwater, surface waters, floodplains, vegetative habitat, wildlife and aquatic habitat, threatened and endangered species, cultural, historical, archeological resources, air quality, climate, noise, utilities, roadways, aesthetic and visual resources, hazardous materials, socioeconomics, environmental justice, sustainability and greening and human health and safety. The EA was made available during public comment period beginning 24 June 2010. Because the CBP A&M Proposed Action would occur on a United States Air Force (USAF) installation, the USAF and CBP A&M have been working in concert to prepare this EA. This EA is attached to the FONSI and incorporated by reference.

Also used in the preparation of the EA was the *Environmental Assessment* [EA] *for the Skid Strip Area Development Plan* [ADP] *at Cape Canaveral Air Force Station* [CCAFS], Florida. This EA presents the environmental analysis for an Area Development Plan which included the construction of hangars and flight line improvements in the same location as this project. This EA is also incorporated by reference.

PROJECT LOCATION: The proposed location for this Project is Cape Canaveral Air Force Station (CCAFS) in Florida. CCAFS is located in Brevard County near the Kennedy Space Center on Florida's Atlantic coastline. The Station is located on a barrier island bordered by the Atlantic Ocean to the east and the Banana River to the west.

PURPOSE AND NEED: The purpose of this action is to establish a U.S. CBP A&M Southeastern Region Operations Center that has the capability to support UAS operations in the vicinity of CCAFS. CBP A&M has identified the need to establish a maritime UAS operating presence along the southeast coastal region.

The need for this project would support CBP's mission, which entails the protection of the nation's borders against the illegal entry of terrorists and terrorist weapons and the enforcement of laws that protect the U.S. homeland. This is done through the detection, interdiction, and apprehension of those who attempt to illegally enter or smuggle any person or contraband across the sovereign borders of the United States. The implementation of this mission is a crucial component of DHS's layered approach to border security. The use of UASs in support of these mission requirements serves as a "force-multiplier" for this agency.

ALTERNATIVES: Four alternatives were considered: The No Action Alternative, the Proposed Action - Alternative 2: Construct New Hangar, Alternative 3: Renovate Hangar F, and Alternative 4: Renovate Hangar C. These alternatives are described below.

No Action Alternative. Under the No Action Alternative, United States (U.S.) Customs and Border Protection (CBP) personnel and CBP assets would leave Cape Canaveral Air Force Station (CCAFS) upon completion of the Operational Testing and Evaluation (OT&E). While the No Action Alternative does not satisfy the stated purpose and need, its inclusion in this EA is required by NEPA regulations (40 CFR 1502.14[c]).

Proposed Action Alternative 2: Construct New Hangar. The Proposed Action includes the beddown of the equipment, personnel, and infrastructure at CCAFS necessary to support CBP's mission. The Proposed Action would also include flight operations for the Guardian. Proposed facility projects include construction of a new hangar and associated parking facilities, placement of a ground data terminal, and infrastructure improvements. Flight operations would consist of a certificate of authorization from the Federal Aviation Administration and the use of special use airspace in the vicinity of CCAFS.

Alternative 3: Renovate Hangar F. Currently, CBP is utilizing Hangar F for the OT&E at CCAFS. Under a memorandum of agreement, the U.S. Air Force (USAF) has allowed CBP to utilize administrative space and hangar facilities in the southern half of the Hangar. The current space is adequate for the OT&E operations, but CBP would require additional administrative space for a permanent mission. This alternative would include renovations to the unoccupied portions of Hangar F to accommodate the incoming CBP personnel described under Alternative 2. UAS flight operations would remain as described in Alternative 2.

Alternative 4: Renovate Hangar C. Hangar C is a structure that was utilized during the manned space flight program and is listed as a National Historic Landmark (NHL) on the National Register of Historic Places (NRHP). The current facility would be available for use by CBP. This site would require extensive lead-based paint and asbestos-containing materials (ACMs) abatement prior to any renovation activities. No tow way or taxiway exists that would provide the Guardian aircraft access to the airfield. With sufficient improvements and use of waivers, an existing vehicular road could be utilized as a tow way. UAS flight operations and support personnel numbers would remain as described in Alternative 2.

ENVIRONMENTAL CONSEQUENCES: Implementation of the Proposed Action would disturb approximately five acres of live oak/saw palmetto habitat for the construction of a hangar, administrative facilities, parking apron and taxiway, and vehicle parking. No impacts to oak/saw palmetto habitat would occur with the implementation of Alternative 3. The implementation of Alternative 4 would impact approximately 3.5 acres of maritime hammock along the existing road between Hangar C and the landfill.

Implementation of the Proposed Action or alternatives would have no direct impact on: surface waters and waters of the United States; floodplains; aesthetic and visual resources; cultural, historical or archeological resources; transportation; minority populations; noise; airspace management; or hydrology and groundwater.

Implementation of the Proposed Action and alternatives is anticipated to have minor impacts to: land usage, geology and soils, vegetative habitat, wildlife resources, threatened and endangered species, air quality, hazardous materials, energy consumption, and human health and safety.

No significant adverse effects to the natural or human environment, as defined in 40 CFR Section 1508.27 of the CEQ's Regulations for Implementing NEPA, are expected upon implementation of the Proposed Action or alternatives.

MITIGATION: Mitigation measures are identified for each resource category that could be potentially affected. Many of these measures have been incorporated as standard operating procedures by CBP in similar past projects. It is CBP policy to mitigate adverse impacts through a sequence of avoidance, minimization, and compensation. These mitigation measures detailed below will be incorporated into a Project Management Plan. If any potentially adverse effects of this project are identified, the following measures will be employed:

General Construction Activities: Best Management Practices (BMPs) will be implemented as standard operating procedures during all construction activities, and would include proper handling, storage, and/or disposal of solid and hazardous and/or regulated materials. To minimize potential impacts from solid and hazardous and regulated materials, all fuels, waste oils and solvents would be collected and stored in tanks or drums within a secondary containment system that consists of an impervious floor and bermed sidewalls capable of containing the volume of the largest container stored therein. The refueling of machinery will be completed in accordance with accepted industry and regulatory guidelines, and all vehicles will have drip pans during storage to contain minor spills and drips. Although it would be unlikely for a major spill to occur, any spill of reportable quantities will be contained immediately within an earthen dike, and the application of an absorbent (e.g., granular, pillow, sock, etc.) will be used to absorb and contain the spill. A Spill Prevention Control and Countermeasures Plan (SPCCP) will be in place prior to the start of construction activities and all personnel will be briefed on the implementation and responsibilities of this plan as is typical in CBP projects. All spills will be reported to the designated CBP point of contact for the project. Furthermore, a spill of any petroleum liquids (e.g., fuel) or material listed in 40 CFR 302 Table 302.4 of a reportable quantity must be cleaned up and reported to the appropriate Federal and state agencies. Reportable quantities of those substances listed on 40 CFR 302 Table 302.4 will be included as part of the SPCC.

All waste oil and solvents will be recycled. All non-recyclable hazardous and regulated wastes will be collected, characterized, labeled, stored, transported, and disposed of in accordance with all Federal, state, and local regulations, including proper waste manifesting procedures.

Solid waste receptacles will be maintained at construction staging areas. Non-hazardous solid waste (trash and waste construction materials) will be collected and deposited in onsite receptacles. Solid waste will be collected and disposed of by a local waste disposal contractor.

Threatened and Endangered Species:

Florida Scrub-Jay. Mitigation for direct and indirect impacts to the Scrub-jay would compensate for impacts caused by the Proposed Action. Provided the following mitigation measures are implemented, the Proposed Action would not significantly impact the

Scrub-jay population at CCAFS. Reasonable and prudent measures and the Terms and Conditions of the BO prepared as part of the Skid Strip EA are included in Appendix D of the Final EA.

The USAF proposes to restore unoccupied Scrub-jay habitat at a ratio of 3:1 (every acre lost would require compensation in the amount of three acres). For each phase of clearing around the Skid Strip, there would be a corresponding project to restore habitat. A combination of mechanical treatment and prescribed burning would be used to restore habitat. In addition to the creation of habitat, CCAFS would avoid construction in Scrub-jay occupied areas during the nesting season from March 1 through June 30; ensure that prior to clearing of Scrub-jay habitat there is suitable habitat within 1,200 feet; that the USFWS would be notified of any unauthorized taking of Scrub-jays identified during construction; and that CCAFS would conduct routine Scrub-jay monitoring and submit reports describing the actions taken to implement the terms and conditions of the "Incidental Take Statement." The mitigation for the portion of the Skid Strip proposed for use in the construction of a new hangar has been completed.

If a dead Scrub-jay is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville

Southeastern Beach Mouse. The following mitigation measures were included in the Skid Strip ADP EA and would be utilized as part of this action. Mitigation for direct and indirect impacts to the southeastern beach mouse would offset impacts caused by the Proposed Action. Provided the following mitigation measures are implemented, the Proposed Action would not significantly impact the southeastern beach mouse population at CCAFS.

The proposed restoration of habitat for the Scrub-jay is expected to be beneficial to southeastern beach mice. Based on a three-year study recently completed for CCAFS, beach mice are benefiting from the same land management activities being conducted for Scrub-jays, and the population is expanding into inland locations. Therefore, the potential exists to create an additional 1,000+ acres of habitat for beach mice. Mitigation has been completed for the portion of the Skid Strip ADP proposed for the construction of a new hangar. Based on observations by USAF biologists of small mammal burrows around the current Skid Strip clear zone, the expansion of that zone has the potential to provide additional habitat. If a dead beach mouse is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville.

Eastern Indigo Snake. Incidental take in the form of mortality to eastern indigo snakes would be avoided through preconstruction surveys and relocation of any individuals present within the boundaries of the work area. As part of the effort to minimize impacts to the gopher tortoise, prior to any land disturbance activities, a survey would be required to identify locations of gopher tortoise burrows within the project areas. This survey would include a burrow count and habitat characterization and would be conducted in accordance with Florida FWCC guidelines. Attempts would be made to relocate eastern indigo snakes encountered during gopher tortoise burrow excavation to land outside the project area. In accordance with Section 7 of the ESA, the USFWS prepared a BO in May of 2008 for the action described in the Skid Strip EA, which includes this Action. The USFWS has issued an "Incidental Take Statement" take that would cover this Action.

Indirect impacts were also evaluated under the Skid Strip EA. Potential negative indirect impacts included the chance of increased mortality due to an increase in the operations of the Skid Strip. The increase in operations would increase vehicular traffic along roadways adjacent to occupied habitat, possibly resulting in eastern indigo snakes being struck by vehicles. In addition, the loss of habitat due to construction activities is likely to increase movement of the snakes and increase the risk of being struck by a vehicle.

The following mitigation measures were included in the Skid Strip ADP EA. Mitigation for direct and indirect impacts to the eastern indigo snake would offset impacts caused by the Proposed Action. This mitigation has already been completed for the portion of the Skid Strip ADP proposed for the construction of a new hangar. Therefore, the Proposed Action would not significantly impact the eastern indigo snake population at CCAFS provided the reasonable and prudent measures are implemented. Reasonable and prudent measures and the Terms and Conditions of the BO are included in Appendix D of the Final EA. Generally, those mitigation measures include the following.

The 45th SW Indigo Snake Protection/Education Plan would be presented to the project manager, construction manager, and personnel. An educational sign would be displayed at the site informing personnel of the snake's appearance, its protected status, and who to contact if any are spotted in the area. If any indigo snakes are encountered during clearing activities, they would be allowed to safely leave the area on their own. Furthermore, indigo snakes encountered during gopher tortoise burrow excavation, if required, would be safely moved out of the project area. An eastern indigo snake monitoring report would be submitted in the event that any indigo snakes are observed. If a dead indigo is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville. Only individuals with permits should attempt to capture or handle the eastern indigo snakes. If an indigo snake is held in captivity, it should be released as soon as possible in release sites approved by the USFWS on the CCAFS.

Gopher Tortoise. Direct impacts could potentially occur to the gopher tortoise as a result of clearing and grading activities associated with the construction of the facilities listed in the Proposed Action. As stated in the Skid Strip ADP EA, significant impacts to gopher tortoises are not expected provided that minimization measures are implemented. Pre-construction surveys would be conducted to find tortoises that are within the project area. These tortoise surveys are conducted in accordance with FWCC guidelines and include a burrow count and habitat characterization. Tortoises found during pre-construction surveys would be relocated to nearby viable habitat within CCAFS areas. A monitoring report is submitted if any gopher tortoises are relocated. If a dead gopher tortoise is found at the project site, it would be salvaged in accordance with proper protocols and the FWCC is notified.

Marine Turtles. CCAFS has developed a 45th SW Instruction (45th SW Instruction 32-7001, Exterior Lighting Management) to minimize potential impacts of lighting on sea turtle movements. All facilities at CCAFS are required to comply with this instruction. In order to comply with these instructions, CBP will prepare and submit a light management plan for operations at CCAFS through the USAF for approval by the USFWS. Significant impacts to sea turtles are not anticipated as a result of implementing the Proposed Action or alternatives as long as an approved lighting management plan is followed.

Surface Waters and Waters of the U.S.: No direct impacts are anticipated to surface waters and waters of the U.S. BMPs would be utilized to minimize impacts from construction sites. All federal, state, local and USAF regulations would be complied with during implementation of the Proposed Action or alternatives including the utilization of a SWPPP. This would include the preparation of an environmental resource permit required by the St. Johns River Water Management District.

Soils: Vehicular traffic associated with construction activities and operational support activities will remain on established roads to the maximum extent practicable. Areas with highly erodible soils will be given special consideration when constructing the proposed project towers and access roads to ensure incorporation of various erosion control techniques such as, straw bales, silt fencing, aggregate materials, wetting compounds, and rehabilitation, where possible, to decrease erosion. Site rehabilitation will include revegetating or the distribution of organic and geological materials (i.e., boulders and rocks) over the disturbed area to reduce erosion while allowing the area to naturally vegetate. Additionally, erosion control measures and appropriate BMPs, as required and promulgated through the Stormwater Pollution Prevention Plan (SWPPP) and engineering designs, will be implemented before, during, and after construction activities.

Road maintenance shall avoid, to the greatest extent practicable, creating wind rows with soils once grading activities are completed. Any excess soils from construction activities will be used on-site to raise and shape road surfaces.

Vegetation Resources: Vegetation that is temporarily disturbed due to construction activities would be reseeded upon completion of construction activities. The permanent loss of vegetation would be minimized by the restoration of similar habitat in Scrub-jay mitigation areas on the installation.

Cultural Resources: Under the Proposed Action, no impacts are anticipated to cultural, historical, and archeological resources. In the unlikely event that previously unrecorded or unevaluated cultural resources are encountered during construction, CCAFS would manage these resources in accordance with the CCAFS Integrated Cultural Resources Management Plan (ICRMP) (45 SW 2004), adhering to federal and state laws, as well as USAF regulations. SHPO has concurred that this project will have no adverse impacts.

Hangar F, built in 1956, is the only building that would be directly affected by Alternative 3. Hangar F has not been evaluated for NRHP eligibility. Renovations to this building would be internal only. The Florida SHPO was provided a copy of the Draft EA and have concurred that no adverse effects are anticipated as long as the proposed alteration are submitted to SHPO for review and that any work complies with the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings.

Hangar C, built in 1956, is the only building that would be directly affected by Alternative 4. Hangar C was utilized during the manned space flight program and is eligible for the NRHP. The Florida SHPO was provided a copy of the Draft EA and has concurred that no adverse effects are anticipated as long as the proposed alteration are submitted to SHPO for review and that any work complies with the Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings.

Air Quality: Mitigation measures will be incorporated to ensure that fugitive dust emission levels do not rise above the minimum threshold as required per 40 CFR 51.853(b)(1). Measures will include dust suppression methods such as access road watering to minimize airborne particulate matter that would be created during construction activities. Standard construction BMPs such as routine watering of the construction site as well as access roads to the site will be used to control fugitive dust during the construction phase of the proposed project. Potential increases to criteria pollutants are monitored at GFAFB under their Title V Permit. The Title V permit will be updated in 2011 to reflect the addition of backup generators associated with the Guardian beddown. Should levels of these pollutants approach the NAAQS limits for the region effects to air quality would be reevaluated.

Noise: Construction noise would be minimized by planning construction to occur during daylight hours and ensuring that construction vehicles have properly functioning mufflers and that the vehicles are in good working order.

Hazardous Materials: Disposal of potentially hazardous materials would be handled through CCAFS Waste Management. All such materials would be handled in accordance with applicable Federal, state and local regulations.

If contaminated groundwater is encountered during the hangar construction, it will be managed in accordance with applicable laws and regulations. CCAFS implements BMPs to minimize the potential for contaminants to reach nearby surface waters, and a Storm Water Pollution Prevention Plan (SWPPP) that includes water quality monitoring.

BMPs and appropriate measures would be strictly adhered too during construction to minimize erosion and control sedimentation. CBP is responsible for managing these materials in accordance with federal, state, and local regulations to protect their employees from occupational exposure to hazardous materials and to protect the public health of the surrounding community. The operating location would be responsible for the safe storage and handling of hazardous materials used in conjunction with all construction and demolition operations. These materials would be delivered to CCAFS in compliance with the Hazardous Materials Transportation Act under 49 CFR.

FINDING: Based upon the analysis in the attached environmental assessment, I conclude the Proposed Action or alternatives if implemented with the stated required mitigation measures will not result in any significant effects to the environment. Therefore, no further environmental impact analysis is required.

08/04/11	
David Chadwick Director, Facilities Management OAM Facilities	Date
	8/31/11
Robert Janson Acting Executive Director Facilities Management & Engineering	Date
Jeffrey C Allen	20 Jun 12
Jeffrey C. Allen SES, DAF Director of Logistics, Installations and Mission Support	Date

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EXECUTIVE SUMMARY

INTRODUCTION

The United States (U.S.) Customs and Border Protection (CBP) Air and Marine (A&M), a component within the Department of Homeland Security (DHS), has the responsibility of protecting the nation's borders against the illegal entry of terrorists and terrorist weapons and to enforce the laws that protect the U.S. homeland. In order to accomplish this mission, CBP A&M requires a location for operations in the Caribbean/southeast coastal regions of the United States. The CBP A&M proposes establishing a permanent Unmanned Aircraft System (UAS) capability at Cape Canaveral Air Force Station (CCAFS), Florida.

CBP A&M is currently conducting Operational Testing and Evaluation (OT&E) for the Predator B (Guardian) at CCAFS. CCAFS was selected for OT&E because the installation infrastructure meets or exceeds the minimum support requirements for flight operations, provides increased physical security, and provides synergy with existing CBP operations in the southeast coastal region of the United States. These same reasons support the selection of CCAFS as a permanent CBP facility.

This Environmental Assessment (EA) evaluates the potential environmental consequences associated with each proposed alternative for UAS flight operations and the infrastructure modification requirements necessary for the incoming CBP mission.

PURPOSE AND NEED

The purpose of this action is to establish a U.S. CBP A&M Southeastern Region Operations Center that has the capability to support UAS operations in the vicinity of CCAFS. CBP A&M has identified the need to establish a maritime UAS operating presence along the southeast coastal region. The need for this project would support CBP's mission. The implementation of this mission is a crucial component of DHS's layered approach to border security. The use of UASs in support of these mission requirements serves as a "force-multiplier" for this agency.

DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

Alternative 1: No Action Alternative

Under the No Action Alternative, U.S. CBP personnel and CBP assets would leave CCAFS upon completion of the OT&E. However, implementation of the No Action Alternative would impact the successful implementation of the Caribbean/southeast coast CBP mission and impair protection of U.S. national security interests.

Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

The Proposed Action would include the beddown of the equipment, personnel, and infrastructure at CCAFS necessary to support CBP's mission. Approximately 65 CBP personnel and contractors would be employed at CCAFS as a result of the Proposed Action along with two Guardian aircraft and the systems to support their operation. The Proposed Action would also include flight operations of the Guardian aircraft. Construction requirements for the new mission would include a new hangar and associated parking facilities; placement of a ground data terminal (GDT) antenna; and infrastructure improvements.

Alternative 3: Renovate Hangar F

Currently, CBP is utilizing Hangar F for the OT&E at CCAFS. Under a memorandum of agreement, the U.S. Air Force (USAF) has allowed CBP to utilize administrative space and hangar facilities in the southern half of the Hangar. The current space is adequate for the OT&E operations, but CBP would require additional administrative space for a permanent mission. This alternative would include renovations to the unoccupied portions of Hangar F to accommodate the incoming CBP personnel described under Alternative 2. UAS flight operations would remain as described in Alternative 2.

Alternative 4: Renovate Hangar C

Hangar C is a structure that was utilized during the manned space flight program and is eligible for listing on the National Register of Historic Places (NRHP). The current facility would be available for use by CBP. This site would require extensive lead-based paint and asbestos-containing materials (ACMs) abatement prior to any renovation activities. No tow way or taxiway exists that would provide the Guardian aircraft access to the airfield. With sufficient improvements and use of waivers, an existing vehicular road could be utilized as a tow way. UAS flight operations and support personnel numbers would remain as described in Alternative 2.

Alternatives Considered but Eliminated from Further Consideration

The Proposed Action is to beddown Guardian aircraft assets at CCAFS. Prior to the establishment of the OT&E operations at CCAFS, CBP evaluated five other locations. CCAFS best met the selection criteria for the OT&E operations, including its close proximity to CBP's operational area in the Caribbean/southeast coastal region of the United States, existing runway and hangar facilities, and the availability of Special Use Airspace (SUA) in the vicinity of a military runway.

Two alternative locations on CCAFS were evaluated for the reuse of existing facilities or the construction of a new hangar. A former Delta Solid Rocket Motor (SRM) Storage

Facility is located on the south side of the airfield in the vicinity of the Alternative 2 location. Although reuse of the former SRM facility was considered, it was not large enough to accommodate the two aircraft and house the administrative areas required for this mission. Parking facilities and a taxiway would have also been required on undeveloped areas that have been designated as mitigation habitat for the protected Scrub-jay.

Construction of a new hangar was also evaluated on the landfill, which is located adjacent to the north side of the Skid Strip. Due to excessive engineering requirements, this alternative was eliminated from detailed analysis.

AFFECTED ENVIRONMENT AND CONSEQUENCES

Implementation of the Proposed Action would disturb approximately five acres of live oak/saw palmetto habitat for the construction of a hangar, administrative facilities, parking apron and taxiway, and vehicle parking.

The Proposed Action would have no direct impact on: surface waters and waters of the United States; floodplains; aesthetic and visual resources; cultural, historical or archeological resources; transportation; minority populations; noise; airspace management; or hydrology and groundwater. Implementation of the Proposed Action is anticipated to have minor impacts to: land usage, geology and soils, vegetative habitat, wildlife resources, threatened and endangered species, air quality, hazardous materials, energy consumption, and human health and safety.

FINDINGS AND CONCLUSIONS

Based upon the analysis conducted in this EA, implementation of Alternatives 2, 3, or 4 is not anticipated to cause significant adverse impacts to any of the resources described in the EA.

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1.0 INTRODUCTION

The United States (U.S.) Customs and Border Protection (CBP), a component within the Department of Homeland Security (DHS), has the responsibility of protecting the nation's borders against the illegal entry of terrorists and terrorist weapons and to enforce the laws that protect the U.S. homeland. This is done through the detection, interdiction, and apprehension of those who attempt to illegally enter or smuggle any person or contraband across the sovereign borders of the United States. Within CBP, CBP Air and Marine (A&M) protects the American people and critical infrastructure by using integrated and coordinated A&M Forces to detect, monitor, intercept, and track illegal activities, such as the illegal movement of people and the transportation of illicit drugs or contraband; thereby guarding our borders, preventing acts of terrorism, and protecting the American public. This mission makes CBP A&M a crucial component of DHS's layered approach to border security.

The mission of CBP is to serve as guardians of our Nation's borders, to safeguard the homeland at and beyond our borders, to protect the American public from terrorists and instruments of terror, and to steadfastly enforce the laws of the United States while fostering our nation's economic security. In order to accomplish this mission, CBP A&M requires a location for operations in the Caribbean/southeast coastal regions of the United States. In order to better meet this mission, CBP A&M proposes to establish a permanent Unmanned Aircraft System (UAS) capability at Cape Canaveral Air Force Station (CCAFS), Florida (Figure 1-1). CBP A&M is currently conducting Operational Testing and Evaluation (OT&E) for the Predator B (Guardian) at CCAFS. CCAFS was selected for OT&E because the installation infrastructure meets or exceeds the minimum support requirements for flight operations, provides increased

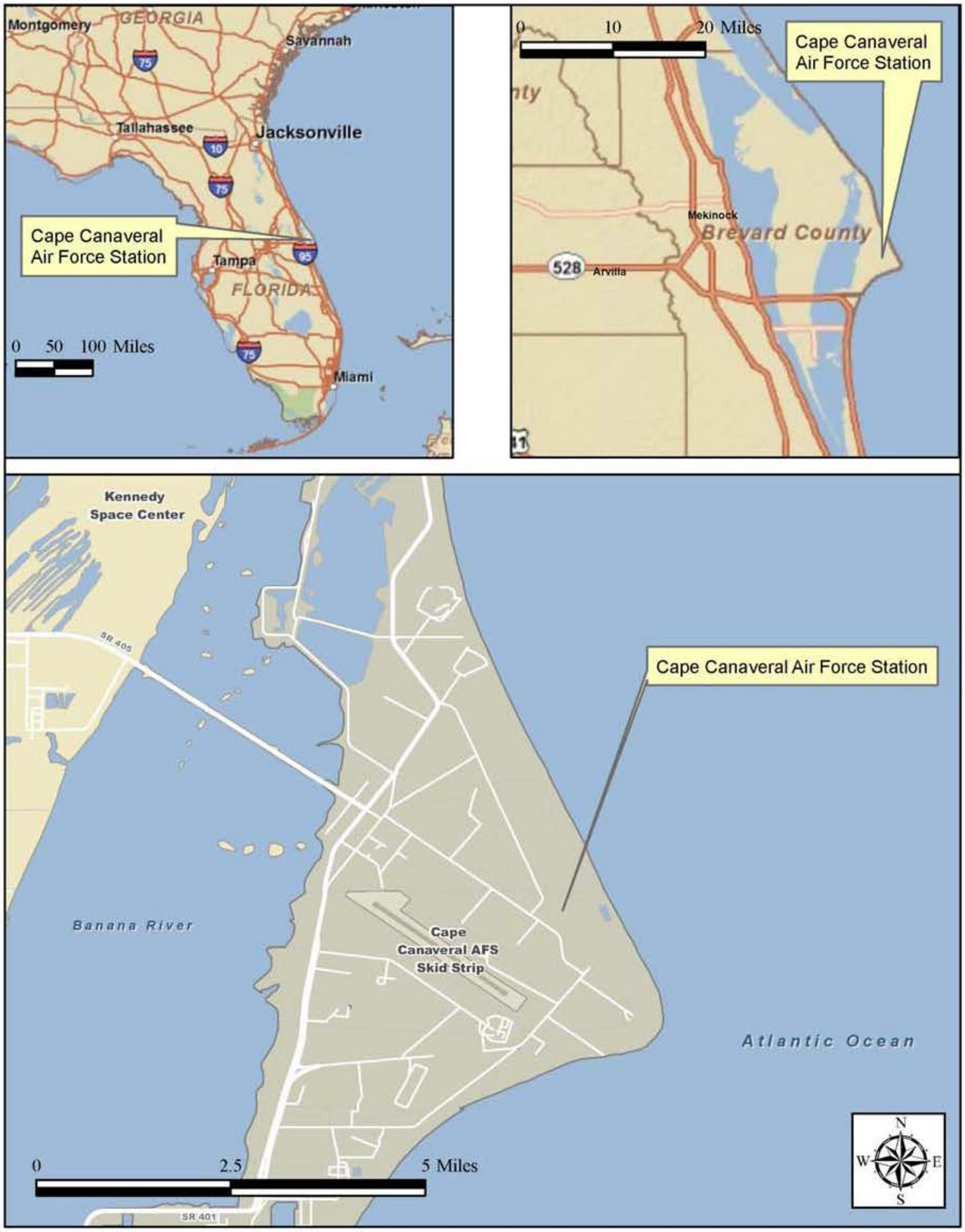

Figure 1-1. Regional Location Map of Cape Canaveral Air Force Station

physical security, and provides synergy with existing CBP operations in the southeast coastal region of the United States. These same reasons support the selection of CCAFS as a permanent CBP facility.

This Environmental Assessment (EA) evaluates the potential environmental consequences associated with each proposed alternative for UAS flight operations and the infrastructure modification requirements necessary for the incoming CBP mission.

1.1 BACKGROUND

In 2004, CBP began utilizing UASs as a law enforcement multiplier along the southwest border of the United States. During 2004 and 2005, CBP flew Hunter and Hermes UASs to protect the southern border. The first Predator B was introduced into service in October 2005. Since that time, the Predator B has flown more than 1,500 flight hours in support of border security missions and contributed to the seizure of more than 15,000 pounds of marijuana and the apprehension of more than 4,000 illegal aliens. Five Predator B UASs now operate out of Sierra Vista, Arizona. CBP began operating a single Predator B at Grand Forks Air Force Base, North Dakota, in 2008.

Figure 1-2. Predator B

Aircraft Characteristics*.* The Predator B is a high-altitude, long endurance aircraft that has the capability to perform surveillance and reconnaissance at altitudes up to 50,000 feet (Figure 1-2). The Predator B is approximately 66 feet wide, 36.2 feet long and nearly 11.8 feet tall. It hosts a 900-horsepower turbo-prop engine that provides the capability for airspeeds of more than 250 miles per hour. The Predator B utilizes a larger and more capable airframe than earlier Predator models and has the ability to carry more than 15 times the payload and cruise at three times the speed of earlier models. The new maritime variant, known as the Guardian, is a modified Predator B with structural, avionics, and communications enhancements. The most visible differences are the addition of the belly-mounted Raytheon SeaVue Marine Search Radar and the wingtip-mounted ultra-high frequency/very high frequency (UHF/VHF) antennas (Figure 1-3).

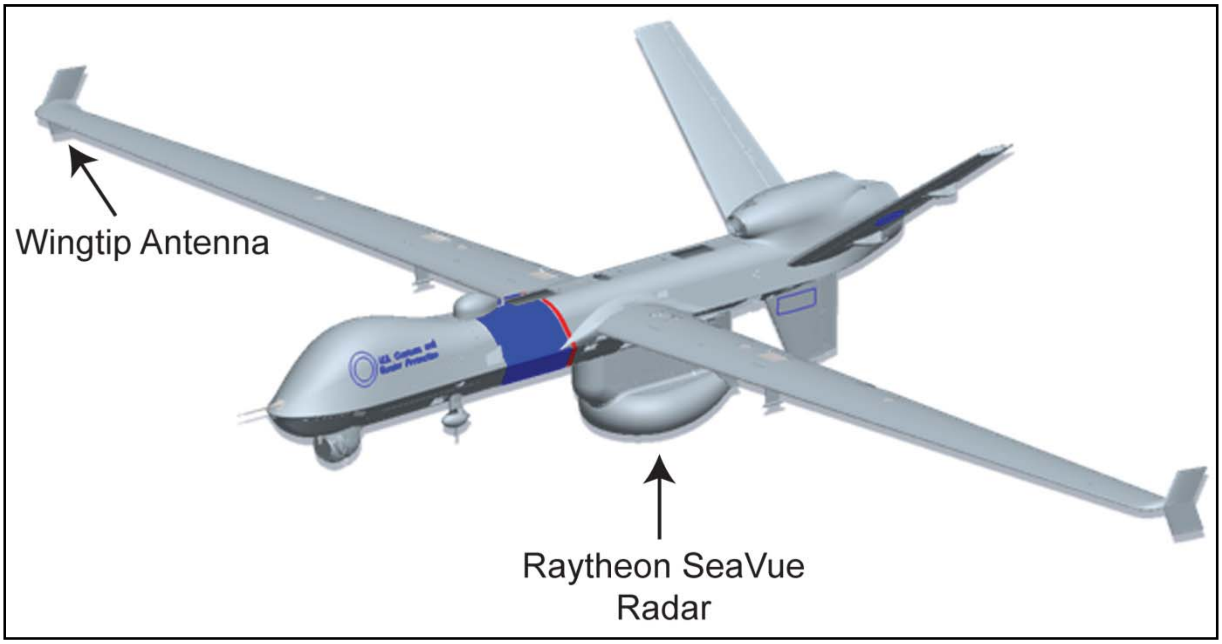

Figure 1-3. Guardian

The aircraft is only one component of the Guardian system. The UAS system is additionally comprised of the ground control stations (GCSs) and line of sight and satellite communication systems (Figure 1-4).

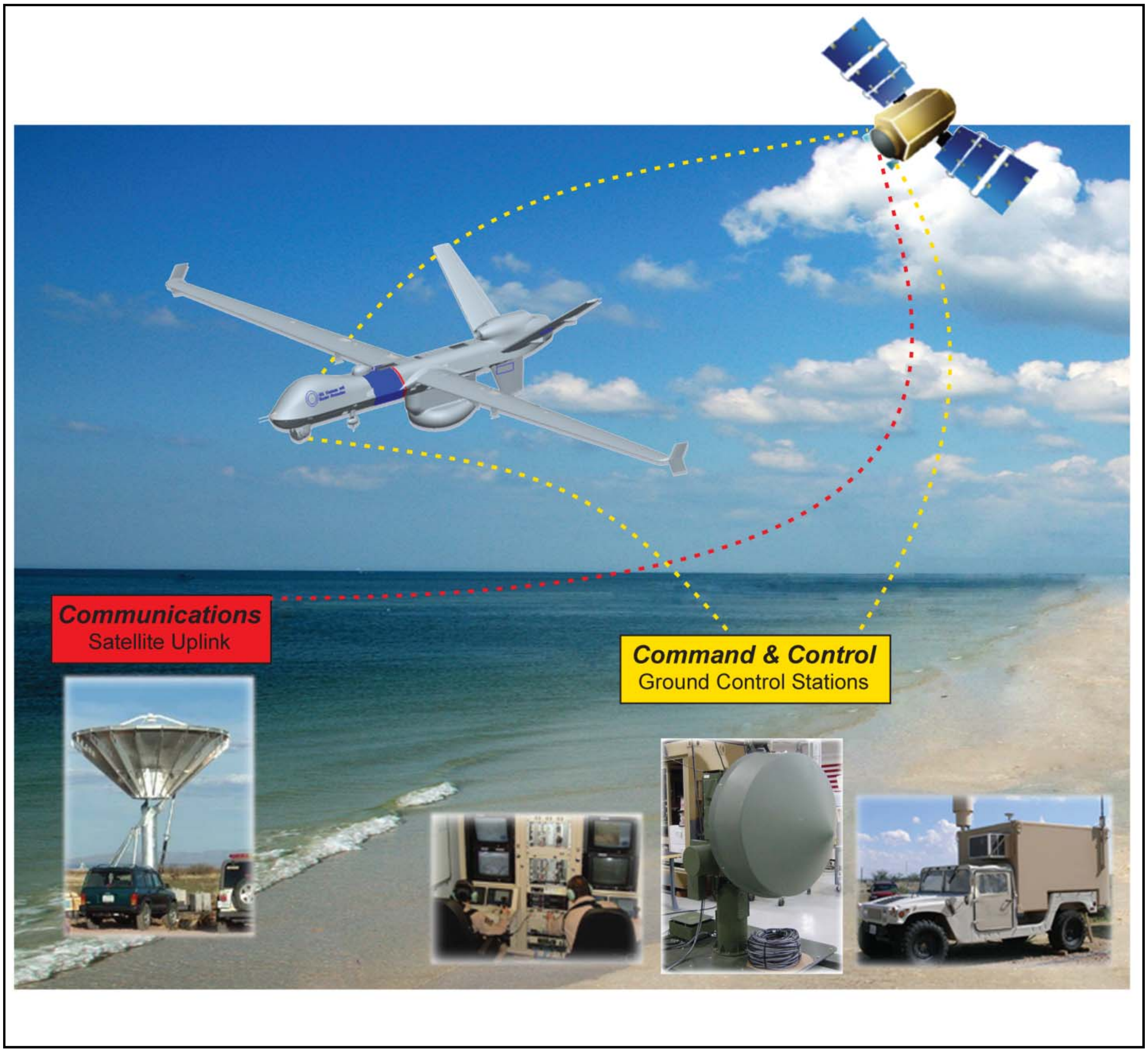

Figure 1-4. Guardian System Components

The basic crew for the Guardian is a pilot, a sensor operator, an electronics technician, and a Command Duty Officer. The pilot controls the aircraft using a standard flight stick and associated instruments. The crew is located at the GCS. This station is typically placed at the operating installation for the aircraft but could potentially be positioned anywhere in the United States.

Two types of communication systems are used to fly the Guardian (Figure 1-4). The pilot can control the aircraft from the GCS using a line of sight data link through the ground data terminal (GDT) or by a satellite link. Take-offs and landings are performed by the line of sight data link. After launch, control of an airborne aircraft may be transferred to a remote operations GCS to execute the mission. In these situations when the aircraft is beyond line of sight, communications are maintained through a satellite uplink.

Cape Canaveral Air Force Station. CCAFS is located in Brevard County near the Kennedy Space Center (KSC) (Figure 1-1) on Florida's Atlantic coastline. The Station is located on a barrier island bordered by the Atlantic Ocean to the east and the Banana River to the west.

CCAFS is home to the 45th Space Wing (45 SW) Mission Support Group. The 45 SW Mission Support Group is responsible for the day-to-day operations at the CCAFS. These responsibilities include management of more than 16,000 acres, 1,500 facilities, 4.6 million square feet (ft^2) of office space, and a work force of 10,000 (USAF undated a).

1.2 PROPOSED ACTION

The Proposed Action would provide personnel and the necessary infrastructure at CCAFS to support CBP's mission of protecting the southeast coastal region of the United States. The Proposed Action would also include flight operations for the Guardian UAS.

1.3 PURPOSE AND NEED FOR THE PROPOSED ACTION

The purpose of this action is to establish a U.S. CBP A&M Southeastern Region Operations Center that has the capability to support UAS operations in the vicinity of

CCAFS. CBP A&M has identified the need to establish a maritime UAS operating presence along the southeast coastal region. The need for this project would support CBP's mission, which entails the protection of the nation's borders against the illegal entry of terrorists and terrorist weapons and the enforcement of laws that protect the U.S. homeland. This is done through the detection, interdiction, and apprehension of those who attempt to illegally enter or smuggle any person or contraband across the sovereign borders of the United States. The implementation of this mission is a crucial component of DHS's layered approach to border security. The use of UASs in support of these mission requirements serves as a "force-multiplier" for this agency.

1.4 PUBLIC INVOLVEMENT

Per the requirements of the National Environmental Policy Act (NEPA), this document will be made available for public and agency comments. Appendix A contains a list of the agencies who were contacted as part of this EA or who received a copy of the Draft EA. Notices would be published in a local newspaper to notify members of the public of the availability of the Draft EA.

1.5 FRAMEWORK FOR ANALYSIS

NEPA requires federal agencies to take into consideration the potential environmental consequences of Proposed Actions in their decision-making process. The intent of NEPA is to protect, restore, and enhance the environment through well-informed federal decisions. The Council on Environmental Quality (CEQ) was established under NEPA to implement and oversee federal policy in this process. The CEQ subsequently issued the regulations for implementing the procedural provisions of NEPA (40 Code of Federal

Regulations [CFR] Sections 1500 to 1508). These requirements specify that an EA be prepared to:

- Briefly provide sufficient evidence and analysis for determining whether to prepare an Environmental Impact Statement (EIS) or a Finding of No Significant Impact (FONSI);
- Aid in an agency's compliance with NEPA when an EIS is not necessary; and
- Facilitate preparation of an EIS when one is necessary.

The activities addressed within this document constitute a federal action and therefore must be assessed in accordance with NEPA. To comply with NEPA, as well as other pertinent environmental requirements, the decision-making process for the Proposed Action includes the development of this EA to address the environmental issues related to the proposed activities. Each federal agency has its own procedures for implementing NEPA, and the DHS implementing procedures are contained in Management Directive 5100.1, *Environmental Planning Program*.

1.5.1 Executive Order 12372

Executive Order (EO) 12372, *Intergovernmental Review of Federal Programs*, requires intergovernmental notifications prior to making any detailed statement of environmental impacts. Through the process of Interagency and Intergovernmental Coordination for Environmental Planning (IICEP), the proponent must notify concerned federal, state, and local agencies and allow them sufficient time to evaluate potential environmental impacts of a Proposed Action. This IICEP process also includes coordination with federally recognized American Indian and Alaska Native governments in order to meet the policies set forth in EO 13084, *Consultation and Coordination with Indian Tribal*

Governments. Comments from all agencies are subsequently incorporated into the Environmental Impact Analysis Process.

In order to meet the requirements of NEPA, EO 12372, and EO 13084, federal, state, and local agencies, as well as members of the general public, would be invited to comment on this EA.

1.5.2 Additional Environmental Statutes and Regulations

Prior to implementation of the actions described in this EA, permitting and compliance with applicable statutes and regulations would occur. The following is a partial list of applicable laws and regulations that guided the development of the EA.

- *NEPA*, Public Law 91-190, 42 U.S. Code (USC) 4321- 4347, January 1, 1970;
- CEQ regulations, 40 CFR Parts 1500 through 1505;
- EO 11988 and 11990, *Floodplain Management* and *Protection of Wetlands*;
- EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*;
- EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*;
- EO 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*;
- *Clean Air Act* (CAA) (1970, Amended 1990);
- EO 13423, *Strengthening Federal Environmental, Energy, and Transportation Management* is a directive that requires federal agencies to implement sustainable practices for a variety of water, energy and transportation related activities;

- 29 CFR *Occupational Safety and Health Standards*;
- 40 CFR Part 93.153, *Air Conformity Determination*; and
- *Resource Conservation Recovery Act* (RCRA) 1970.

1.6 COOPERATING AGENCY

The CBP A&M is the proponent for this proposal and is the lead agency for the preparation of the document. Other agencies, such as the USAF, may participate in the process by serving as a cooperating agency.

As defined in 40 CFR §1508.5, a cooperating agency…

> means any federal agency other than a lead agency which has jurisdiction by law or special expertise with respect to any environmental impact involved in a proposal (or a reasonable alternative) for legislation or other major federal action significantly affecting the quality of the human environment.

The CBP A&M Proposed Action would occur on a USAF installation under the control of the Air Force Space Command; as such the USAF has been working in concert with the CBP A&M as part of a multidisciplinary team to complete this project.

2.0 PROPOSED ACTION AND ALTERNATIVES

The Proposed Action and alternatives section of this Environmental Assessment (EA) provides the framework for the impact analysis in Section 3. Section 2 defines the scope of the Proposed Action and alternatives. Information is also provided on the No Action Alternative and alternatives that were considered but eliminated from further consideration.

2.1 ALTERNATIVE 1: NO ACTION ALTERNATIVE

An analysis of the No Action Alternative provides a basis for comparing the environmental impacts of the Proposed Action and alternatives with existing conditions. Under the No Action Alternative, there would be no beddown of the Guardian aircraft at Cape Canaveral Air Force Station (CCAFS). The United States (U.S.) Customs and Border Protection (CBP) personnel and CBP assets would leave CCAFS upon completion of the Operational Testing and Evaluation (OT&E). However, implementation of the No Action Alternative would impact the successful implementation of the Caribbean/southeast coast CBP mission and impair protection of U.S. national security interests.

2.2 PROPOSED ACTION – ALTERNATIVE 2: CONSTRUCT NEW HANGAR

The Proposed Action includes the beddown of the equipment, personnel, and infrastructure at CCAFS necessary to support CBP's mission. Approximately 65 CBP personnel and contractors would be employed at CCAFS as a result of the Proposed Action along with two Guardian aircraft and the systems to support their operation. The Proposed Action also includes flight operations of the Guardian aircraft. Construction requirements for the new mission would include a new hangar and associated parking facilities; placement of a ground data terminal (GDT) antenna; and infrastructure improvement. These actions are described in more detail in the following subsections.

2.2.1 Construction Requirements

Under the Proposed Action, CBP is proposing to construct a new 8,840 square foot hangar within the Skid Strip Development Area along the south side of the Skid Strip (Figure 2-1). The hangar would provide a consolidated space for two aircraft and a ground control station (GCS). Additional requirements for the facility include a back-up power supply and communication upgrades. CBP would also require approximately 14,135 square feet for administrative purposes.

In 2004, CCAFS prepared the Skid Strip Area Development Plan (ADP) (CCAFS 2004). This plan was prepared to focus planning and development along the Skid Strip. The plan describes improvements that would increase the safety and function of the runway at CCAFS and plans improvements to support existing and future 45th Space Wing (45 SW) missions. The ADP for this area included the construction of additional hangars, aircraft parking ramps, taxiways, and a new tower facility. Construction of the CBP hangar in this location would be compatible with the intent of the ADP. In addition to construction of the hangar and an administrative facility, CBP would construct a parking apron large enough to accommodate two Guardian aircraft and a taxiway to connect the hangar and parking apron with the runway.

As described in Section 1.1 the Guardian requires a GDT for takeoff and landing (Figure 1-4). During OT&E, the GDT was located in the vicinity of the airfield tower. For

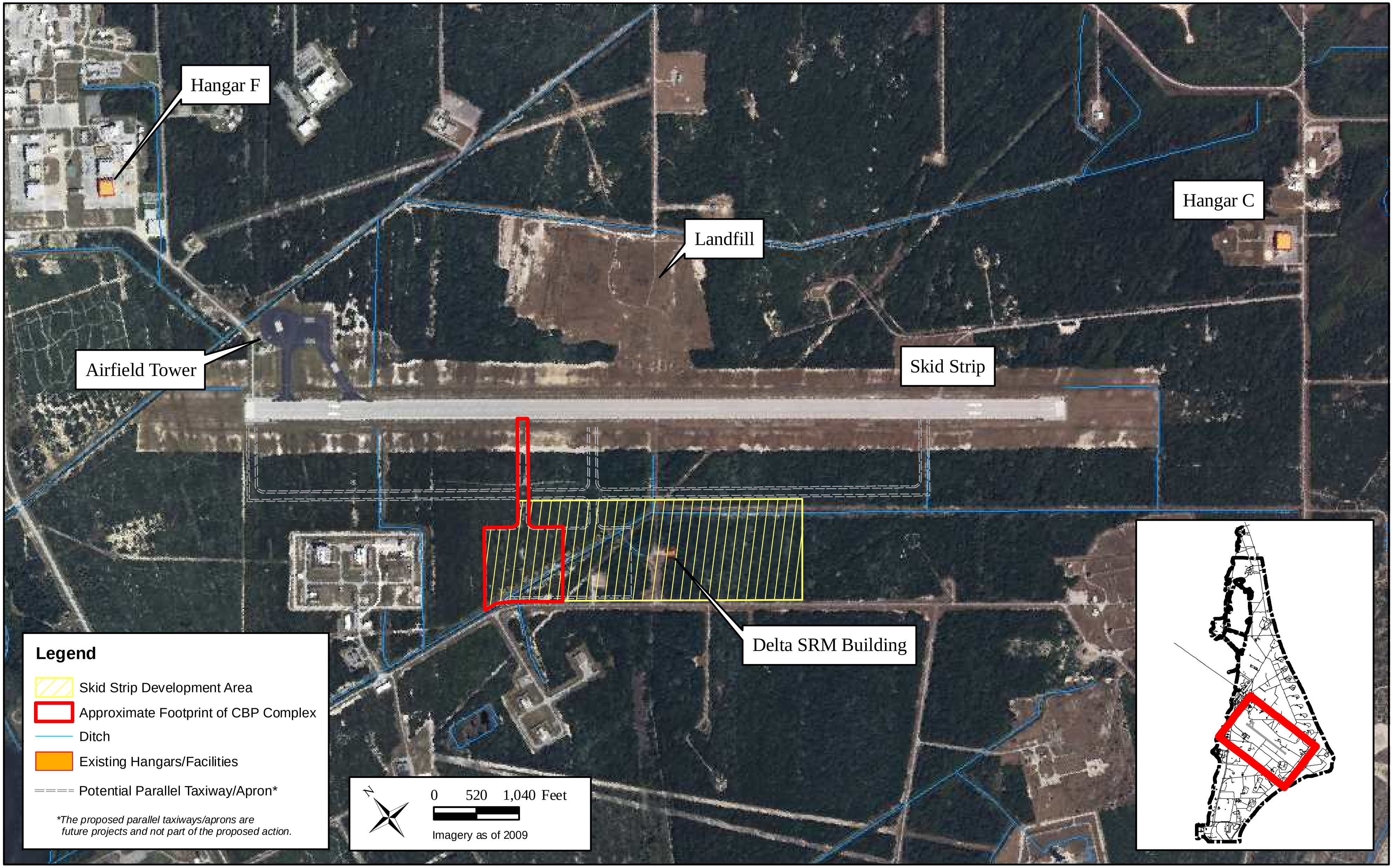

Figure 2-1. Proposed CBP Complex

the permanent beddown of the Guardian, the GDT would be moved south of the Skid Strip (Figure 2-1). This location places the GDT closer to midfield along the runway and provides a better line of sight for take-off and landings. Placement of the GDT in this location would require the construction of a platform.

2.2.2 UAS Flight Operations

Airspace Requirements*.* In order to conduct Unmanned Aircraft System (UAS) flight operations from CCAFS, CBP is required to coordinate with the Federal Aviation Administration (FAA) to develop an airspace construct in the vicinity of CCAFS. This airspace construct must allow for UAS operations (take offs, landings, transition from restricted area to Class A airspace) and UAS training operations (take offs, landings, and touch-and-goes). CBP proposes to accomplish this, in coordination with the FAA, through the use of a Certificate of Authorization (COA).

COAs are managed through the FAA's Unmanned Aircraft Program Office. A COA is an authorization issued by the Air Traffic Organization to an operator for a specific unmanned aircraft. After the operator submits a completed application, the FAA conducts a comprehensive operational and technical review of the proposal. If necessary, some limitations may be imposed as part of the approval process to ensure the UAS can operate safely with other airspace users.

The current OT&E operations being conducted at CCAFS are occurring under the FAA's policy that allows for unmanned aircraft to fly during their testing and evaluation period in Special Use Airspace. CBP has initiated the COA process with the FAA for flight operations associated with the beddown of the Guardian at CCAFS. The following section describes CBP's proposed operational areas for the Guardian beddown.

Figure 2-2 shows the proposed southeast region operating area for Guardian operations. CBP intends to utilize existing warning and restricted areas as much as feasible during flight operations. As shown in Figure 2-3, CBP would require a COA when transitioning through Class A airspace from one restricted/warning area to another. CBP is also proposing to utilize an overland route that would allow the Guardian to divert into Class A airspace over the Florida peninsula (Figure 2-4) should weather conditions deteriorate and the Guardian be unable to return safely to CCAFS through special use airspace.

Figure 2-2. Existing and Proposed UAS Operational Area

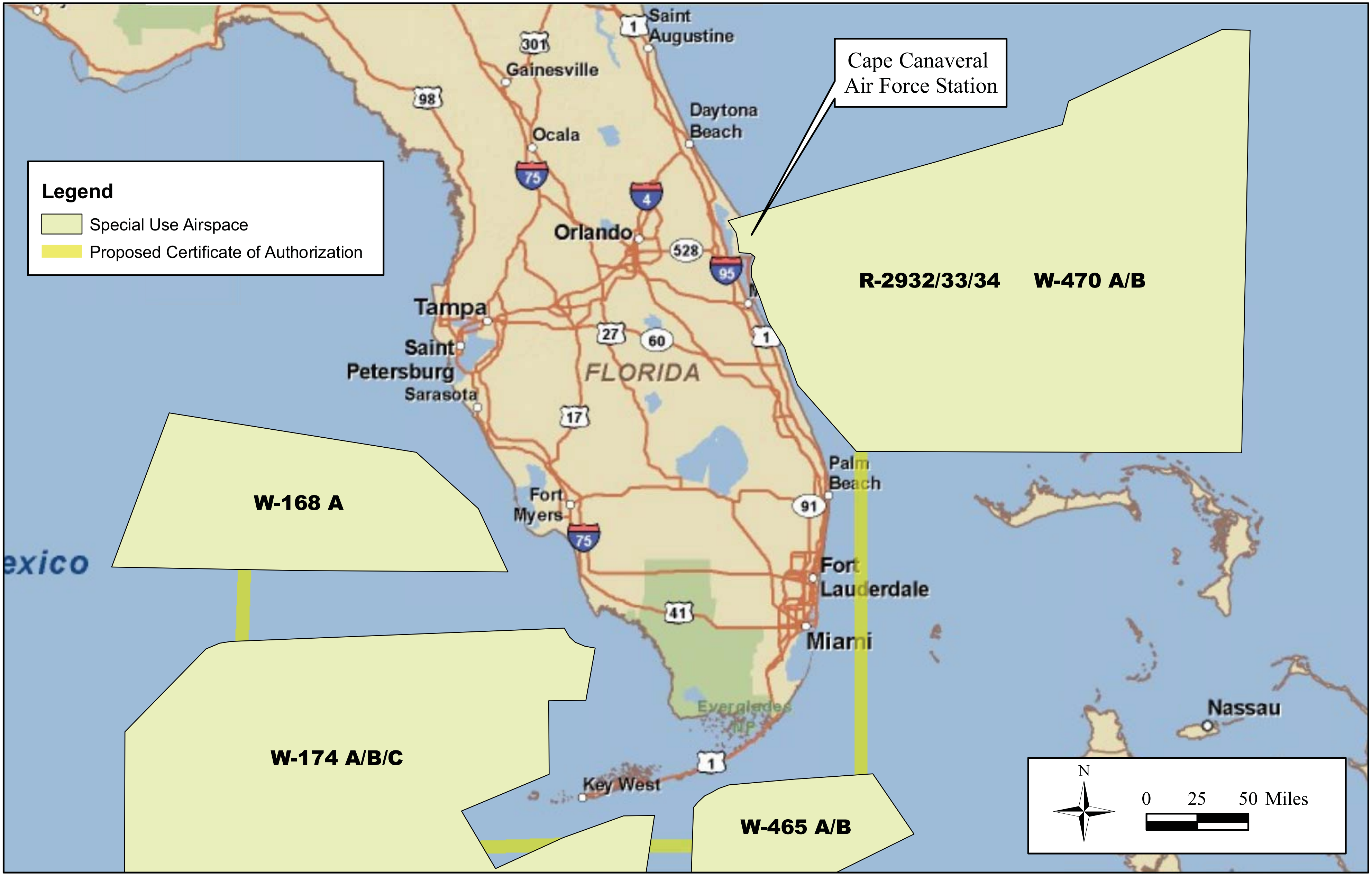

Figure 2-3. Location of Special Use Airspace and Proposed COA

Figure 2-4. Special Circumstances Flight Path

CBP anticipates conducting 166 operational and 24 training sorties per year at CCAFS. A sortie consists of a complete mission from the initial take off to the return landing. Operational sorties are estimated to be 12 to 15 hours in duration. Training sorties would be approximately two to three hours in duration. Sorties would consist primarily of night operations (70 percent). The remaining 30 percent of operations would occur during daylight hours.

2.3 ALTERNATIVE 3: RENOVATE HANGAR F

2.3.1 Facility Requirements

Currently, CBP is utilizing Hangar F for the OT&E at CCAFS. Under a memorandum of agreement, the USAF has allowed CBP to utilize administrative space and hangar facilities in the southern half of the Hangar. The current space is adequate for the OT&E operations, but CBP would require additional administrative space for a permanent mission. In addition, the area occupied by CBP would normally be utilized by the USAF for accident investigations. Should the USAF require this space, CBP would have to consolidate their administrative needs into a smaller space to accommodate the accident investigation team.

The northern administrative side of Hangar F is currently unoccupied due to environmental issues associated with lead-based paint and asbestos-containing materials (ACMs). It would be possible to renovate the northern administrative side of Hangar F and provide the necessary administrative space for CBP personnel. Renovations would include lead-based paint and ACM abatement and then renovation of the existing office space.

Currently, the Guardian aircraft accesses the airfield by being towed on a road designed for vehicular traffic. The road does not meet USAF requirements for a tow way, and as a result several temporary waivers for various obstructions have been provided to CBP. These waivers have been issued for the OT&E period and would have to be re-evaluated prior to using Hangar F as a permanent location for CBP operations.

2.3.2 UAS Flight Operations

UAS flight operations would remain as described in Section 2.2.2.

2.4 ALTERNATIVE 4: RENOVATE HANGAR C

2.4.1 Facility Requirements

Hangar C is a structure that was utilized during the manned space flight program and is eligible for listing on the National Register of Historic Places (NRHP). The current facility would be available for use by CBP. This site would require extensive lead-based paint and ACMs abatement prior to any renovation activities. No tow way or taxiway exists that would provide the Guardian aircraft access to the airfield. With sufficient improvements and use of waivers, an existing vehicular road could be utilized as a tow way.

2.4.2 UAS Flight Operations

UAS flight operations would remain as described in Section 2.2.2.

2.5 ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER CONSIDERATION

In compliance with the National Environmental Policy Act (NEPA) and Department of Homeland Security (DHS) Management Directive 5100.1, the DHS must consider reasonable alternatives to the Proposed Action. Only those alternatives determined reasonable to fulfill the purpose and the need for the Proposed Action warrant detailed analysis. The following section presents a summary of alternatives considered but eliminated from further consideration in this EA.

The Proposed Action is to beddown Guardian aircraft assets at CCAFS. Prior to the establishment of the OT&E operations at CCAFS, CBP evaluated five other locations, including Rafael Hernández Airport, Aguadilla, Puerto Rico; Ceiba Airport, Puerto Rico; Homestead Air Force Reserve Base, Homestead, Florida; Key West Naval Air Station, Key West, Florida; and Shuttle Landing Facility, Kennedy Space Center (KSC, Florida. CCAFS best met the selection criteria for the OT&E operations, including its close proximity to CBP's operational area in the Caribbean/southeast coastal region of the United States, existing runway and hangar facilities, and the availability of Special Use Airspace (SUA) in the vicinity of a military runway. These same selection criteria apply to the beddown of the Guardian aircraft at CCAFS.

Two alternative locations on CCAFS were evaluated for the reuse of existing facilities or the construction of a new hangar. A former Delta Solid Rocket Motor (SRM) Storage Facility is located on the south side of the airfield in the vicinity of the Alternative 2 location. Although reuse of the former SRM facility was considered, it was not large enough to accommodate the two aircraft and house the administrative areas required for this mission. Parking facilities and a taxiway would have also been required on undeveloped areas that have been designated as mitigation habitat for the protected Scrub-jay.

Construction of a new hangar was also evaluated on the landfill, which is located adjacent to the north side of the Skid Strip. Due to excessive engineering requirements, this alternative was eliminated from detailed analysis.

2.6 SUMMARY

Four alternatives, including Alternative 1: No Action Alternative, were selected for analysis in this EA. Proposed Action - Alternative 2: Construct New Hangar, Alternative 3: Renovate Hangar F, and Alternative 4: Renovate Hangar C would meet the stated purpose and need of providing a U.S. CBP Caribbean/Southeast Operations Center that would protect the southeast coastal border of the United States. Alternative 1: No Action Alternative would not meet the stated purpose and need but is included as a basis for comparison.

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3.0 AFFECTED ENVIRONMENT AND CONSEQUENCES

3.1 PRELIMINARY IMPACT SCOPING

This section presents an evaluation of the environmental impacts that could potentially result from implementation of Alternatives 2, 3, and 4 as compared to Alternative 1: No Action. Potential impacts are addressed in the context of the scope of the Proposed Action as described in Section 2. The extent to which an action might affect an environmental resource depends on many factors. Environmental resources can be affected directly, indirectly, or not at all, and could occur in the short or long-term. Environmental resources could also be affected in terms of context and intensity.

The significance of an action is measured in terms of context and intensity. The context can be analyzed in several ways, such as society as a whole (human, national), the region of influence (ROI), the affected interests, and the locality. Significance might vary with the context of the action.

Intensity refers to the severity of impact. Impacts could be beneficial or adverse. Consideration must be given to whether an impact affects public health or safety, and whether it affects areas having unique characteristics, such as cultural resources or wetlands. The significance of impacts could also depend on the degree of controversy or posing highly uncertain, unique, or unknown risks. Significance can be found where an action sets a precedent for future actions having significant effects, as well as in cases involving cumulative impacts. For example, when considering intensity, consideration must be given to the degree to which the action might adversely affect animal or plant species listed as endangered or threatened or their habitat. Finally, in evaluating intensity, consideration must be given to whether an action threatens a violation of a law or regulation imposed for the protection of the environment. The following environmental resources were evaluated as part of this Environmental Assessment (EA) process: land use, geology and soils, hydrology and groundwater, surface water and floodplains, vegetative habitat, wildlife resources, threatened and endangered species, cultural, historical and archeological resources, air quality, climate, noise, utilities and infrastructure, roadways/traffic, aesthetic and visual resources, hazardous materials, socioeconomic, environmental justice and protection of children, sustainability and greening, human health and safety, and airspace management.

Per National Environmental Policy Act (NEPA) regulation (40 Code of Federal Regulations [CFR] 1501.7), and Council on Environmental Quality (CEQ) guidance, only those resources that have the potential to be impacted by the implementation of the Proposed Action or alternatives were carried through the EA for detailed evaluation. No impacts are anticipated as a result of this project to climate, floodplains, utilities and infrastructure, and aesthetics and visual resources. Therefore these resources were not carried forward for detailed analysis in the EA.

3.2 LAND USE

Land use classifications reflect either natural or human activities occurring at a given location. Land uses resulting from human activities include residential, commercial, industrial, airfield, recreational, agriculture, and other types of developed areas. Natural uses include resource production such as forestry, mining, or agriculture, and resource protection such as conservation areas, wild lands, and parks. Management plans, policies, and regulations define the type and extent of land use allowable in specific areas and protection specially designated for environmentally sensitive areas. The ROI for land use includes land use within the boundaries of the installation and land use within a five-mile radius of Skid Strip.

The overriding principles that have historically guided land use planning at the installation has been “risk avoidance” for the general public and “risk management” for on-installation personnel. These safety considerations are based on the premise that the general public shall not be subject to additional hazards in their daily lives as a result of launch activities (USAF 2002).

3.2.1 Affected Environment

The installation occupies 15,800 acres on a barrier island along the eastern shore of Florida. The installation is north of Cape Canaveral, adjacent to Kennedy Space Center (KSC), and within close proximity of Merritt Island (Figure 3-1).

The installation is currently divided into thirteen land use categories represented on Figure 3-2. The primary land use at the installation, other than conservation, is industrial. Land use around the Skid Strip is predominately conservation. An area of Aircraft Operations & Maintenance land use is immediately adjacent to the northwest area of the Skid Strip. The proposed new hangar is located in the Skid Strip Development Area which is presently a conservation area. Hangar F is located in an institutional land use area, with a vehicular road (East Skid Strip Road) through a conservation area to the Skid Strip. Hangar C is located in an industrial land use area, with a vehicular road (Control Tower Road) through a conservation area to the Skid Strip.

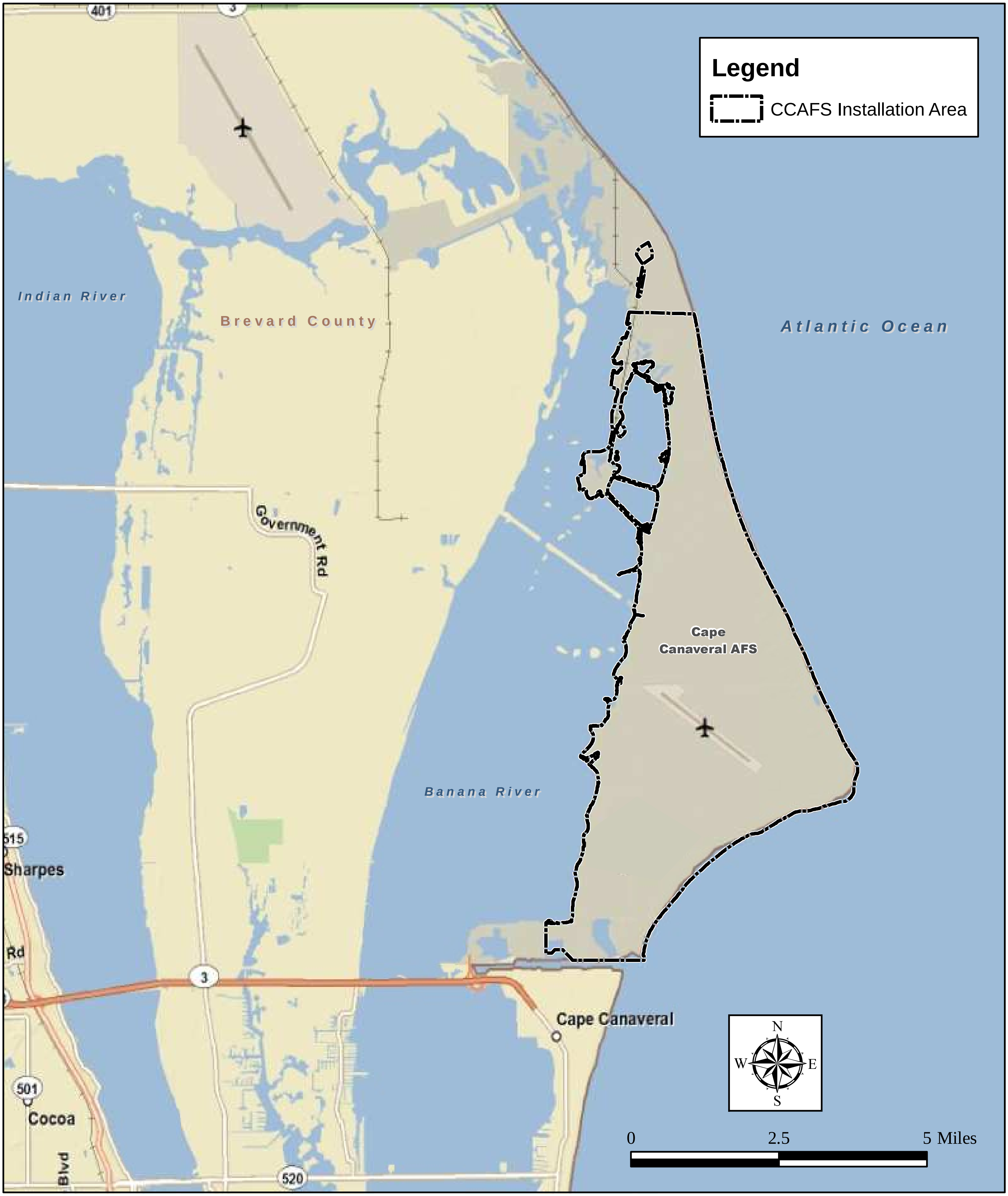

Figure 3-1. Cape Canaveral AFS

Figure 3-2. Cape Canaveral AFS Land Use

3.2.2 Environmental Consequences

Land use impacts could result if an action displaces an existing use or affects the suitability of an area for its current, designated, or formally planned use. This analysis considers whether the resulting changes improve public safety and well being, and whether they are compatible with surrounding uses and functions. A proposed activity may be incompatible with local plans and regulations that provide for orderly development to protect the general welfare of the public, or conflict with management objectives of a federal or state agency of an affected area. Compatible land use development would need to comply with federal and state environmental laws and regulations and with any Land Use Controls (LUC). The significance of potential land use impacts is based on the level of land use sensitivity in areas affected by the Proposed Action Alternative and compatibility of the Proposed Action on existing conditions.

Land use surrounding the installation consists of commercial and industrial land uses in Port Canaveral and moderate-density commercial and residential land uses in Cape Canaveral. Port Canaveral and Cape Canaveral are located adjacent to the south boundary of the installation. Recreational areas in the vicinity of the installation include Kennedy Athletic, Recreation and Social (KARS) Parks and King’s and Kelly Parks on Merritt Island.

Criteria used to evaluate impacts on land use include:

- Potential to disrupt an existing or planned future land use;
- Potential to reduce the suitability of the surrounding land (land not directly impacted by an action) for its current or planned use;

- Potential for inconsistency with the installation's plans, regulations, and guidelines that provide for appropriate development of the land; and
- Potential for incompatibility of the action with plans and management objectives for adjacent areas under control of other entities (e.g., state, local, federal).

Projects are evaluated for their potential to affect existing and planned land uses either positively (a beneficial effect), or negatively (a detracting effect).

3.2.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no construction or renovation activities would occur and no changes would occur to land use.

3.2.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Alternative 2 consists of the construction of a new hangar facility within the Skid Strip Development Area along the south side of the Skid Strip. The construction of this facility would be compatible with the intent of the *Cape Canaveral Air Force Station* [CCAFS] *Skid Strip Area Development Plan* (ADP) (CCAFS 2004) and the environmental impacts as discussed in the *Environmental Assessment* [EA] *for the Skid Strip Area Development Plan* [ADP] *at Cape Canaveral Air Force Station* [CCAFS]*, Florida* (CCAFS 2009). There are no expected impacts to land use outside of the installation.

3.2.2.3 Alternative 3: Renovate Hangar F

Alternative 3 is the renovation of a Hangar F located east of the Phillips Parkway and north of Skid Strip Road. Hangar F is presently being used on an interim basis by the U.S. Customs and Border Protection CBP. Renovations of existing facilities and additions of flight operations would only affect areas within the airfield land use and would be consistent with present land use. There are no expected impacts to land use outside of the installation.

3.2.2.4 Alternative 4: Renovate Hangar C

Alternative 4 is the renovation of a Hangar C east of the south end of the Skid Strip, on a parcel of land that is currently designated for conservation uses. Renovations of existing facilities and additions of flight operations would only affect areas within the airfield land use and would be consistent with present land use. The existing vehicular road from Skid Strip to Hangar C would need to be upgraded to allow for usage as a tow road. However, the road would still be in a conservation area. There are no expected impacts to land use outside of the installation.

3.3 GEOLOGY AND SOILS

Geology. Geology involves the study of the surface and subsurface materials of the earth and is typically described in terms of the general geological setting, stratigraphic sequence, lithology, structures, characteristic landforms, and surface characteristics (i.e., topography). Many of these geological factors also affect the hydrogeologic properties of the site, as discussed in Section 3.4 (Hydrology and Groundwater).

Soils. Soils, in general, refer to unconsolidated earth materials overlying bedrock or other parent geologic material. They develop from the weathering of mineral and organic materials and are typically described in terms of landscape position, slope, and physical and chemical characteristics. Soil types differ in structure, texture, strength, shrink-swell potential, drainage characteristics, and erodibility. These soil properties affect their suitability to support particular construction activities or land use types.

3.3.1 Affected Environment

Geology. CCAFS is located on the northern portion of a large, geologically recent (Quaternary period) barrier island. The Atlantic Coastal Plain tectonic province in which CCAFS is located has long been tectonically stable and so is characterized by generally low seismic activity. This area is not prone to sinkholes due to the depth of the limestone formations (more than 100 feet below ground surface [bgs]) and the presence of low permeability layers that minimize recharge to the limestone (45 SW 1996).

The topography of CCAFS is flat to gently sloping, with elevations ranging from sea level to approximately 20 feet above mean sea level (MSL). The average land surface elevation is approximately 10 feet above MSL (USAF 1998). The higher elevations are generally found along the eastern portion of CCAFS, with a gentle slope to lower elevations toward the marshlands along the Banana River. The landscape is generally characterized by a ridge-swale topography comprised of relic dunes separated by narrow swales.

The geology underlying CCAFS can be generally defined by four stratigraphic units: the surficial sands, the Caloosahatchee Marl, the Hawthorn Formation, and the carbonate formations of the Floridan Aquifer (USAF 1991). The surficial sands are marine deposits that typically extend to depths of approximately 10 to 30 feet bgs. The Caloosahatchee Marl underlies the surficial sands and consists of sandy shell marl that extends to a depth of approximately 70 feet bgs. The Hawthorn Formation, which consists of sandy limestone and clays, underlies the Caloosahatchee Marl. It is generally 80 to 120 feet thick and typically extends to a depth of approximately 180 feet bgs. Beneath the Hawthorn Formation lie the carbonate formations of the Floridan Aquifer, which extend several thousand feet bgs at CCAFS (USAF 1991). The Floridan aquifer system beneath CCAFS consists of a series of highly permeable carbonate units including the Ocala Group and the Avon Park Limestone, both of Eocene age. The Ocala Group consists of a series of fossiliferous, chalky to granular limestone formations. The Avon Park underlies the Ocala Group and primarily consists of soft, dense, chalky limestone but in places has been altered to dolomite (USGS 1962).

Soils. Based on the *Soil Survey for Brevard County, Florida*, the predominant soils at CCAFS are in the Canaveral-Palm Beach-Welaka association (USDA 1974). The specific soil types identified within the proposed project location are dominated by the Canaveral Complex, which consists of nearly level and gently sloping, moderately well-drained quartz sand mixed with shell fragments. These soils are loose, generally unstable, highly erodible, and have rapid permeability (>20 inches per hour). They typically have low available water capacity, low shrink-swell potential, and low organic matter content. Also present in the project area are the soils of the Canaveral-Urban land complex. Areas of this complex are partially covered by buildings, pavement, and other construction related to urban use. The majority of the soils of the Canaveral-Urban complex consist of a mixture of sand and shells having similar properties as the Canaveral Complex soils.

3.3.2 Environmental Consequences

3.3.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no construction or renovation activities would take place at the site; therefore, no impacts to soils or geology are expected.

3.3.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Construction of a new hangar, parking, taxiway, and other support areas would involve grading existing soils, excavating, and covering portions of the site with impervious materials. Increased runoff associated with the construction for the impervious surfaces would be a minor adverse impact not rising to a level of significance.

Construction activities would increase the potential for wind and water erosion in the short-term. Best management practices (BMPs) for erosion and sediment control would be implemented to reduce the potential for negative impacts. BMPs could include directing surface runoff away from denuded areas, silt fencing, sediment traps, and straw mulching or vegetating of disturbed surfaces, as necessary. Therefore, long-term impacts to soils and geology are expected to be minimal under the Proposed Action.

3.3.2.3 Alternative 3: Renovate Hangar F

The renovation activities at Hangar F would not involve excavations or soil disturbance. No impacts to the soil or deeper geologic units are expected from the construction activities associated with Alternative 3.

3.3.2.4 Alternative 4: Renovate Hangar C

The renovation activities at Hangar C would not involve excavations or soil disturbance. Approximately 3.5 acres of vegetation would be disturbed due to clearing activities associated with the tow way. Minor short-term disturbances to soils may result; however, given the limited area that would be impacted, they would not be considered significant. BMPs would be implemented to minimize soil disturbance. Therefore, there would be no significant impact to geology or soils as a result of implementing this alternative.

3.4 HYDROLOGY AND GROUNDWATER

Hydrology. In a general sense, hydrology deals with the redistribution of water through the processes of evapotranspiration, surface runoff, and subsurface flow. Some important factors that influence surface water hydrology include temperature, precipitation, topography, land use, and soil properties. These factors influence drainage patterns as well as the rate of infiltration and recharge to the groundwater. For the purposes of this EA hydrology refers to subsurface flows.

Groundwater. Groundwater refers to subsurface hydrologic resources, such as aquifers, that are used for domestic, agricultural, and industrial purposes. Groundwater can be described in terms of depth from the surface, flow rates and directions, water quality, and the permeability of the aquifers and surrounding geologic formations.

3.4.1 Affected Environment

The uppermost water-bearing formation beneath CCAFS is the surficial aquifer. The surficial aquifer consists of approximately 70 feet of undifferentiated Late Miocene, Pliocene, and Recent Pleistocene deposits. These deposits consist primarily of medium to coarse quartz sands, with coquina and shell occurring more frequently at depth (USGS 1962). The surficial aquifer is unconfined and its upper boundary is defined by the water table, which generally occurs just a few feet below the ground surface. Water enters the aquifer through direct infiltration of precipitation and generally flows laterally from topographically higher areas to lower areas such as the canals or the Banana River. The predominant groundwater flow direction is to the west except along the extreme eastern coast of the peninsula (USGS 1962). Under the airfield, groundwater reportedly occurs at depths ranging from about 3.2 to 18.0 feet bgs and flows to the west and south under a hydraulic gradient that ranges from 0.001 to 0.003 foot/foot (CCAFS 2009).

At the base of the surficial aquifer system is the Hawthorn Group of Miocene Age, consisting of clays, silts, and marls. These sediments make up the intermediate confining unit between the unconfined surficial aquifer and the confined Floridan aquifer system. The relatively low permeability of the confining unit (aquitard) restricts the vertical exchange of water between the surficial aquifer and the underlying Floridan aquifer (USGS 1962).

The Floridan aquifer system consists of a series of highly permeable carbonate units including the Ocala Group and the Avon Park Limestone, both of Eocene age. The top of the first carbonate unit occurs at a depth of approximately 180 feet bgs (USAF 1991). Water enters the Floridan aquifer system near the center of the Florida peninsula and moves laterally toward the coasts. In the vicinity of CCAFS, groundwater in the Floridan aquifer flows to the northeast. The Floridan aquifer is the primary source of potable water for the east-central Florida region. Within the Floridan aquifer system, multiple permeable intervals, or producing zones, are sandwiched between low permeability materials. The usage of groundwater from this aquifer varies in different areas due to differences in water quality (typically salinity and hardness) and the depth to the producing zones. Groundwater in the Floridan aquifer at CCAFS is highly mineralized and therefore is not used as a source of drinking water. CCAFS is provided with potable water by the City of Cocoa, which obtains water from Floridan aquifer wells located in eastern Orange County (CCAFS 2009).

All groundwater in Florida is classified according to its designated use into one of five categories (F-1 and G-I through G-IV). These categories are used to rate the quality of groundwater in a particular area and the degree of protection that should be afforded to that groundwater source. Both the surficial and Floridan aquifers at CCAFS are classified as Class G-II aquifers, indicating that they are potential potable water sources and generally have a total dissolved solids (TDS) content of less than 10,000 milligrams/liter (parts per million [ppm]) (Florida Administrative Code [FAC] 62-520.410). No groundwater resources at CCAFS are currently being used as sources of potable drinking water (45 SW 2001).

3.4.2 Environmental Consequences

3.4.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no construction or renovation activities would take place at the site; therefore, no impacts to hydrology or groundwater are expected.

3.4.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

None of the elements of the Proposed Action would involve substantive changes having the potential to adversely affect hydrology or groundwater at CCAFS in the long-term. The Proposed Action would not interfere with groundwater recharge or deplete groundwater resources.

Chemical spills during construction, maintenance and operational activities associated with the project could adversely affect quality. However, if BMPs are successfully applied to prevent and minimize chemical spills, there should be no significant effects on surface water hydrology and groundwater.

3.4.2.3 Alternative 3: Renovate Hangar F

Construction activities associated with the renovation of Hangar F are not expected to adversely impact groundwater quality or alter the hydrogeologic characteristics of the aquifers and therefore there are no significant impacts anticipated for these resources.

3.4.2.4 Alternative 4: Renovate Hangar C

As with Alternative 3, no significant impacts to the hydrology or groundwater are expected from the renovation activities to be conducted under Alternative 4. Existing programs, policies and practices would avoid or minimize impacts to surface water and shallow groundwater during renovation activities and operations at the site. BMPs would be followed to ensure that asbestos and lead abatement activities do not result in the release of contamination to surface water or groundwater.

3.5 SURFACE WATERS AND WATERS OF THE UNITED STATES

Water resources analyzed in this section include surface water quantity and quality. Surface water resources include lakes, rivers, and streams and are important for a variety of reasons, including economic, ecological, recreational, and human health. The ROI for surface water is the drainage system/watershed in which the installation is located.

3.5.1 Affected Environment

The installation is within the Florida Middle East Coast Basin and situated on a barrier island that separates the Banana River from the Atlantic Ocean. This basin contains three major bodies of water: the Banana River immediately to the west, Mosquito Lagoon to the north, and farther west, the Indian River, separated from the Banana

River by Merritt Island. All three water bodies are estuarine lagoons, with circulation provided mainly by wind-induced currents.

Several water bodies in the Florida Middle East Coast Basin have been designated as Outstanding Florida Water (OFW) in FAC 62-3, including most of Mosquito Lagoon of the Banana River, Indian River Aquatic Preserve, Banana River State Aquatic Preserve, Pelican Island National Wildlife Refuge, and Canaveral National Seashore. These water bodies are afforded the highest level of protection, and any compromise of ambient water is prohibited.

The Indian River Lagoon System has also been designated an Estuary of National Significance by the U.S. Environmental Protection Agency (USEPA). Estuaries of National Significance are identified to balance conflicting uses of the nation's estuaries while restoring or maintaining their natural character. The Banana River has been designated a Class III surface water, as described by the Clean Water Act (CWA). Class III standards are intended to maintain a level of water quality suitable for recreation and the production of fish and wildlife communities. There are no wild and scenic rivers located on or near the installation.

Bordering the installation is the Port Canaveral area. The port is an artificial harbor that supports both commercial and industrial activities. The Canaveral Locks connect the harbor to the Banana River.

According to National Wetlands Inventory (NWI) maps, a wide variety of wetland and deepwater habitats exists at the installation. The most predominate are palustrine and estuarine. Palustrine wetlands lack flowing water and are inland systems like marshes and swamps as well as bogs, fens, tundra, and floodplains. Estuarine systems are found where salt and fresh waters mix with river systems having open, restricted, or sporadic connection to the open ocean with tidal influences near the connection points. Estuarine wetlands at the installation include mangrove swamps, salt marshes, salt pans, Borrichia/glasswort marshes and various impounded wetland areas.

There are approximately 52 miles of drainage canals comprising 63 acres of surface waters on the installation. Canals were constructed by the USAF to provide drainage of low-lying areas. The surface water drains west by overland flow to the Banana River. The major canals of this system have certainly altered the hydrology on the installation but now offer habitat for numerous species of fish and wildlife.

Presently, there are six borrow pits on the installation that were excavated in the past to support construction of new facilities. Over the years, ecological succession has transformed these pits into productive fresh water ponds. Two of the ponds are connected to the installation drainage canal system. Wading birds and migratory waterfowl wintering on the installation use the ponds for feeding and resting.

3.5.2 Environmental Consequences

Criteria for evaluating impacts related to water resources associated with the Proposed Action and its alternatives are water availability, water quality, and adherence to applicable regulations. Impacts are measured by the potential to reduce water availability to existing users; endanger public health or safety by creating or worsening health hazards or safety conditions; or violate laws or regulations adopted to protect or manage water resources.

3.5.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no construction would occur and no impacts to surface water resources or waters of the United States would occur.

3.5.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

The construction activities under Alternative 2 have the potential to affect surface drainage and accelerate erosion in the short term. However, any erosion that could cause adverse impacts to water resources would be controlled using BMPs. Erosion and sediment control measures would be designed and implemented to retain sediment on-site and prevent violations of state and federal water quality standards.

Construction of a new hangar would be in the Skid Strip Development Area. A discussion of environmental impacts to the surface waters and waters of the United States was presented in the *Environmental Assessment* [EA] *for the Skid Strip Area Development Plan* [ADP] *at Cape Canaveral Air Force Station* [CCAFS]*, Florida* (CCAFS 2009). This EA found that significant impacts to wetland resources and surface water resources are not likely to occur as a result of this Proposed Action due to the lack of these resources in the construction area.

3.5.2.3 Alternative 3: Renovate Hangar F

Under Alternative 3, no new construction would occur and no impacts to surface water resources or waters of the United States would occur. There are no expected impacts to surface waters and waters of the United States.

3.5.2.4 Alternative 4: Renovate Hangar C

Under Alternative 4, improvements to the vehicular road from Hangar C to the Skid Strip would be required, including removing trees/shrubs to create adequate clearance for Guardian transport to and from Hangar C. BMPs and appropriate measures would be strictly adhered to during construction to minimize erosion and control sedimentation. The vehicular road seemingly intersects some palustrine wetlands, which would need to be surveyed to assess site conditions to confirm the extent of the wetlands. However, significant impacts to wetland resources and surface water resources are not anticipated to occur as a result of this Proposed Action.

3.6 VEGETATIVE HABITAT

3.6.1 Affected Environment

CCAFS is located in the Florida Coastal Lowlands (Eastern) Section of the Outer Coastal Plain Mixed Forest Province (USFS 1994). The original vegetative community of this area was dominated by oak scrub communities. The majority of the native vegetation in this region has been altered by development, fire-suppression, and artificial drainages.

Approximately 80 percent of the land (approximately 13,000 acres) at CCAFS is classified as undeveloped lands (CCAFS 2010b). Undeveloped land includes land that is used for conservation purposes or land maintained as an open area. A variety of natural communities exist with the undeveloped lands at CCAFS. A survey conducted by the Florida's Natural Area Inventory (FNAI) documented the following eleven natural communities at CCAFS (FNAI 1998):

- Beach Dune
- Scrub
- Hydric Hammock
- Coastal Grassland
- Xeric Hammock
- Estuarine Tidal Swamp
- Coastal Strand
- Maritime Hammock
- Estuarine Tidal Marsh
- Coastal Interdunal Swale
- Shell Mound

Not all of the land area at CCAFS can be classified into the FNAI natural communities and a large area within the central portion of CCAFS has been classified as live oak/saw palmetto shrubland and live oak/saw palmetto hammock (Gulledge et al. 2009). Most of the vegetation at CCAFS consists of coastal strand, maritime hammock, live oak/palmetto, scrub, and xeric hammock. Of these habitat types, live oak/palmetto and maritime hammock are the most likely to be impacted by the Proposed Action and general characteristics of these habitat types are described below. The live oak/palmetto association has characteristics similar to xeric hammock and so this natural community is also described below.

Xeric Hammock. Xeric hammock is an upland community that occurs in well-drained sandy soils (FNAI 1990, FNAI 2010). This forest community generally consists of a low closed canopy of mature or nearly mature tree species such as live oak (*Quercus virginiana*). At CCAFS this community occurs along the broad, former dune ridges that angle across CCAFS and is interspersed with coastal interdunal swales (CCAFS 2008). The original occurring stands of xeric hammock were a result of the fire suppression created by wetlands or other naturally occurring firebreaks. Large areas of xeric hammock have developed at CCAFS as a result of the artificial fire suppression that started in the 1950s.

Xeric hammock communities often transition from scrub communities and at CCAFS are distinguished by the lack of scrub species such as sand live oak (*Quercus geminate)*, myrtle oak (*Quercus myrtifolia*), and Chapman's oak *(Quercus chapmanii*). Live oak is typically the dominant overstory species in this community. Due to the closed canopy in this community, the shrub layer and understory do not typically contain an abundance of species. Saw palmetto is common in the shrub layer and American beautybush (*Callicarpa americana*) and groundsel tree (*Baccharis halimifolia*) may be present. The herb layer may contain wingstem (*Verbesina virginica*), passion flower (*Passiflora incarnata*), and climbing aster (*Ampelaster carolinianus*) (CCAFS 2008).

Xeric hammock does not generally provide suitable habitat for the Florida Scrub-jay (*Aphelocoma coerulescens*). Other threatened species may utilize this habitat for foraging including gopher tortoise (*Gopherus polyphemus*) and Eastern indigo snake (*Drymarchon corais couperi*), but it is not considered a crucial habitat.

Maritime Hammock. Maritime hammock is a coastal upland community that occurs on stabilized coast dune with a sand substrate. This forest community generally contains a dense canopy of mature trees such as live oak and red bay (*Persea borbonia*) (FNAI 2010). At CCAFS this community occurs on the southeast part of the Cape on an undulating terrain of old dunes between swales. Predominant shrubs include Simpson's stopper (*Myrcianthes fragrans*) and saw palmetto. Brazilian pepper (*Schinus terebinthifolius*), lantana (*Lantana camara*), and American beautyberry may also be present. The herbaceous layer is usually sparse but may contain Florida Keys hempvine (*Mikania cordifolia*), white crown beard (*Verbesian virginica*), and fourangle flatsedge (*Cyperus tetragonus*) (Gulledge et al 2009).

Live Oak/Saw Palmetto Hammock. This association is an upland forest type with low species diversity intermediate between maritime hammock and xeric hammock. It appears to be the result of fire suppression (Gulledge et al 2009). The canopy primarily consists of mature live oak with occasional red bay, cabbage palm (*Sabal palmetto*), and Brazilian pepper. The shrub layer is predominantly saw palmetto. Other shrub species are present at low densities and include groundsel tree, American beautyberry, coralbean (*Erythrina herbacea*), yaupon (*Ilex vomitoria*), lantana, and wax myrtle (*Myrica cerifera*). The herbaceous layer is sparse and includes bluestem (*Andropogon* sp.), flatsedge (*Cyperus* sp.), Florida hempvine, and white crownbeard.

Live Oak/Saw Palmetto Shrubland. This association is an upland shrub layer and also appears to be the result of fire suppression. The association is bordered by the scrub community to the east and differs from scrub by the lack of sand live oak and Chapman's oak. The canopy consists of live oak with occasional red bay and myrtle oak. The shrub layer is dominated by saw palmetto. Other shrubs include groundsel tree, American beautyberry, yaupon, lantana, and wax myrtle. Herbaceous species include hammock snakeroot (*Ageratina jucunda*), common ragweed (*Ambrosia artemisiifolia*), bluestem, capillary hairsedge (*Bulbostylis ciliatifolia),* and sensitive pea (*Chamaecrista nictitans*) (Gulledge et al 2009).

3.6.2 Environmental Consequences

3.6.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no construction or renovation activities would take place at the site; therefore, no impacts to vegetative resources would occur.

3.6.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

The Proposed Action would occur along the southwest side of the Skid Strip (Figure 2-1) in an area that is predominantly live oak/saw palmetto hammock. The oaks (live, myrtle, sand live, and Chapman's) in this area have reached their maximum height of 25 to 30 feet. Other large trees/plants located in this area include over-mature cabbage palms and red bay. Shrub species observed in the area include saw palmetto, wax myrtle, tough buckthorn, nakedwood (*Myrsianthes fragrans*), and rust lyonia (L*yonia feruginea*). Grape vines (*Vitis rotundifolia*) occur throughout the area (CCAFS 2010b). An herb layer is present in disturbed areas with sandy openings and consists of such species as sand cordgrass (*Spartina bakerii*), gopher apple (*Licania michauzii*), prickly pear cactus (*Opuntia humifusa*), partridge pea (*Galactia elliottii*), milkwort (*Polygala* sp.), blueberry (*Vaccinium* sp.), hempvine (*Mikania scandens*), and Madagascar periwinkle (*Catharantus roseus*). Brazilian pepper is found along the edges of disturbed areas throughout this area at CCAFS.

This vegetative community appears to be the remnant of historic vegetative community at the CCAFS, however the quality and distribution of this habitat has been altered by the creation and operation of the launch base. The construction of roads, airfields, buildings, lines of sight, utilities, launch complexes, and artificial drainages have altered this natural vegetative community to some extent. In areas such as those immediately adjacent to the airfield, native vegetation has been intentionally replaced with maintained grasses. Invasive species utilize disturbance corridors and replace native vegetation. The predominant invasive species at CCAFS is Brazilian pepper followed by Australian pine (*Casuarina glauca*), cogon grass (*Imperata cylindrica*), melaleuca (*Melaleuca quinquenervia*), and small populations of thistles and nettles.

Implementation of the Proposed Action is anticipated to remove approximately 5 acres of vegetative habitat. The majority of these impacts are associated with the construction of the hangar, parking apron, and taxiway. These impacts would occur in a portion of the installation that was previously evaluated for environmental impacts for the Skid Strip ADP (CCAFS 2004). The Skid Strip ADP EA evaluated the impacts of the loss of approximately 411 acres of vegetative habitat and concluded that the potential impacts to the vegetative habitat would be minimized by the restoration of 1,157 acres of similar habitat at CCAFS (CCAFS 2009).

3.6.2.3 Alternative 3: Renovate Hangar F

No new construction would occur under this alternative and impacts to vegetative habitat would be similar to the No Action Alternative.

3.6.2.4 Alternative 4: Renovate Hangar C

Implementation of Alternative C would impact approximately 3.5 acres of maritime hammock along the edge of the proposed tow way. These impacts are considered minor and would not result in a significant impact due to the low quality of the maritime hammock in this portion of the installation and the abundance of this habitat type at CCAFS.

3.7 WILDLIFE RESOURCES

3.7.1 Affected Environment

Various wildlife studies and observations indicate that CCAFS supports a diversity of wildlife species. The Integrated Natural Resources Management Plan (INRMP) lists 175 species of birds, 28 mammal species, 37 species of amphibians and reptiles, and an unknown number of fish species.

CCAFS is located along the Atlantic Flyway and a variety of birds utilize the habitat in the vicinity of CCAFS for winter habitat, foraging during migration, or for nesting and breeding habitat.

During November waterfowl such as black scoter (*Melanitta americana*), blue-winged teal (*Anas discors*), lesser scaup (*Aythya affinis*), northern pintail (*Anas acuta*), red-breasted merganser (*Mergus serrator*), and northern shoveler (*Anas clypeata*) occupy the installation. Neotropical migrants observed on the installation include species such as blue-winged (*Vermivora pinus*) and black and white warblers (*Mniotilta varia*), yellow-throated (*Vireo flavifrons*) and red-eyed vireos (*Vireo olivaceus*), eastern kingbird (*Tyrannus tyrannus*), ovenbird (*Seiurus aurocapillus*), and the American redstart (*Setophaga ruticilla*). Migrating raptors include merlin (*Falco columbarius*), Cooper's hawk (*Accipiter cooperii*), and peregrine falcons (*Falco peregrinus*) as well as resident raptors such as red-tailed hawks (*Buteo jamaicensis*), red-shouldered hawks (*Buteo lineatus*), ospreys (*Pandion haliaetus*), and American kestrel (*Falco sparverius*) (CCAFS 2008).

Numerous birds occupy the scrub and hammock habitat found at CCAFS. Species include the mourning dove (*Zenaida macroura*), gray catbird (*Dumetella carolinensis*), rufous-sided towhee (*Pipilo erythrophthalmus*), common yellowthroat (*Geothlypis trichas*), and red-bellied woodpeckers (*Melanerpes carolinus*). Shorebirds observed at CCAFS include black-necked stilt (*Himantopus mexicanus*), willet (*Tringa semipalmata*), ruddy turnstone (*Arenaria interpres)*, great blue heron (*Ardea herodias*), and roseate spoonbill (*Platalea ajaja*) (CCAFS 2008).

Large and medium sized mammal species commonly found at CCAFS include white-tailed deer (*Odocoileus virginianus*), armadillo (*Dasypus novemcinctus*), bobcat (*Lynx rufus*), feral hog (*Sus scrofa*), raccoons (*Procyon lotor*), and round-tailed muskrat (*Neofiber alleni*). Small mammals observed at the installation include eastern gray squirrel (*Sciurus carolinensis*), eastern mole (*Scalopus aquaticus*), least shrew (*Cryptotis parva*), cotton mouse (*Peromyscus gossypinus*), Norway rat (*Rattus norvegicus*), eastern cottontail rabbit (*Sylvilagus floridanus*), and pocket gopher (*Geomys pinetis*). Two bat species, the Seminole bat (*Lasiurus seminolus*) and the yellow bat (*Lasiurus intermedius*) have been observed at CCAFS. Reptiles observed at CCAFS include the Florida box turtle (*Terrapene carolina bauri*), northern diamondback terrapin (*Malaclemys terrapin terrapin*), Florida cooter (*Chrysemys floridana floridana*), eastern garter snake (*Thamnophis sirtalis sirtalis*), black racer (*Coluber constrictor*), dusky pygmy rattlesnake (*Sistrurus miliarius barbouri*), eastern coral snake (*Micrurus fulvius fulvius*), eastern diamondback and the green (*Anolis carolinensis*) and brown anole (*A sagrei*). Amphibians include eastern spadefoot toad (*Scaphiopus holbrooki holbrooki*), green tree frog (*Hyla cinerea*), southern leopard frog (*Rana utricularis*), and gopher frog (*Rana capito*) (CCAFS 2008).

CCAFS implements a Bird/Wildlife Aircraft Strike Hazard (BASH) plan due to resident and migratory bird/wildlife species on the installation and in the general vicinity. The 2009 BASH Plan implements the program required by AFI 91-202, *The U.S. Air Force Mishap Prevention Program*. It provides a base program to minimize bird strikes to aircraft by identifying hazards and applying risk controls to eliminate or lower the risk of bird strikes, as discussed in USAF Pamphlet 91-212, *BASH Management Techniques.* The plan is designed to: establish a bird hazard working group; establish procedures to identify high hazard situations; establish aircraft and airfield operating procedures to avoid high-hazard situations; provide means of disseminating bird hazard information to all assigned and transient aircrews and procedures for bird avoidance; establish procedures and guidelines to decrease airfield attractiveness to birds in accordance with AFI 32-7064, *Integrated Natural Resources Management*; and provide guidelines for dispersing birds when they congregate on the airfield (45 SW OPlan 91-212 2009a).

3.7.2 Environmental Consequences

3.7.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no CBP personnel or assets would remain at CCAFS and no impacts to wildlife would occur. Conditions would remain as described in Section 3.7.

3.7.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Impacts to wildlife are anticipated to be the same as those described in the Skid Strip ADP EA (CCAFS 2009). The Proposed Action is occurring in the same location as described in that EA and would replace hangar and administrative facilities proposed by the USAF with similar facilities proposed by CBP. The 2009 EA evaluated a project that would extend over a period of eight years and remove approximately 411 acres of wildlife habitat. Construction of a new hangar and associated facilities for the CBP mission is anticipated to take less than two years and impact less than five acres of wildlife habitat.

Impacts to wildlife species are anticipated to be minimal as a result of implementing the Proposed Action alternative. Construction related impacts are anticipated to cause disruption to populations of wildlife in the vicinity of the Proposed Action. These impacts would be short-term and temporary.

There is the potential for species protected by the Migratory Bird Treaty Act to occur with the project area. Avian surveys would occur immediately before construction activities to identify the presence of any nests. Monitoring during construction would identify potential disturbances so measures could be implemented to avoid adverse effects.

In addition to the potential for migratory bird impacts during construction, this action represents an increase in the number of flight operations at CCAFS which has the potential to increase mortality in bird species due to bird aircraft strikes. CCAFS has an active BASH plan as discussed in Sections 3.7.1 and 3.16. This program reduces the potential for bird strikes at CCAFS and it is not anticipated that the increase in aircraft operations associated with the Proposed Action would result in a significant increase in migratory bird mortality.

It is anticipated that the majority of wildlife species would not be located in areas of construction but some mortality would result because of some species not being able to leave the area. The Proposed Action would permanently remove approximately five acres of scrub/saw-palmetto habitat at CCAFS. These impacts are not anticipated to represent a significant impact due to the mitigation of Scrub-jay habitat described in Section 3.8.

3.7.2.3 Alternative 3: Renovate Hangar F

No new construction would occur under this alternative and impacts to wildlife would be similar to the No Action Alternative.

3.7.2.4 Alternative 4: Renovate Hangar C

Impacts to wildlife under Alternative 4 would be minimal and similar in nature to those described under Alternative 2. Implementation of Alternative 4 would result in fewer impacts to wildlife habitat due to the minor construction requirements under this alternative. Impacts would be limited to an approximately 3.5 acre area adjacent to Control Tower Road. Vegetation within 60 feet of this road would be cleared for a tow way right of way. Avian surveys would occur prior to construction and monitoring during construction would identify potential disturbances to protected species. No significant impacts to wildlife are anticipated as a result of implementing Alternative 4.

3.8 THREATENED AND ENDANGERED SPECIES

3.8.1 Affected Environment

Under the Endangered Species Act (ESA) (16 USC 1536), an “endangered species” is defined as any species in danger of extinction throughout all or a significant portion of its range. A “threatened species” is defined as any species likely to become an endangered species in the foreseeable future. The U.S. Fish and Wildlife Service (USFWS) also maintains a list of species considered to be candidates for possible listing under the ESA. Although candidate species receive no statutory protection under the ESA, the USFWS has attempted to advise government agencies, industries, and the public that these species are at risk and may warrant future protection under the ESA.

The CCAFS INRMP lists 11 federally endangered and six threatened species that have been observed at CCAFS or are known to occur in the vicinity of the installation (Table 3-1). Slightly more than half of these species (9 of 17) are marine species and include four species of sea turtles, four species of whale, and the Florida manatee. The Atlantic loggerhead sea turtle, Atlantic green sea turtle, and the leatherback sea turtle have all been observed nesting on CCAFS beaches. Manatees have been observed in the turning basin on the west side of Cape Canaveral and in the Trident basin located at the southern border of the station. Several species of whale have been observed in the Atlantic Ocean in the vicinity of CCAFS. None of the marine species would be affected through implementation of the Proposed Action or alternatives.

Other federally listed species located or potentially located at CCAFS are primarily terrestrial and include two mammal species (southeastern beach mouse, gray bat), three bird species (Florida Scrub-jay, wood stork, piping plover), and two reptile species (American alligator, eastern indigo snake). The American alligator is the only federally listed species that actively uses freshwater aquatic habitats at CCAFS.

In addition to federally listed species, the Florida Fish and Wildlife Conservation Commission (FWCC) maintains a list of imperiled animal species specific to the state of Florida. This list includes endangered, threatened, and species of special concern. The Florida Department of Agriculture and Consumer Service maintain a list of state endangered, threatened, and commercially exploited plants. State listed species known to occur at CCAFS are listed in Table 3-1.

Table 3-1. Threatened and Endangered Species of Flora and Fauna Found on and in The Vicinity of CCAFS

Common Name	Scientific Name	Status	
		Federal	State
PLANTS			
Curtiss' milkweed	*Asclepias curtissii*		E
Sand dune spurge	*Chamaesyce cumulicola*		E
Satinleaf	*Chrysophyllum oliviforme*		T
Florida lantana	*Lantana depressa var. floridana*		E
Nodding pinweed	*Lechea cernua*		T
Hand fern	*Ophioglossum palmatum*		E
Nakedwood, Simpson's stopper	*Myrcianthes fragrans*		T
Shell mound prickly-pear cactus	*Opuntia stricta*		T
Beach star	*Remirea maritime*		E
Scaevola, inkberry	*Scaevola plumieri*		T
Sea lavender	*Tournefortia gnaphalodes*		E
Coastal vervain	*Verbena maritime*		E
REPTILES AND AMPHIBIANS			
American Alligator	*Alligator mississippiensis*	T (S/A)	SSC
Atlantic Loggerhead Turtle	*Caretta caretta*	T	T
Atlantic Green Turtle	*Chelonia mydas*	E	E
Leatherback Turtle	*Dermochelys coriacea*	E	E
Atlantic Ridley Sea Turtle	*Lepidochelys kempi*	E	E
Hawksbill Turtle *	*Eretmochelys imbricata*	E	E
Gopher Tortoise	*Gopherus polyphemus*		T
Eastern Indigo Snake	*Drymarchon corais couperi*	T	T
Florida Pine Snake	*Pituophis melanoleucus mugitus*		SSC
Florida Gopher Frog	*Rana capito aesopus*		SSC
BIRDS			
Roseate Spoonbill	*Ajaia ajaja*		SSC
Florida Scrub-Jay	*Aphelocoma coerulescens*	T	T
Piping Plover	*Charadrius melodus*	T	T
Little Blue Heron	*Egretta caerulea*		SSC
Reddish Egret	*Egretta rufescens*		SSC
Snowy Egret	*Egretta thula*		SSC
Tricolored Heron	*Egretta tricolor*		SSC
White Ibis	*Eudocimus albus*		SSC

Table 3-1. Threatened and Endangered Species of Flora and Fauna Found on and in The Vicinity of CCAFS (cont'd)

Common Name	Scientific Name	Status	
		Federal	State
BIRDS (cont'd)			
Arctic Peregrine Falcon	*Falco peregrinus tundrius*		E
Southeastern American Kestrel	*Falco sparverius paulus*		T
American Oystercatcher	*Haematopus palliates*		SSC
Wood Stork	*Mycteria americana*	E	E
Brown Pelican	*Pelecanus occidentalis*		SSC
Black Skimmer	*Rynchops niger*		SSC
Least Tern	*Sterna antillarum*		T
MAMMALS			
Right Whale *	*Balaena glacialis*	E	E
Sei Whale *	*Balaenoptera borealis*	E	E
Finback Whale *	*Balaenoptera physalus*	E	E
Humpback Whale *	*Megaptera novaeangliae*	E	E
Gray Bat *	*Myotis grisescens*	E	E
Southeastern Beach Mouse	*Peromyscus polionotus niveiventris*	T	T
Florida Mouse	*Podomys floridanus*		SSC
Florida Manatee	*Trichechus manatus*	E	T

Source: CCAFS 2008
SSC – Species of Special Concern
T – Threatened
E – Endangered
S/A – Similar in Appearance
* Not observed on CCAFS, but known to occur in the vicinity.

3.8.2 Environmental Consequences

3.8.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no CBP Air and Marine (A&M) personnel or assets would deploy to CCAFS and no impacts to threatened or endangered species would occur. Conditions would remain as described above.

3.8.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

As noted earlier, this project is occurring in the same location that was previously evaluated under the Skid Strip ADP EA. Three federally threatened wildlife species

(Florida Scrub-jay, southeastern beach mouse, and eastern indigo snake) and one Florida threatened species (gopher tortoise) have the potential to be impacted by the implementation of the Proposed Action. Construction activities have the potential to impact these wildlife species from activities such as disturbance, excavation, crushing or burial. The USFWS has determined that implementation of the Proposed Action is not likely to jeopardize the continued existence of the Florida Scrub-jay, southeastern beach mouse or eastern indigo snake. It is important to note that all of the disturbance proposed under the 2009 Skid Strip EA would not be required for this project.

Florida Scrub-Jay. Direct impacts to the Florida Scrub-jay would include the loss of habitat for one group of Florida Scrub-jay. The loss of this habitat may result in a “take.” This group of Florida Scrub-jays was evaluated in the Skid Strip ADP EA which anticipated the loss of habitat to potentially impact 12 groups of Florida Scrub-jays. It is possible that, as construction proceeds, Florida Scrub-jays would move away from the construction site; however, the USFWS anticipates that “take” would occur. Clearing would be restricted to outside the nesting season; therefore, mortality associated with actual clearing activities is not expected to occur. The Skid Strip ADP EA proposed to minimize impacts by restoring 1,157.48 acres of potential Scrub-jay, southeastern beach mouse, and eastern indigo snake habitat at CCAFS over a nine-year period. In accordance with the ESA, the USFWS prepared a biological opinion (BO) on this Action in May of 2008 and has issued an “Incidental Take Statement” for the clearing required under the Skid Strip EA Action. The USFWS has confirmed that this project falls within the biological opinion. This correspondence is included in Appendix A, the biological opinion is included in Appendix D.

Indirect impacts were also evaluated under the Skid Strip EA. Potential negative indirect impacts included the chance of increased mortality due to an increase in the operations of the Skid Strip. The increase in operations would add to vehicular traffic along roadways adjacent to occupied habitat, possibly resulting in Scrub-jays being struck by vehicles. A potential positive indirect impact was the increase in habitat due to proposed habitat restoration and management activities. These activities are expected to enhance Scrub-jay dispersal when complete. The same indirect impacts are anticipated as a result of implementing the Proposed Action.

Mitigation for direct and indirect impacts to the Scrub-jay would compensate for impacts caused by the Proposed Action. Provided the following mitigation measures are implemented, the Proposed Action would not significantly impact the Scrub-jay population at CCAFS. Reasonable and prudent measures and the Terms and Conditions of the BO prepared as part of the Skid Strip EA are included in Appendix C. Again, it is important to note that the clearing required under this project is only a small percentage of that evaluated in the 2009 Skid Strip EA.

The USAF proposes to restore unoccupied Scrub-jay habitat at a ratio of 3:1 (every acre lost would require compensation in the amount of three acres). For each phase of clearing around the Skid Strip, there would be a corresponding project to restore habitat. A combination of mechanical treatment and prescribed burning would be used to restore habitat. In addition to the creation of habitat, CCAFS would avoid construction in Scrub-jay occupied areas during the nesting season from March 1 through June 30; ensure that prior to clearing of Scrub-jay habitat there is suitable habitat within 1,200 feet; that the USFWS would be notified of any unauthorized taking of Scrub-jays identified during construction; and that CCAFS would conduct routine Scrub-jay monitoring and submit reports describing the actions taken to implement the terms and conditions of the “Incidental Take Statement.”

If a dead Scrub-jay is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville.

Southeastern Beach Mouse. According to the Skid Strip Development EA, the majority of habitat in the vicinity of the Skid Strip is overgrown and is not likely to support beach mice. However, some small mammal burrows have been observed in similar habitat elsewhere on the installation and trapping in similar habitat approximately 0.5 miles to the south of the Skid Strip resulted in the capture of beach mice. Therefore, a take of an unknown number of beach mice was anticipated as a result of implementation of the clearing described under the Skid Strip EA and thus a take could also be possible under this Proposed Action. The take would result from the loss of habitat and the destruction of burrows. In accordance with Section 7 of the ESA, the USFWS prepared a BO on the Action described in the Skid Strip EA in May of 2008 and has issued an “Incidental Take Statement” for that Action, which would include the Proposed Action described in this document. Indirect effects of the Proposed Action would include the continued loss of foraging habitat for the southeastern beach mouse.

The following mitigation measures were included in the Skid Strip ADP EA. Mitigation for direct and indirect impacts to the southeastern beach mouse would offset impacts caused by the Proposed Action. Provided the following mitigation measures are implemented, the Proposed Action would not significantly impact the southeastern beach mouse population at CCAFS.

The proposed restoration of habitat for the Scrub-jay is expected to be beneficial to southeastern beach mice. Based on a three-year study recently completed for CCAFS, beach mice are benefiting from the same land management activities being conducted for Scrub-jays, and the population is expanding into inland locations. Therefore, the potential exists to create an additional 1,000+ acres of habitat for beach mice. Based on observations by USAF biologists of small mammal burrows around the current Skid Strip clear zone, the expansion of that zone has the potential to provide additional habitat. If a dead beach mouse is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville.

Eastern Indigo Snake. Direct impacts could potentially occur to the eastern indigo snake as a result of clearing and grading activities associated with the construction of the facilities listed in the Proposed Action. As stated in the Skid Strip Development EA, the probability and level of incidental take is dependent upon the number of eastern indigo snakes within the region; their ability to disperse; and the amount and distribution of available suitable habitat elsewhere. It is possible that, as construction proceeds, they would move away from the construction site; however, the USFWS anticipates that “take” would occur. Incidental take in the form of mortality to eastern indigo snakes would be avoided through preconstruction surveys and relocation of any individuals present within the boundaries of the work area. As part of the effort to minimize impacts to the gopher tortoise, prior to any land disturbance activities, a survey would be required to identify locations of gopher tortoise burrows within the project areas. This survey would include a burrow count and habitat characterization and would be conducted in accordance with Florida FWCC guidelines. Attempts would be made to relocate eastern indigo snakes encountered during gopher tortoise burrow excavation to land outside the project area. In accordance with Section 7 of the ESA, the USFWS prepared a BO in May 2008 for the action described in the Skid Strip EA, which includes this Action. The USFWS has issued an "Incidental Take Statement" take that would cover this Action.

Indirect impacts were also evaluated under the Skid Strip EA. Potential negative indirect impacts included the chance of increased mortality due to an increase in the operations of the Skid Strip. The increase in operations would increase vehicular traffic along roadways adjacent to occupied habitat, possibly resulting in eastern indigo snakes being struck by vehicles. In addition, the loss of habitat due to construction activities is likely to increase movement of the snakes and increase the risk of being struck by a vehicle.

The following mitigation measures were included in the Skid Strip ADP EA. Mitigation for direct and indirect impacts to the eastern indigo snake would offset impacts caused by the Proposed Action. Therefore, the Proposed Action would not significantly impact the eastern indigo snake population at CCAFS provided the reasonable and prudent measures are implemented. Reasonable and prudent measures and the Terms and Conditions of the BO are included in Appendix C. Generally, those mitigation measures include the following.

The 45th SW Indigo Snake Protection/Education Plan would be presented to the project manager, construction manager, and personnel. An educational sign would be displayed at the site informing personnel of the snake's appearance, its protected status, and who to contact if any are spotted in the area. If any indigo snakes are encountered during clearing activities, they would be allowed to safely leave the area on their own. Furthermore, indigo snakes encountered during gopher tortoise burrow excavation, if required, would be safely moved out of the project area. An eastern indigo snake monitoring report would be submitted in the event that any indigo snakes are observed. If a dead indigo is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville. Only individuals with permits should attempt to capture or handle the eastern indigo snakes. If an indigo snake is held in captivity, it should be released as soon as possible in release sites approved by the USFWS on the CCAFS.

Gopher Tortoise. Direct impacts could potentially occur to the gopher tortoise as a result of clearing and grading activities associated with the construction of the facilities listed in the Proposed Action. As stated in the Skid Strip ADP EA, significant impacts to gopher tortoises are not expected provided that minimization measures are implemented. Pre-construction surveys would be conducted to find tortoises that are within the project area. These tortoise surveys are conducted in accordance with FWCC guidelines and include a burrow count and habitat characterization. Tortoises found during pre-construction surveys would be relocated to nearby viable habitat within CCAFS areas. A monitoring report is submitted if any gopher tortoises are relocated. If a dead gopher tortoise is found at the project site, it would be salvaged in accordance with proper protocols and the FWCC is notified.

Marine Turtles. No direct impacts to marine turtles are anticipated as a result of implementing the Proposed Action. However, there is a possibility that lighting from the proposed project area could be visible to sea turtles. Lighting that is visible from the beach can cause disorientation in adult and hatching sea turtles resulting in movements landward instead of seaward. This may result in increased mortality. CCAFS has developed a 45th SW Instruction (45th SW Instruction 32-7001, Exterior Lighting Management) to minimize potential impacts of lighting on sea turtle movements. All facilities at CCAFS are required to comply with this instruction. In order to comply with these instructions, CBP will prepare and submit a light management plan for operations at CCAFS through the USAF for approval by the USFWS. Significant impacts to sea turtles are not anticipated as a result of implementing the Proposed Action as long as an approved lighting management plan is followed.

3.8.2.3 Alternative 3: Renovate Hangar F

No additional construction or habitat disturbance would occur as a result of implementing Alternative 3 and therefore no impacts to federal or state listed species are anticipated.

3.8.2.4 Alternative 4: Renovate Hangar C

Implementation of Alternative C would impact approximately 3.5 acres of maritime hammock along the edge of the proposed tow way. No populations of Florida Scrub-jay are known to occur in this portion of the installation. Maritime hammock is not considered a suitable habit for the Scrub-jay and therefore impacts to this species are not anticipated to occur. There is a potential for impacts to eastern indigo snake and gopher tortoise due to clearing and grading activities associated with expanding the existing road for use as a tow way. Impacts would be similar to those described in Section 3.8.2.2. Coordination with USFWS has occurred regarding potential impacts associated with Alternative 4 (Appendix A).

3.9 CULTURAL, HISTORICAL, AND ARCHEOLOGICAL RESOURCES

Cultural resources are any prehistoric or historic district, site, building, structure, or object considered important to a culture, subculture, or community for scientific, traditional, religious or other purposes. They include archaeological resources, historic architectural resources, and traditional resources. Archaeological resources are locations where prehistoric or historic activity measurably altered the earth or produced deposits of physical remains (e.g., arrowheads, bottles). Historic architectural resources include standing buildings and other structures of historic or aesthetic significance. Traditional resources are associated with cultural practices and beliefs of a living community which are rooted in its history and are important in maintaining the continuing cultural identity of the community.

Historic properties (as defined in 36 CFR 60.4) are significant archaeological, architectural, or traditional resources eligible for listing, or listed in, the National Register of Historic Places (NRHP). Historic properties are evaluated for potential adverse impacts from an action, as are significant traditional resources identified by American Indian tribes or other groups. Executive Order (EO) 13175, Consultation and Coordination with Indian Tribal Governments requires in part that federal agencies establish regular and meaningful consultation and collaboration with tribal officials in developing federal policies that have tribal implications and conduct such collaboration in a government-to-government relationship. The ROI for cultural resources for the Proposed Action consists of those portions of CCAFS that would be directly affected by ground-disturbing activities and building alterations, as well as all lands under the current airspace and the proposed Certificates of Authorization (COAs).

3.9.1 Affected Environment

3.9.1.1 Historic Context

Humans first occupied Florida between 12,000 and 10,000 years ago during the Paleoindian Period, the oldest known cultural tradition in native North America. To date, no archaeological remains from the Paleoindian Period have been discovered at CCAFS. Archaeological investigations at CCAFS indicate that human occupation of the Cape Canaveral Peninsula area first occurred during the subsequent Archaic Period by at least 4,000 years ago (45 SW 2004).

Prehistoric occupation periods represented by archaeological remains at CCAFS include the Late Archaic/Orange/Transitional Period, the St. John's I/Malabar I Period, and the St. John's II/Malabar II Period. Early settlement was focused within the Banana River Lagoon salt marsh area; however, there is archaeological evidence that the entire peninsula was exploited for a wide variety of marine, estuarine, and terrestrial resources. At the time of European contact, the Cape Canaveral Peninsula was populated by a group of Indians known as the Ais. Based on Spanish accounts the Ais were a chiefdom level society who maintained a non-agricultural subsistence economy based on hunting, fishing, and gathering. The subsistence economy likely had remained unchanged from the end of the Late Archaic Period due to the abundant naturally occurring food resources (45 SW 2004).

Historic occupation periods of CCAFS include First Spanish (1513-1763), British (1763-1783), Second Spanish (1783-1821), American Territorial (1821-1842), Early Statehood (1842-1861), Civil War (1861-1865), Reconstruction and Late Nineteenth Century (1865-1899), and Twentieth Century (1900+). Spanish explorers were first known to have visited the CCAFS area in 1513 when Ponce de Leon first set foot in Florida near Cape Canaveral. The first recorded encounter between the Ais and Europeans was in 1605 when Alvar Mexia, a soldier stationed at St. Augustine, visited Cape Canaveral. Over the years there were periodic encounters between the Ais and Spanish who also made treaties with them. Although the Cape was not settled by the Spanish, the Indian River area became fall and winter fishing grounds for some Spaniards by the 1760s. The British did not inhabit the Cape during their two decades of rule in Florida which is known as the British Period (45 SW 2004). During this period, the area was subjected to slave raids, and diseases depopulated the region; the death of the last of the Ais was recorded in Cuba in 1783.

During the Second Spanish Period, the Spanish regained control of Florida under the 1783 Treaty of Paris but could not maintain it. Cape Canaveral, with its isolation, vegetation, and soils, was not attractive to 18th century Spanish planters. The CCAFS area remained essentially devoid of human occupation until the American Territorial Period when the Seminole Indians were known to occupy Central Florida, and Douglas Dummett homesteaded lands north of what is now KSC. The earliest documented continuous human occupation of CCAFS was in the mid-1840s when veterans of the Seminole Indian Wars were granted land patents for their service in the wars. A number of temporary Army posts had been established in the Indian River area during the second Seminole Indian War, including Fort Ann, north of Cape Canaveral. The presence of the forts encouraged settlement, and some of the names of these forts still exist today (45 SW 2004).

Due to the concerns about the safe passage of vessels sailing the notably treacherous waters of Cape Canaveral and the Straits of Florida, the first lighthouse was established on what is now CCAFS in 1844. There were no battles on Cape Canaveral during the Civil War, and the population remained low. During the Reconstruction and Post Reconstruction years following the Civil War, displaced southerners, former slaves, and veterans from the north moved to Florida to begin a new life, many of whom were prospective orange growers lured by advertisements promising great profits for little work. CCAFS remained somewhat isolated until well into the 1880s and was accessible only by boat. Transportation improvements brought more homesteaders to Cape Canaveral between 1875 and 1925, and by the time of the Florida Land Boom in the 1920s small communities were springing up on the island. This ended with the start of the Great Depression and remained after World War II.

Government interest in Cape Canaveral increased in the late 1940s when they began buying land from the state to establish a long-range proving ground. In 1946, a committee formed by the Department of Defense (DoD) chose Cape Canaveral for a mission test center. The evolution of facilities at CCAFS has been divided into three phases including Early Launches (1950-1955), the Industrial Area Development (1950-present), and the Vertical Integration or Assembly Concept (1964-present) (45 SW 2004). The first construction activity at CCAFS included a road leading to a point one-half mile northeast of the lighthouse, as well as very simple and primitive launch pads and related facilities for the earliest missiles. In the early 1950s, launch activities were confined to the area near the tip of the Cape, which included a communications building, a water plant, a fire fighting unit, and numerous camera roads. A few hangars (C and O) were built near the launching areas at the tip of the Cape, but as the missiles became larger, more sophisticated, and more explosive, safety considerations required a support area further from the launch pads (45 SW 2004).

In the mid-1950s, greatly increased missile development efforts related to national security brought about development of the Industrial Area of the Cape adjacent to the Banana River midway between the northern and southern boundaries of CCAFS. It included missile assembly buildings, shops, laboratories, a cafeteria, heating and power plants, operational buildings, a fire station, chemical storage buildings, and miscellaneous utilities, structures, and systems. By the early to mid-1960s, missiles were constructed using the vertical integration concept, which meant that the boosters did not have to spend as much time on the pad - requiring fewer new launch pads (45 SW 2004).

As programs were completed or terminated, remaining facilities were used for other functions, demolished, or "abandoned in place" depending on the needs of the military. For these reasons, and also because of the corrosive environment of Florida's coast, little remains of many structures relating to the early missile and space program (45 SW 2004).

3.9.1.2 Archaeological Resources

Prehistoric archaeological sites within CCAFS are typically middens and mounds. A midden is a refuse deposit resulting from human activities, generally consisting of soil, food remains (bone and shell), and discarded artifacts. At CCAFS there are two types of middens. A black earth or sheet midden is identifiable by the presence of black organic soils. They tend to be linear and can range in size from a few meters to a kilometer (or more) in size. A mound can consist of just soil or a combination of shell and soil. A shell midden (or shell mound) is a mound-like deposit of shell. Mounds typically were used for interment of the dead, ceremonial centers, or as the home of high status individuals. At CCAFS both were used as living floors and some are known to contain human remains. Other prehistoric archaeological sites at CCAFS include isolated finds or small clusters of just a few artifacts.

Historic period archaeological sites on CCAFS tend to be homestead/farmstead sites, small surface scatters, linear resources such as former unpaved roads or trails, and cemeteries. Most tend to be twentieth century in origin and not eligible for the NRHP.

Archaeological investigations have been conducted on the Cape Canaveral peninsula and the CCAFS area since the late 19th century. To effectively manage all cultural resources located on CCAFS, the growing body of data pertaining to site and environmental relationships on Cape Canaveral was used to develop an archaeological sensitivity map of CCAFS, which shows high and low levels of probability for finding archaeological sites (45 SW 2004). In 1992 an intensive archeological survey of CCAFS was conducted, which focused on 1,430 acres of land located adjacent to the Banana River shoreline on the west coast of the Cape Canaveral peninsula (45 SW 2004). A total of 56 archaeological sites have been identified and evaluated for NRHP eligibility, of which 14 have been determined to be eligible for listing on the National Register.

3.9.1.3 Architectural Resources

Inventory and evaluation of all the historic buildings and structures at CCAFS has not been completed. However, 21 launch complexes and five individual buildings have been evaluated for NRHP eligibility (Table 3-2). Seven of the properties (six launch complexes and the Original Mission Control Building, which belongs to National Aeronautics and Space Administration [NASA]) are designated as National Historic Landmarks (NHLs). Ten other properties, including seven launch complexes, the Cape Canaveral Lighthouse, the Original Lighthouse Site, and Hangar C have been determined to be eligible for listing on the NRHP. The remaining nine properties evaluated are not considered eligible for the NRHP (45 SW 2004). Although not officially evaluated, the Skid Strip is of sufficient age to be potentially eligible for the NRHP (Penders 2010).

Table 3-2. CCAFS Historic Property Inventory

Property	Construction Date	Early Uses	Previous NRHP Recommendations
Complex 1/2	1951-1953	Snark, Matador	Eligible
Complex 3/4	1950-1952	Bumper, Matador, Bomarc	Eligible
Complex 5/6 *	1955-1956	Project Mercury	Designated NHL
Complex 11	1956-1958	Atlas	Not Eligible
Complex 12	1956-1957	Atlas	Not Eligible
Complex 13	1956-1958	Atlas	Not Eligible
Complex 13 (MST only)	1958	Atlas Agena	Designated NHL
Complex 14	1957	Project Mercury	Designated NHL
Complex 15	1957-1958	Titan I/II	Not Eligible
Complex 16	1957-1958	Titan I	Not Eligible
Complex 17	1956-1957	Thor	Eligible
Complex 18	1956-1957	Vanguard	Not Eligible
Complex 19	1959	Project Gemini	Designated NHL
Complex 21/22	1956-1957	Bull Goose, Matador, Mace	Eligible
Complex 25	1957 & 1968	Polaris, Poseidon	Eligible
Complex 26	1959	Redstone, Jupiter	Designated NHL
Complex 30	1960	Pershing	Not Eligible
Complex 31/32	1959-1960	Minuteman	Eligible
Complex 34 *	1961	Saturn I/IB, Project Apollo	Designated NHL
Complex 37	1962-1963	Saturn I/IB	Not Eligible
Cape Canaveral Lighthouse	1893	Lighthouse	Eligible
Complex 9/10	1955-1956	Navaho	Eligible

Table 3-2. CCAFS Historic Property Inventory (cont'd)

Property	Construction Date	Early Uses	Previous NRHP Recommendations
Hangar C	1953	Missile Research and Development	Eligible
Hangar S	1957	Project Mercury (1959)	Not Eligible
Original Lighthouse Site	1843	Lighthouse	Eligible
Original Mission Control Building *	1957	Project Mercury/Gemini	Designated NHL

*Facility 21900H at Launch Complex 34 is owned by NASA
MST – Mobile Service Tower

3.9.1.4 Traditional Resources

At the present time it is not possible to determine which Native American group or groups were responsible for creating most of the prehistoric archaeological sites. Two tribes, the Seminoles and the Miccosukees, are associated with Cape Canaveral's Native American heritage. However, no American Indian traditional resources or Traditional Cultural Properties have been identified at CCAFS. The Seminole Tribe of Florida and the Miccosukee Tribe of Florida are recognized as the appropriate Native American culture for consultation in the treatment of archaeological sites on CCAFS that can be confidently associated with the Ais culture (45 SW 2004).

3.9.2 Environmental Consequences

Impact analysis for cultural resources focuses on assessing whether the Proposed Action or the alternatives have the potential to affect cultural resources that are eligible for listing in the NRHP or have traditional significance for American Indian groups. Under Section 106 of the National Historic Preservation Act (NHPA), the proponent of the action is responsible for determining whether any historic properties are located in the area; assessing whether the proposed undertaking would adversely affect the resources, and notifying the State Historic Preservation Officer (SHPO) of any adverse effects. An adverse effect is any action that may directly or indirectly change the characteristics that make the historic property eligible for listing in the NRHP. If an adverse effect is identified, the federal agency consults with the SHPO and federally-recognized American Indian tribes to develop measures to avoid, minimize, or mitigate the adverse effects of the undertaking.

Direct impacts may occur by:

- physically altering, damaging, or destroying all or part of a resource;
- altering characteristics of the surrounding environment that contribute to the resource's significance;
- introducing visual or audible elements that are out of character with the property or alter its setting; or
- neglecting the resource to the extent that it deteriorates or is destroyed.

Direct impacts can be assessed by identifying the types and locations of proposed activity and determining the exact location of cultural resources that could be affected. Indirect impacts occur later in time or farther from the Proposed Action. Indirect impacts to cultural resources generally result from the effects of project-induced population increases, such as the need to develop new housing areas, utility services, and other support functions to accommodate population growth. These activities and the subsequent use of the facilities can impact cultural resources.

The ROI for impacts to cultural resources consists of areas of CCAFS that require ground disturbance and the buildings requiring renovation and alteration, as well as all lands under the current airspace and the proposed COAs.

3.9.2.1 Alternative 1: No Action Alternative

Impacts to cultural resources are not expected under the No Action Alternative. The CCAFS would maintain existing facilities and would not build new facilities or infrastructure. Cultural resources would continue to be managed in compliance with federal law and USAF regulations.

3.9.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Under the Proposed Action, CBP is proposing to construct a new hangar, parking apron, and taxiway to the Skid Strip (Figure 2-1). Flight operations of the UAS would utilize existing warning and restricted areas as much as feasible during operations, but would require a COA when transitioning through Class A airspace from one existing restricted/warning area to another.

New construction that would occur under the Proposed Action would have no effect on the 10 NRHP-eligible installation facilities and the seven designated as NHLs (Table 3-2), as they are located well beyond the ROI of the Proposed Action. Changes to the setting or viewscape from the construction would have no effect on NRHP-eligible and potentially eligible installation facilities, including the Skid Strip, because their NRHP eligibility is based, in part, on their association with an active military installation on which infrastructure changes routinely occur.

New construction would have no effect on the 56 known archaeological resources. All of the area required for the proposed project has been identified as a low probability area for the discovery of archaeological resources, based on the existing surveys and excavations (45 SW 2004). However, because all of CCAFS has not been subjected to a cultural resources inventory (45 SW 2004), compliance with Section 106 of the NHPA, including consultation with the Florida SHPO and possible archaeological survey, may be necessary prior to project ground disturbing activities. This consultation occurred during the development of the Skid Strip EA and a copy of that correspondence is included in Appendix A. In addition, the Florida SHPO reviewed this Draft EA and a copy of that correspondence is in Appendix A.

There is always the possibility that previously unknown or unrecorded archaeological resources could be present beneath the ground surface, sometimes underneath existing development. In the unlikely event that previously unrecorded or unevaluated cultural resources are encountered during construction, CCAFS would manage these resources in accordance with the CCAFS Integrated Cultural Resources Management Plan (ICRMP) (45 SW 2004), adhering to federal and state laws, as well as USAF regulations.

Impacts to traditional resources are not expected under the Proposed Action, as no traditional resources have been identified to date within CCAFS.

3.9.2.2.1 Airspace

The proposed COA routes from one existing restricted/warning area to another associated with the Proposed Action are not anticipated to impact cultural resources. Unmanned Aircraft System (UAS) overflight would not have direct or indirect impacts on historic properties.

3.9.2.3 Alternative 3: Renovate Hangar F

No new facilities would be constructed under Alternative 3. However, renovation of the northern half of Hangar F to provide the necessary administrative space for CBP personnel would be required. Renovations would include abatement of lead-based paint and asbestos-containing material (ACM) and then renovation of the existing office space. UAS flight operations would remain as described for Alternative 2.

Hangar F, built in 1956, is the only building that would be directly affected by Alternative 3. Hangar F has not been evaluated for NRHP eligibility. The Florida SHPO was consulted on Alternative 3 and concurred with the U.S. Air Force's determination that the renovations proposed would have no adverse effect on historic properties. However, the Florida SHPO stipulated the following conditions: (a) all proposed alterations are to be submitted to SHPO for review; and (b) all work must comply with the Secretary of Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings. The correspondence associated with that consultation is included in Appendix A.

Impacts to traditional resources are not expected under the Alternative 3, as no traditional resources have been identified to date within CCAFS.

3.9.2.4 Alternative 4: Renovate Hangar C

No new facilities would be constructed Under Alternative 4. However, renovation of Hangar C, including abatement of lead-based paint and ACM, would be necessary for its use by CBP. UAS flight operations would remain as described for Alternative 2.

Hangar C, built in 1956, is the only building that would be directly affected by Alternative 4. Hangar C was utilized during the manned space flight program and is eligible for listing on the NRHP. The Florida SHPO was consulted on Alternative 4 and concurred with the U.S.

Air Force's determination that the renovations proposed would have no adverse effect on historic properties. However, the Florida SHPO stipulated the following conditions: (a) all proposed alterations are to be submitted to SHPO for review; and (b) all work must comply with the Secretary of Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings. The correspondence associated with that consultation is included in Appendix A.

Because all of CCAFS has not been subjected to a cultural resources inventory (45 SW 2004), compliance with Section 106 of the NHPA, including consultation with the Florida SHPO and possible archaeological survey, is generally necessary prior to project ground disturbing activities. The Cape Canaveral consulted with the SHPO during the Skid Strip Development EA and determined that the area in the vicinity of Hangar C is an area of low archaeological potential and no further action would be required in this location. Consultation with the SHPO has occurred regarding this project and the correspondence is included in Appendix A.

Impacts to traditional resources are not expected under Alternative 4, as no traditional resources have been identified to date within CCAFS.

3.10 AIR QUALITY

Air quality is determined by the type and amount of pollutants emitted into the atmosphere, the size and topography of the air basin, and the prevailing meteorological conditions. The levels of pollutants are generally expressed on a concentration basis in units of parts per million (ppm) or micrograms per cubic meter ($\mu g/m^3$).

The baseline standards for pollutant concentrations are the National Ambient Air Quality Standards (NAAQS) and state air quality standards. These standards represent the maximum allowable atmospheric concentration that may occur and still protect public health and welfare. Further discussion of the NAAQS and state air quality standards are included in Appendix B, Air Quality.

Based on measured ambient air pollutant concentrations, the USEPA designates whether areas of the United States meet the NAAQS. Those areas demonstrating compliance with the NAAQS are considered "attainment" areas, whereas those that are not are known as "nonattainment." Those areas that cannot be classified on the basis of available information for a particular pollutant are "unclassifiable" and are treated as attainment areas until proven otherwise.

Climate change has come to the forefront recently and the potential impacts to our climate are assessed by measuring greenhouse gases (GHGs). GHGs are chemical compounds in the earth's atmosphere that trap heat. Gases exhibiting greenhouse properties come from both natural and human sources. Water vapor, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) are examples of GHGs that have both natural and manmade sources, whereas other gases such as those used for aerosols are exclusively manmade. In the United States, GHG emissions come mostly from energy use. These are driven largely by economic growth, fuel used for electricity generation, and weather patterns affecting heating and cooling needs.

In an effort to reduce GHG emissions, climate change research and policy have increased in the recent years. The USEPA, under the Clean Air Act (CAA), and other statutory authorities have taken regulatory actions. GHG federal and state regulations are discussed more fully in Appendix B, Air Quality. Currently there are no standards to determine the significance of impacts with regards to GHG emissions in the NEPA process.

3.10.1 Affected Environment

The Proposed Actions would occur in Cape Canaveral, Florida, which is located in Brevard County within the Central Florida Intrastate Air Quality Control Region (AQCR) 48. AQCR 48 includes the Florida Counties of Brevard, Lake, Orange, Osceola, Seminole, and Volusia. Air pollutant emissions are compared against the ROI of Brevard County. This is a much smaller area than is required by the General Conformity Rule, which recommends using the AQCR, thus this provides a conservative approach.

Florida air quality is monitored by the Florida Department of Environmental Protection's (FDEP's) Division of Air Resource Management. In Brevard County there are three active monitors measuring ozone (O_3) and/or particle pollution. The USEPA has determined that Brevard county is in attainment for all criteria pollutants (USEPA 2010a) and the monitors indicate the 2009 O_3 levels averaged over three months were 66 parts per billion (ppb) which is below the 75 ppb threshold (FDEP 2010).

For comparison purposes, Table 3-3 presents the USEPA's 2002 National Emissions Inventory (NEI) data for Brevard County (USEPA 2002). The county data includes emissions data from point sources, area source, and mobile sources. *Point sources* are stationary sources that can be identified by name and location. *Area sources* are point sources whose emissions are too small to track individually, such as a home or small office building or a diffuse stationary source, such as wildfires or agricultural tilling. *Mobile sources* are any kind of vehicle or equipment with gasoline or diesel engine, an airplane, or a ship. Two types of mobile sources are considered: on-road and non-road.

On-road mobile sources consist of vehicles such as cars, light trucks, heavy trucks, buses, engines, and motorcycles. Non-road sources are aircraft, locomotives, diesel and gasoline boats and ships, personal watercraft, lawn and garden equipment, agricultural and construction equipment, and recreational vehicles (USEPA 2005).

Table 3-3. Baseline Emissions Inventory for Brevard County

	Emissions (tons/year)					
Source Type	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**VOC**
Area Source	2,161	666	13,026	1,792	374	13,100
Non-Road Mobile	47,071	3,777	496	449	435	6,364
On-Road Mobile	123,813	15,239	420	307	721	12,014
Point Source	1,324	12,152	2,525	2,122	15,547	659
Total	*174,369*	*31,834*	*16,467*	*4,670*	*17,078*	*32,137*

CO = Carbon monoxide; NO_x = Nitrogen oxides; PM_{10} = Particulate matter with a diameter less than or equal to 2.5 microns; $PM_{2.5}$ = Particulate matter with a diameter less than or equal to 10 microns; SO_2 = Sulfur dioxide; VOC = Volatile organic compound
Source: USEPA 2002

Florida state CO_2 level is estimated from fossil fuel combustion, by commercial, industrial, residential, transportation, and electric power, in million metric tons of carbon dioxide ($MMTCO_2$) from 1990 through 2007 (USEPA 2010b). These CO_2 levels were estimated using fuel consumption data from the Department of Energy, (Energy Information Administration *DOE.EIA State Energy Data 2007 Consumption Tables* and emission factors from the *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 – 2007)*. A ten year average of CO_2 emissions for the state of Florida are shown in Table 3-4.

Table 3-4. Average Florida Carbon Dioxide Emissions 1997-2007

Sector	**Average CO_2 Emissions1997-2007 ($MMTCO_2$)**
Total	*243.12*
Commercial	4.23
Industrial	14.85
Residential	1.88
Transportation	102.90
Electric Power	119.25

Source: USEPA 2010b

3.10.2 Environmental Consequences

The CAA Section 176(c), General Conformity, requires federal agencies to demonstrate that their proposed activities would conform to the applicable State Implementation Plan (SIP) for attainment of the NAAQS. General conformity applies only to nonattainment and maintenance areas. If the emissions from a federal action proposed in a nonattainment area exceed annual *de minimis* thresholds identified in the rule, a formal conformity determination is required of that action. The thresholds are more restrictive as the severity of the nonattainment status of the region increases. Because the project region is designated as attainment for all criteria pollutants, a conformity analysis is not required. The construction and Guardian flight operations proposed by CBP are compared to Brevard County, which is in attainment.

In order to evaluate the air emissions and their impact to the overall ROI, the emissions associated with the project activities were compared to the total emissions on a pollutant-by-pollutant basis for the ROI's 2002 NEI data (USAF, undated b). Potential adverse impacts to air quality are identified as the total emissions of any pollutant that equals 10 percent or more of the ROI's emissions for that specific pollutant. The 10-percent criteria approach is used in the USEPA's General Conformity Rule as an indicator for impact analysis for nonattainment and maintenance areas. Although Brevard County is attainment, the General Conformity Rule's impact analysis was utilized to provide a consistent approach to evaluating the impact of construction. Rather than comparing emissions from construction activities to regional inventories (as required in the General Conformity Rule), emissions were compared to the individual county (Brevard) potentially impacted, which is a smaller area than required. CO_2 (GHG) emissions from construction equipment, worker trips, and the Guardian operations are compared to the total 10 year average CO_2 emissions for the state of Florida.

The Air Conformity Applicability Model (ACAM) version 4.3.0 was utilized to provide a level of consistency with respect to emissions factors and calculations. The ACAM provides estimated air emissions from proposed federal actions in areas designated as non-attainment and/or maintenance for each specific criteria and precursor pollutant as defined in the NAAQS. ACAM was utilized to provide emissions for construction, demolition, grading, and paving activities by providing user inputs for each; details are discussed in Appendix B, Air Quality. Guardian aircraft emissions were calculated in Microsoft Excel using emission factors from the *USAF* [Institute for Environmental Safety and Occupational Health Risk Analysis] *IERA Air Emissions Inventory Guidance Document for Mobile Sources at Air Force Installations*. CO_2 emissions for both construction and operational emissions were calculated in Microsoft Excel using emission factors for pounds of CO_2 in the fuels used.

Since all potentially affected areas are in attainment for the criteria pollutants, no conformity determination in accordance with 42 USC 7506(c) (CAA Sec. 176(c)) is required for the proposed action.

The air quality analysis focused on emissions associated with the construction activities and operational activities of the Guardian aircraft at CCAFS.

3.10.2.1 Alternative 1: No Action Alternative

Under Alternative 1 there would be no new Guardian operations or new construction and therefore air quality would not change from current levels. Thus no change or impact to air quality would occur for Alternative 1.

3.10.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

The Proposed Action includes the construction of a new hangar, vehicle parking area, Guardian aircraft parking apron, and taxiway. Emissions are based on the construction of a 8,840 ft^2 hangar, a 14,135 ft^2 administrative facility, a 34,200 ft^2 parking apron, approximately 3.6 acres of paved surface for a new taxiway, and approximately 16,120 ft^2 of paved vehicle parking area. It was assumed that all of the area would require grading (5.28 acres) and would be completed in a single year. Construction emissions are shown in Table 3-5.

Table 3-5. Proposed Action Construction Emissions

	Emissions (tons/year)				
Source Category	**CO**	**NO_x**	**PM_{10}**	**SO_2**	**VOC**
Grading Equipment	0.264	0.995	0.082	0.101	0.106
Grading Operations	0.000	0.000	29.165	0.000	0.000
Acres Paved	0.000	0.000	0.000	0.000	0.006
Mobile Equipment	1.631	3.889	0.314	0.481	0.355
Non-Residential Acrh. Ctgs	0.000	0.000	0.000	0.000	0.124
Residential Arch. Ctgs.	0.000	0.000	0.000	0.000	0.000
Stationary Equipment	11.060	0.286	0.008	0.015	0.414
Workers Trips	0.175	0.009	0.001	0.000	0.008
Total	*13.130*	*5.178*	*29.570*	*0.596*	*1.013*

Guardian aircraft emissions were calculated based on 166 operations per year. Emissions for aircraft focus on the take-off and landing portions of the operation as emissions that occur above the mixing height of 3,000 feet above ground level (AGL) would not affect regional air quality. Total emissions from construction and operations are shown in Table 3-6. Emissions would not exceed the 10 percent threshold for any of the criteria pollutants and the construction and operational emissions would cause a very small increase in GHG emissions (0.002 percent). No adverse impacts to regional air quality are anticipated from the implementation of the Proposed Action.

Table 3-6. Proposed Action Construction and Operation Emissions

	Emissions (tons/year)						
Emission Activities	**CO**	**NO_x**	**PM_{10}**	**$PM_{2.5}$ [1]**	**SO_2**	**VOC**	**CO_2 [2]**
Construction Emissions	13.13	5.18	29.57	29.57	0.60	1.01	4,691.31
Point Source	0.07	0.08	0.01	0.01	0.00	0.00	--
Guardian Aircraft Emissions	0.11	0.02	N/A	N/A	0.01	0.04	91.37
Total	13.31	5.28	29.58	29.58	0.61	1.05	4,782.68
Brevard County Emissions	174,368.82	31,833.77	16,466.94	4,670.17	17,077.59	32,137.09	243.12 MMT [3]
Percentage of County Emissions	0.01%	0.02%	0.18%	0.63%	0.00%	0.00%	0.002%

[1] $PM_{2.5}$ emissions were conservatively assumed to be the same as PM_{10}.
[2] CO_2 emissions were not calculated in ACAM and are provided only for informational purposes. There are no current standards in which to determine significance at this time.
[3] CO_2 emissions are compared to Florida state's ten year average of GHG emissions (1997-2007) reported in million metric tons (MMT)

3.10.2.3 Alternative 3: Renovate Hangar F

Alternative 3 would house the new operations in Hangar F. The Guardian operations are the same as discussed and analyzed in Alternative 2. This would require renovations to the interior of the facility. These types of activities would not cause any impacts to regional air quality. Safety concerns to the contractors completing the renovation from lead based paint and ACMs are addressed in Hazardous Materials and Wastes section of this document. Operationally, this alternative is the same as Alternative 2. No adverse impacts to regional air quality would occur from implementation of Alternative 3.

3.10.2.4 Alternative 4: Renovate Hangar C

The utilization of Hangar C, as proposed in Alternative 4, would also require renovations similar to Alternative 3. The Guardian operations are the same as discussed and analyzed in Alternative 2. No adverse impacts to regional air quality would occur from implementation of Alternative 4.

3.11 NOISE

Noise is considered to be unwanted sound that interferes with normal activities or otherwise diminishes the quality of the environment. There is wide diversity in responses to noise that not only vary according to the type of noise and the characteristics of the sound source, but also according to the sensitivity and expectations of the receptor, the time of day, and the distance between the noise source (e.g., an aircraft) and the receptor (e.g., a person or animal).

The physical characteristics of noise, or sound, include its intensity, frequency, and duration. Sound is created by acoustic energy, which produces minute pressure waves that travel through a medium, like air, and are sensed by the ear drum. This may be likened to the ripples in water that would be produced when a stone is dropped into it. As the acoustic energy increases, the intensity or amplitude of these pressure waves increase, and the ear senses louder noise. The unit used to measure the intensity of sound is the decibel (dB). Sound intensity varies widely (from a soft whisper to a jet engine) and is measured on a logarithmic scale to accommodate this wide range. The logarithm, and its use, is nothing more than a mathematical tool that simplifies dealing with very large and very small numbers. For example, the logarithm of the number 1,000,000 is 6, and the logarithm of the number 0.000001 is -6 (minus 6). Obviously, as more zeros are added before or after the decimal point, converting these numbers to their logarithms greatly simplifies calculations that use these numbers.

The frequency of sound is measured in cycles per second, or hertz (Hz). This measurement reflects the number of times per second the air vibrates from the acoustic energy. Low frequency sounds are heard as rumbles or roars, and high frequency sounds are heard as screeches. Sound measurement is further refined through the use of "A-weighting." The normal human ear can detect sounds that range in frequency from about 20 Hz to 15,000 Hz. However, all sounds throughout this range are not heard equally well. Therefore, through internal electronic circuitry, some sound meters are calibrated to emphasize frequencies in the 1,000 to 4,000 Hz range. The human ear is most sensitive to frequencies in this range, and sounds measured with these instruments are termed "A-weighted," and are shown in terms of A-weighted decibels (dBA).

As a basis for comparison when noise levels are considered, it is useful to note that, at distances of about three feet, noise from normal human speech ranges from 63 to 65 dB, operating kitchen appliances range from about 83 to 88 dB, and rock bands approach 110 dB.

Some noises, such as aircraft overflight noise, vary over time. For an observer, the noise level starts at the ambient noise level, rises up to a maximum level as the aircraft flies closest to the observer, and returns to the ambient level as the aircraft recedes into the distance. Aircraft overflight noise is often described using the maximum noise level (L_{max}) reached during the overflight. In this analysis, L_{max} is used to describe noise associated with aircraft operations as well as construction activities.

The time-averaged metric differential non-linearity (DNL) is used in this analysis to quantify overall noise levels. DNL is a noise metric combining the levels and durations of noise events and the number of events over a 24-hour period. DNL also accounts for more intrusive night time noise, adding a 10 dB penalty for sounds after 10:00 P.M. and before 7:00 A.M. DNL is the appropriate measure to account for total noise exposure around airfields and airports (EPA 1974).

The computer programs NOISEMAP and SELCALC were used to estimate noise levels associated with aircraft operations, in keeping with standard USAF noise assessment methodology. The Federal Highway Administration's Roadway Construction Noise Model (RCNM) computer program was used to estimate noise associated with construction (USDOT 2006).

3.11.1 Affected Environment

The following section describes existing noise levels within the ROI. The ROI includes CCAFS and its vicinity as well as the Special Use Airspace (SUA) proposed for use by the Guardian aircraft.

Noise in the Installation Vicinity: The Skid Strip at CCAFS supports a diverse array of aircraft and operations types. Predominant users of the airfield are listed in Table 3-7. The majority of aircraft operations are conducted in support of rocket launches. These operations typically involve transporting heavy rocket payloads, ferrying distinguished visitors and support staff, or conducting shuttle launch support. Other frequent users of the airfield include the 920th Rescue Wing and the Department of State. The 920th Rescue Wing, which is based at nearby Patrick Air Force Base, conducts parachute drops and night vision goggle training at and near the airfield. The Department of State uses the Skid Strip as a training location for its mission to eradicate illicit drug crops through aerial spraying. L_{max} values generated by representative aircraft types are shown in Table 3-8.

Table 3-7. Current Users of the Skid Strip at CCAFS

User Category	Representative Aircraft Type(s)	Percentage of Total Operations
Large Cargo Rocket Payload	C-5, An-124	6%
Shuttle Support	Gulfstream G2, Gulfstream G3	39%
Distinguished Visitor	C-21, C-12, C-20, Boeing 747	10%
920th Rescue Wing Training	C-130	39%
Department of State Illicit Drug Crop Spray Training	Air Tractor 802	6%

Source: Bron, 2010

Table 3-8. Representative Maximum Noise Levels

Aircraft and Power Type	L_{max} Values (dBA) at Varying Distances (Feet)				
	500[1]	1,000[1]	3,000[1]	5,000[1]	10,000[1]
C-5 Takeoff	114	106	91	83	70
C-5 Landing	112	104	89	80	62
Gulfstream G2 Takeoff [1]	106	99	86	79	68
Gulfstream G2 Landing [1]	96	89	73	66	55
C-21 Takeoff	92	85	72	65	54
C-21 Landing	78	71	58	51	41
C-130P Takeoff	92	85	73	66	57
C-130P Landing	90	83	70	63	53
Air Tractor 802 Takeoff [2]	85	78	67	61	52
Air Tractor 802 Landing [2]	83	76	64	58	49

[1] C-9 used as noise surrogate noise source for Gulfstream G2
[2] T-6 used as noise surrogate noise source for Air Tractor 802
Source: SELCALC computer program

The Skid Strip supports approximately 1,540 airfield operations annually. The air traffic control tower (ATCT) is open from 8:00 A.M. to 4:00 P.M. Monday through Friday. Aircraft operations are sometimes conducted outside of tower operational hours, but rarely occur during the ‘late night’ time period between 10:00 P.M. and 7:00 A.M. The airfield has not been the subject of an Air Installation Compatible Use Zone (AICUZ) Study due to the relatively low number of airfield operations conducted per average day (Bron 2010).

The program NOISEMAP was utilized to estimate time-averaged noise levels under baseline conditions. Using a conservative set of assumptions as to how aircraft would operate, it was determined that noise generated at the Skid Strip do not exceed 55 dB DNL on any land area not owned by the USAF. Noise levels exceeding 65 dB DNL would not occur beyond the shores of the Cape.

Rocket launches are a distinctive element of the noise environment at CCAFS. The launches are typically extremely loud, but are also relatively infrequent and of short duration. Each type of launch vehicle (e.g. Delta IV) is associated with a noise footprint. Because the noise of launch exceeds Occupational Safety and Health Administration (OSHA) thresholds for allowable noise exposure, all persons are cleared from an area surrounding the launch complex. Even outside of this clear zone area, noise levels are often still quite high. For example, launch of the Medium Launch Vehicle III generates noise levels of approximately 120 dB for two minutes at a distance of 1,500 feet from the launch pad (Headquarters Space and Missile Command 1994).

During times when no rocket launches or aircraft operations are under way, the noise environment on CCAFS is characteristic of a light industrial area. Characteristic sounds include vehicular traffic, equipment noise, and natural sounds.

Airspace. SUA units within the ROI (W-470 A/B, W-465 A/B, W-174 A/B/C, and W-168 A) are currently utilized by a variety of military aircraft types. These areas are located almost entirely over open water and when aircraft are not audible, noise levels in these areas are dominated by natural sounds such as wind and waves.

3.11.2 Environmental Consequences

In this section, noise associated with proposed aircraft operations, construction activities, and long-term facility operations are considered and compared with current conditions to assess impacts. Data developed during this process also supports analyses in other resource areas.

Based on numerous sociological surveys and recommendations of federal interagency councils, the most common noise level impact benchmark referred to is a day-night average sound level (Ldn) of 65 dBA. This threshold is often used to determine residential land use compatibility around airports, highways, or other transportation corridors. Two other average noise levels are also useful:

- An Ldn of 55 dBA was identified by the USEPA as a level ". . . requisite to protect the public health and welfare with an adequate margin of safety" (USEPA 1974). Noise may be heard, but there is no risk to public health or welfare.
- An Ldn of 75 dBA is a threshold above which effects other than annoyance may occur. For example, it is also a level above which some adverse health effects, such as hearing loss cannot be categorically discounted (CHABA 1977).

Public annoyance is the most common impact associated with exposure to elevated noise levels. When subjected to Ldn of 65 dBA, approximately 12 percent of persons so exposed would be "highly annoyed" by the noise. At levels below 55 dBA, the percentage of annoyance is correspondingly lower (less than 3 percent). The percentage of people annoyed by noise never drops to zero (some people are always annoyed), but at levels below 55 dBA it is reduced enough to be essentially negligible.

3.11.2.1 Alternative 1: No Action Alternative

Under Alternative 1, the beddown would not occur and no additional construction or aircraft operations would take place. The noise environment at CCAFS would remain as it is currently.

3.11.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Noise in the Installation Vicinity. The “Guardian” is a modified version of the Predator B aircraft used by the USAF and is powered by the same Honeywell TPE 331 Turboprop engine used in the Predator B. Environmental noise level measurements for the Predator B/Guardian aircraft are not available. Therefore, after consultation with the Air Force Center for Engineering and the Environment (AFCEE), the Cessna Conquest was selected as a surrogate noise source for the purposes of modeling time-averaged (DNL) noise levels. Because the Cessna Conquest is powered by two TPE 331 engines instead of one, noise energy was reduced by half (3 dB) to approximate the noise levels generated by the Guardian aircraft. Noise source data for a single TPE331 engine was taken from the Federal Aviation Administration’s (FAA’s) Integrated Noise Model source noise database.

No change to baseline noise contours was observed due to the addition of the proposed Guardian aircraft operations. Under the Proposed Action, the 55 dB DNL contour would still not extend onto any lands not owned by the USAF and the 65 dB DNL contour would still not extend beyond the land area of the Cape. Guardian aircraft airfield operations would sometimes occur during time periods at which no flying currently occurs at the Skid Strip. These events may be noticeable by persons off-installation and could potentially cause annoyance. However, due to the low noise levels generated by the Guardian aircraft and the low number of operations per day, noise impacts would be minimal.

Construction noise would be noticeable in the immediate vicinity of the construction project sites. A hypothetical scenario was developed to assess potential noise associated with construction activities on a construction site. Primary noise sources during such activity would be expected to be heavy vehicles and earth moving equipment. Table 3-9 shows sound levels associated with the operation of typical heavy construction equipment.

Table 3-9. Construction Equipment Noise Levels

Equipment	L_{max} at 50 Feet (dBA)
Backhoe	78
Ground Compactor	83
Crane	81
Dozer	82

Source: U.S. DOT 2006

To assess potential impacts of noise from construction activities, estimated on-site equipment usage was modeled using the Federal Highway Administration's RCNM. The results calculated by the model are conservative. Noise levels in the model originated from data developed by the USEPA, and were refined using a standard "acoustical usage factor" to estimate the fraction of time each piece of construction equipment is operating at full power (i.e., its loudest condition) during the project (U.S. DOT 2006).

The RCNM collects acoustic data at identified receptor points, and reports DNL at those points. For this project, a range of points were identified at varying distances from the edge of the site. As shown in Table 3-10, modeled data indicate that noise levels fall below 65 dB DNL at less than 400 feet from the edge of the site.

Table 3-10. Noise Levels at Varying Distances From Site Edge

Distance from Site Edge (feet)	Noise Level (dB DNL)
100	76
200	70
300	66
400	64
500	62

Source: U.S. DOT 2006

Construction noise emanating off-site would probably be noticeable in the immediate site vicinity, but would not be expected to create adverse impacts. Furthermore, construction-related noise is intermittent and transitory, ceasing at the completion of construction. No impacts are expected other than mild annoyance while construction is under way.

Once the beddown is complete, noise associated with the ground control element of the Proposed Action would be extremely limited. Vehicular traffic noise on CCAFS would increase slightly due to the additional employees commuting to jobs on station. However, traffic noise would remain below levels experienced in recent years when the total number of persons employed at CCAFS was substantially higher than it is currently. Backup electrical generators at the Guardian ground facilities would generate noise, but would operate only in the rare event that the primary power supply to the site were to become inoperable.

Noise in the Airspace. Guardian aircraft would operate in several SUA units (W-470 A/B, W-465 A/B, W-174 A/B/C, and W-168 A) and would transition between non-adjacent Warning Areas using specified routes at flight level (FL) 190. While in the

Warning Areas, Guardian aircraft would operate at altitudes as low as 3,000 MSL, with the specific operational altitude depending on the type of mission being flown. At 3,000 MSL, a direct overflight by a Guardian aircraft would generate an L_{max} of approximately 59 dB (Table 3-11). The Warning Areas are located almost entirely over open water, and the number of persons affected by this noise would be very low. In addition, Guardian aircraft would conduct the majority of operational missions during the night, when the number of persons in the affected areas would be lower than during the day. When the aircraft is operating at FL 190, it would often not be audible over ambient sound levels and no noise impacts would be expected.

Table 3-11. Representative Aircraft Maximum Noise Levels

Aircraft and Power Type	L_{max} Values (dBA) at Varying Distances (Feet)				
	500[1]	1,000[1]	3,000[1]	5,000[1]	10,000[1]
C-5 Takeoff	114	106	91	83	70
C-5 Landing	112	104	89	80	62
Gulfstream G2 Takeoff [1]	106	99	86	79	68
Gulfstream G2 Landing [1]	96	89	73	66	55
C-21 Takeoff	92	85	72	65	54
C-21 Landing	78	71	58	51	41
C-130P Takeoff	92	85	73	66	57
C-130P Landing	90	83	70	63	53
Air Tractor 802 Takeoff [2]	85	78	67	61	52
Air Tractor 802 Landing [2]	83	76	64	58	49
Guardian Takeoff [3]	81	74	65	56	50
Guardian Landing [3]	76	69	59	50	43

[1] C-9 used as noise surrogate noise source for Gulfstream G2
[2] T-6 used as noise surrogate noise source for Air Tractor 802
[3] The TPE331 engine (engine used in the Cessna Conquest) was used as surrogate noise source for the Guardian. Single-event noise calculations. Noise levels were estimated using the INM computer program and noise levels were interpolated where not provided explicitly.
Source: SELCALC computer program and the INM source noise database

Overall, noise impacts due to operations in training airspace would be limited to minor annoyance. Noise impacts would be not significant in nature.

3.11.2.3 Alternative 3: Renovate Hangar F

Renovation of Hangar F and use of existing airfield infrastructure in lieu of construction of a new hangar, apron, and taxiway would result in less construction noise than would be generated under the Proposed Action. Noise generated during renovation would be audible and potentially annoying in nearby areas. However, the noise would be temporary and only mild annoyance would be expected to occur. UAS flight operations and noise impacts associated with those operations would be the same under Alternative 3 as they would be under Alternative 2. Noise impacts under Alternative 3 would be minor and insignificant in nature.

3.11.2.4 Alternative 4: Renovate Hangar C

Under Alternative 4, Hangar C would be renovated and the vehicular road leading to the airfield from the hangar would be improved such that it could act as a Guardian aircraft tow way. No new hangar, parking apron, or taxiway would be required. Noise impacts associated with implementation of Alternative 4 would be similar to those described for Alternative 3. Flight operations and noise impacts associated with those operations would be the same under Alternative 3 as they would be under Alternative 2. Overall, noise impacts under Alternative 3 would be minor and insignificant in nature.

3.12 TRANSPORTATION

The transportation system on CCAFS refers to the following modes of transportation: the roadway system (roadways, parking lots, bridges, etc.), the airfield (runway, apron, lighting, etc.), launch infrastructure, and railway system. Capacity, efficiency, and access of these resources are the primary concerns with regards to transportation.

3.12.1 Affected Environment

3.12.1.1 Roadway System

There are two primary roadways that provide access to CCAFS (Figure 3-3). Samuel C. Phillips Parkway, also called Phillips Parkway, provides access to CCAFS from the south through Gate 1 on State Highway 401 and from the north through KSC. This four-lane divided highway accommodates most of the north-south traffic and serves as the primary access to CCAFS and main arterial road (CCAFS 2010b). In the CCAFS Industrial Area, Phillips Parkway provides one way traffic flow in a northerly direction with Hangar Road splitting off and providing one way traffic flow in a southerly direction. NASA Causeway East provides access to CCAFS from the west continuing onto Industrial Road once on the Cape. Industrial Road functions as a continuation of Central Control Road westward although off-set at the intersection with the Phillips Parkway (CCAFS 2010b). Central Control Road, Intercontinental Ballistic Missile (ICBM), Lighthouse, Titan III, and Pier Roads also serve as arterial roads on CCAFS. The arterial roadways allow access to the collector roads, local roads, and parking lots. The roadway system on CCAFS consists of 185 paved and 71 unpaved roads as well as 350 parking lots, 570 driveways, and numerous trails. The roads, driveways, and parking lots are in various states of repair needing a considerable amount of resurfacing and repair to meet current and future mission requirements (CCAFS 2010b).

The Florida Department of Transportation (FDOT) Level of Service Standard (LOSS) tables are used as a measuring guide to describe the quality of traffic flow on roadways

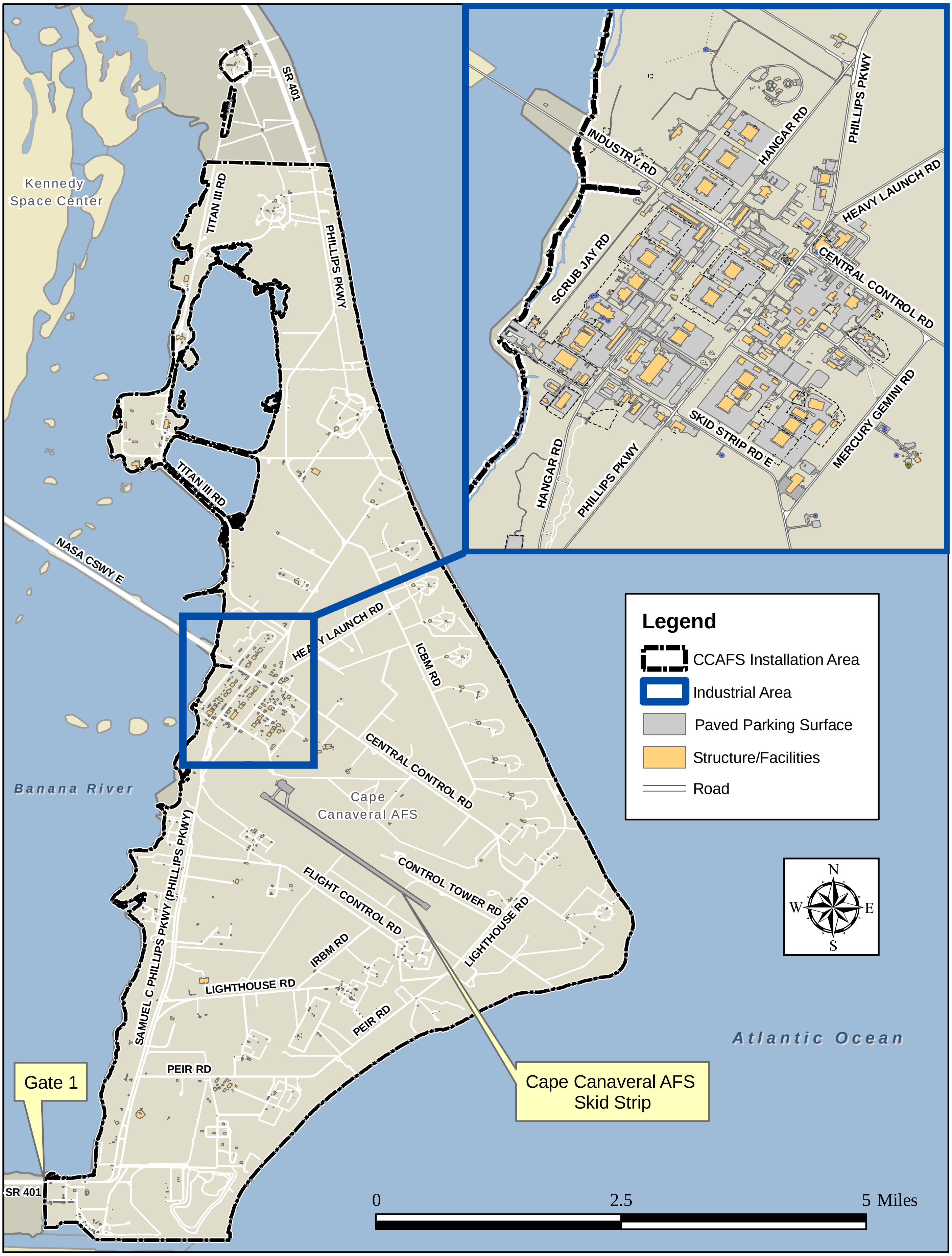

Figure 3-3. Cape Canaveral AFS Roadway System

within CCAFS. As traffic volumes increase, the level of service degrades. The LOSS is listed in alpha form with a rating of "A" being the best and "F" being the worst (CCAFS 2010b). As part of the 2002 Cape Canaveral Spaceport Master Plan (CCSMP), the 45SW adopted a minimum acceptable peak hour operating standard of LOSS D allowing for maximum use of available capacity (USAF 2002). The majority of the CCAFS roadway segments operate at LOSS C or better with the exception of Hangar Road. During the peak travel period, Hangar Road in the CCAFS Industrial Area experiences a LOSS D rating (USAF 2002, CCAFS 2010b).

The parking lots on CCAFS provide employee parking and many serve as heavy equipment storage areas having special requirements due to the nature of the stored materials. The majority of employees drive their personnel vehicles to and from work putting a high demand on parking which is at capacity. Many of the parking surfaces are in poor condition and have deteriorated to the point that it is no longer economically feasible to upgrade or repair them through normal maintenance (CCAFS 2010b).

3.12.1.2 Airfield/Skid Strip

The Airfield, known as the "Skid Strip" is a single runway 10,000 feet long and 200 feet wide oriented southeast to northwest (Figure 3-4). This Class B runway is primarily used by the 45th Space Wing (45 SW), NASA, and Navy to receive cargo via heavy transport planes like the C-5 and Russian AN-124. The Skid Strip was built in 1952 and was originally designed as a landing facility for missile testing. This special designation allowed the runway to operate outside traditional USAF runway criteria. Under the current mission, the Skid Strip must now comply with all USAF instructions for airfields and design guidelines found in the Unified Facilities Criteria (UFC) 3-260-01. These guidelines specify dimensions, pavement, and lighting requirements for runways,

Figure 3-4. CCAFS Airfield/Skid Strip

taxiways, and other airfield surfaces. Terminal Instrument Procedures (TERPS), Air Traffic Control (ATC), and Airfield Management regulations also apply to the Skid Strip. Efforts have been made to bring the Skid Strip into compliance with these regulations (CCAFS 2010b).

The CCAFS Airfield is more commonly known as the Skid Strip.

The Skid Strip has two taxiways located at the western end and on the north side of the runway (Figure 3-4). Taxiway Alpha is 115 feet wide and extends southwest between the apron and runway. The Bravo taxiway is 130 feet wide extending south between the apron and runway. Bravo is located east of Alpha and contains a parking pad. Both taxiways exceed UFC 3-260-01 width requirements but neither has paved shoulders (CCAFS 2010b).

The Skid Strip has a 328,897 ft^2 asphalt apron located at the western end and on the north side of the runway (Figure 3-4). The apron contains three concrete parking pads and a completed parking plan. This parking plan allows up to three heavy airframes to park on the apron. However, the Skid Strip apron lacks the UFC 3-260-01 required paved shoulders. A project to correct this violation is scheduled for 2012, and a permanent airfield waiver has been granted until this project is complete. The Skid Strip is also operating with several other airfield waivers for airfield lighting deficiencies (CCAFS 2010b).

CCAFS Skid Strip's ATCT and OFP facility.

An ATCT, Operations Flight Planning (OFP) facility, Uninterrupted Power Supply (UPS) building, and a guard house are buildings associated with the Skid Strip. Because of the close proximity and/or location relative to the runway, these facilities violate the airfield criteria in UFC 3-260-01. An airfield waiver is not required because these buildings fall within the Building Restricted Line (BRL) (CCAFS 2010b).

The volume of operations at the Skid Strip is relatively low. An average of four (4) operations per business day or 1,000 plus operation per year take place. The apron is typically used by only one aircraft at a time but occasionally up to three heavy airframes utilize the parking pads. Plans and long-term projects to correct the airfields known deficiencies and/or acquiring the needed airfield waivers are contained in the Skid Strip ADP (CCAFS 2004).

3.12.1.3 Launch Infrastructure and Railway System

No impacts are anticipated as a result of this project regarding the launch infrastructure and railway system at CCAFS. Therefore these transportation resources were not carried forward for detailed analysis in the EA.

3.12.2 Environmental Consequences

3.12.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no personnel or assets would deploy to CCAFS; thus there would be no impact to the transportation system. Conditions would remain as described in Section 3.12.1.

3.12.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Impacts to the transportation system are assessed based on the effects to capacity, efficiency and access in and around CCAFS. No adverse impacts to the transportation system are anticipated from the implementation of the Proposed Action.

Minor impacts to the roadway system could be experienced during construction of the new hangar, parking facilities, placement of the ground data terminal (GDT), and other associated infrastructure improvements. By locating this hangar and CBP operations area outside of the industrial area and the beddown of a relatively low number of personnel, no adverse impacts to the roadway system and LOSS rating are anticipated.

Skid Strip Road East between Hangar F and the Skid Strip which is currently used as a tow way for CBP Guardian during OT&E.

With the relatively low current and expected volume of operations and by locating the new hangar, taxiway, and apron away from the current apron and taxiways, no adverse impacts are anticipated to the Skid Strip.

3.12.2.3 Alternative 3: Renovate Hangar F

Minor impacts to the roadway system could be experienced during the renovation Hangar F, placement of the GDT, and other associated infrastructure improvements. Additionally, with CBP operations located in the CCAFS Industrial Area, impacts to traffic flow, congestion, and parking is expected to be slightly higher than those of the Proposed Action. With the selection of this alternative, the Skid Strip Road East would be used as a tow way from Hangar F to the Skid Strip. This road was designed for and used by vehicular traffic. The Skid Strip Road East is currently being used during Operational Testing and Evaluation (OT&E) as a tow way with temporary waivers. Implementation of Alternative 3 would require most of these temporary waivers to be corrected by upgrading the road to a tow way and by clearing obstructions. The Skid Strip Road East dead ends at the airfield and vehicular traffic is relatively light between Hangar F and the airfield. Overall, no adverse impacts to the roadway system are expected from the beddown of a relatively low number of personnel and the actions associated with this Alternative.

Impacts to the Skid Strip would be slightly higher than those experienced by the implementation of the Proposed Action. Under this Alternative, the Guardian aircraft would use the same apron and taxiways as the heavy transport aircraft currently utilizing the Skid Strip. With the relatively low volume of current and proposed operations, no adverse impacts to the Skid Strip are anticipated with the implementation of Alternative 3.

3.12.2.4 Alternative 4: Renovate Hangar C

Impacts to the transportation system with the implementation of this Alternative would be similar to those experienced by the implementation of the Proposed Action discussed in Section 3.12.2.2. Although, this alternative would require the use of the Control Tower Road as a tow way from Hangar C to the Skid Strip. With sufficient improvements, such as upgrading the road to a tow way, clearing obstructions and limited use of permanent waivers, this road could be utilized. Control Tower Road is a dead end road with relatively light vehicular traffic. No adverse impacts to the transportation system are anticipated from the implementation of Alternative 4.

3.13 HAZARDOUS MATERIALS

3.13.1 Affected Environment

3.13.1.1 Definition of Resource

This section describes hazardous materials/waste management sites and facilities that could potentially be affected by the Proposed Action or Alternatives. This section also addresses potential hazardous waste contamination areas being investigated as part of the USAF Environmental Restoration Program (ERP).

The ROI for hazardous materials and waste includes the proposed facility sites at CCAFS and their immediate vicinities where construction and operations activities would occur as a result of project-related actions.

3.13.1.2 Environmental Setting

Hazardous Materials/Waste Management. Hazardous materials are those substances defined as hazardous by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the Toxic Substances Control Act (TSCA), and the Hazardous Materials Transportation Act (HMTA). In general, this includes substances that, because of their quantity, concentration, or physical, chemical, or infectious characteristics, may present substantial danger to public health or welfare, or to the environment, when released. AFI 32-7086, Hazardous Materials Management, establishes procedures and standards that govern management of hazardous materials on USAF installations.

Numerous types of hazardous materials are used to support the various missions and general maintenance operations at CCAFS. These materials range from common building paints to industrial solvents and hazardous fuels. Management of hazardous materials, excluding hazardous fuels, is the responsibility of each individual or organization.

Management of hazardous waste must comply with the Resource Conservation and Recovery Act (RCRA), as amended by the Hazardous and Solid Waste Amendments (HSWA) of 1984, which is administered by the USEPA, unless otherwise exempted through CERCLA actions. Title C Part 261 identifies which solid wastes are classified as hazardous waste. RCRA requires that hazardous wastes be treated, stored, and disposed of to minimize the present and future threat to human health and the environment. USAF guidance in AFI 32-7042, Solid and Hazardous Waste Compliance, provides a framework for complying with environmental standards applicable to hazardous waste. Hazardous waste materials on CCAFS are handled according to the 45 SW OPLAN 19-14, Petroleum Products and Hazardous Waste Management Plan (45 SW 2009a), which ensures that adequate and appropriate guidance, policies, and protocols regarding hazardous material incidents and associated emergency response are available to all installation personnel.

Asbestos. ACMs are those materials that contain greater than 1 percent asbestos. Friable, finely divided, and powdered wastes containing greater than 1 percent asbestos are subject to regulation. A friable waste is one that can be reduced to a powder or dust under hand pressure when dry. Nonfriable ACMs, such as floor tiles, are considered to be nonhazardous, except during removal and/or renovation, and are not subject to regulation. The 45 Space Wing Asbestos Management Plan (45 SW 2009b) provides guidance on the management of asbestos. Persons inspecting, designing, or conducting asbestos response actions in public or commercial buildings must be properly trained and accredited through an applicable asbestos training program. The design of building alteration projects and requests for self-help projects are reviewed to determine if asbestos contaminated materials are present in the proposed work area and, if so, are disposed of in an off-installation permitted landfill.

Lead-based Paint. Lead-based paint is defined as surface paint that contains lead in excess of 1 milligram per square centimeter as measured by X-ray fluorescence spectrum analyzer, or 0.5 percent lead by weight. Demolition and renovation of facilities with lead-based paint require special procedures and disposal. In 1993, OSHA, under 29 CFR Part 1926, restricted the permissible exposure limit for general industrial workers to 50 micrograms per cubic centimeter of air, which would include workers in the construction field. The 45 Space Wing has also developed a Lead Management Plan (45 SW 2009c) that provides guidance and procedures when renovating or demolishing facilities that may have material with lead-based paint.

Environmental Restoration Program Sites. The ERP is a USAF program that identifies, characterizes, and remediates past environmental contamination on USAF installations. The program has established a process to evaluate past disposal sites, control the migration of contaminants, and control potential hazards to human health and the environment. In response to CERCLA and Section 211 of Superfund Amendments and Reauthorization Act (SARA) requirements, DoD established the Defense ERP to facilitate clean up of past hazardous waste disposal and spill sites nationwide.

ERP sites at 45 SW facilities include abandoned launch complexes and support facilities, fire-fighter training areas, fuel storage and dispensing areas, and several abandoned landfills. The three ERP sites present at CCAFS at or near the proposed

ROI are Hangar C, C154; Hangar F, C152; and Landfill #2, C019. The Landfill and Hangar F have been identified as "No Further Action Required" and Hangar C has "Long Term Monitoring Requirements." In addition, each site has associated ground water plumes (CCAFS 2010a). The locations of the CCAFS ERP sites are shown on Figure 3-5.

CCAFS is not listed on the USEPA National Priority List (NPL), also known as Superfund sites, which is used to determine which sites warrant further investigation and/or abatement or clean-up orders.

3.13.2 Environmental Consequences

This section addresses the proposed citing and ongoing activities associated with the Proposed Action and alternatives relating to hazardous materials use, hazardous waste generations and disposal, and effects on ERP sites. Principal areas of concern addressed in the analysis include direct and indirect impacts associated with use and disposal of hazardous materials and waste and potential impact to known ERP hazardous material sites.

3.13.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, the existing CCAFS facilities would not be modified and new facilities would not be constructed. Fielding of Guardian UAS assets and the expansion of the training and support facilities would not occur. Therefore, impacts relating to hazardous materials, waste, and ERP sites would not occur.

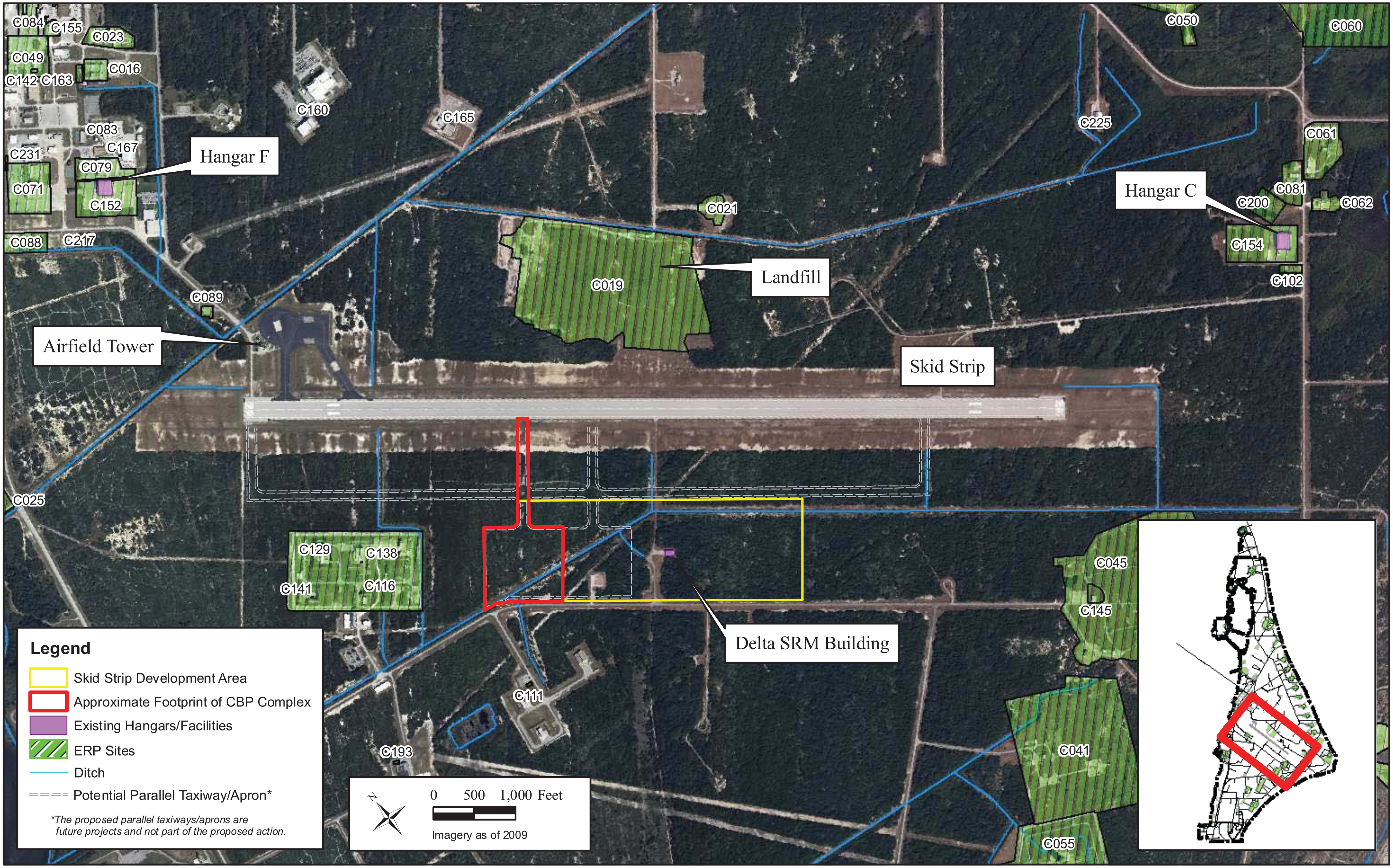

Figure 3-5. CCAFS Environmental Restoration Program Sites

3.13.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

During construction activities associated with Alternative 2, contractors and CCAFS personnel could use hazardous and toxic materials, including paint, adhesives, roofing materials, and other building materials. All hazardous materials disposal would continue to be managed according to the 45 SW OPLAN 19-14, and in accordance with all state and local laws and all USAF regulations. The hazardous waste disposal procedures and facilities currently used are adequate for the amount of waste generated by construction activities and would continue to be used.

After completion of construction, CCAFS personnel would continue to use hazardous and toxic materials in compliance with applicable regulations and USAF instructions. Materials used could include paints, solvents, thinners, adhesives, aircraft fuel, diesel, gasoline, lubrication oils, batteries, anti-freeze, aerosol cans, and solvent and cleaner-contaminated rags, as part of activities associated with the Proposed Action. The largest amount of hazardous materials are anticipated to result from Guardian operations. Based on operations at Grand Forks AFB, North Dakota annual operations of the Guardian aircraft would likely result in the following types and quantities of hazardous material: Used jet fuel (JP-8) (55 gallon drum), used oil (55 gallon drum), used fuel filters (15 gallon drum), used oil filters (15 gallon drum), used Antifreeze (15 gallon drum). It is CBP's policy to reuse hazardous materials when feasible to minimize the volumes of hazardous waste requiring disposal. For example, if the Guardian aircraft should need to be defueled for routine maintenance or repairs, CBP will reuse the fuel. At other CBP facilities, this is accomplished by using a fuel truck to pump and filter the JP-8 and then reuse it in the aircraft. Based on the USAF policy of minimizing waste, it is expected that CBP would generate less hazardous materials than described above. Should CBP generate all of the above materials, the estimated cost of disposal would be less than $1,000. All hazardous materials generated as a result of this action would be handled in accordance with all Federal, State, local, and installation regulations and directives. CBP would be responsible for sampling all wastes to determine whether they are hazardous or non-hazardous and ensuring they are stored in new labeled containers that meet the Department of Transportation's (DOT's) performance-oriented packaging requirements. CBP would comply with all relevant requirements of the CCAFS OPLAN 19-14 (45 SW, 2009a) and 40 CFR 260-279.

Generators would be required to provide backup power to communications in the Guardian control center and for satellite antennas. During the OT&E, backup power was provided by small portable generators. Fuel storage for these generators was contained within the generator. Should more permanent above-ground storage tanks be required for the Proposed Action, CBP would comply with all appropriate state and federal regulations and consult with 45 CES/CEAN prior to installation.

The USAF maintains data within the supply system that are used to generate listings of the hazardous materials that are used for various purposes/processes at the ranges and operations areas. Aircraft maintenance and other CCAFS maintenance processes such as vehicle maintenance would continue. Existing USAF pollution prevention processes, known as HAZMART for the management of procurement, handling, storage, and issuing of hazardous materials used on CCAFS, would be adequate for the foreseeable future and would be retained and used. Transportation of hazardous material would continue to be performed in accordance with the DOT requirements and regulations.

The types of waste generated would continue under this alternative and would likely stay the same as current conditions. The hazardous waste disposal procedures and facilities are adequate for the amount of waste generated and would be retained and used. The USAF would continue to manage the 90-Day Accumulation Sites for some hazardous waste generators. Waste generation tracking procedures would remain in place. Therefore, impacts associated with hazardous waste management would not be significant.

3.13.2.3 ERP Sites

Construction of a new hangar would not be located on, or affect any ERP sites on CCAFS.

3.13.2.4 Alternative 3: Renovate Hangar F

Under Alternative 3, Hangar F would be renovated. Hangar F may require the disposal of ACMs and lead-based paint. If ACMs or lead-based paint are found in or near renovation areas, then the following federal and state regulations must be followed.

- ***Asbestos Removal and Disposal***. During renovation operations, the contractor would remove ACM from units and personnel involved in the process would adhere to established procedures set forth for the safe handling and transport of these materials. All actions would be done in accordance with the Asbestos Management Plan and all applicable federal and state regulations, and would therefore not result in any significant effects.
- ***Lead-Based Paint Removal and Disposal.*** The proposed project should comply with the U.S. Department of Labor, OSHA regulations, and with the USEPA regulations addressing Lead: Management and Disposal of Lead-Based Paint

Debris (40 CFR Part 745). Lead-based paint debris that meets the definition of a hazardous waste would be disposed of through the 45 SW procedures.

To ensure that proposed excavations and other construction activities do not damage or interfere with existing ERP sites, coordination with the appropriate environmental office prior to project implementation would occur. In most cases, projects are able to work within ERP sites as long as contaminated soils are left on site, contaminated groundwater is not disturbed, and monitoring/treatment locations are not impacted while working under appropriate safety guidelines. If during excavations contaminated sites are inadvertently discovered, the appropriate environmental office would immediately be contacted and further excavations at the site would cease until a remedial investigation of the site has been conducted.

No significant impacts are anticipated due to the presence of lead based paint, ACM, or ERP sites.

3.13.2.5 Alternative 4: Renovate Hangar C

Under Alternative 4, Hangar C would be renovated. Hangar C may require the disposal of ACMs and lead-based paint. If ACMs or lead-based paint are found in or near renovation areas, then the following federal and state regulations must be followed.

- ***Asbestos Removal and Disposal.*** During renovation operations, the contractor would remove ACM from units and personnel involved in the process would adhere to established procedures set forth for the safe handling and transport of these materials. All actions would be done in accordance with the Asbestos Management Plan and all applicable federal and state regulations, and would therefore not result in any significant effects.

- ***Lead-Based Paint Removal and Disposal.*** The proposed project should comply with the U.S. Department of Labor, OSHA regulations, and with the USEPA regulations addressing Lead: Management and Disposal of Lead-Based Paint Debris (40 CFR Part 745). Lead-based paint debris that meets the definition of a hazardous waste would be disposed of through the 45 SW procedures.

To ensure that proposed excavations and other construction activities do not damage or interfere with existing ERP sites, coordination with the appropriate environmental office prior to project implementation would occur. In most cases, projects are able to work within ERP sites as long as contaminated soils are left on site, contaminated groundwater is not disturbed, and monitoring/treatment locations are not impacted while working under appropriate safety guidelines. If during excavations contaminated sites are inadvertently discovered, the appropriate environmental office would immediately be contacted and further excavations at the site would cease until a remedial investigation of the site has been conducted.

3.14 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

Socioeconomic resources are defined as the basic attributes associated with the human environment, particularly population and economic activity. Population is described by the change in magnitude, characteristics, and distribution of people. Economic activity is typically composed of employment distribution, personal income, and business growth. Any impact on these two fundamental socioeconomic indicators can have ramifications for secondary considerations, like housing availability and public service provision.

The planning and decision-making process for actions proposed by federal agencies involves a study of other relevant environmental statutes and regulations, including EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations. The essential purpose of EO 12898 is to ensure the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic groups, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, tribal, and local programs and policies.

Because children may suffer disproportionately from environmental health risks and safety risks, EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, was introduced in 1997 to prioritize the identification and assessment of environmental health risks and safety risks that may affect children and to ensure that federal agency policy, programs, activities, and standards address environmental risks and safety risks to children. This section identifies the distribution of children and locations where the number of children in the affected area may be proportionately high (e.g., schools, child care centers, etc.).

The ROI comprises CCAFS and the surrounding areas in Brevard County, Florida. The ROI particularly focuses on the cities of Cape Canaveral, Cocoa, Titusville, Rockledge, and Cocoa Beach where information is available. Socioeconomic and environmental justice information is presented for the ROI and, where appropriate, comparisons are presented with conditions for the state of Florida.

3.14.1 Affected Environment

The cities immediately surrounding CCAFS were selected as the ROI in order to better estimate the impacts of the Proposed Action. The population of Brevard County is more than half a million persons. The largest cities in the county is Melbourne and Palm Bay comprising nearly half of Brevard County's population. Melbourne and Palm Bay are located approximately 40 miles south of CCAFS. Given the distance and commute time involved, it is anticipated that the socioeconomic effects of the personnel change and construction expenditures would be focused within the cities immediately surrounding CCAFS.

The City of Cape Canaveral is located directly south of CCAFS on the Atlantic coast of Florida. In 2007, the latest information available, the City of Cape Canaveral had a total population of 10,244 persons (Table 3-12). The largest city in the ROI is the City of Titusville which is located inland and north of CCAFS. Titusville had a 2008 population of 44,756 persons. Between 2000 and 2007, the City of Cape Canaveral experienced population growth at an average annual rate of 2.1 percent, a higher rate than the population growth experienced in the county or the state of Florida as a whole. Between 2000 and 2008, the City of Rockledge had the highest rate of growth with an average annual increase of 2.6 percent during the same time period. The City of Cocoa Beach actually experienced a slight decrease in population at an average annual rate of 0.6 percent, losing 562 persons.

Table 3-12. Socioeconomic Indicators in the ROI

	Population			Labor Force	Employment	Unemployment Rate
	2000	2008	Average Annual Change 2000-2008	2009	2009	2009
Brevard County	476,230	536,521	1.5%	268,759	240,492	10.5
City of Cape Canaveral[1]	8,829	10,244	2.1%	5,824	5,533	5.0
City of Cocoa	16,412	16,478	0.1%	9,584	7,986	16.7
City of Cocoa Beach	12,482	11,920	-0.6%	6,534	5,691	12.9
City of Rockledge	20,170	24,747	2.6%	11,929	10,854	9.0
City of Titusville	40,670	44,756	1.2%	20,961	18,729	10.6
Florida	15,982,813	18,328,340	1.7%	9,197,484	8,231,731	10.5

[1] Data for the City of Cape Canaveral is 2007, the latest data available.
Source: U.S. Census Bureau 2009, Economic Development Commission of Florida's Space Coast 2009 and 2010, U.S. Bureau of Labor Statistics 2010

In 2007, the latest data available for the City of Cape Canaveral, unemployment was low. With a total labor force of 5,824 persons 5,533 persons were employed resulting in a 5.0 percent unemployment rate (Table 3-12). However, this unemployment rate was estimated prior to or at the beginning of the nationwide recession which has driven unemployment rates higher in most urban areas. Because of that, the current unemployment rate in the City of Cape Canaveral is anticipated to be higher than the 2007 rate available. The unemployment rates in the remaining cities in the ROI, do reflect the impacts of the nationwide recession. Particularly in the cities of Cocoa and Cocoa Beach, the unemployment rates are much higher than the unemployment rates in Brevard County or the state of Florida. Both of these cities rely on tourism as a key industry and are more likely influenced by the national economy. Prior to the recession, the unemployment rates in Brevard County and Florida in 2007 were 4.2 percent and 4.1 percent, respectively.

CCAFS is closely connected with Patrick AFB which is located approximately 20 miles south of CCAFS and south of the City of Cocoa Beach. CCAFS is closely supported by Patrick AFB in terms of personnel, mission support, and services support for personnel. Therefore, the total economic impact of CCAFS is combined with the economic impact of Patrick AFB. The two combined installations comprise the 45 SW which has a total personnel of 10,606 military and civilians and 2,493 dependents (USAF 2008). The total annual payroll from the military and civilian personnel associated with the two installations is estimated to be more than $256 million. Construction contracts, service contracts, and the procurement of materials, equipment, and supplies contributes a total of $593 million into the Brevard County economy. The personnel and the expenditures from CCAFS and Patrick AFB in turn generate additional indirect employment and income within Brevard County. The number of indirect jobs generated is an estimated 5,036 jobs with an annual payroll of $216 million assuming an average annual pay of $42,982 for each job. Therefore, the total economic contribution of CCAFS and Patrick AFB is estimated to be $1.06 billion per year (USAF 2008).

For environmental justice, EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, directs federal agencies to address environmental and human health conditions in minority and low-income communities. In addition to environmental justice issues, are concerns pursuant to EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, which directs federal agencies to identify and assess environmental health and safety risks which may disproportionately affect children.

For purposes of this analysis, minority, low-income and youth populations are defined as follows:

- Minority Population: Persons of Hispanic origin of any race, African Americans, American Indians, Eskimos, Aleuts, Asians, or Pacific Islanders.
- Low-Income Population: Persons living below the poverty level.
- Youth Population: Children under the age of 18 years.

Estimates of these three population categories in the ROI were developed based on data from the U.S. Bureau of the Census.

As presented in Table 3-13, the incidence of minority persons in the City of Cocoa Beach, the City of Rockledge, and the City of Titusville were higher than the incidence of minority persons in Brevard County. The incidence of minority persons in the City of Cape Canaveral and City of Cocoa Beach were much lower than in Brevard County. African Americans account for the largest share of the minority population, particularly in the City of Cocoa where African American's comprise more than 32 percent of the city's total population.

Table 3-13. Environmental Justice Populations of Concern

	2000 Population	Percent Minority	Percent Low Income	Percent Youth
Brevard County	476,230	17.8%	9.5%	22.0%
City of Cape Canaveral	8,829	8.8%	11.6%	11.3%
City of Cocoa	16,412	42.5%	24.1%	26.4%
City of Cocoa Beach	12,482	5.9%	6.5%	12.2%
City of Rockledge	20,170	22.2%	6.5%	23.8%
City of Titusville	40,670	19.7%	12.4%	22.9%
Florida	15,982,813	38.8%	12.5%	22.8%

Source: U.S. Census Bureau 2000a, 2000b, 2000c

In the cities of Cape Canaveral, Cocoa Beach, and Titusville, the share of persons living below the poverty level were higher as compared to Brevard County and comparable to the share of low-income persons in the state. In the cities of Cocoa Beach and Rockledge, the share of low-income persons was below that of Brevard County.

The share of population comprised by children under the age of 18 is comparable to the youth population in Brevard County with the exception of the cities of Cape Canaveral and Cocoa Beach (Table 3-13). These two cities may have a larger share of retirees or families without children than the other cities in the ROI.

3.14.2 Environmental Consequences

In order to assess the potential socioeconomic impacts of the action alternatives, demographic and economic characteristics at CCAFS and Brevard County were analyzed, as presented in Section 3.14. Potential socioeconomic consequences were assessed in terms of effects of the Proposed Action and alternatives on the local economy, typically driven by changes in personnel and expenditure levels. For this EA, potential socioeconomic impacts are evaluated for factors associated with the incoming CBP personnel and construction expenditures related to the beddown.

Environmental justice analysis applies to adverse environmental impacts. The minority and low-income populations in the vicinity of CCAFS and in Brevard County were identified as presented in Section 3.14. Potential disproportionate impacts to minority and low-income populations are assessed only when adverse environmental consequences to the human population are anticipated, otherwise no additional analysis is required.

3.14.2.1 Alternative 1: No Action Alternative

There are approximately 44 personnel associated with CBP's OT&E mission conducting UAS operations. Under Alternative 1 the No Action Alternative, the OT&E would be completed and all CBP assets would leave CCAFS. This would cause a subsequent decrease in 44 personnel. However, this population change is minimal compared to the total population related to CCAFS and the ROI as a whole. Therefore, conditions under the No Action Alternative would be comparable to those described in Section 3.14.1.

3.14.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Under Alternative 2 the Proposed Action, CBP would implement the construction projects described in Section 2.2.1. The construction projects include building a new hangar, installing new infrastructure, and relocating the GDT. The increase in construction expenditures from CCAFS from implementing these projects would increase the employment and income in the ROI, particularly for the construction industry. However, the economic benefits would be temporary and would last only for the duration of the construction. Therefore, the construction expenditures would generate minor beneficial economic impacts to the ROI.

The Proposed Action also entails the beddown of the CBP Guardian mission at CCAFS in terms of personnel. The OT&E mission, which is currently operating out CCAFS, would become permanent and approximately 21 personnel would be added to the mission bringing the full complement to 65 CBP personnel. The addition of 21 new personnel to the ROI is not sufficient to result in an increase in the demand for goods or services. In the City of Cape Canaveral, 21 additional personnel would increase the population approximately 0.2 percent. Employment would increase only 0.4 percent. Therefore, population and employment would increase slightly resulting in a comparable increase in indirect employment. However, this increase is not substantial enough to impact the provision of public services and would not result in significant impacts. Additionally, flight operations would typically be conducted over water and not over populated areas. However, the CBP is proposing an overland route to be used under special circumstances such as inclement weather which the Guardian can utilize to return to the installation. The proposed overland route would be a COA through Class A airspace (Figure 2-4). In Class A airspace, the Guardian would be under the direction of ATC through the COA which would also deconflict any civil aircraft also traversing in the vicinity of the COA. Therefore, no significant socioeconomic impacts to civil aviation or airports are anticipated.

Impact relating to environmental justice would occur if minority populations were disproportionally impacted by the Proposed Action. As discussed in Sections 3.10 Air Quality, 3.11 Noise, or 3.16 Human Health and Safety, no adverse impacts are anticipated to these resources. The proposed construction would be occur within the installation boundaries and would not adversely impact any off-installation populations. Noise levels generated by the Guardian may be noticed by off-installation populations; however, the noise levels are such that annoyance is not likely (See Section 3.11). Noise may be noticeable under the proposed overland route; however, the overland route would be used infrequently only when special circumstances dictate. Therefore, no adverse impacts are anticipated to disproportionately impact minority, low-income, or youth populations.

3.14.2.3 Alternative 3: Renovate Hangar F

Potential socioeconomic and environmental justice impacts under Alternative 3 would be the same as those described in Section 3.14.2.2 Alternative 2 Proposed Action. Personnel changes and Guardian flight operations would be the same. The proposed construction under Alternative 3 would not be as extensive as under the Proposed Action. However, the construction would still generate temporary, beneficial impacts to the local economy, particularly for the construction industry. Therefore no significant socioeconomic impacts are anticipated and no adverse impacts are anticipated to disproportionately impact populations of concern.

3.14.2.4 Alternative 4: Renovate Hangar C

Potential socioeconomic and environmental justice impacts under Alternative 4 would be the same as those described in Section 3.14.2.2 Alternative 2 Proposed Action. Personnel changes and Guardian flight operations would be the same. The proposed construction under Alternative 4 would not be as extensive as under the Proposed Action. However, the construction would still generate temporary, beneficial impacts to the local economy, particularly for the construction industry. Therefore no significant socioeconomic impacts are anticipated and no adverse impacts are anticipated to disproportionately impact populations of concern.

3.15 SUSTAINABILITY AND GREENING

3.15.1 Affected Environment

In accordance with EO 13423, Strengthening Federal Environmental, Energy, and Transportation Management, CBP A&M would incorporate sustainability and greening practices by minimizing waste during construction, recycling appropriate materials and purchasing items produced from recycled materials. EO 13423 is a directive that requires federal agencies to implement sustainable practices for a variety of water, energy and transportation related activities. Where possible, the CBP would incorporate sustainable building concepts into the engineering design process. The ROI for sustainability and greening is CCAFS.

3.15.2 Environmental Consequences

3.15.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no CBP A&M personnel or assets would permanently deploy to CCAFS and no construction would be necessary. No additional sustainability and greening practices would be required.

3.15.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

To the extent possible, the proposed construction projects would be implemented using sustainable design concepts. Sustainable design concepts emphasize state-of-the-art strategies for site development, efficient water and energy use, and improved indoor environmental quality.

3.15.2.3 Alternative 3: Renovate Hangar F

Implementation of Alternative 3 would entail the use of the same sustainable concepts and practices as described for the Proposed Action.

3.15.2.4 Alternative 4: Renovate Hangar C

Implementation of Alternative 4 would entail the use of the same sustainable concepts and practices as described for the Proposed Action.

3.16 HUMAN HEALTH AND SAFETY

This section addresses ground and flight safety associated with operations involving the Guardian UAS conducted from CCAFS. Ground safety considers issues associated with operations and maintenance activities that support installation operations, including fire and crash response. Flight safety considers aircraft flight risks such as aircraft accidents and bird-aircraft strikes.

The ROI for safety in this EA includes CCAFS, R-2932/33/34, W-470 A/B, W-168 A, W-174 A/B/C, W-465 A/B, airspace in the proximity of CCAFS, the proposed UAS transit corridors, and federal airways transiting the airspace.

3.16.1 Affected Environment

3.16.1.1 Existing Conditions

Ground Safety. Day-to-day operations and maintenance activities conducted at CCAFS are performed in accordance with applicable USAF safety regulations, published USAF Technical Orders, and standards prescribed by Air Force Occupational Health and Safety (AFOSH) requirements.

Flight Safety. Primary public concern regarding flight safety would be the environmental impact in the event of an aircraft mishap. Such mishaps may occur as a result of mid-air collisions, collisions with manmade structures or terrain, weather-related accidents, mechanical failure, pilot error, or bird-aircraft collisions. Flight risks apply to all aircraft; they are not limited to the military. Flight safety considerations addressed include aircraft mishaps and bird-aircraft strikes.

Aircraft Mishaps. The USAF defines four categories of aircraft mishaps: Classes A, B, C, and High Accident Potential (HAP). Class A mishaps result in a loss of life, permanent total disability, a total cost in excess of $2 million, destruction of an aircraft, or damage to an aircraft beyond economical repair. Class B mishaps result in total costs of more than $500,000, but less than $2 million, result in permanent partial disability or inpatient hospitalization of three or more personnel, but do not result in fatalities. Class C mishaps involve reportable damage of more than $50,000, but less than $500,000, or a lost workday involving 8 hours or more away from work beyond the day or shift on which it occurred; or occupational illness that causes loss of work at any time. HAP represents minor incidents not meeting any of the criteria for Class A, B, or C. Class C mishaps and HAP, the most common types of accidents, represent hazardous occurrences that have a high potential for becoming a mishap, but generally involve minor damage and injuries, and rarely affect property or the public (AFSC 2010a).

It is impossible to predict the precise location of an aircraft accident, should one occur. Major considerations in any accident are loss of life and damage to property. The probability of an aircraft crashing into a populated area is extremely low, however it cannot be totally discounted. Several factors are relevant: the ROI and immediate surrounding areas have relatively low population densities; the coordinated and designated aircraft routes avoid direct overflight of population centers; and, finally, the limited amount of time the aircraft is over any specific geographic area limits the probability that impact of a disabled aircraft in a populated area would occur.

According to 45 SW/SEF large operational UAS aircraft have a mishap rate of just over 8 per 100,000 flight hours. For the purposes of this EA a worst case assumption was made that the MQ-9 would experience the same mishap rate as other larger UAS aircraft and that if it were flown 15 hours a day, five days a week for a total of 260 days it would experience a serious mishap no more frequently than once every three years. This estimate was considered conservative since the aircraft is anticipated to fly no more than 190 days a year with mission durations of 12 to 15 hours.

A unique aspect of the Guardian flying operations is that the aircraft is unmanned. This means that a Guardian Class A mishap has no risk to aircrew. The pilot flies the aircraft via a data-link from a GCS. In flight, if malfunctions occur and the data-link is lost, the aircraft is programmed to return to a predetermined area within the Restricted Airspace. Then, it orbits while attempts are made to restore the data-link. If all fails, the aircraft simply orbits until fuel exhaustion. However, the orbit location is such that there is little or no risk to persons on the ground.

Bird/Wildlife-Aircraft Strike Hazards. The BASH constitutes a safety concern because of the potential for damage to aircraft or injury to aircrews or local populations if an aircraft crash should occur in a populated area. Aircraft occasionally encounter birds at altitudes of 30,000 feet above MSL or higher. However, most birds fly close to the ground. More than 97 percent of reported bird strikes occur below 3,000 feet AGL. Approximately 30 percent of bird strikes happen in the airport environment, and almost 55 percent occur during low-altitude flight training (AFSC 2010b).

The potential for bird-aircraft strikes is greatest in areas used as migration corridors (flyways) or where birds congregate for foraging or resting (e.g., open water bodies, rivers, and wetlands). At CCAFS resident waterfowl are the greatest hazard to runway flight operations. Other birds identified in CCAFS's BASH Plan (45 SW OPlan 31-212 2009a) include gulls and terns, wading birds, raptors, pelicans, shorebirds, and smaller birds and migratory birds. Gulls and terns are present throughout the installation and these species tend to congregate on the runway after rain showers. Long legged wading birds are common along the Banana River and on the approach course to the runway. Raptors are common throughout the installation and are especially common near the north end of the runway. Pelicans and shorebirds are most abundant along the coast which presents a hazard to aircraft making a final approach to the runway. Small birds and migratory species are common in the brushy areas.

Although any bird-aircraft strike has the potential to be serious, many result in little or no damage to the aircraft, and only a minute portion result in a Class A mishap. During the years 1985 to 2004, the USAF BASH Team documented 59,156 bird strikes. Of these, five resulted in Class A mishaps where the aircraft was destroyed. These occurrences constituted approximately 0.04 percent of all reported bird-aircraft strikes (AFSC 2010b).

3.16.2 Environmental Consequences

Numerous federal, civil, and military laws and regulations govern operations at CCAFS. Individually and collectively, they prescribe measures, processes, and procedures required to ensure safe operations and to protect the public, military, and property. These regulations govern all aspects of the daily activity at the installation, and their applicability ranges from standard industrial ground safety requirements (e.g., wearing of hard hats and safety clothing) to complex procedures concerning aircraft flight and maintenance of munitions.

For the Proposed Action and alternatives, the elements of the proposal having a potential to affect safety are evaluated relative to the degree to which the action increases or decreases safety risks to aircrews, the public, and property. Ground, fire, and crash safety are assessed for the potential to increase risk, and the unit's capability to manage that risk by responding to emergencies and suppressing fire. In considering explosive safety, projected changed uses and handling requirements are compared to current uses and practices. If a unique situation is anticipated to develop as a result of any of the proposals, the capability to manage that situation is assessed. Analysis of flight risks correlates Class A mishap rates and BASHs with projected airspace utilization associated with the action. When compared to similar data for current use of the airspace, assessments can be made of the magnitude of the safety impacts resulting from the change. Because fire and crash risk are also a function of the risks associated with mishaps and bird-aircraft strikes, those statistical data are also considered in assessing that risk. Finally, when new or altered risks arising from the proposals are considered individually and collectively, assessments can be made about the adequacy of disaster response planning, and any additional or modified requirements that may be necessary as a result of the action.

3.16.2.1 Alternative 1: No Action Alternative

Under the No Action Alternative, no changes to airspace or installation construction would occur. Because no specific safety impacts result from the No Action Alternative, risks associated with ground and flight safety would remain unchanged from current conditions. The No Action Alternative would result in no changes or impacts to CCAFS airspace or facilities. However, implementation of the No Action Alternative would impact the successful implementation of the CBP mission and impair protection of U.S. national security interests.

Under this alternative, CBP personnel and assets would leave CCAFS upon completion of the OT&E. Overall, ground and flying safety risks would remain unchanged from current conditions.

3.16.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

Ground Safety. The Proposed Action Alternative 2 would include the equipment, personnel, and infrastructure at CCAFS to support CBP's mission. This would include 65 CBP personnel and contractors along with two Guardian aircraft and the systems to support their operation.

The fire and crash response capability currently provided is sufficient to meet all requirements. Existing mutual aid agreements currently in effect with abutting communities would remain in effect, thus providing additional response support should it be required.

To support the proposed assignment of two Guardian UASs, construction of a new hangar and associated parking facilities, placement of a GDT antenna, and infrastructure improvements would be required. However, no construction or modification activities would involve any unusual or extraordinary techniques. During construction, BMPs would be employed, and standard industrial safety requirements and procedures would be enforced, thereby minimizing any safety risks associated with these activities. All proposed new facilities would be cited so as to comply with all safety guidelines prescribed by UFC criteria pertaining to Airfield and Heliport Planning and Design.

Flight Safety. A thorough flight safety analysis was conducted by 45 SW/SEF and determined that a mishap is improbable and the risk is low. As discussed in Section 3.2,. large operational UAS aircraft have a mishap rate of just over 8 per 100,000 flight hrs, a worst case assumption that the MQ-9 Guardian experienced the same generic mishap rate and flew every weekday for 15 hours would result in a serious mishap no more frequently than once every three years. In the unlikely event that there was an MQ-9 Guardian mishap, and that the failure mode resulted in a crash, the MQ-9 Guardian has a maximum fuel load of 4000lbs, this is one tenth the fuel load of a C-130 and approximately 1.2 percent of the fuel weight of a C-5 aircraft which typically use the Skid Strip. Other hazardous materials are similarly in much smaller quantities than manned aircraft frequenting CCAFS.

While the probability of a mishap is somewhat higher than manned aircraft, the quantities of hazardous materials are much less than comparable manned aircraft flying into CCAFS such that the overall environmental impact of such a mishap would be minimal. The potential exposure to recovery crews to a hazardous material would not be significant. All appropriate remediation measures would be implemented in compliance with state and federal regulations.

3.16.2.3 Alternative 3: Renovate Hangar F

Under Alternative 3, Hangar F would be renovated to meet the requirements of a permanent mission. Extensive renovation on the hangar and several improvements to the existing road to create a tow way area would be required. Implementation of the renovation is not expected to increase ground safety risks above those which are normally associated with construction projects on CCAFS. Contractors would adhere to installation safety requirements and each would follow a project specific health and safety plan. Under Alternative 3, flight safety is expected to be the same as under Alternative 2.

3.16.2.4 Alternative 4: Renovate Hangar C

Under Alternative 4, Hangar C would be renovated to meet the requirements of a permanent mission. Extensive renovation on the hangar and several improvements to the existing road to create a tow way area would be required. Implementation of the renovation is not expected to increase ground safety risks above those which are normally associated with construction projects on CCAFS. Contractors would adhere to installation safety requirements and each would follow a project specific health and safety plan. Under Alternative 4, flight safety is expected to be the same as under Alternative 2.

3.17 AIRSPACE MANAGEMENT

3.17.1 Affected Environment

The ROI for airspace and ATC includes the airspace areas in which the Guardian would fly. These areas include the Class D airspace associated with CCAFS, the COAs for the Guardian, the SUA and Airspace for Special Use (ASU) identified around the state of Florida (see Figure 2-3). Airspace management and ATC is defined as the direction, control, and handling of flight operations in the "navigable airspace" that overlies the geopolitical borders of the United States and its territories. "Navigable airspace" is airspace above the minimum altitudes of flight prescribed by regulations under U.S. Code (USC) Title 49, Subtitle VII, Part A, and includes airspace needed to ensure safety in the takeoff and landing of aircraft, as defined in FAA Order 7400.2E (49 USC). This navigable airspace is a limited natural resource that Congress has charged the FAA to administer in the public interest as necessary to ensure the safety of aircraft and its efficient use (FAA 2001).

SUA identified for military and other governmental activities is charted and published by the FAA. ASU is identified for non-standard use by the FAA, but is not charted. Management of this resource considers how airspace is designated, used, and administered to best accommodate the individual and common needs of military, commercial, and general aviation. The FAA considers multiple and sometimes competing demands for aviation airspace in relation to airport operations, federal airways, jet routes, military flight training activities, and other special needs to determine how the National Airspace System (NAS) can best be structured to address all user requirements. The FAA has designated four types of airspace within the United States: Controlled, Special Use, Other, and Uncontrolled airspace.

Controlled airspace is airspace of defined dimensions within which ATC service is provided to Instrument Flight Rules (IFR) flights and to Visual Flight Rules (VFR) flights in accordance with the airspace classification (Pilot/Controller Glossary 2004). Controlled airspace is categorized into five separate classes: Classes A through E. These classes identify airspace that is controlled, airspace supporting airport operations, and designated airways affording en route transit from place-to-place. The classes also dictate pilot qualification requirements, rules of flight that must be followed, and the type of equipment necessary to operate within that airspace. Class A airspace includes all FLs or operating altitudes more than 18,000 feet (or FL 180) above MSL and its use is dominated by commercial and military aircraft using the airspace between 18,000 and 60,000 feet (or FL 600) above MSL. Class B (generally surface to 10,000 feet MSL) and C (generally surface to 4,000 feet MSL) airspace are generally associated with major metropolitan or airports with control towers and serviced by a radar approach facility. Class D (generally surface to 2,500 feet MSL) airspace is established around an ATC-controlled airport. All aircraft operating within Class D airspace must be in two-way radio communication with the ATC facility. Class E airspace is controlled airspace that is not Class A, B, C, or D and includes designated federal airways consisting of the high altitude jet routes (J-) and low altitude Victor (V-) route system.

SUA is designated airspace within which flight activities are conducted that requires separation from non-participating aircraft. In some cases, non-participating aircraft may enter certain types of SUA but may have special operating limitations imposed while in the SUA. Prohibited areas, Restricted Areas, Warning Areas, Alert areas and Military Operations Areas (MOAs) are examples of SUA.

Other airspace (sometimes referred to as ASU) consists of airspace with defined dimensions wherein separation from non-participating aircraft may be essential and limitations may be imposed upon aircraft operations that are not a part of those activities. ASU includes Military Training Routes (MTRs) (Instrument Routes [IR]/Visual Routes [VR]), Air Traffic Control Assigned Airspace (ATCAA), aerial refueling (AR) track/anchors, slow routes (SR), and low-altitude tactical navigation areas. When not required for other needs, ATCAA is airspace authorized for military use by the managing ARTCC, usually to extend the vertical boundary of SUA. ATCAAs do not appear on any sectional or en route charts.

Uncontrolled airspace is designated Class G airspace and has no specific prohibitions associated with its use.

The USAF manages airspace in accordance with processes and procedures detailed in Air Force Instruction (AFI) 13-201, *Air Force Airspace Management*. AFI 13-201 implements Air Force Planning Document 13-2, *Air Traffic Control, Airspace, Airfield, and Range Management* and DoD Directive 5030.19, *DoD Responsibilities on Federal Aviation and National Airspace System Matters*. These address the development and processing of SUA, and cover aeronautical matters governing the efficient planning, acquisition, use, and management of airspace required to support USAF flight operations.

CCAFS is located within or adjacent to R-2932, R-2933, R-2934, R-2935, and the KSC Space Operations Area. Class D Controlled Airspace has been established around the facility to manage air traffic arriving at, or departing from the airfield. This airspace extends from the surface to 2,500 feet MSL within a 4.4 mile radius around the CCAFS Skid Strip. The ROI includes numerous federal airways consisting of Victor and jet routes which are used by general and commercial aviation that fly under VFR and IFR control. Two FAA ATC centers (Miami and Jacksonville) provide separation between IFR air traffic in this portion of Florida. Although the minimum en route altitude for many of these IFR jet routes is FL 180, the majority of flight activity on these routes is at higher altitudes up to FL 450. In addition to those listed above, there are numerous other SUA areas in the ROI. This SUA is used for DoD and NASA operations and training.

3.17.2 Environmental Consequences

The potential effects of the proposed beddown on the airspace management ROI (the regional air traffic environment) were assessed by considering the changes in aircraft operations and airspace uses that could occur relative to current conditions.

The type, size, shape, and configuration of individual airspace elements in a region are based upon, and are intended to satisfy, competing aviation requirements. Potential impacts could occur if air traffic in the region and/or the ATC systems were encumbered by changed flight activities. When any significant change is planned, such as new or revised defense-related activities within airspace areas, the FAA re-assesses the airspace configuration to determine if such changes could adversely affect:

- ATC systems and/or facilities;

- Movement of other air traffic in the area; or
- Airspace already designated and used for other purposes supporting military, commercial, or civil aviation.

The creation of any of these conditions could constitute a significant impact.

3.17.2.1 Alternative 1: No Action Alternative

Under this alternative, neither the Guardian aircraft deployment nor the proposed construction or renovation activities would occur. No impacts to the airspace environment would occur.

3.17.2.2 Alternative 2: Proposed Action – Alternative 2: Construct New Hangar

To accomplish the CBP mission it would be necessary to launch and recover Guardian aircraft from CCAFS and to conduct 12 to 15-hour sorties within the operational area defined in Figure 2-3. The CBP anticipates conducting approximately 166 operational and 24 training sorties per year. Training sorties would be approximately two to three hours in duration. Approximately 70 percent of sorties would take place at night with the other 30 percent of operations occurring during day light hours.

In order to conduct UAS flight operation from CCAFS, CBP is required to coordinate with the FAA to develop an airspace construct in the vicinity of CCAFS and around the state of Florida. This airspace construct must allow for UAS operations (take offs, landings, transition from restricted/warning area to Class A airspace) and UAS training operations (closed patterns, low approaches, touch and go’s, full stop landings, and takeoffs). CBP is also proposing to utilize an overland route that would allow the Guardian to divert into Class A airspace over the Florida peninsula (Figure 2-4) should weather conditions deteriorate and the Guardian was unable to return safely to CCAFS through SUA. CBP proposes to accomplish this in coordination with the FAA, through the use of COAs and SUA.

COAs are managed through the FAA's Unmanned Aircraft Program Office. A COA is an authorization issued by the Air Traffic Organization to an operator for a specific unmanned aircraft. After the operator submits a completed application, the FAA conducts a comprehensive operational and technical review of the proposal. Under Title 49 of the CFR (49 CFR § 40103), the FAA has authority to formulate policy regarding the navigable NAS. If necessary, some limitations may be imposed as part of the approval process to ensure the UAS can operate safely with other users of the airspace involved.

The COAs would be established within Class A airspace for the movement of the Guardian from one restricted or warning area to another and overland across the Florida peninsula. These proposed COAs are depicted on Figures 2-3 and 2-4.

The Guardian would operate in SUA/ASU, consisting of restricted, warning areas, and ATCAA, around Florida's peninsula. The SUAs are listed in Table 3-14 and depicted on Figure 2-3. The CBP would coordinate the use of the SUA/ASU with the FAA and/or the DoD.

Table 3-14. SUA Areas Proposed for Use by the CBP Guardian[a]

Number	Altitude	Time of Use	Controlling Agency/ Contact Facility
R-2932	To but not incl 5000	Continuous	Miami Center
R-2933	5000 to unlimited	Intermittent by NOTAM Normally 24 hrs in advance	Miami Center
R-2934	Unlimited	Intermittent By NOTUM Normally 24 hrs in advance	Miami Center

Table 3-14. SUA Areas Proposed for Use by the CBP Guardian[a] (cont'd)

Number	Altitude	Time of Use	Controlling Agency/ Contact Facility
W-168 A	Unlimited	Intermittent by NOTAM	Miami Center
W-174 A	To FL 700	Intermittent 0700-2300	Miami Center
W-174 B	To FL 700	Intermittent 0700-2300[b]	Miami Center
W-174 C	To FL 700	Intermittent 0700-2300[b]	Miami Center
W-465 A	To FL 700	Intermittent 0700-2300[b]	Miami Center
W-465 B	To FL 700	Intermittent 0700-2300[b]	Miami Center
W-497 A	Unlimited	By NOTAM	Miami Center
W-497 B	Unlimited	By NOTAM	Miami Center

[a] Data from the Miami and Jacksonville Sectional Aeronautical Charts (Eff. Date 10042)
[b] Other times by DoD NOTAM

Class D controlled airspace currently exists around CCAFS to support USAF aircraft operations. It extends to 2,500 feet MSL. Upon exiting the CCAFS Class D airspace, the Guardian would enter the surrounding SUA. Within the SUA, the Guardian would climb and transition to Class A airspace (i.e., FL 180 or greater) operating under the COAs to transit from SUA to SUA. With the limitations specified in an appropriate COA, in Class A airspace, the Guardian can operate safely and in concert with FAA requirements under IFR.

Use of the transit COAs would not have significant impacts on airspace management and use. When utilizing the COA, the Guardian would be under IFR conditions under the control of an FAA ARTCC which would maintain separation from other commercial or general aviation aircraft. The Guardian would transit at approximately FL 190 which is in the lower portion of Class A airspace and is used to a lesser extent by commercial aircraft. Between W-174 B and W-174 C, the Guardian would transit below 5,500 feet MSL to remain within the Warning Areas. The CBP would adhere to FAA requirements for UAS operations when using these COAs. General and commercial aviation could avoid COA transit airspace when it is potentially occupied by a UAS. Avoidance could be accomplished by flying above or around the COA transit airspace.

There are no significant impacts anticipated to airspace management as a result of implementing this alternative. Since the Guardian would operate in existing Class D and special use airspace no impacts are anticipated in regards to ATC systems and/or facilities, movement of other air traffic in the area, or airspace already designated and used for other purposes supporting military, commercial, or civil aviation.

To avoid radio frequency conflicts, CBP would not over-fly or radiate any payload on CCAFS. Protected areas would be identified by the 45 SW and the CBP would incorporate that into its flight plans and antennae direction. The CBP would avoid all no-fly and no-radiate zones.

3.17.2.3 Alternative 3: Renovate Hangar F

Under Alternative 3, the processes and procedures for military and civilian aircraft operations in Class A, and Class D airspace currently being used would continue unchanged. Operations of the Guardian UAS would be the same as described in Section 3.17.2.2. All of the airspace involved in supporting current military and civilian activities is capable of accommodating those levels of operations. There are no significant impacts anticipated to airspace management as a result of implementing this alternative.

3.17.2.4 Alternative 4: Renovate Hangar C

Under Alternative 4, the processes and procedures for military and civilian aircraft operations in Class A, and Class D airspace currently being used would continue unchanged. Operations of the Guardian UAS would be the same as described in Section 3.17.2.2. All of the airspace involved in supporting current military and civilian activities is capable of accommodating those levels of operations. There are no significant impacts anticipated to airspace management as a result of implementing this alternative.

4.0 CUMULATIVE IMPACTS

4.1 PRELIMINARY IMPACT SCOPING

Cumulative impacts to environmental resources result from the incremental effects of an action when combined with other past, present and reasonably foreseeable future projects in the region of influence (ROI). Cumulative impacts can result from individually minor, but collectively substantial, actions undertaken over a period of time by various agencies (federal, state, and local) or individuals. In accordance with the National Environmental Policy Act (NEPA), a discussion of cumulative impacts resulting from projects that are proposed (or anticipated over the foreseeable future) is required.

To identify cumulative effects, the analysis needs to address two fundamental questions:

1. Does a relationship exist such that affected resource areas of the Proposed Action or alternatives might interact with the affected resource areas of past, present, or reasonably foreseeable actions?
2. If such a relationship exists, then does an Environmental Assessment (EA) reveal any potentially significant impacts not identified when the Proposed Action is considered alone?

The scope of the cumulative effects analysis involves both the geographic extent of the effects and the time frame in which the effects could be expected to occur, as well as a description of what resources could potentially be cumulatively affected.

When addressing cumulative impacts on wetlands and waters of the United States, the geographic extent for the cumulative effects analysis is the watershed in which the

Proposed Action and alternatives have the potential to impact, primarily concentrating on past, present and reasonably foreseeable actions on and within Cape Canaveral Air Force Station (CCAFS) and the surrounding ecosystem.

When addressing cumulative impacts on noise quality, the geographic extent for the cumulative effects analysis is the ROI in which the Proposed Action and alternatives have the potential to impact, primarily concentrating on past, present and reasonably foreseeable actions on CCAFS and in the surrounding community. The time frame for cumulative effects analysis centers on the timing of the Proposed Action and would continue into the foreseeable future.

The 45th Space Wing (45 SW) updates facilities at CCAFS on a continual basis. Planning efforts in the ROI include the actions described in this EA, as well as those additional projects that are ongoing, or planned in the vicinity of CCAFS. Additional projects within the ROI are discussed below.

Known actions proposed over the next five years at CCAFS are shown in Table 4-1 and are described below.

Table 4-1. Proposed Projects at CCAFS

Project Name/Description	Anticipated Fiscal Year
Repair Runway Lateral Clearance	2012
Repair Turning Areas, Skid Strip	2012
Add Fence Around Airfield	2012
Repair Runway Clear Zone, Phase 4	2013

As an active military installation, CCAFS and its tenant organizations undergo changes in mission and training requirements in response to defense policies, current threats, and tactical and technological advances, and as such, require new construction, facility improvements, infrastructure upgrades, and ongoing maintenance and repairs on a continual basis. Although such known construction and upgrades are a part of the analysis contained in this section, some future requirements cannot be predicted. As those requirements surface, future NEPA analysis would be conducted, as necessary.

4.2 LAND USE

Given the limited infrastructure improvements in the Proposed Action or alternatives, cumulative impacts on land use are not anticipated.

4.3 GEOLOGY AND SOILS

No significant cumulative impacts (negative or positive) to soil, geology, or groundwater resources are expected to result from the Proposed Action. Although construction activities would result in disturbance of the soils with a potential to accelerate erosion, best management practices (BMPs) would be followed to prevent significant impacts. The Proposed Action may alter the existing local drainage patterns but the overall impact is expected to be minimal.

4.4 HYDROLOGY AND GROUNDWATER

No significant cumulative impacts (negative or positive) to hydrology, or groundwater resources are expected to result from the Proposed Action. BMPs would be followed to prevent significant impacts. The Proposed Action may alter the existing local drainage patterns but the overall impact is expected to be minimal and would not impact groundwater resources.

4.5 SURFACE WATERS AND WATERS OF THE UNITED STATES

Given there are no infrastructure improvements in the Proposed Action that are not evaluated in the Skid Strip ADP EA and no-to-limited infrastructure improvements in the alternatives, cumulative impacts on surface waters and waters of the United States are not anticipated.

4.6 VEGETATIVE HABITAT

Implementation of the Proposed Action would result in impacts to vegetative habitat at CCAFS. According to the Skid Strip Area Development Plan (ADP), the United States Air Force (USAF) intends to construct additional aircraft aprons, taxiways, and hangar facilities in the vicinity of the proposed Guardian facilities. The Skid Strip ADP EA analyzed the impacts of these projects and it was determined that with the proper mitigation the impacts resulting from these projects would not be significant. Changes in the USAF's plans for constructing and implementing the projects have occurred and it is probable that not all of the projects outlined in the Skid Strip ADP EA would occur or projects could be delayed by 10 to 15 years. There is a potential for cumulative impacts to vegetative habitat should all of the construction projects planned in the Skid Strip Development Area occur. These cumulative impacts would result should the USAF need to clear additional habitat to offset the habitat utilized by the projects described in the Proposed Action. Given the uncertainty of these planned developments and the long-range time frame of these impacts any potential impacts are not anticipated to be significant. Additional evaluation would be required should future projects expand outside of the extent of the Skid Strip Development EA.

4.7 WILDLIFE RESOURCES

Implementation of the Proposed Action would result in minor impacts to wildlife resources at CCAFS. According to the Skid Strip ADP the USAF intends to construct additional aircraft aprons, taxiways, and hangar facilities in the vicinity of the proposed Guardian facilities. The Skid Strip ADP EA analyzed the impacts of these projects and it was determined that with the proper mitigation the impacts resulting from these projects would not be significant. Changes in the USAF's plans for constructing and implementing the projects have occurred and it is possible that not all of the projects outlined in the Skid Strip ADP EA would occur or projects could be delayed by 10 to 15 years. There is a potential for cumulative impacts to wildlife resources should all of the construction projects planned in the Skid Strip Development Area occur. These cumulative impacts would result should the USAF needing to clear additional habitat to offset the habitat utilized by the projects described in the Proposed Action. These cumulative impacts would result should the USAF need to clear additional habitat to offset the habitat utilized by the projects described in the Proposed Action. Given the uncertainty of these planned developments and the long-range time frame of these impacts any potential impacts are not anticipated to be significant. Additional evaluation would be required should future projects expand outside of the extent of the Skid Strip Development EA.

4.8 THREATENED AND ENDANGERED SPECIES

Implementation of the Proposed Action would result in minor impacts to threatened and endangered species at CCAFS. According to the Skid Strip ADP the USAF intends to construct additional aircraft aprons, taxiways, and hangar facilities in the vicinity of the proposed Guardian facilities. The Skid Strip ADP EA analyzed the impacts of these projects and it was determined that with the implementation of proper mitigation the impacts resulting from these projects would provide beneficial impacts to certain certain threatened and endangered species such as the Florida scrub-jay and the southeastern beach mouse.

Changes in the USAF's plans for constructing and implementing the projects have occurred and it is possible that not all of the projects outlined in the Skid Strip ADP EA would occur or projects could be delayed by 10 to 15 years. There is a potential for additional cumulative impacts to threatened and endangered species should all of the construction projects planned in the Skid Strip Development Area occur. These cumulative impacts would result should the USAF need to clear additional habitat to offset the habitat utilized by the projects described in the Proposed Action. These cumulative impacts would result should the USAF need to clear additional habitat to offset the habitat utilized by the projects described in the Proposed Action. Given the uncertainty of these planned developments and the long-range time frame of these impacts any potential impacts are not anticipated to be significant. Additional evaluation would be required should future projects expand outside of the extent of the Skid Strip Development EA.

4.9 CULTURAL, HISTORICAL, AND ARCHEOLOGICAL RESOURCES

Because no significant impacts would result from the Proposed Action and alternatives, no cumulative impacts to cultural, historical, and archeological resources are anticipated.

4.10 AIR QUALITY

Given the limited infrastructure improvements in the Proposed Action or alternatives, significant cumulative impacts on air quality are not anticipated.

4.11 NOISE

Given the limited impacts to noise issues as a result of the Proposed Action or alternatives, significant cumulative noise impacts are not anticipated.

4.12 TRANSPORTATION

Given the limited infrastructure improvements in the Proposed Action or alternatives, significant cumulative impacts on transportation are not anticipated.

4.13 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

Implementation of the Proposed Action would not introduce new hazardous materials and wastes at installations, and only a small increase in wastes would occur. Therefore, no significant cumulative impacts from the management of hazardous materials and waste are anticipated.

4.14 SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE AND PROTECTION OF CHILDREN

Given the limited impacts to socioeconomic and environmental justice issues as a result of the Proposed Action or alternatives, significant cumulative impacts to socioeconomic and environmental justice are not anticipated.

4.15 SUSTAINABILITY AND GREENING

Given the limited infrastructure improvements in the Proposed Action or alternatives, significant cumulative impacts on sustainability and greening are not anticipated.

4.16 HUMAN HEALTH AND SAFETY

Flight and ground safety associated with the beddown of the Guardian UAS is not expected to have any cumulative effects in conjunction with other past, present, and reasonably foreseeable actions. Cumulative airspace safety would not be expected to change with the proposed beddown in conjunction with other projects. Implementation of the Proposed Action would not result in any significant cumulative effects to safety.

4.17 AIRSPACE MANAGEMENT

Given the limited impacts to airspace management issues as a result of the Proposed Action or alternatives, significant cumulative impacts on these issues are not anticipated.

5.0 MITIGATION MEASURES

This section of the document outlines measures that would be implemented to reduce or eliminate potential adverse impacts to the human and natural environment. Impacts to construction related impacts may be avoided or minimized by incorporating proper construction techniques, erosion control measures, and structural engineering designs into project development. Best management practices (BMPs) would be implemented to minimize potential construction related impacts.

In an effort to further minimize impacts, the United States (U.S.) Customs and Border Protection (CBP) Air and Marine (A&M) would comply with all applicable federal and state laws, as well as applicable U.S. Air Force (USAF) regulations during the implementation of the Proposed Action or alternatives.

5.1 SOILS

Only minimal disturbance of soils would result from the implementation of the Proposed Action. To further minimize impacts to soils BMPs would be utilized to control erosion and sedimentation.

5.2 SURFACE WATERS AND WATERS OF THE UNITED STATES

No direct impacts are anticipated to surface waters and waters of the United States. BMPs would be utilized to minimize impacts from construction sites. All federal, state, local and USAF regulations would be complied with during implementation of the Proposed Action or Alternatives including the utilization of a Storm Water Pollution Prevention Plan (SWPPP).

5.3 VEGETATIVE HABITAT

Vegetation that is temporarily disturbed due to construction activities would be treated mechanically or with prescribed fire as allowed upon completion of construction activities to control invasive species and stimulate native vegetation.

5.4 WILDLIFE RESOURCES

Impacts to wildlife species are anticipated to be minimal. Impacts would be anticipated to cause disruption to populations of wildlife in the vicinity of construction. These impacts would be short-term and temporary.

There is the potential for species protected by the Migratory Bird Treaty Act to occur with the project area. Avian surveys would occur immediately before construction activities to identify the presence of any nests. Monitoring during construction would identify any potential disturbances so measures could be implemented to avoid adverse effects.

5.5 THREATENED AND ENDANGERED SPECIES

The USAF has continued to coordinate with the USFWS regarding potential impacts to threatened and endangered species. On January 18, 2011, the USAF received confirmation from the USFWS that the Proposed Action, as described in the Skid Strip documents, has not changed and therefore the Proposed Action under this project is considered a covered activity under the Biological Opinion for the Skid Strip ADP. Therefore, the USFWS has determined that implementation of the Proposed Action in the Skid Strip ADP EA and thus the CBP Proposed Action is not likely to jeopardize the continued existence of the Florida Scrub-jay, southeastern beach mouse or eastern indigo snake if the USAF employs U.S. Fish and Wildlife Service (USFWS) mitigation measures.

Scrub-Jay

The USAF proposes to restore unoccupied Scrub-jay habitat at a ratio of 3:1 (every acre lost would require compensation in the amount of three acres). For each phase of clearing around the Skid Strip, there would be a corresponding project to restore habitat. A combination of mechanical treatment and prescribed burning as allowed would be used to restore habitat. In addition to the creation of habitat, CCAFS would avoid construction in Scrub-jay occupied areas during the nesting season from March 1 through June 30; ensure that prior to clearing of Scrub-jay habitat there is suitable habitat within 1,200 feet; that the USFWS would be notified of any unauthorized taking of Scrub-jays identified during construction; and that CCAFS would conduct routine Scrub-jay monitoring and submit reports describing the actions taken to implement the terms and conditions of the "Incidental Take Statement."

If a dead Scrub-jay is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville.

Southeastern Beach Mouse

The proposed restoration of habitat for the Scrub-jay is expected to be beneficial to southeastern beach mice. Based on a three-year study recently completed for CCAFS, beach mice are benefiting from the same land management activities being conducted for Scrub-jays, and the population is expanding into inland locations. Therefore, the potential exists to create an additional 1,000+ acres of habitat for beach mice. Based on observations by USAF biologists of small mammal burrows around the current Skid

Strip clear zone, the expansion of that zone has the potential to provide additional habitat. If a dead beach mouse is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville.

Eastern Indigo Snake

The 45th SW Indigo Snake Protection/Education Plan would be presented to the project manager, construction manager and personnel. An educational sign would be displayed at the site informing personnel of the snake’s appearance, its protected status, and who to contact if any are spotted in the area. If indigo snakes are encountered during clearing activities, they would be allowed to safely leave the area on their own. Furthermore, indigo snakes encountered during gopher tortoise burrow excavation, if required, would attempt to be safely moved out of the project area. An eastern indigo snake monitoring report would be submitted in the event that any indigo snakes are observed. If a dead indigo snake is found at the project site, it would be salvaged in accordance with proper protocols and notification would be made to the USFWS office in Jacksonville. Only individuals with permits should attempt to capture the eastern indigo snakes. If an indigo snake is held in captivity, it should be released as soon as possible in release sites approved by the USFWS on the CCAFS.

5.6 CULTURAL, HISTORICAL, AND ARCHEOLOGICAL RESOURCES

No significant impacts are anticipated to cultural, historical, and archeological resources. The lease, renting or transfer of ownership from one federal agency to another is not considered an adverse impacts under Section 106 of the National Historic Preservation Act. In the unlikely event that previously unrecorded or unevaluated cultural resources are encountered during construction, CBP would notify CCAFS immediately, who would manage these resources in accordance with the CCAFS Integrated Cultural Resources Management Plan (ICRMP) (45 SW 2004), adhering to federal and state laws, as well as USAF regulations.

5.7 AIR QUALITY

Potential increases to criteria pollutants are monitored at CCAFS under their Title V Permit. Should project induced levels of these pollutants approach the National Ambient Air Quality Standards (NAAQS) limits for the region, effects to air quality would be reevaluated.

5.8 NOISE

Construction noise would be minimized by planning construction to occur during daylight hours and ensuring that construction vehicles have properly functioning mufflers and that the vehicles are in good working order.

5.9 HAZARDOUS MATERIALS AND WASTE MANAGEMENT

Disposal of potentially hazardous materials would be handled through CCAFS Waste Management. All such materials would be handled in accordance with applicable federal, state, Air Force, and local regulations. The largest amount of hazardous materials are anticipated to result from Guardian operations which would likely result in the following types and quantities of hazardous material: used jet fuel (JP-8) (55 gallon drum), used oil (55 gallon drum), used fuel filters (15 gallon drum), used oil filters (15 gallon drum), used Antifreeze (15 gallon drum). The estimated cost of disposal of these materials would be less than $1,000. Based on the USAF policy of minimizing waste, it is expected that CBP would generate less hazardous materials than described above.

If contaminated groundwater is encountered during the hangar construction, it would be managed in accordance with applicable laws and regulations. Appropriate personal protective equipment would be used in such situations.

CCAFS implements BMPs to minimize the potential for contaminants to reach nearby surface waters, and a SWPPP that includes water quality monitoring.

BMPs and appropriate measures would be strictly adhered too during construction to minimize erosion and control sedimentation.

CBP is responsible for managing these materials in accordance with federal, state, and local regulations to protect their employees from occupational exposure to hazardous materials and to protect the public health of the surrounding community. The operating location would be responsible for the safe storage and handling of hazardous materials used in conjunction with all construction and demolition operations. These materials would be delivered to CCAFS in compliance with the Hazardous Materials Transportation Act (HMTA) under 49 Code of Federal Regulations (CFR).

Therefore, the Proposed Action is not anticipated to have a long-term impact on the small quantity generator (SQG) status of CCAFS.

Asbestos or asbestos-containing materials (ACM) encountered during facility renovation would be the responsibility of the 45 SW and is regulated under National Emission Standards for Hazardous Air Pollutants (NESHAP) to prevent the release of asbestos fibers due to damage and disturbance of ACMs. Exposed friable asbestos would be removed in accordance with the 45 SW Asbestos Management Plan (45 SW 2009b), USAF policy and applicable health laws, regulations, and standards.

Lead-based paint encountered during facility renovation would be managed according to the 45 SW Lead Management Plan (45 SW 2009c), Occupational Health and Safety Administration (OSHA) regulations, and with the U.S. Environmental Protection Agency (USEPA) regulations addressing Lead: Management and Disposal of Lead-Based Paint Debris (40 CFR Part 745). Lead-based paint debris that meets the definition of a hazardous waste would be disposed of through the 45 SW procedures.

It is recognized that Hangars C and F contain asbestos and lead-based paint. Therefore, if disturbed as part of this project, construction debris associated with these Hangars would be disposed of in accordance with applicable federal, state, and USAF regulations.

5.10 SUSTAINABILITY AND GREENING

Construction and service contracts would comply with AFI 32-7086, Hazardous Materials Management. Per the National Energy Conservation Act, sustainable design principles and life-cycle cost effective technologies would be applied to the construction of new facilities. Recyclable materials such as concrete, etc., should be recycled and quantities reported to the 45 SW Environmental Office. Purchases would comply with Air Force Green Purchasing Program requirements. Energy efficient appliances and products would be utilized in accordance with the Federal Energy Management Program.

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7.0 ACRONYMS/ABBREVIATIONS

$\mu g/m^3$	Micrograms per Cubic Meter
45 SW	45th Space Wing
A&M	Air and Marine
ACAM	Air Conformity Applicability Model
ACM	Asbestos-Containing Material
ADP	Area Development Plan
AFCEE	Air Force Center for Engineering and the Environment
AFI	Air Force Instruction
AFOSH	Air Force Occupational Health and Safety
AGL	Above Ground Level
AICUZ	Air Installation Compatible Use Zone
AQCR	Air Quality Control Region
AR	Aerial Refueling
ASU	Airspace for Special Use
ATC	Air Traffic Control
ATCAA	Air Traffic Control Assigned Airspace
ATCT	Air Traffic Control Tower
BASH	Bird/Wildlife-Aircraft Strike Hazard
bgs	Below Ground Surface
BMP	Best Management Practice
BO	Biological Opinion
BRL	Building Restricted Line
CAA	Clean Air Act
CBP	Customs and Border Protection
CCAFS	Cape Canaveral Air Force Station
CCSMP	Cape Canaveral Spaceport Master Plan
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COA	Certificate of Authorization
CWA	Clean Water Act
dB	Decibel

ACRONYMS/ABBREVIATIONS (cont'd)

dBA	A-Weighted Decibel
DHS	Department of Homeland Security
DNL	Differential Non-Linearity
DoD	Department of Defense
DOT	Department of Transportation
EA	Environmental Assessment
EIS	Environmental Impact Statement
EO	Executive Order
ERP	Environmental Restoration Program
FAA	Federal Aviation Administration
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FL	Flight Level
FNAI	Florida's Natural Area Inventory
FONSI	Finding of No Significant Impact
ft^2	Square Feet
FWCC	Fish and Wildlife Conservation Commission
GCS	Ground Control Station
GDT	Ground Data Terminal
HAP	High Accident Potential
HMTA	Hazardous Materials Transportation Act
HSWA	Hazardous and Solid Waste Amendments
Hz	Hertz
ICBM	Intercontinental Ballistic Missile
ICRMP	Integrated Cultural Resources Management Plan
IERA	Institute for Environmental Safety and Occupational Health Risk Analysis
IFR	Instrument Flight Rules
IICEP	Intergovernmental Coordination for Environmental Planning
IR	Instrument Route
KARS	Kennedy Athletic, Recreation and Social
KSC	Kennedy Space Center
Ldn	Day-Night Average Sound Level
L_{max}	Maximum Noise Levels
LOSS	Level of Service Standard

ACRONYMS/ABBREVIATIONS (cont'd)

LUC	Land Use Controls
MOA	Military Operations Areas
$MMTCO_2$	million metric tons of carbon dioxide
MSL	Mean Sea Level
MST	Mobile Service Tower
MTR	Military Training Route
N2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NAS	National Airspace
NASA	National Aeronautics and Space Administration
NEI	National Emissions Inventory
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutant
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NO_X	Nitrogen Oxides
NPL	National Priority List
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
OFP	Operations Flight Planning
OFW	Outstanding Florida Water
OSHA	Occupational Safety Health Administration
OT&E	Operational Testing and Evaluation
$PM_{2.5}$	Particulate Matter With a Diameter Less Than or Equal to 2.5 Microns
PM_{10}	Particulate Matter With a Diameter Less Than or Equal to 10 Microns
ppb	Parts per Billion
ppm	Parts per Million
RCNM	Roadway Construction Noise Model
RCRA	Resource Conservation Recovery Act
ROI	Region of Influence
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SQG	Small Quantity Generator
SR	Slow Route

ACRONYMS/ABBREVIATIONS (cont'd)

SRM	Solid Rocket Motor
SWPPP	Storm Water Pollution Prevention Plan
TDS	Total Dissolved Solids
TERPS	Terminal Instrument Procedures
TSCA	Toxic Substances Control Act
U.S.	United States
UAS	Unmanned Aircraft System
UHF/VHF	Ultra-high frequency/very high frequency
UPS	Uninterrupted Power Supply
USAF	United States Air Force
USC	United States Code
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
VFR	Visual Flight Rules
VOC	Volatile Organic Compound

8.0 LIST OF PREPARERS

This Environmental Assessment (EA) has been prepared under the direction of the United States (U.S.) Customs and Border Protection (CBP) Air and Marine (A&M) and 45th Space Wing (45 SW) by Science Applications International Corporation (SAIC). The individual preparers of this document are listed below.

Jay Austin, Environmental Scientist
B.A., Biology
Years of Experience: 10

Matthew Bange, Environmental Engineer, P.E.
B.S., Biological Engineering
Years of Experience: 8

Alysia Baumann, NEPA Specialist/Planner
B.S., Chemical Engineer
Years of Experience: 6

Rachel Baxter, Environmental Analyst
B.A., Economics
Years of Experience: 5

Tom Daues, PMP, CHMM, Project Manager
M.S., Natural Resources; B.S., Biology
Years of Experience: 18

Denise DeLancey, Electronic Publishing Specialist
B.A., English/Communications
Years of Experience: 3

Nathan Gross, Environmental Scientist
B.S., Wildlife and Fisheries Mgt
Years of Experience: 8

Joseph Jimenez, Cultural Resources Manager
M.A., Anthropology; B.A., Anthropology
Years of Experience: 25

Claudia Laughlin, Graphics Artist
Years of Experience: 13

Anthony Finley, Electronic Publishing Specialist
B.A., English
Years of Experience: 3

Kristi Regotti, Environmental Analyst
M.H.S, Environmental Health; M.P.A, Environmental and Natural Resource Policy; B.S., Political Science
Years of Experience: 9

Brian Tutterow, Environmental Scientist
B.S., Biology
Years of Experience: 13

Catherine Woehr, Hydrogeologist
B.S., Geology; M.S., Environmental Scientist
Years of Experience: 18

APPENDIX A

PUBLIC INVOLVEMENT AND AGENCY CORRESPONDENCE

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This Appendix contains comments received from federal, state, and local agencies during the public comment period for the Draft EA. No comments were received from members of the general public. The 30-day public review process began with the publication of the Notice of Availability (NOA) of the Draft EA in the August 8, 2010 addition of the Florida Today newspaper. A hard copy or compact disc (CD) of the Draft EA was distributed to the Florida Clearinghouse. A hard copy was also sent to the Cape Canaveral Public Library for the purpose of making the document available for public review. The Draft EA was also posted on the World Wide Web at http://ecso.swf.usace.army.mil/Pages/Publicreview.cfm, which is accessible to the public. In accordance with the National Environmental Policy Act (NEPA), agency comments were reviewed and incorporated into this Final EA. The Department of Homeland Security and the United States Air Force (USAF) have considered these agency comments in the decision making process. This Appendix presents a summary of these comments and the modifications made to the Final EA based on these comments. Copies of agency comments are also included in this Appendix.

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NEWSPAPER NOTIFICATION

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Mailed to:

Environmental Scientist
Energy, Environment & Infrastructure Solutions
13397 Lakefront Frive, Suite 100
Earth City , MO. 63045

A daily publication by:

THE SPACE COAST'S NEWSPAPER FLORIDA TODAY PUBLISHED IN BREVARD COUNTY

STATE OF FLORIDA
COUNTY OF BREVARD

Before the undersigned authority personally appeared **KATHY CICALA,** who on oath says that she is **LEGAL ADVERTISING SPECIALIST** of the **FLORIDA TODAY**, a newpaper published in Brevard County, Florida; that the attached copy of advertising being a

LEGAL NOTICE

Ad # (	**379990)**	**$ 1,082.34**	**the matter of:**
Acct. #(	**6SA622**		
			SCIENCE APPPLICATIONS
the		**Court**	**LEGAL NOTICE**
			NOTICE OF AVAILABILITY

as published in the **FLORIDA TODAY** in the issue(s) of:

August 8, 2010

Affiant further says that the said **FLORIDA TODAY** is a newspaper in said Brevard County, Florida, and that the said newspaper has heretofore been continuously published in said Brevard County, Florida, regularly as stated above, and has been entered as periodicals matter at the post office in **MELBOURNE** in said Brevard County, Florida, for a period of one year next preceding the first publication of the attached copy of advertisement; and affiant further says that she has neither paid nor promised any person, firm or corporation any discount, rebate, commission or refund for the purpose of securing this advertisement for publication in said newspaper.

Kathy Cicala
(Signature of Affiant)

Sworn to and subscribed before this: **8th Day of August 2010**

Renee Ambrose
(Signature of Notary Public)

RENEE AMBROSE
MY COMMISSION # DD781217
EXPIRES: April 29, 2012
NOTARY PUBLIC STATE OF FLORIDA
Fl. Notary Discount Assoc. Co.

Renee Ambrose
(Name of Notary Typed, Printed or Stamped)

Personally Known __X__ or Produced Identification ________
Type Identification Produced: ________

PUBLIC LEGAL NOTICE

NOTICE OF AVAILABILITY

DRAFT ENVIRONMENTAL ASSESSMENT AND PROPOSED FINDING OF NO SIGNIFICANT IMPACT FOR THE BEDDOWN AND FLIGHT OPERATIONS OF UNMANNED AIRCRAFT SYSTEMS AT CAPE CANAVERAL AIR FORCE STATION, FLORIDA

U.S. CUSTOMS AND BORDER PROTECTION OFFICE OF AIR AND MARINE

U.S. Customs and Border Protection (CBP), a component of the Department of Homeland Security (DHS), announces the availability of a Draft Environmental Assessment (EA) and proposed Finding of No Significant Impact (FONSI) for the proposed Beddown and Unmanned Aircraft Systems (UAS) Flight Operations Project. Pursuant to the National Environmental Policy Act (NEPA) of 1969, 42 U.S.C. 4321 et seq., CBP has prepared the Draft EA and proposed FONSI to identify and assess the potential impacts associated with the proposed beddown and flight operations of UAS at Cape Canaveral Air Force Station, Florida.

The Draft EA and proposed FONSI were prepared in accordance with CBP's obligations under NEPA, the Council on Environmental Quality (CEQ) implementing regulations at 40 CFR Parts 1500–1508, and DHS Management Directive 5100.1 (Environmental Planning Program). A review copy of this document will be available at the Cape Canaveral Library, 201 Polk Avenue, Cape Canaveral, FL 32920; and, on the internet at http://ecso.swf.usace.army.mil/Pages/Publicreview.cfm. The Draft EA and FONSI will be available for a 30 day review period starting with the first day of publication in this newspaper.

Pursuant to the CEQ regulations, CBP invites public participation in the NEPA process. The public may participate by reviewing and submitting comments on the Draft EA and proposed FONSI. The public may submit comments by one of the methods described below. CBP will consider all applicable and pertinent comments submitted during the public comment period, and subsequently will prepare the Final EA. CBP will announce the availability of the Final EA and FONSI.

Comments on the Draft EA and FONSI should be received by September 6. Please use only one of the following methods:

(a) By mail to: Attn: Jennifer DeHart Hass, Acting Director
Environmental and Energy Division, U.S. Customs and Border Protection
1331 Pennsylvania Avenue, NW, NP 1220, Washington, D.C. 20229-1106.

(b) By email to: Jennifer.Hass@cbp.dhs.gov

When submitting comments, please include your name and address, and identify your comments as being for the Draft Cape Canaveral EA and FONSI.

FT-0000379990

residents who work until 5 p.m. have time to get to local elections offices before lines close. Voters who are in line at 6 p.m. can still cast their ballots.

The old early voting hours were 8:30 p.m. to 4:30 p.m.

"It just didn't seem conducive to me for our working voters," Scott said.

Brevard County election offices are open Monday through Saturday until Aug. 21 for early voting.

State lawmakers approved a measure in 2004 that required local supervi-

primary will fall somewhere in between those numbers.

So far, 39,000 Brevard County voters requested absentee ballots. That compares to only about 9,000 voters requested absentee ballots during the 2006 primary, the last gubernatorial race.

Part of that comes because poll workers now ask voters at polling sites if they would like to have absentee ballots mailed to them for subsequent elections. ■

Contact Cervenka at 242-3632 or scervenka@floridatoday.com.

Two winners of the "Fantasy 5" game will collect $114,075.97 each, the Florida Lottery said Saturday.

The winning tickets were bought in Oakland Park and Melbourne.

■ 486 tickets matching four numbers won $75.50;

■ 11,920 tickets matching three numbers won $8.50;

■ 104,829 tickets won a Quick Pick ticket for picking two numbers.

The numbers drawn Friday were 8-12-15-16-24.

— FLORIDA TODAY wires

NEWS OF RECORD: MARRIAGE LICENSES

and Ashley Ann **Haney**, 31, both of Merritt Island.

Scott Allen **Winfree**, 34, and Jamie Nicole **Baird**, 28, both of

26, and Sarah Ruth **Ingraham**, 23, both of Palm Bay

Jordan Shea **Arnold**, 26, of Robert Lee, Texas and Natalie Fern

James Thomas **Burnett**, 30, of Winter Springs and Nguyet Minh **Pham**, 28, of Hanoi, Vietnam.

PUBLIC LEGAL NOTICE

NOTICE OF AVAILABILITY

DRAFT ENVIRONMENTAL ASSESSMENT AND PROPOSED FINDING OF NO SIGNIFICANT IMPACT FOR THE BEDDOWN AND FLIGHT OPERATIONS OF UNMANNED AIRCRAFT SYSTEMS AT CAPE CANAVERAL AIR FORCE STATION, FLORIDA

U.S. CUSTOMS AND BORDER PROTECTION OFFICE OF AIR AND MARINE

U.S. Customs and Border Protection (CBP), a component of the Department of Homeland Security (DHS), announces the availability of a Draft Environmental Assessment (EA) and proposed Finding of No Significant Impact (FONSI) for the proposed Beddown and Unmanned Aircraft Systems (UAS) Flight Operations Project. Pursuant to the National Environmental Policy Act (NEPA) of 1969, 42 U.S.C. 4321 et seq., CBP has prepared the Draft EA and proposed FONSI to identify and assess the potential impacts associated with the proposed beddown and flight operations of UAS at Cape Canaveral Air Force Station, Florida.

The Draft EA and proposed FONSI were prepared in accordance with CBP's obligations under NEPA, the Council on Environmental Quality (CEQ) implementing regulations at 40 CFR Parts 1500–1508, and DHS Management Directive 5100.1 (Environmental Planning Program). A review copy of this document will be available at the Cape Canaveral Library, 201 Polk Avenue, Cape Canaveral, FL 32920; and, on the internet at http://ecso.swf.usace.army.mil/Pages/Publicreview.cfm. The Draft EA and FONSI will be available for a 30 day review period starting with the first day of publication in this newspaper.

Pursuant to the CEQ regulations, CBP invites public participation in the NEPA process. The public may participate by reviewing and submitting comments on the Draft EA and proposed FONSI. The public may submit comments by one of the methods described below. CBP will consider all applicable and pertinent comments submitted during the public comment period, and subsequently will prepare the Final EA. CBP will announce the availability of the Final EA and FONSI.

Comments on the Draft EA and FONSI should be received by September 6. Please use only one of the following methods:

(a) By mail to: Attn: Jennifer DeHart Hass, Acting Director
Environmental and Energy Division, U.S. Customs and Border Protection
1331 Pennsylvania Avenue, NW, NP 1220, Washington, D.C. 20229-1106.

(b) By email to: Jennifer.Hass@cbp.dhs.gov

When submitting comments, please include your name and address, and identify your comments as being for the Draft Cape Canaveral EA and FONSI.

FT-0000379990

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FLORIDA CLEARINGHOUSE LETTER

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1300 Pennsylvania Avenue NW
Washington, DC 20229

U.S. Customs and
Border Protection

FL201008045386C

AUG 0 3 2010
RECEIVED
AUG 04 2010
DEP Office of
Intergovt'l Programs

Lauren Milligan
Environmental Manager
Florida State Clearinghouse
Department of Environmental Protection
3900 Commonwealth Blvd, Mail Station 47
Tallahassee, Fl 32399-3000

Dear Ms. Milligan:

The U.S. Customs and Border Protection Office of Air and Marine (CBP OAM) is proposing beddown and flight operations of unmanned aircraft systems at Cape Canaveral Air Force Station in Florida. In compliance with the National Environmental Policy Act, a Draft Environmental Assessment (EA) and a Finding of No Significant Impact (FONSI) were prepared to document potential environmental consequences associated with implementation of the proposed action.

Enclosed is one hard copy of the referenced EA and FONSI as well as eleven electronic copies on compact disc. The U.S. CBP OAM respectfully requests your review and comments. An expedited review of 45 days or less would be appreciated.

If you have any questions or require additional information, please contact me at (202) 344-1929 or via email at Jennifer.Hass@cbp.dhs.gov. Written correspondence may be submitted to me by mail as follows:

> Jennifer DeHart Hass
> Acting Director
> Environmental and Energy Division
> U.S. Customs and Border Protection
> 1331 Pennsylvania Avenue, NW, NP 1220
> Washington, DC 20229-1106

Sincerely,

Jennifer DeHart Hass
Acting Director
Environmental and Energy Division

Enclosure(s)

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AGENCY COMMENT SUMMARY

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Florida Department of
Environmental Protection
Marjory Stoneman Douglas Building
3900 Commonwealth Boulevard
Tallahassee, Florida 32399-3000

September 15, 2010

Ms. Jennifer DeHart Hass, Acting Director
Environmental and Energy Division
U.S. Customs and Border Protection
1331 Pennsylvania Avenue NW, Suite 1220N
Washington, DC 20229-1106

RE: U.S. Customs and Border Protection – Draft Environmental Assessment (EA) for Beddown and Flight Operations of Unmanned Aircraft Systems at Cape Canaveral Air Force Station – Brevard County, Florida.
SAI # FL201008045386C

Dear Ms. Hass:

The Florida State Clearinghouse has coordinated a review of the subject Draft EA under the following authorities: Presidential Executive Order 12372; Section 403.061(40), *Florida Statutes*; the Coastal Zone Management Act, 16 U.S.C. §§ 1451-1464, as amended; and the National Environmental Policy Act, 42 U.S.C. §§ 4321-4347, as amended.

The St. Johns River Water Management District (SJRWMD) notes that several alternatives detailed in the Draft EA involve the renovation of existing facilities, which would likely minimize impacts to natural resources. Alternative 2, the Proposed Action, does involve construction of a new hangar facility. The SJRWMD concurs with the EA, which indicates that significant impacts to water resources are not likely to occur from the construction of Alternative 2. It advises, however, that the Proposed Action has the potential to impact scrub habitat and protected wildlife species, including the scrub-jay, southeastern beach mouse, gopher tortoise, and eastern indigo snake.

Development of the new hangar is expected to exceed SJRWMD environmental resource permitting (ERP) thresholds and will require issuance of an ERP. During the ERP application review process, the applicant will be required to demonstrate that any direct and secondary impacts to wetlands and surface waters, including adverse impacts to the wildlife value of wetlands, have been avoided or minimized. Unavoidable impacts will require mitigation, in accordance with the Unified Mitigation Assessment Method found in Chapter 62-345, *Florida Administrative Code* (F.A.C.). In addition, compliance with the environmental review criteria in Chapter 12 of the SJRWMD *Applicant's Handbook: Management and Storage of Surface Waters* will be required. Please contact Ms. Susan Moor, Supervising Regulatory Scientist, in the Palm Bay Service Center at smoor@sjrwmd.com or (321) 676-6626 for further assistance.

The Florida Fish and Wildlife Conservation Commission (FWC) notes that twenty-one federal and state-listed species occur within the project study area. Since there is a likelihood that the project will impact Florida scrub-jay and eastern indigo snake habitat, the Draft EA indicates that 1,157.28 acres of potential scrub-jay, southeastern beach mouse and eastern indigo snake habitat will be restored as mitigation for these impacts over a nine year period. The FWC concurs with the Draft EA's assertion that scrub-jay mitigation actions will also mitigate for impacts to the southeastern beach mouse. Staff recommends that wildlife surveys for state-listed species that may be affected be conducted during the year immediately before construction. Species-specific surveys should follow the established protocols and guidelines found online in the Florida Wildlife Conservation Guide. The FWC also recommends that mitigation actions proposed close to the impact site begin before land clearing to provide relocation opportunities. Staff supports the proposed mitigation and believes it will significantly improve habitat conditions on the base. Please refer to the enclosed FWC letter for additional information.

The Florida Department of Environmental Protection's (DEP) Central District Office in Orlando indicates that, while the hanger will be an unregulated source, the emergency backup generators will need to be included in the facility's Title V air permit when it is renewed in July 2011. Based on the Draft EA estimates for air pollutant emissions associated with the proposed project, the staff advises that construction of the facility should include measures to minimize the large PM2.5 emissions (29 tons) from the construction grading operations. The applicant is advised to develop a management plan with appropriate Best Management Practices for controlling these emissions. For additional information, please contact Ms. Caroline Shine, Air Resources Program Administrator, at (407) 893-3332.

The DEP District states that because the City of Cocoa wholesales water to the base, the base is a regulated consecutive public water system. Any extension of water mains to serve the proposed facility will require a drinking water permit under Chapter 62-555, *F.A.C.* Questions may be directed to Mr. Reggie Phillips, Drinking Water Supervisor at (407) 893-3319. Additionally, if the facility generates any domestic wastewater, it will require a permitted collection/transmission system in order to connect to the Cape Canaveral wastewater treatment facility. Questions may be directed to Ms. Dennise Judy, Domestic Waste Permitting Engineer, at (407) 893-3311.

Based on the information contained in the Draft EA and enclosed state agency comments, the state has determined that, at this stage, the proposed federal action is consistent with the Florida Coastal Management Program (FCMP). To ensure the project's continued consistency with the FCMP, the concerns identified by our reviewing agencies must be addressed prior to project implementation. The state's continued concurrence will be based on the activity's compliance with FCMP authorities, including federal and state monitoring of the activity to ensure its continued conformance, and the adequate resolution of issues identified during this and subsequent reviews. The state's final concurrence of the project's consistency with the FCMP will be determined during the environmental permitting process.

Thank you for the opportunity to review the proposed project. Should you have any questions regarding this letter, please contact Ms. Suzanne E. Ray at (850) 245-2172.

Yours sincerely,

Sally B. Mann

Sally B. Mann, Director
Office of Intergovernmental Programs

SBM/ser
Enclosures

cc: Lu Burson, DEP, Central District
Steve Fitzgibbons, SJRWMD
Mary Ann Poole, FWC

Project Information	
Project:	FL201008045386C
Comments Due:	09/09/2010
Letter Due:	09/20/2010
Description:	U.S. CUSTOMS AND BORDER PROTECTION - DRAFT ENVIRONMENTAL ASSESSMENT FOR BEDDOWN AND FLIGHT OPERATIONS OF UNMANNED AIRCRAFT SYSTEMS AT CAPE CANAVERAL AIR FORCE STATION - BREVARD COUNTY, FLORIDA.
Keywords:	CBP - OPERATE UNMANNED AIRCRAFT SYSTEMS AT CAPE CANAVERAL AFS - BREVARD CO.
CFDA #:	97.078

Agency Comments:

E. CENTRAL FL RPC - EAST CENTRAL FLORIDA REGIONAL PLANNING COUNCIL

The East Central Florida Regional Planning Council has received notice of the U.S. Customs and Border Protection's Draft Environmental Assessment in accordance with the Executive Order of the Governor and Presidential Executive Order 12372, Intergovernmental Review of Federal Programs. Council staff has not identified any significant or adverse effects to regional resources or facilities, nor have any extra-jurisdictional impacts been identified that would adversely affect neighboring jurisdictions. The proposed project is found to be consistent with the goals, policies, and objectives of the East Central Florida Regional Planning Council. Should there be any questions concerning this review, please contact Mr. Matt Boerger, Planner II, at (407) 262-7772.

FISH and WILDLIFE COMMISSION - FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

The FWC notes that 21 federal and state-listed species occur within the project study area. Since there is a likelihood that the project will impact Florida scrub-jay and eastern indigo snake habitat, the Draft EA indicates that 1,157.28 acres of potential scrub-jay, southeastern beach mouse and eastern indigo snake habitat would be restored as mitigation for these impacts over a 9-year period. FWC concurs with the Draft EA's assertion that scrub-jay mitigation actions would also mitigate for impacts to the southeastern beach mouse. Staff recommends that wildlife surveys for state-listed species that may be affected be conducted during the year immediately before construction. Species-specific surveys should follow the established protocols and guidelines found in the Florida Wildlife Conservation Guide on FWC's website. The FWC also recommends that mitigation actions proposed close to the impact site begin before land clearing to provide relocation opportunities. Staff supports the proposed mitigation and believes it will significantly improve habitat conditions on the base.

STATE - FLORIDA DEPARTMENT OF STATE

No Comment/Consistent

ENVIRONMENTAL PROTECTION - FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

The DEP Central District Office in Orlando indicates that, while the hanger will be an unregulated source, the emergency backup generators will need to be included in the facility's Title V air permit when it is renewed in July 2011. Based on the Draft EA estimates for air pollutant emissions associated with the proposed project, the staff advises that construction of the facility should include measures to minimize the large PM2.5 emissions (29 tons) from the construction grading operations. The applicant is advised to develop a management plan with appropriate Best Management Practices for controlling these emissions. For additional information, please contact Ms. Caroline Shine, Air Resources Program Administrator, at (407) 893-3332. The DEP District states that because the City of Cocoa wholesales water to the base, the base is a regulated consecutive public water system. Any extension of water mains to serve the proposed facility will require a drinking water permit under Chapter 62-555, F.A.C. Questions may be directed to Mr. Reggie Phillips, Drinking Water Supervisor at (407) 893-3319. Additionally, if the facility generates any domestic wastewater, it will require a permitted collection/transmission system in order to connect to the Cape Canaveral wastewater treatment facility. Questions may be directed to Ms. Dennise Judy, Domestic Waste Permitting Engineer, at (407) 893-3311.

ST. JOHNS RIVER WMD - ST. JOHNS RIVER WATER MANAGEMENT DISTRICT

Several alternatives detailed in the environmental assessment (EA) involve the renovation of existing facilities. Generally, these alternatives would minimize impacts to natural resources. Alternative 2, the Proposed Action, involves construction of a new hangar facility. The EA indicates that significant impacts to water resources are not likely to occur from the construction of Alternative 2. This conclusion appears to be accurate based on an aerial assessment of the site. However, the construction of the Proposed Action has the potential to impact scrub habitat and protected wildlife species, including the scrub jay, southeastern beach mouse, gopher tortoise, and eastern indigo snake. Development of the Proposed Alternative (i.e., a new hangar) is expected to exceed St. Johns River Water Management District (SJRWMD) environmental resource permitting (ERP) thresholds and will require an ERP. During the ERP application review process, the applicant will be required to demonstrate that any direct and secondary impacts to wetlands and surface waters, including adverse impacts to the wildlife value of wetlands, have been avoided or minimized. Unavoidable impacts will require mitigation, in accordance with the Unified Mitigation Assessment Method found in Chapter 62-345, F.A.C. In addition, compliance with the environmental review criteria in Chapter 12 of the SJRWMD Applicant's Handbook: Management and Storage of Surface Waters will be required. Please contact Ms. Susan Moor, Supervising Regulatory Scientist, in the Palm Bay Service Center at (321) 676-6626 or smoor@sjrwmd.com if there are any questions.

Florida Fish and Wildlife Conservation Commission

Commissioners
Rodney Barreto
Chairman
Miami
Richard A. Corbett
Vice Chairman
Tampa
Kathy Barco
Jacksonville
Ronald M. Bergeron
Fort Lauderdale
Dwight Stephenson
Delray Beach
Kenneth W. Wright
Winter Park
Brian S. Yablonski
Tallahassee

Executive Staff
Nick Wiley
Executive Director
Greg Holder
Assistant Executive Director
Karen Ventimiglia
Deputy Chief of Staff

Office of Planning and Policy Coordination
Nancy Linehan
Director
(850) 487-3794
(850) 410-5265 FAX
(850) 410-5272
(850) 922-5679 FAX

Managing fish and wildlife resources for their long-term well-being and the benefit of people.

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32399-1600
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Hearing/speech impaired:
(800) 955-8771 (T)
(800) 955-8770 (V)

MyFWC.com

September 7, 2010

Ms. Lauren P. Milligan
Florida State Clearinghouse
Department of Environmental Protection
3900 Commonwealth Boulevard, Mail Station 47
Tallahassee, FL 32399-3000

RECEIVED
SEP 09 2010
DEP Office of
Intergovt'l Programs

Re: SAI #FL201008045386C, U.S. Customs and Border Protection – Draft Environmental Assessment for Beddown and Flight Operations of Unmanned Aircraft Systems at Cape Canaveral Air Force Station, Brevard County

Dear Ms. Milligan:

The Division of Habitat and Species Conservation, Habitat Conservation Scientific Services Section, of the Florida Fish and Wildlife Conservation Commission (FWC) has coordinated our agency's review of the referenced Draft Environmental Assessment (DEA), and provides the following comments and recommendations. These are being provided in accordance with the National Environmental Policy Act and the Coastal Zone Management Act/Florida Coastal Management Program.

Project Description

The U.S. Customs and Border Patrol Office of Air and Marine is proposing construction of a facility for beddown and flight operations of unmanned aircraft systems at Cape Canaveral Air Force Station (CCAFS). The proposed action includes construction of a new hangar and parking facilities, placement of a ground data terminal antenna, and infrastructure improvements on approximately five acres on the southwest side of the existing runway, known as the "Skid Strip." In 2004, the Cape Canaveral Air Force Station prepared a *Skid Strip Area Development Plan* (ADP), which described improvements that would increase the safety and function of this runway, for 411 acres on the southwest side of the runway.

Potentially Affected Resources

The Skid Strip area is currently within a conservation area and consists primarily of live oak/saw palmetto hammock. According to our Geographic Information System (GIS) analysis, the study area contains or falls within:

- U.S. Fish and Wildlife Service Consultation Area – Florida scrub- jay

Please note that our analysis identified 21 wildlife species that are protected by state or federal law and which have been identified as possibly occurring on the uplands and freshwater wetlands of the CCAFS site.

Potentially Occurring Listed Wildlife Species

Common Name	*Scientific Name*	Status*
Gopher frog	*Rana capito*	SSC
Eastern indigo snake	*Drymarchon corais couperi*	ST; FT
Florida pine snake	*Pituophis melanoleucus*	SSC

	mugitus	
Gopher tortoise	*Gopherus polyphemus*	SSC
Southeastern American kestrel	*Falco sparverius paulus*	ST
Peregrine falcon	*Falco peregrinus*	SE
Least tern	*Sterna antillarum*	ST
Brown pelican	*Pelecanus occidentalis*	SSC
White ibis	*Eudocimus albus*	SSC
Wood stork	*Mycteria americana*	SSC
Snowy egret	*Egretta thula*	SE, FE
Reddish egret	*Egretta rufescens*	SSC
Little blue heron	*Egretta caerulea*	SSC
Tricolored heron	*Egretta tricolor*	SSC
Roseate spoonbill	*Platalea ajaja*	SSC
Black skimmer	*Rynchops niger*	SSC
American oystercatcher	*Haematopus palliatus*	SSC
Piping plover	*Charadrius melodus*	ST
Florida scrub-jay	*Aphelocoma coerulescens*	ST, FT
Florida mouse	*Podomys floridanus*	SSC
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	ST

* SSC - Species of Special Concern; ST - State Threatened; SE - State Endangered; FT - Federally Threatened; FE - Federally Endangered

According to the DEA a three-year study to assess for potential impacts on the southeastern beach mouse was conducted, and the results of that study indicate that this species is using the inland areas of the site. Further, the DEA asserts that the U.S. Fish and Wildlife Service (USFWS) concluded in their Biological Opinion that there is a likelihood of the project impacting on scrub-jay and eastern indigo snake habitat. In response, the DEA offers to restore 1,157.28 acres of potential scrub-jay, southeastern beach mouse, and eastern indigo snake habitat as mitigation for these impacts within the CCAFS over a nine-year period. The DEA predicts that the restoration/creation of scrub-jay habitat would also benefit the state-listed southeastern beach mouse. According to the DEA, the USFWS has issued an "Incidental Take Statement" for indigo snakes and scrub-jays for this proposal.

Recommendations

Wildlife Surveys: The DEA asserts that the scrub-jay mitigation actions would also mitigate for impacts to habitat of the southeastern beach mouse, and our staff concurs with that assertion. In order to provide the best available information when finalizing the Environmental Assessment for the project, we recommend that it include the state-listed species that may be affected and commit to surveying for the presence of these species during the year immediately before construction. Species-specific surveys should follow established survey protocols and guidelines where applicable. Survey protocols can be found in the Florida Wildlife Conservation Guide at http://myfwc.com/conservation/fwcg.html. If there is evidence that any individuals of these species are present, then the U.S. Customs and Border Patrol or its agent should report the findings to the FWC or the U.S. Fish and Wildlife Service as appropriate. If impacts to these species cannot be avoided, then the U.S. Customs and Border Patrol or its agent should contact the appropriate agency before taking any action that might result in an impact to those species. We are providing the following recommendations to assist the applicant with development of strategies to avoid, minimize, or mitigate impacts to these wildlife resources.

Mitigation for Wildlife Impacts: From what we can see from aerials, the impact site may have limited value to the Conservation Area overall. Further, the DEA indicates a preference for restoration activities to occur close to the impact site. A potential benefit for performing mitigation activities close to the impact area is to provide opportunity for listed species to move from the impacted area to better conditions. However, in order to maximize this benefit, we suggest that mitigation actions begin before land clearing for the proposed development. We support the proposed mitigation and believe it will significantly improve habitat conditions on the CCAFS site.

Copies of Existing Studies: Please note that the DEA did not include copies of the beach mouse study, the USFWS' Biological Opinion, nor did it identify the dates those documents were finalized. The final Environmental Assessment should include copies of the Skid Pad ADP, the southeastern beach mouse study, the Biological Opinion, and any other recent environmental studies related to development around the Skid Pad and potential mitigation areas.

Summary

At this point, we do not find this project to be inconsistent with our authorities (Chapter 379, Florida Statutes) as provided for under the Florida Coastal Management Program. This finding does not relieve the applicant from following requirements of all Florida Administrative Code rules relating to surveying for and obtaining necessary permits for impacts to wildlife (especially those listed as endangered, threatened or of special concern) that might be a result of future construction. If you or your staff have any questions or need any additional information, please feel free to contact Steve Lau by telephone at 772-778-6354 or by email at steve.lau@MyFWC.com.

Sincerely,

Mary Ann Poole

Mary Ann Poole
Commenting Program Administrator

map/sl
ENV 1-3-2
Beddown and Flight Operations at Cape Canaveral_2990_090710
cc: Jennifer DeHart Hass, Acting Director
Environmental and Energy Division
U.S. Customs and Border Protection
1331 Pennsylvania Avenue, NW, NP 1220
Washington, DC 20229-1106

COUNTY: BREVARD
SCH-106-USCBP-CCAFS
2010 - 3785

DATE: 8/4/2010
COMMENTS DUE DATE: 9/9/2010
CLEARANCE DUE DATE: 9/20/2010
SAI#: FL201008045386C

RECEIVED
BUREAU OF
HISTORIC PRESERVATION
2010 AUG -4 A 11:20

MESSAGE:

STATE AGENCIES	WATER MNGMNT. DISTRICTS	OPB POLICY UNIT	RPCS & LOC GOVS
ENVIRONMENTAL PROTECTION	ST. JOHNS RIVER WMD		
FISH and WILDLIFE COMMISSION			
X STATE			

The attached document requires a Coastal Zone Management Act/Florida Coastal Management Program consistency evaluation and is categorized as one of the following:

_ **Federal Assistance to State or Local Government (15 CFR 930, Subpart F). Agencies are required to evaluate the consistency of the activity.**

X **Direct Federal Activity (15 CFR 930, Subpart C). Federal Agencies are required to furnish a consistency determination for the State's concurrence or objection.**

_ **Outer Continental Shelf Exploration, Development or Production Activities (15 CFR 930, Subpart E). Operators are required to provide a consistency certification for state concurrence/objection.**

_ **Federal Licensing or Permitting Activity (15 CFR 930, Subpart D). Such projects will only be evaluated for consistency when there is not an analogous state license or permit.**

Project Description:

U.S. CUSTOMS AND BORDER PROTECTION - DRAFT ENVIRONMENTAL ASSESSMENT FOR BEDDOWN AND FLIGHT OPERATIONS OF UNMANNED AIRCRAFT SYSTEMS AT CAPE CANAVERAL AIR FORCE STATION - BREVARD COUNTY, FLORIDA.

To: Florida State Clearinghouse

AGENCY CONTACT AND COORDINATOR (SCH)
3900 COMMONWEALTH BOULEVARD MS-47
TALLAHASSEE, FLORIDA 32399-3000
TELEPHONE: (850) 245-2161
FAX: (850) 245-2190

EO. 12372/NEPA

- [x] No Comment
- [ ] Comment Attached
- [ ] Not Applicable

Federal Consistency

- [x] No Comment/Consistent
- [ ] Consistent/Comments Attached
- [ ] Inconsistent/Comments Attached
- [ ] Not Applicable

From:

Division/Bureau: Division of Historical Resources
Bureau of Historic Preservation

Reviewer: S. Edwards

Date: 8/17/2010

RECEIVED
AUG 1 9 2010
DEP Office of
Intergov't'l Programs

ADDITIONAL AGENCY CORRESPONDENCE
SHPO and USFWS

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SHPO CORRESPONDENCE

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DETERMINATION OF NO ADVERSE EFFECT: PROPOSED CONSTRUCTION OF A HANGAR, SOUTH SIDE OF THE SKID STRIP, CAPE CANAVERAL AIR FORCE STATION, FLORIDA

Prepared By:

45TH Space Wing, U. S. Air Force
Environmental Flight (45CES/CEAN)
1224 Jupiter Street
Patrick Air Force Base, Florida 32925

October 14, 2010

DETERMINATION OF NO ADVERSE EFFECT: PROPOSED CONSTRUCTION OF A HANGAR, SOUTH SIDE OF THE SKID STRIP, CAPE CANAVERAL AIR FORCE STATION, FLORIDA

Prepared For:

Florida State Historic Preservation Office
R.A. Gray Building, 4th Floor
500 South Bronough Street
Tallahassee, Florida 32399

Prepared By:

____

THOMAS E. PENDERS
45th Space Wing Cultural Resources Manager

45TH Space Wing, U. S. Air Force
Environmental Flight (45CES/CEVP)
1224 Jupiter Street
Patrick Air Force Base, Florida 32925

October 14, 2010

DETERMINATION OF NO ADVERSE EFFECT:
PROPOSED CONSTRUCTION OF A HANGAR,
SOUTH SIDE OF THE SKID STRIP,
CAPE CANAVERAL AIR FORCE STATION, FLORIDA

INTRODUCTION

The 45th Space Wing (45 SW) of the United States Air Force (USAF) proposes to lease land on the south side of the Skid Strip on Cape Canaveral Air Force Station (CCAFS), Florida and the construction and use of the Customs and Border Protection (CBP) Unmanned Aircraft Systems (UAS) facilities south of the Skid Strip, midfield (Exhibit A, Figures 1 and 2).

DESCRIPTION

The project will include an aircraft apron totaling 34,200 square feet (SF), hangar totaling 8,840 SF, administration and maintenance space totaling 14,135 SF, and miscellaneous facilities totaling 6,700 SF. This will be in a previously undeveloped area on the south side of the Skid Strip.

The 45 SW has reviewed the Scope of Work for the proposed undertaking and determined that the activity has the potential to affect this historic building. Subsequently, the 45 SW has prepared the following documentation in accordance with the Documentation Standards published in 36 CFR 800.11 (e), Finding of no adverse effect or adverse effect. In addition, we have also applied the Criteria of Adverse Effect using the examples provided in 36 CFR 800.5 (a) (2) Examples of adverse effects. The results of that assessment are shown in paragraph 5, a.) – g.) below. Based upon the findings of our assessment, we have determined that the proposed undertaking would have an effect on the property, however, that effect would not be adverse, but rather support the continued preservation and reuse of historic properties on CCAFS.

This documentation is being submitted to the Florida State Historic Preservation Office (SHPO) in accordance with the requirements of Section 106 of the National Historic Preservation Act (NHPA) and the guidance provided in 36 CFR 800.

1. A description of the undertaking, specifying the Federal involvement, and its area of potential effects, including photographs, maps, and drawings

A lease land on the south side of the Skid Strip on Cape Canaveral Air Force Station (CCAFS), Florida for the construction and use of the Customs and Border Protection (CBP) Unmanned Aircraft Systems (UAS) facilities south of the Skid Strip, midfield.

Federal involvement in the proposed undertaking is as follows:

- The proposed undertaking would occur on CCAFS, a Department of Defense (DoD) installation. The leasee, U.S. Department of Homeland Security, U.S. Customs and Border Protection, Office of Air and Marine, is also a Federal agency.

The Area of Potential Effects (APE) is as follows:

- The identified APE would be limited to the construction area indicated in Figure 2. The proposed undertaking should not affect any other historic properties.

2. A description of the steps taken to identify historic properties;

In March 2009, the 45 SW consulted with the Florida SHPO regarding the proposed improvements to the Skid Strip and vegetation mitigation. At that time the

Florida SHPO concurred with the 45 SW that the lands at the east and west ends of the Skid Strip were high probability zones and should have a Phase 1 archaeological survey conducted. Furthermore, the Florida SHPO concurred that the south and north sides of the Skid Strip were Low Areas of Archaeological Potential and should be subject to a reconnaissance level survey. The areas to be cleared and directly associated with the Skid Strip were part of Season 1 of the Skid Strip Area Cultural Resource Assessment Survey. These areas were surveyed by the 45 SW Cultural Resource Manager from December 2009 through March 2010 (Figure 3). A report on the findings is currently being written with an estimated completion date of January 30, 2011. Below is a synopsis of the archaeological survey results.

The historic research indicated that the entire area immediately around the Skid Strip was previously cleared down to bare soil suggesting that any historic structures/features and possible prehistoric sites may have been destroyed or seriously impacted. There were also no record of any historic structures being located on the south, east or west sides of the Skid Strip, and most of the north side of the Skid Strip. A small area at the northwestern portion may have contained a homestead but that location now the CCAFS landfill. The archaeological potential survey and recently updated Integrated Cultural Resource Management Plan sensitivity map (currently under review) identifies the east and west ends of the Skid Strip as being High Areas of Archaeological Potential (High AAPs) with the north and south sides being Low AAPs. This is based on proximity to water, topography, vegetation, soil type, and data on all previously recorded sites at CCAFS.

The reconnaissance level survey was conducted for the east, west, north, and south sides of the Skid Strip followed by the Phase I survey at east and west ends (Figure 4). The reconnaissance level survey included a systematic pedestrian survey of the areas at 50 meter (164 ft) intervals. All open areas, trails, roads, canals and other fence lines were inspected as well. It became apparent during the reconnaissance level survey that the west end of the Skid Strip had been altered to the extent that very little of the original natural dune and swale system remained. This was also the case for the east end. However, due to the close proximity of the Cape Canaveral Lighthouse and known historic trails in the area the subsurface testing at the east end continued. A total of 20 shovel tests were excavated in this location at 50 m (164 ft) intervals (Figure 6).

The result of the survey found no prehistoric or historic archaeological sites within the project area. A single historic feature was identified at the east end of the Skid Strip. This was a Navaho X-10 Camera Pad (8BR2397) (Figure 5). A Florida Master Site File form will be submitted with the report on the archaeological survey once it is completed.

In summary, the archaeological survey for the Skid Strip did not identify any cultural resources within the Area of Potential Effect for the proposed Undertaking described in the present Section 106 consultation package.

3. **A description of the affected historic properties, including information on the characteristics that qualify them for the National Register;**

   There are no historic properties affected by this Undertaking.

4. **A description of the undertaking's effects on historic properties;**

   There are no historic properties affected by this Undertaking.

5. **An explanation of why the criteria of adverse effect were found applicable or inapplicable, including any conditions or future actions to avoid, minimize or mitigate adverse effects;**

The 45 SW has assessed potential adverse impacts from the proposed undertaking utilizing the examples of adverse impacts provided in 36 CFR 800.5 (a) (2), with the following results;

a. Physical destruction of, or damage to all or part of the property,

The proposed undertaking would not result in the destruction of any other historically significant property on CCAFS.

b. Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access, that is not consistent with the Secretary's Standards for the treatment of Historic Properties (36 CFR part 68) and applicable guidelines,

The proposed undertaking is not intended to alter a historic property.

c. Removal of the property from its historic location,

The actions identified in the proposed undertaking would not result in the removal of historic property from its existing, and also original, location on CCAFS. Consequently, it has been determined that this example of a Criteria of Adverse Effect is not applicable to the proposed undertaking.

d. Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance,

The proposed undertaking would not significantly alter the character of the property's original use. Additionally, the proposed undertaking would not affect the building in such a way as to disassociate the structure from its original historic setting

e. Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features,

None.

f. Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization,

This action would not result in deterioration of a historic property. Conversely, the undertaking would eliminate neglect of this facility in the future, and thereby prevent deterioration of this historic facility. Therefore, it is the finding of our assessment of the Criteria of Adverse Effect that this example of an adverse effect does not apply to the proposed undertaking.

g. Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

The proposed undertaking would result in the lease of the historic property. However, the lease is also a Federal agency. The land will remain the property of the Air Force and would not be removed from federal ownership.

CONCLUSION

In summary, the 45th Space Wing (45 SW) of the United States Air Force (USAF) proposes to lease land on the south side of the Skid Strip on Cape Canaveral Air Force Station (CCAFS), Florida and the construction and use of the Customs and Border

Protection (CBP) Unmanned Aircraft Systems (UAS) facilities south of the Skid Strip, midfield

The 45 SW has applied the Criteria of Effect and found that the proposed undertaking would have no adverse effect. Therefore, the 45 SW requests the concurrence of the Florida State Historic Preservation Office with our No Effect determination for the proposed undertaking on Cape Canaveral Air Force Station, Florida.

EXHIBITS

EXHIBIT A

FIGURES

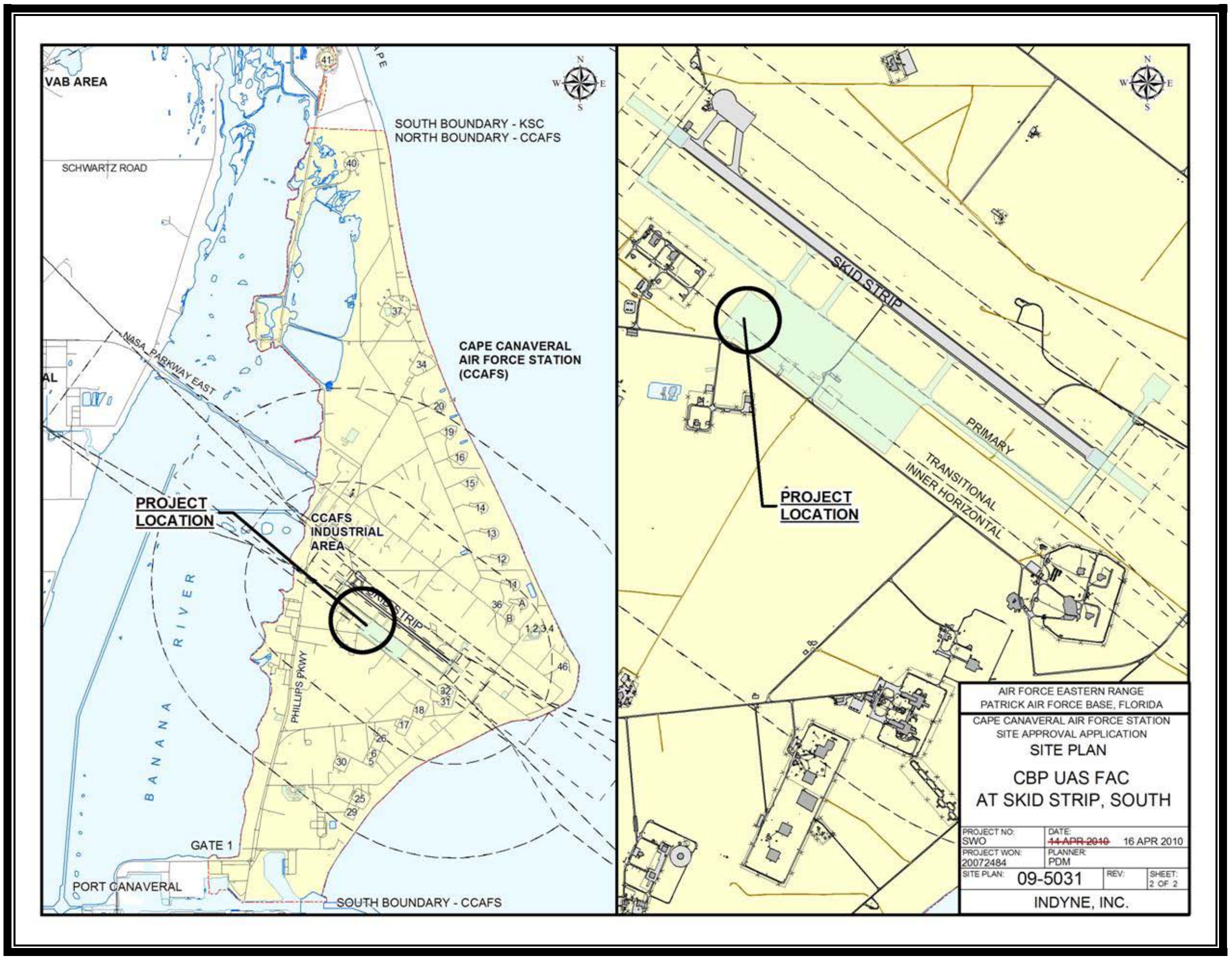

Figure 1. Location of the Area of Potential Effect at CCAFS

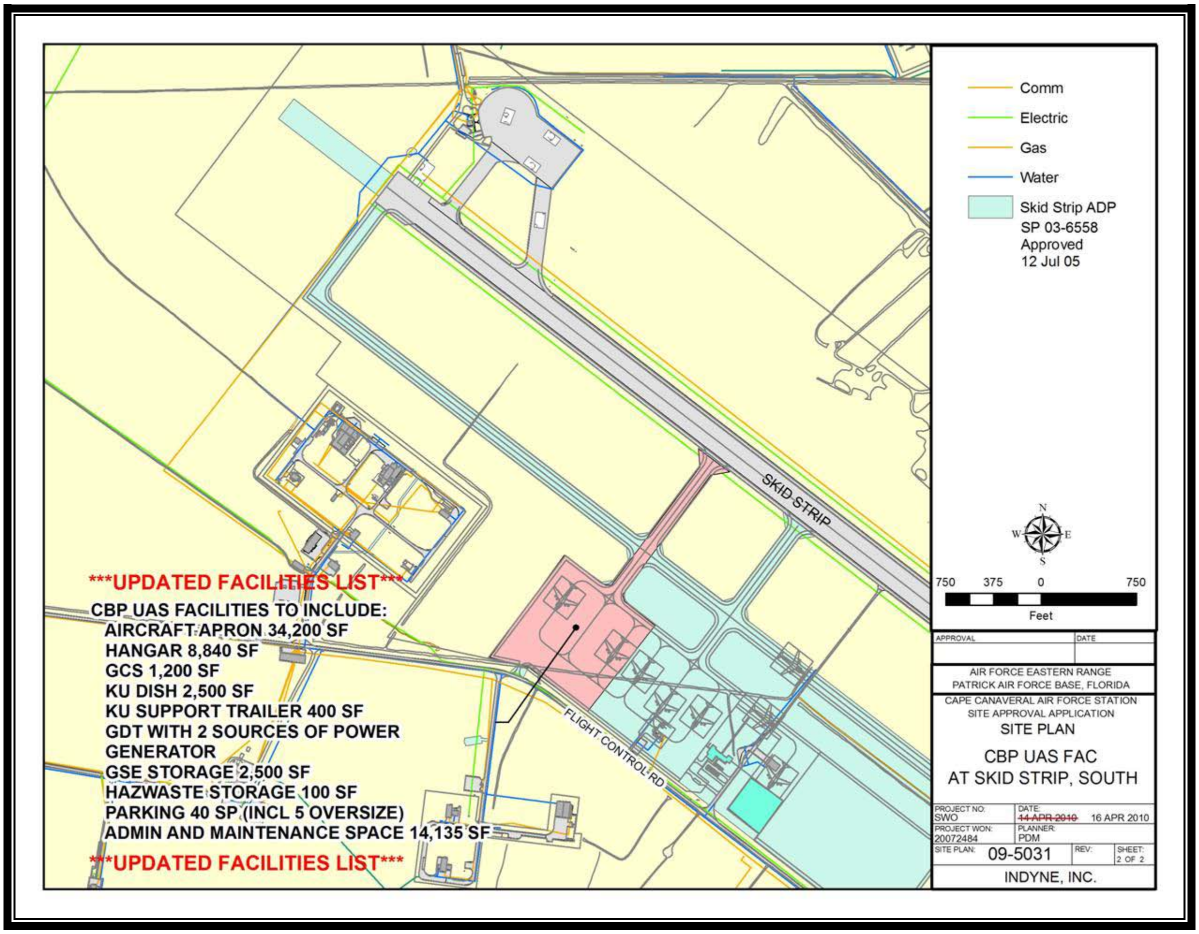

Figure 2. Close up of the Area of Potential Effect at midfield of the Skid Strip

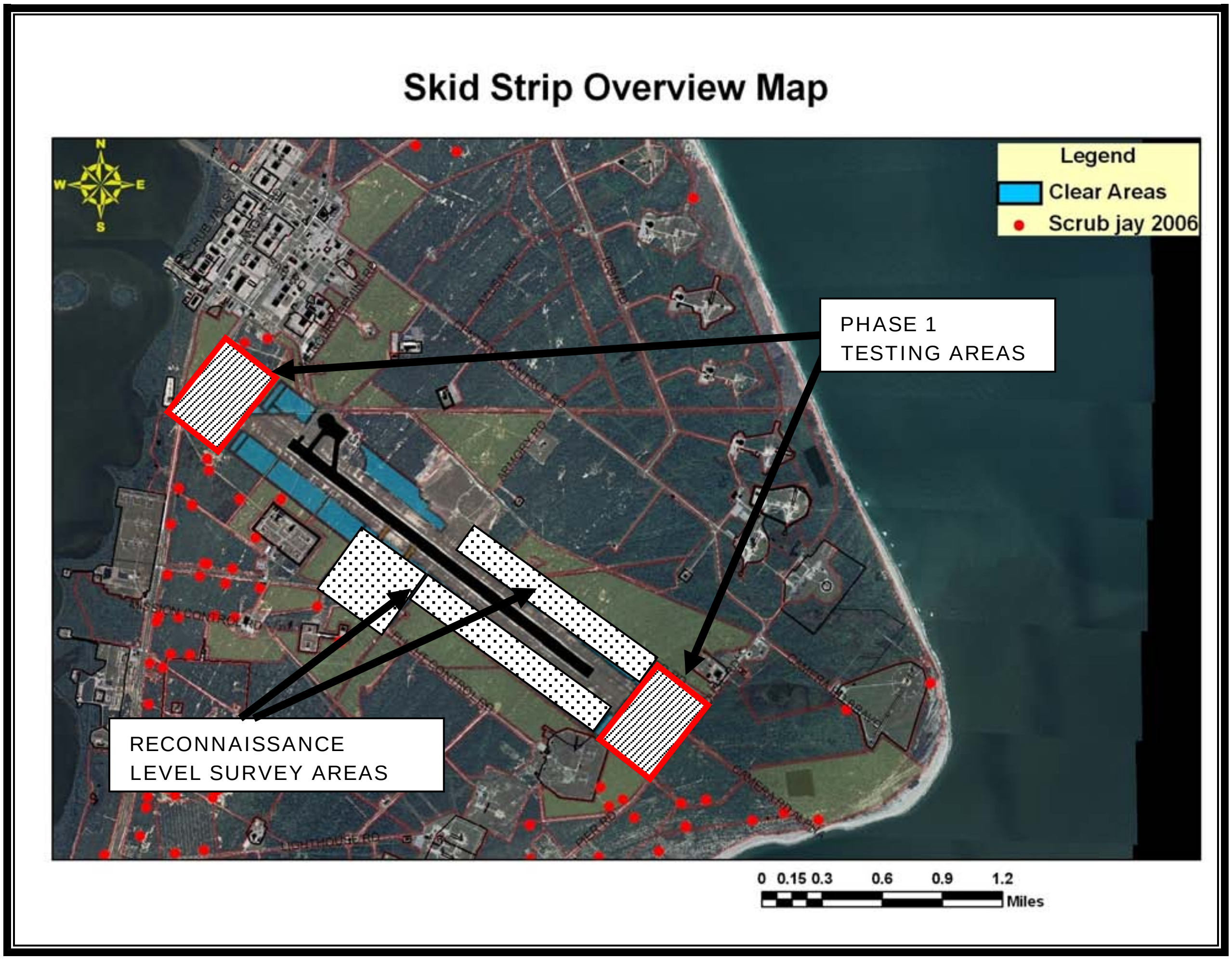

Figure 3. Survey areas of Season 1 of the Skid Strip Mitigation Cultural Resource Assessment Survey.

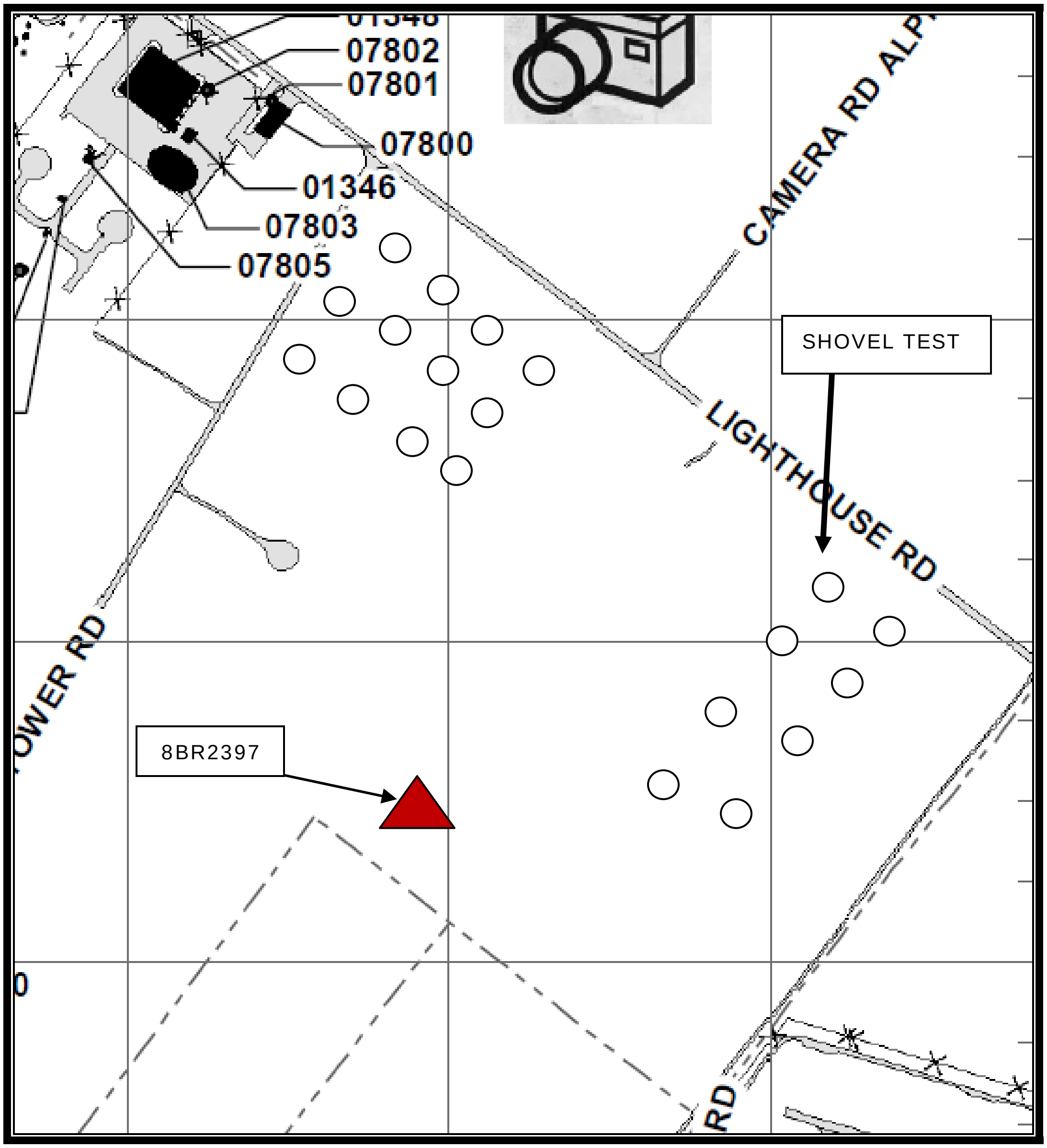

Figure 4. Shovel testing locations east end of Skid Strip

Figure 5. Navaho X-10 Camera Pad (8BR2397)

DETERMINATION OF NO ADVERSE EFFECT: PROPOSED LEASE OF HANGAR C (FACILITY 1348), CAPE CANAVERAL AIR FORCE STATION, FLORIDA

Prepared By:

45TH Space Wing, U. S. Air Force
Environmental Flight (45CES/CEAN)
1224 Jupiter Street
Patrick Air Force Base, Florida 32925

September 17, 2010

DETERMINATION OF NO ADVERSE EFFECT: PROPOSED LEASE OF HANGAR C (FACILITY 1348), CAPE CANAVERAL AIR FORCE STATION, FLORIDA

Prepared For:

Florida State Historic Preservation Office
R.A. Gray Building, 4th Floor
500 South Bronough Street
Tallahassee, Florida 32399

Prepared By:

____

THOMAS E. PENDERS
45th Space Wing Cultural Resources Manager

45TH Space Wing, U. S. Air Force
Environmental Flight (45CES/CEVP)
1224 Jupiter Street
Patrick Air Force Base, Florida 32925

September 17, 2010

DETERMINATION OF NO ADVERSE EFFECT: PROPOSED LEASE OF HANGAR C (FACILITY 1348), CAPE CANAVERAL AIR FORCE STATION, FLORIDA

INTRODUCTION

The 45th Space Wing (45 SW) of the United States Air Force (USAF) proposes to lease Facility 1348-Hangar C (8BR1980) on Cape Canaveral Air Force Station (CCAFS), Florida (Exhibit A, Figure 1). The lease will be between the 45 SW and U.S. Department of Homeland Security, U.S. Customs and Border Protection, Office of Air and Marine.

DESCRIPTION

Hangar C is a recorded historic structure (8 BR 1980) located near the eastern-most point of CCAFS just north of the intersection of Lighthouse Road and Control Tower Road. The building faces east-southeast towards the Atlantic Ocean. It is a large rectangular building with a central high bay flanked on both the north and south sides by two-story lean-to's. The east and west sides of the central high bay contain full-height steel and glass sliding hangar doors. When completed in 1953-1954, the building contained a total of 40,177 square feet. It is the first permanent and oldest surviving structure at CCAFS built and used exclusively for missile assembly. Work on many of America's earliest long-range guided missiles occurred in Hangar C between 1953 and 1956. It continued to be used for missile assembly until 1994. During the early years, the hangar was also used by Project Vanguard, the United States' first official satellite program. It was constructed with a poured reinforced concrete frame and concrete block infill. The missile assembly room contains three overhead cranes; a 15-ton, a 5-ton, and a 3-ton crane. The cranes were used to lift, maneuver, and place missile components during assembly and check out.

This facility is significant for its role in the first satellite program, Project Vanguard, in the United States. It also served as the service area for most of the early Air Force missiles tested and fired at CCAFS. Reuse of historic facilities is considered an effective route for preservation and required by Section 110. As part of the re-use of the facility the roof and external ladders will undergo repair and replacement. The 45 SW has reviewed the Scope of Work for the proposed undertaking and determined that the activity has the potential to affect this historic building. Subsequently, the 45 SW has prepared the following documentation in accordance with the Documentation Standards published in 36 CFR 800.11 (e), Finding of no adverse effect or adverse effect. In addition, we have also applied the Criteria of Adverse Effect using the examples provided in 36 CFR 800.5 (a) (2) Examples of adverse effects. The results of that assessment are shown in paragraph 5, a.) – g.) below. Based upon the findings of our assessment, we have determined that the proposed undertaking would have an effect on the property, however, that effect would not be adverse, but rather support the continued preservation and reuse of historic properties on CCAFS.

This documentation is being submitted to the Florida State Historic Preservation Office (SHPO) in accordance with the requirements of Section 106 of the National Historic Preservation Act (NHPA) and the guidance provided in 36 CFR 800.

1. A description of the undertaking, specifying the Federal involvement, and its area of potential effects, including photographs, maps, and drawings

The proposed undertaking would be a lease between two Federal agencies.

Federal involvement in the proposed undertaking is as follows:

- The proposed undertaking would occur on CCAFS, a Department of Defense (DoD) installation. The leasee, U.S. Department of Homeland Security, U.S. Customs and Border Protection, Office of Air and Marine, is also a Federal agency.

The Area of Potential Effects (APE) is as follows:

- The identified APE would be limited to the subject building. The APE is restricted to the confines of the building and the proposed undertaking should not affect any other historic properties.

2. A description of the steps taken to identify historic properties;

Hangar C is a two-story building located near the eastern-most point of Cape Canaveral Air Force Station just north of the intersection of Lighthouse Road and Control Tower Road. It is adjacent to a known prehistoric occupation site (8 BR 1660) and the Cape Lighthouse Site (8 BR 212). In 2001, the 45 SW contracted with the USACOE, Construction Engineering Research Laboratory (CERL) to conduct a HABS/HAER Study on Hangar C. The results of that study are documented in *Historic American Building Survey of Hangar C, Cape Canaveral Air Station, Cape Canaveral, Florida.* Consequently, Hangar C has been included in the 45 SW Integrated Cultural Resource Management Plan (ICRMP) and is subsequently protected in accordance with the requirements of the National Historic Preservation Act (NHPA).

3. A description of the affected historic properties, including information on the characteristics that qualify them for the National Register;

The property that would be affected by the proposed undertaking is Hangar C (Facility 1348), a two-story rectangular shaped building with a central high bay flanked on both the north and south sides by two story annexes. The east and west facades of the central high bay contain full-height steel and glass sliding hangar doors. The areas along the north and south sides of the hangar are office spaces, restrooms, and work areas. The remainder of the facility is a single open room. There are two types of roof construction that comprise Hangar C. The missile assembly shop (central high bay) contains a low pitched front single-gabled roof. The two annexes had shed type roofs pitched to the north and south respectively. There were four lower ladders which allowed access to the lower annexes roofs and a second set of four ladders to allow access to the central high bay roof. These ladders were originally wood and metal ladders. By 1960, the metal and wood ladders were replaced with caged steel ladders. The ladders can be seen in the attached documentation.

A Florida Master Site File Historic Structure form was submitted to the FDHR in 2006 by the 45 SW Cultural Resources Manager (45 SW CRM). It was the opinion of the 45 SW CRM that Hangar C is eligible for listing in the NRHP under Criterion A (association with "events that have made a significant contribution to the broad patterns of our history") and Criterion C ("embodying distinctive characteristics of a type, period or method of construction…").

4. A description of the undertaking's effects on historic properties;

The proposed undertaking's potential affects on historic properties should be strictly positive.

5. An explanation of why the criteria of adverse effect were found applicable or inapplicable, including any conditions or future actions to avoid, minimize or mitigate adverse effects;

The 45 SW has applied the Criteria of Adverse Effect (36 CFR 800.5 (a) (1)) to the proposed undertaking and found the lease of Hangar C would not alter, directly or indirectly, any of the characteristics that qualify this property for inclusion in the NRHP. In addition, the proposed undertaking would not diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Furthermore, the 45 SW has assessed potential adverse impacts from the proposed undertaking utilizing the examples of adverse impacts provided in 36 CFR 800.5 (a) (2), with the following results;

a. Physical destruction of, or damage to all or part of the property,

The proposed undertaking would not result in the destruction of Hangar C or any other historically significant property on CCAFS. In summary, there are no aspects of the proposed undertaking that would damage, or result in the destruction of, Hangar C, or any other historic structures within the potential Area of Potential Effect (APE).

b. Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation and provision of handicapped access, that is not consistent with the Secretary's Standards for the treatment of Historic Properties (36 CFR part 68) and applicable guidelines,

The proposed undertaking is not intended to alter the subject property.

c. Removal of the property from its historic location,

The actions identified in the proposed undertaking would not result in the removal of historic property from its existing, and also original, location on CCAFS. Consequently, it has been determined that this example of a Criteria of Adverse Effect is not applicable to the proposed undertaking.

d. Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance,

The proposed undertaking would not significantly alter the character of the property's original use. Additionally, the proposed undertaking would not affect the building in such a way as to disassociate the structure from its original historic setting

e. Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features,

None.

f. Neglect of a property which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe or Native Hawaiian organization,

This action would not result in deterioration of the property. Conversely, the undertaking would eliminate neglect of this facility in the future, and thereby prevent deterioration of this historic facility. Therefore, it is the finding of our assessment of the Criteria of Adverse Effect that this example of an adverse effect does not apply to the proposed undertaking.

g. Transfer, lease, or sale of property out of Federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

The proposed undertaking would result in the lease of the historic property. However, the lease is also a Federal agency. The historic building will remain the property of the Air Force and would not be removed from federal ownership. Hangar C would remain as a component of the 45 SW Integrated Cultural Resource Management Plan (ICRMP) and would continue to receive its current level of protection under Section 110 of the National Historic Preservation Act.

h. Copies or summaries of any views provided by consulting parties and the public

To date, the 45 SW has not received any views, objections or comments from the public or any other consulting parties. With submittal of this Determination of No Adverse Effect, the 45 SW is requesting the comments of the Florida SHPO, in accordance with Section 106 of the NHPA, as described in 36 CFR 800 Part 800.3, Initiation of the Section 106 process.

CONCLUSION

In summary, the 45 SW of the United States Air Force (USAF) proposes to lease Facility 1348-Hangar C (8BR1980) on Cape Canaveral Air Force Station (CCAFS), Florida. The lease will be between the 45 SW and U.S. Department of Homeland Security, U.S. Customs and Border Protection, Office of Air and Marine (also a Federal agency).

The 45 SW has applied the Criteria of Effect and found that the proposed undertaking would have no adverse effect on Hangar C. Therefore, the 45 SW requests the concurrence of the Florida State Historic Preservation Office with our No Effect determination for the proposed undertaking at Hangar C on Cape Canaveral Air Force Station, Florida.

EXHIBITS

EXHIBIT A

FIGURES

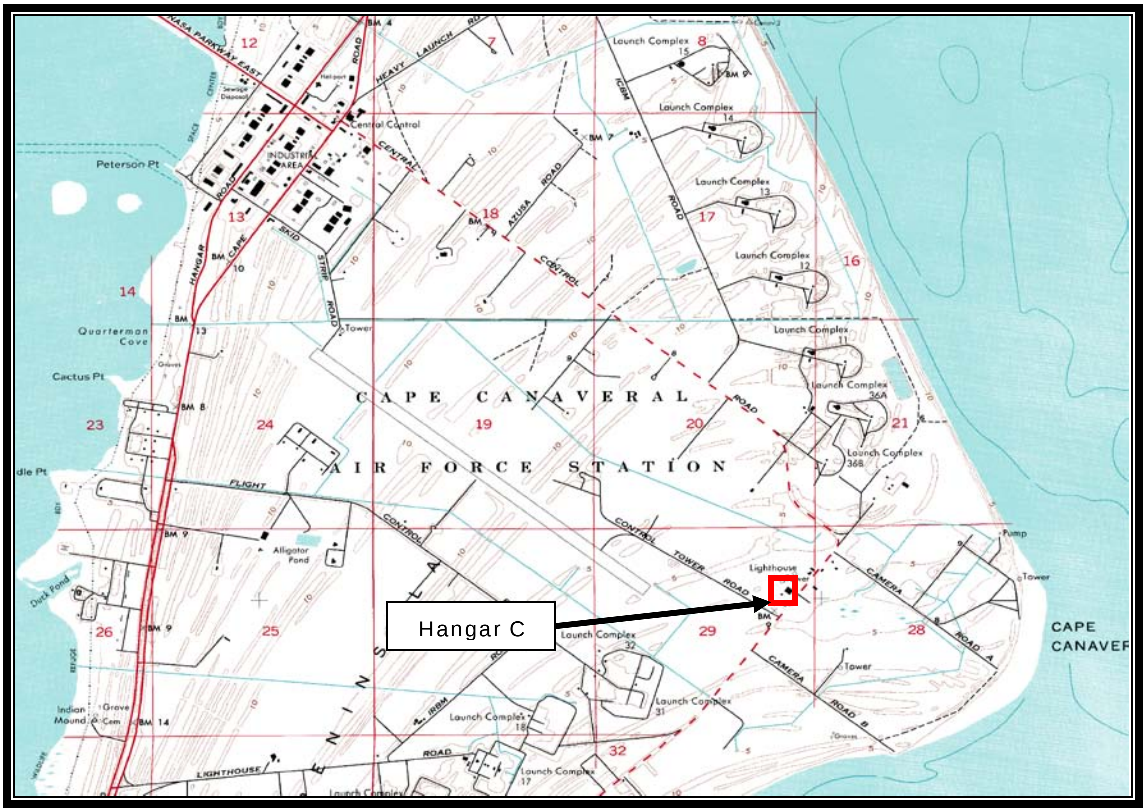

Figure 1. Location of Hangar C at CCAFS

Figure 2. Aerial photograph of Hangar C.

Figure 3. Front façade of Hangar C.

EXHIBIT B

FMSF FORM

FLORIDA DEPARTMENT OF STATE
Kurt S. Browning
Secretary of State
DIVISION OF HISTORICAL RESOURCES

Mr. E. Alexander Stokes III
Department of the Air Force
45 CES/CEVP
1224 Jupiter Street, MS-9125
Patrick Air Force Base, Florida 32925-3343

April 9, 2009

RE: DHR Project File Number: 2009-1902
Skid Strip Vegetation Management Plan
Cape Canaveral Air Force Station, Brevard County

Dear Mr. Stokes:

Our office reviewed the referenced project for possible impact to historic properties listed, or eligible for listing, in the *National Register of Historic Places*. The review was conducted in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended and *36 CFR Part 800: Protection of Historic Properties* and the implementing state regulations.

We note that portions of this project will take place within two high areas of archaeological potential (AAP) while the remainder will take place in low AAP. Ground disturbing activities in these areas could have an adversely affect on archaeological sites. Therefore, this office concurs with your conditions of archaeological monitoring, reconnaissance level survey in low AAP area, and a Phase I survey in high AAP areas. A copy of the resultant monitoring and survey reports must be forwarded to this office after completion of the investigations.

If you have any questions concerning our comments, please contact Scott Edwards, Historic Preservationist, by electronic mail *sedwards@dos.state.fl.us*, or at 850-245-6333 or 800-847-7278.

Sincerely,

Frederick P. Gaske, Director, and
State Historic Preservation Officer

500 S. Bronough Street • Tallahassee, FL 32399-0250 • http://www.flheritage.com

☐ Director's Office (850) 245-6300 • FAX: 245-6436
☐ Archaeological Research (850) 245-6444 • FAX: 245-6452
☑ Historic Preservation (850) 245-6333 • FAX: 245-6437

FLORIDA DEPARTMENT OF STATE

Dawn K. Roberts

Interim Secretary of State

DIVISION OF HISTORICAL RESOURCES

Mr. Mark Kershner
45 SW Cultural Resource Manager
Department of the Air Force
45 CES/CEAN
1224 Jupiter Street, MS-9125
Patrick Air Force Base, Florida 32925-3343

October 14, 2010

RE: DHR Project File Number: 2010-4649
Determination of No Adverse Effect for the Proposed Lease of Facility 1611 - Hangar F
Cape Canaveral Air Force Station, Brevard County

Dear Mr. Kershner:

This office reviewed the referenced project for possible impact to historic properties listed, or eligible for listing, in the *National Register of Historic Places.* The review was conducted in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended and *36 CFR Part 800: Protection of Historic Properties*.

Based on the information provided, this office concurs with your determination that the proposed undertaking will have no adverse effect on the historic character of *Facility 161-Hangar F* with the conditions outlined below.

- Any proposed alterations to Facility 1611 are to be submitted to the SHPO office for review
- All work must meet the *Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*

Please inform this office if Department of the Air Force agrees to these conditions.

This office is pleased to know that Cape Canaveral Air Force Station will conduct a comprehensive historic building survey of the Industrial area in Fiscal Year 2013. If you have any questions concerning our comments, please contact Scott Edwards, Historic Preservationist, by electronic mail *sedwards@dos.state.fl.us*, or at 850-245-6333.

Sincerely,

Laura A. Kammerer
Deputy State Historic Preservation Officer
For Review and Compliance

500 S. Bronough Street • Tallahassee, FL 32399-0250 • http://www.flheritage.com

❒ **Director's Office** (850) 245-6300 • FAX: 245-6436
❒ **Archaeological Research** (850) 245-6444 • FAX: 245-6452
☑ **Historic Preservation** (850) 245-6333 • FAX: 245-6437

FLORIDA DEPARTMENT OF STATE
Dawn K. Roberts
Interim Secretary of State
DIVISION OF HISTORICAL RESOURCES

Mr. Mark Kershner
45 SW Cultural Resource Manager
Department of the Air Force
45 CES/CEAN
1224 Jupiter Street, MS-9125
Patrick Air Force Base, Florida 32925-3343

October 14, 2010

RE: DHR Project File Number: 2010-4649
Determination of No Adverse Effect for the Proposed Lease of Facility 1348 - Hangar C (8BR1980)
Cape Canaveral Air Force Station, Brevard County

Dear Mr. Kershner:

This office reviewed the referenced project for possible impact to historic properties listed, or eligible for listing, in the *National Register of Historic Places.* The review was conducted in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended and *36 CFR Part 800: Protection of Historic Properties*.

This office previously determined that *Facility 1348 - Hangar C* appears to meet the criteria for listing in the *National Register.* Based on the information provided, this office concurs with your determination that the proposed undertaking will have no adverse effect on the historic character of *Facility 1348 - Hangar C* with the conditions outlined below.

- Any proposed alterations to Facility 1348 are to be submitted to the SHPO office for review
- All work must meet the *Secretary of the Interior's Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings*

Please inform this office if Department of the Air Force agrees to these conditions.

If you have any questions concerning our comments, please contact Scott Edwards, Historic Preservationist, by electronic mail *sedwards@dos.state.fl.us*, or at 850-245-6333.

Sincerely,

Laura A. Kammerer

Laura A. Kammerer
Deputy State Historic Preservation Officer
For Review and Compliance

FLORIDA DEPARTMENT OF STATE
Dawn K. Roberts
Interim Secretary of State
DIVISION OF HISTORICAL RESOURCES

Mr. Mark Kershner
45 SW Cultural Resource Manager
Department of the Air Force
45 CES/CEAN
1224 Jupiter Street, MS-9125
Patrick Air Force Base, Florida 32925-3343

November 9, 2010

RE: DHR Project File Number: 2010-5203
Determination of No Adverse Effect for the Proposed Construction of a Hangar on the South Side of the Skid Strip
Cape Canaveral Air Force Station, Brevard County

Dear Mr. Kershner:

This office reviewed the referenced project for possible impact to historic properties listed, or eligible for listing, in the *National Register of Historic Places.* The review was conducted in accordance with Section 106 of the *National Historic Preservation Act of 1966*, as amended and *36 CFR Part 800: Protection of Historic Properties*.

Based on the information provided, this office concurs with the finding that the proposed undertaking will have no adverse effect on historic properties.

If you have any questions concerning our comments, please contact Scott Edwards, Historic Preservationist, by electronic mail *sedwards@dos.state.fl.us*, or at 850-245-6333.

Sincerely,

Laura A. Kammerer
Deputy State Historic Preservation Officer
For Review and Compliance

500 S. Bronough Street • Tallahassee, FL 32399-0250 • http://www.flheritage.com

❒ **Director's Office** (850) 245-6300 • FAX: 245-6436
❒ **Archaeological Research** (850) 245-6444 • FAX: 245-6452
☑ **Historic Preservation** (850) 245-6333 • FAX: 245-6437

USFWS CORRESPONDENCE

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Tutterow, Brian W.

From: Hawkins, Dale Civ USAF AFSPC 45 CES/CEAO [Dale.Hawkins@patrick.af.mil]
Sent: Friday, January 14, 2011 6:32 AM
To: Daues, Tom V.; Tutterow, Brian W.
Cc: MARION, KENNETH R.; URBATCH, ROGER E; Nguyen, Lan B LtCol USAF AFSPC AFLOA/JACE-FSC; Bateman, Sarah E Capt USAF AFSPC 45 SW/JA; Trepczynski, Susan J Capt USAF AFSPC 45 SW/JA; Follo, Shaunna M Civ USAF AFSPC 45 SW/XPE
Subject: USFWS Opinion on CBP Actions at Skid Strip

Below is the US Fish and Wildlife determination that the proposed Customs and Border Protection action has not changed the overall development scheme for the Cape Canaveral Air Force Station Skid Strip.

Internal to Cape Canaveral AFS are modifications to mitigation plans with the USFWS. This does not affect your project.

Please proceed with the Environmental Assessment for the CBP Beddown.

Very respectfully,

Dale Hawkins
Environmental Planner
Asset Optimization
Cape Canaveral Air Force Station

(321) 853-0960
DSN 467-0960
cell (321) 394-1212

-----Original Message-----
From: Todd_Mecklenborg@fws.gov [mailto:Todd_Mecklenborg@fws.gov]
Sent: Thursday, January 13, 2011 4:06 PM
To: Chambers, Angy L Civ USAF AFSPC 45 CES/CEAN
Cc: craig.faulhaber@myfwc.com
Subject: Re: Skid Strip Biological Opinion

Angy,

Yes the proposed action has not change, therefore it is a covered activity in the biological opinion for the Skid Strip Project.

We are currently working on prioritizing the recently changed land management units and will be recommending time frames for these areas to aid in the management of Florida scrub-jays on CCAFS.

Todd Mecklenborg, Fish & Wildlife Biologist
U.S. Fish and Wildlife Service
600 Fourth Street South
Saint Petersburg, Florida 33701

(727) 820-3705
www.fws.gov/northfllorida/

"Chambers, Angy L Civ USAF AFSPC 45 CES/CEAN" <Angy.Chambers@patrick.af.mil>

01/13/2011 03:34 PM To
<Todd_Mecklenborg@fws.gov>
cc
Subject
Skid Strip Biological Opinion

Todd – Per our phone conversation, an email is acceptable in order for the Custom's Border Patrol (CBT) Environmental Assessment to proceed forward for signature. Per our Biological Assessment, the CBT facility is within the footprint that is covered by this BO, which is why it was included in the same BA. Per our conversation, can you concur that the project may proceed forward and that stipulations/requirements will not change, your office is just working on prioritizing which mitigation units will be worked. I'm not sure what additional verbiage you can provide to assuage them; if you have anything standard, maybe you can include it in your reply. Thanks again.

Angy L. Chambers
Natural Assets
45 CES/CEAN
Phone 853-6822
Fax 853-6517

APPENDIX B

AIR QUALITY

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ACRONYMS AND ABBREVIATIONS

$\mu g/m^3$	Micrograms Per Cubic Meter
ACAM	Air Conformity Applicability Model
AFEPPM	Air Force Energy Program Policy Memorandum
AFMC	Air Force Material Command
AVGAS	Aviation Gasoline
CH4	Methane
CAA	Clean Air Act
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CY	Calendar Year
DOT	Department of Transportation
EAC	Early Action Compact
EO	Executive Order
ETS/CEM	Emission Tracking System/Continuous Emissions Monitoring
FDEP	Florida Department of Environmental Protection
ft^2	Square Feet
FY	Fiscal Year
GHG	Greenhouse Gas
HAPs	Hazardous Air Pollutants
IERA	Institute for Environmental Safety and Occupational Health Risk Analysis
mg/m^3	Milligrams per cubic Meter
N2O	Nitrous Oxide
NAAQS	National Ambient Air Quality Standards
NEI	National Emissions Inventory
NHTSA	National Highway Transportation Safety Administration
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
O_3	Ozone
$PM_{2.5}$	Particulate Matter With a Diameter Less Than or Equal to 2.5 Microns
PM_{10}	Particulate Matter With a Diameter Less Than or Equal to 10 Microns
ppm	Parts per Million
PSD	Prevention of Significant Deterioration
PTE	Potential to Emit
ROI	Region of Influence
SER	Significant Emissions Rate
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
TSP	Total Suspended Particulate
U.S.	United States
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

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AIR QUALITY

This appendix presents an overview of the Clean Air Act (CAA) and the state of Florida air quality program. The appendix also discusses emission factor development and calculations, including the assumptions used for the air quality analyses presented in the Air Quality sections.

AIR QUALITY PROGRAM OVERVIEW

In order to protect public health and welfare, the United States Environmental Protection Agency (USEPA) has developed numerical concentration-based standards, or National Ambient Air Quality Standards (NAAQS), for six "criteria" pollutants (based on health-related criteria) under the provisions of the CAA Amendments of 1970. There are two kinds of NAAQS: Primary and Secondary standards. Primary standards prescribe the maximum permissible concentration in the ambient air to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards prescribe the maximum concentration or level of air quality required to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings (40 Code of Federal Regulations [CFR] 50).

The CAA gives states the authority to establish air quality rules and regulations. These rules and regulations must be equivalent to, or more stringent than, the federal program. The Division of Air Resource Management within the Florida Department of Environmental Protection (FDEP) administers the state's air pollution control program under the authority of the Florida Air and Water Pollution Control Act and the Environmental Protection Act.

Florida has adopted the NAAQS except for sulfur dioxide (SO_2). The USEPA has set the annual and 24-hour standards for SO_2 at 0.03 parts per million (ppm) (80 micrograms per cubic meter [$\mu g/m^3$]) and 0.14 ppm (365 $\mu g/m^3$), respectively. Florida has adopted the more stringent annual and 24-hour standards of 0.02 ppm (60 $\mu g/m^3$) and 0.1 ppm (260 $\mu g/m^3$), respectively. In addition, Florida has adopted the national secondary standard of 0.50 ppm (1,300 $\mu g/m^3$). Federal and state of Florida ambient air quality standards are presented in Table B-1.

Based on measured ambient air pollutant concentrations, the USEPA designates areas of the United States as having air quality better than (attainment) the NAAQS, worse than (nonattainment) the NAAQS, and unclassifiable. The areas that cannot be classified (on the basis of available information) as meeting or not meeting the NAAQS for a particular pollutant are “unclassifiable” and are treated as attainment until proven otherwise. Attainment areas can be further classified as “maintenance” areas, which are areas previously classified as nonattainment but where air pollutant concentrations have been successfully reduced to below the standard. Maintenance areas are under special maintenance plans and must operate under some of the nonattainment area plans to ensure compliance with the NAAQS. All areas of the state are in compliance with the NAAQS.

A general conformity analysis is required if (1) the action’s direct and indirect emissions have a potential to emit (PTE) one or more of the six criteria pollutants at or above emission rates shown in Table B-2 or Table B-3, or (2) the action’s direct and indirect emissions of any criteria pollutant represent 10 percent of a nonattainment or maintenance area’s total emissions inventory for that pollutant.

Table B-1. Summary of National and State Ambient Air Quality Standards

Criteria Pollutant	Averaging Time	Federal Primary NAAQS(8)	Federal Secondary NAAQS (8)	*Florida Standards*
Carbon Monoxide (CO)	8-hour(1)	9 ppm (10 mg/m^3)	No standard	9 ppm (10 µg/m^3)
	1-hour(1)	35 ppm (40 mg/m^3)	No standard	35 ppm (40 µg/m^3)
Lead	Quarterly	1.5 µg/m^3	1.5 □g/m^3	1.5 µg/m^3
Nitrogen Dioxide (NO_2)	Annual	0.053 ppm (100 µg/m^3)	0.053 ppm (100 □g/m^3)	0.053 ppm (100 µg/m^3)
Particulate Matter ≤10 Micrometers (PM_{10})	24-hour(2)	150 µg/m^3	150 µg/m^3	50 µg/m^3
Particulate Matter <2.5 Micrometers ($PM_{2.5}$)	Annual(3)	15 µg/m^3	15 µg/m^3	150 µg/m^3
	24-hour(4)	35 µg/m^3	35 µg/m^3	15 µg/m^3
Ozone (O_3)	1-hour(7)	0.12 ppm (235 µg/m^3)	0.12 ppm (235 µg/m^3)	65 µg/m^3 0.12 ppm
	8-hour(5)	0.075 ppm (2008 std)		(235 µg/m^3)
	8-hour(6)	0.08 ppm (1997 std) (157 µg/m^3)	0.08 ppm (157 µg/m^3)	
SO_2	Annual	0.03 ppm (80 µg/m^3)	No standard	0.02 ppm (60 µg/m^3)
	24-hour(1)	0.14 ppm (365 µg/m^3)	No standard	0.10 ppm (260 µg/m^3)
	3-hour(1)	No standard	0.50 ppm (1300 µg/m^3)	0.50 ppm (1300 µg/m^3)

Source: USEPA 2008 (Federal Standards)
FDEP 2006 (Florida Standards)
mg/m³ = milligrams per cubic meter

(1) Not to be exceeded more than once per year.
(2) Not to be exceeded more than once per year on average over 3 years
(3) To attain this standard, the 3-year average of the weighted annual mean PM2.5 concentrations from single or multiple community-oriented monitors must not exceed 15.0 µg/m³
(4) To attain this standard, the 3-year average of the 98th percentile of 24-hour concentrations at each population-oriented monitor within an area must not exceed 35 µg/m³ (effective December 17, 2006)
(5) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm. (effective May 27, 2008)
(6) (a) To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average O_3 concentrations measured at each monitor within an area over each year must not exceed 0.08 ppm.
(b) The 1997 standard-and the implementation rules for that standard -would remain in place for implementation purposes as USEPA undertakes rulemaking to address the transition from the 1997 O_3 standard to the 2008 O_3 standard
(7) (a) The standard is attained when the expected number of days per calendar year (CY) with maximum hourly average concentrations above 0.12 ppm is ≤ 1.
(b) As of June 15, 2005 USEPA revoked the 1-hour O_3 standard in all areas except the 8-hour O_3 nonattainment Early Action Compact (EAC) Areas.

Table B-2. Emission Rates for Criteria Pollutants in Nonattainment Areas*

Pollutant		Emission Rate (tons/year)
O_3 (Volatile Organic Compounds [VOCs] or Nitrogen Oxide [NO_x])		
	Serious nonattainment areas	50
	Severe nonattainment areas	25
	Extreme nonattainment areas	10
	Other O_3 nonattainment areas outside an O_3 transport region	100
Marginal and moderate nonattainment areas inside an O_3 transport region		
	VOC	50
	NO_x	100
CO: All nonattainment areas		100
SO_2 or NO_2: All nonattainment areas		100
PM_{10}		
	Moderate nonattainment areas	100
	Serious nonattainment areas	70
$PM_{2.5}$		
	Direct emissions	100
	SO_2	100
	NO_x (unless determined not to be a significant precursor)	100
	VOC or ammonia (if determined to be significant precursors)	100
Lead: All nonattainment areas		25

Source: USEPA 2006
**De minimus* threshold levels for conformity applicability analysis.

Each state is required to develop a state implementation plan (SIP) that sets forth how CAA provisions would be imposed within the state. The SIP is the primary means for the implementation, maintenance, and enforcement of the measures needed to attain and maintain the NAAQS within each state and includes control measures, emissions limitations, and other provisions required to attain and maintain the ambient air quality standards. The purpose of the SIP is twofold. First, it must provide a control strategy that would result in the attainment and maintenance of the NAAQS. Second, it must demonstrate that progress is being made in attaining the standards in each nonattainment area.

Table B-3. Emission Rates for Criteria Pollutants in Attainment (Maintenance) Areas*

Pollutant		Emission Rate (tons/year)
O_3 (NO_x, SO_2, or NO_2): All maintenance areas		100
O_3 (VOCs)		
	Maintenance areas inside an O_3 transport region	50
	Maintenance areas outside an O_3 transport region	100
CO: All maintenance areas		100
PM_{10}: All maintenance areas		100
$PM_{2.5}$		
	Direct Emissions	100
	SO_2	100
	NO_x (unless determined not to be a significant precursor)	100
	VOC or ammonia (if determined to be significant precursors)	100
Lead: All maintenance areas		25

Source: USEPA 2006
**De minimus* threshold levels for conformity applicability analysis.

In attainment areas, major new or modified stationary sources of air emissions on and in the area are subject to Prevention of Significant Deterioration (PSD) review to ensure that these sources are constructed without causing significant adverse deterioration of the clean air in the area. A major new source is defined as one that has the PTE any pollutant regulated under the CAA in amounts equal to or exceeding specific major source thresholds; that is, 100 or 250 tons/year based on the source's industrial category. A major modification is a physical change or change in the method of operation at an existing major source that causes a significant "net emissions increase" at that source of any regulated pollutant. Table B-4 provides a tabular listing of the PSD significant emissions rate (SER) thresholds for selected criteria pollutants (USEPA 1990).

Table B-4. Criteria Pollutant Significant Emissions Rate Increases Under PSD Regulations

Pollutant	Significant Emissions Rate (tons/year)
PM $_{10}$	15
$PM_{2.5}$	10
Total Suspended Particulate (TSP)	25
SO_2	40
NO_x	40
O_3 (VOCs)	40
CO	100

Source: Title 40 CFR Part 51.

The goals of the PSD program are to (1) ensure economic growth while preserving existing air quality; (2) protect public health and welfare from adverse effects that might occur even at pollutant levels better than the NAAQS; and (3) preserve, protect, and enhance the air quality in areas of special natural recreational, scenic, or historic value, such as national parks and wilderness areas. Sources subject to PSD review are required by the CAA to obtain a permit before commencing construction. The permit process requires an extensive review of all other major sources within a 50-mile radius and all Class I areas within a 62-mile radius of the facility. Emissions from any new or modified source must be controlled using Best Available Control Technology. The air quality, in combination with other PSD sources in the area, must not exceed the maximum allowable incremental increase identified in Table B-5. National parks and wilderness areas are designated as Class I areas, where any appreciable deterioration in air quality is considered significant. Class II areas are those where moderate, well-controlled industrial growth could be permitted. Class III areas allow for greater industrial development. The areas surrounding CCAFS are classified as Class II. Currently, there are no designated Class III areas in the United States.

Table B-5. Federal Allowable Pollutant Concentration Increases Under PSD Regulations

Pollutant	Averaging Time	Maximum Allowable Concentration ($\mu g/m^3$)		
		Class I	Class II	Class III
PM_{10}	Annual	4	17	34
	24-hour	8	30	60
SO_2	Annual	2	20	40
	24-hour	5	91	182
	3-hour	25	512	700
NO_2	Annual	2.5	25	50

Source: Title 40 CFR Part 51

Florida has a statewide air quality monitoring network that is operated by both state and local environmental programs (FDEP 2010a). The air quality is monitored for carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone (O_3), particulate matter, and SO_2. The monitors tend to be concentrated in areas with the largest population densities. Not all pollutants are monitored in all areas. The air quality monitoring network is used to identify areas where the ambient air quality standards are being violated and plans are needed to reduce pollutant concentration levels to be in attainment with the standards. Also included are areas where the ambient standards are being met, but plans are necessary to ensure maintenance of acceptable levels of air quality in the face of anticipated population or industrial growth.

The end result of this attainment/maintenance analysis is the development of local and statewide strategies for controlling emissions of criteria air pollutants from stationary and mobile sources. The first step in this process is the annual compilation of the ambient air monitoring results, and the second step is the analysis of the monitoring data for general air quality, exceedances of air quality standards, and pollutant trends.

The FDEP Northwest District operates monitors in several counties, including Brevard County. Over the years of record, there have been exceedances (pollutant concentration greater than the numerical standard) of a NAAQS. However, there has not been a violation (occurrence of more exceedances of the standard than is allowed within a specified time period) of an ambient standard (FDEP 2010b).

Greenhouse Gases

Greenhouse gases (GHGs) are chemical compounds in the earth's atmosphere that trap heat. Gases exhibiting greenhouse properties come from both natural and human sources. Water vapor, carbon dioxide (CO_2), methane (CH4), and nitrous oxide (N2O) are examples of GHGs that have both natural and manmade sources, whereas other gases such as those used for aerosols are exclusively manmade. In the United States, GHG emissions come mostly from energy use. These are driven largely by economic growth, fuel used for electricity generation, and weather patterns affecting heating and cooling needs.

Transportation sources accounted for approximately 29 percent of total United States (U.S.) GHG emissions in 2006 and are the fastest-growing source of U.S. GHGs according to USEPA Transportation and Climate sources (USEPA 2009a). The majority of CO_2 emissions come from the combustion of fossil fuels based on the fuel's carbon content. To a lesser degree, transportation sources emit CH4 and N2O during fossil fuel consumption. Aircraft GHG emissions from military aircraft in 2003 made up 12 percent compared to the 72 percent produced from commercial aircraft. Commercial and military aircraft rely almost exclusively on jet fuel, whereas approximately one-quarter of the fuel used for general aviation is aviation gas. GHG emissions from aircraft in 2003 were 99 percent CO_2, about 1 percent N2O, and less than 1 percent CH4 (USEPA 2009a).

The use of construction equipment is expected to cause some increase in GHG emissions. The combustion of fossil fuels is considered the primary source of CO_2 emissions based on the fuel's carbon content. To a lesser degree, mobile sources emit CH4 and N2O during fossil fuel consumption. Construction equipment emits approximately 22.37 pounds of CO_2 per gallon of diesel and 19.54 pounds of CO_2 per gallon of gasoline (USEPA 2009b). These emission rates can be decreased with less idling and improved maintenance of equipment. Any stationary fuel combustion sources may require future GHG emission reporting of CO_2, CH4, and N2O for the facility per the USEPA's proposed 40 CFR 98 Subparts C and D. The USEPA has released the proposed reporting of GHGs (USEPA 2009c, USEPA 2009d) but there are currently no standards for GHG emissions with which to compare or determine significance.

Research and policy for climate change and GHGs has increased dramatically in recent years. The following is a summary of regulatory actions that have taken place to address issues related to climate change.

FEDERAL REGULATIONS

Proposed Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards. April 1, 2010 the USEPA and the Department of Transportation's (DOT's) National Highway Transportation Safety Administration (NHTSA) announced the joint final rule that would reduce GHG emissions and improve fuel economy for all new cars and trucks sold in the United States. This final rule follows

USEPA and DOT's joint proposal on September 15, 2009. This rule would allow automobile manufacturers to build a single light-duty national fleet that satisfies all requirements under both federal programs and the standards of California and other states (USEPA 2010a).

Final Mandatory GHG Inventory Rule. The USEPA has issued the Final Mandatory Reporting of Greenhouse Gases Rule in response to the Fiscal Year (FY) 2008 Consolidated Appropriations Act (House of Representatives 2764; Public Law 110-161). The final rule was signed September 22, 2009, and requires that suppliers of fossil fuels and industrial GHGs, manufacturers of vehicles and engines outside of the light-duty sector, and facilities that emit 25,000 metric tons or more of the GHGs per year to submit annual reports to USEPA. The intent of this rule is to collect accurate and timely emissions data to guide future policy decisions on climate change. Four new proposed rules amending the GHG Inventory rule were signed on March 22, 2010. These would require reporting of emissions data from the oil and natural gas, industries that emit fluorinated GHGs, and from facilities that inject and store CO_2 underground for the purposes of geologic sequestration or enhanced oil and gas recovery (USEPA 2010b).

Proposed Greenhouse Gas Permitting Requirements on Large Industrial Facilities. On September 30, 2009, the USEPA proposed new thresholds for GHGs that define when CAA permits under the New Source Review and Title V operating permits programs would be required. The proposed thresholds would tailor these permit programs to limit which facilities would be required to obtain permits and would cover nearly 70 percent of the nation's largest stationary-source GHG emitters – including power plants, refineries, and cement production facilities, while shielding small businesses and farms from permitting requirements.

Comment Requested on Greenhouse Gas Permitting Guidance under Reconsideration. On September 30, 2009, the USEPA released a request of public comment as the agency reconsiders the December 18, 2008, memorandum titled "[US]EPA's Interpretation of Regulations that Determine Pollutants covered by Federal Prevention of Significant Deterioration Permit Program." This interpretive memorandum, from then-USEPA Administrator Stephen L. Johnson to the USEPA Regional Administrators addressed when the PSD Program applies to CO_2, a chief GHG, and other GHGs.

Executive Order 13514. Signed on October 5, 2009, Executive Order (EO) 13514, "Federal Leadership in Environmental, Energy, and Economic Performance," introduced new GHG emissions management requirements for the federal government. This EO requires agencies to establish percentage reduction targets for agency-wide GHG emissions in absolute terms by FY2020, using FY2008 as a baseline. It also requires agencies to develop an inventory (total quantity of metric tons of CO_2 equivalent) of GHG emissions for FY2010 by January 2011. Each year thereafter, agencies must submit an annual inventory for the preceding FY to the CEQ and office of Management and Budget.

Final Endangerment Finding. On December 7, 2009, USEPA Administrator Lisa Jackson signed a final action, under Section 202(a) of the CAA, finding that six key, well-mixed GHGs constitute a threat to public health and welfare, and that the combined emissions from motor vehicles cause and contribute to the climate change problem (USEPA 2010c).

STATE REGULATIONS

Florida's Governor, Charlie Crist, signed three EOs regarding emissions in 2007 (FDEP 2009c).

- EO 07-126 requires state government to measure their GHG emissions and work to reduce emissions by:
  - 10 percent by 2012,
  - 25 percent by 2017, and
  - 40 percent by 2025.
- The second EO, EO 07-127 directed the adoption of maximum emission levels of GHGs for electric utilities requiring a reduction of emissions:
  - to year 2000 levels by 2017,
  - to year 1990 levels by 2025, and
  - by 80 percent of year 1990 levels by 2050.
  - Florida would also adopt the California motor vehicle emission standards of 22 percent reduction in vehicle emissions by 2012 and a 30 percent reduction by 2016, pending approval of the USEPA waiver.
- Finally, EO 07-128 creates a Governor's Action Team on Climate Change who would be responsible for producing a Florida Climate Change Action Plan that would include strategies beyond the EOs to reduce emissions, including recommendations for proposed legislation for consideration during the 2008 Legislative Session and beyond.

Currently Florida does not have a set standard or rule regarding GHG emission reporting. FDEP initiated three rulemaking projects aimed at reducing Florida's GHG emissions (FDEP 2009d):

- Rules to reduce GHG emissions from electric utilities,
- Adoption of the California motor vehicle emissions standards, and
- Developing a diesel idle reduction standard.

Florida has a compact with nearly 30 states for the national Climate Registry which allows Florida to collaborate with other states in creating emission reporting guidelines for industry. This group is committed to standardizing best practices in GHG emissions data reporting and management, establish a set of common protocols and support a common reporting system. The Climate Registry would ensure consistency between state climate programs (FDEP 2009a). The Climate Registry is a tool to measure, track, verify and publicly report GHG emissions from any entity wishing to participate (i.e., corporations, state agencies, municipalities, educational institutions and nonprofit groups) (FDEP 2009b).

AIR FORCE GUIDANCE

Based on the Air Force Energy Program Policy Memorandum (AFEPPM) disseminated June 16, 2009, the U.S. Air Force (USAF) is evaluating and developing protocols that would allow it to identify, quantify, and manage GHG emissions as well as potential carbon offsets. These would include point and mobile sources as well as direct and indirect emissions resulting from USAF operations (USAF 2009).

Air Force Materiel Command (AFMC) has created a guide to assist AFMC bases to develop GHG emission inventories in preparation for upcoming federal and/or state regulations. This plan is based on recommendations provided in the Greenhouse Gas Inventory Guidance for AFMC (CH2M Hill/GEOMET 2008).

Regulatory Comparisons

In order to evaluate the air emissions and their impact to the overall region of influence (ROI), the emissions associated with the construction activities were compared to the total emissions on a pollutant-by-pollutant basis for the ROI's 2002 National Emissions Inventory (NEI) data. Potential impacts to air quality were then identified as the total emissions of any pollutant that equals 10 percent or more of the ROI's emissions for that specific pollutant. The 10 percent criteria approach is used based on the General Conformity Rule, as an indicator for impact analysis for nonattainment and maintenance areas, and although Brevard County is in attainment for the NAAQS, the General Conformity Rule's impact analysis was used to provide a consistent approach to evaluating the impact from emissions that could result from the Proposed Action.

To provide a conservative evaluation, the impacts screening in this analysis used a more restrictive criteria than required in the General Conformity Rule. Rather than comparing emissions from construction activities to regional inventories (as required in the General Conformity Rule), emissions were compared to the individual county potentially impacted, which is a smaller area.

Project Calculations

Construction Emissions

Calculations for construction emissions were completed using the calculation methodologies described in the USAF Air Conformity Applicability Model (ACAM). As previously indicated, a conformity determination is not required because Brevard County is designated as "attainment."

The ACAM was used to provide a level of consistency with respect to emission factors and calculations. The ACAM evaluates the individual emissions from different sources associated with the construction phases. These sources include grading activities, asphalt paving, construction worker trips, stationary equipment (such as saws and generators), nonresidential architectural coatings, and mobile equipment emissions (USAF 2003).

As discussed in Chapter 2, during the construction of a hangar (8,840 square feet [ft^2]), administrative facility (14,135 ft^2), new parking apron (34,200 ft^2), taxiway (3.6 acres), and vehicle parking (16,120 ft^2). These quantities were input into the ACAM. Based on these assumptions, the construction emissions were calculated using the calculation methodology expressed below.

Grading Activities

Grading activities are divided into grading equipment emissions and grading operation emissions.

Grading equipment emissions are combustive emissions from equipment engines and are calculated in the following manner:

$$VOC = .22\ (pound/acre/day) * Acres * DPY_1/2000$$

$$NO_x = 2.07\ (pound/acre/day) * Acres * DPY_1/2000$$

$$PM_{10} = .17\ (pound/acre/day) * Acres * DPY_1/2000$$

$$CO = .55\ (pound/acre/day) * Acres * DPY_1/2000$$

$$SO_2 = .21\ (pound/acre/day) * Acres * DPY_1/2000$$

Where:

Acres = number of gross acres to be graded during Phase I construction
DPY_1 = number of days per year used for grading during Phase I construction
2000 = conversion factor from pounds to tons

All emissions are represented as tons per year.

Grading operation emissions are calculated using a similar equation from the Sacramento Air Quality Management District and South Coast Air Quality Management District (USAF 2003). This calculation includes grading and truck hauling emissions.

Emission Calculation:

$$PM_{10}\ (tons/year) = 60.7\ (pound/acre/day) * Acres * DPY_1/2000$$

Where:

Acres = number of gross acres to be graded during Phase I construction
DPY_1 = number of days per year used for grading during Phase I construction
2000 = conversion factor from pounds to tons

The calculations assumed that there were no controls used to reduce fugitive emissions. Also, it was assumed that construction activities would occur within calendar year (CY) 2011 and that grading activities would represent 100 percent of the construction total, for 182 days. The emission factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (USAF 2003).

Architectural Coatings

Non-residential architectural coating emissions are released through the evaporation of solvents contained in paints, varnishes, primers, and other surface coatings.

Emission Calculation:

$$VOC_{SF}\ (pound/year) = (SQR\_GRSQF * 1.63)/2000$$

Where:

SQR_GRSQF = square root of gross ft^2 of nonresidential building space to be constructed in the given year of construction

1.63 = emission factor

2000 = conversion factor from pounds to tons

It was assumed that construction activities would occur within 182 days. The emission factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (USAF 2003).

Asphalt Paving

Volatile organic compound (VOC) emissions are released during asphalt paving operations.

Emission calculation:

$$VOC_{PT}\ (tons/year) = (2.62\ pound/acre) * Acres\ Paved/2000$$

Where:

Acres Paved = total number of acres to be paved at the site.

2000 = conversion factor from pounds to tons

It was assumed that 4.76 acres would be paved with asphalt for the parking apron, taxiway, and vehicle parking lot. The specific emission factors used in the calculations were available through the Sacramento Air Quality Management District and South Coast Air Quality Management District (USAF 2003).

Construction Worker Trips

Construction worker trips during the construction phases of the project are calculated and represent a function of the number of residential units to be constructed and/or ft^2 of commercial construction.

Calculation:

*Trips (trips/day) = .42 (trip/unit/day) * Area of training facilities*

Total daily trips are applied to the following factors depending on the corresponding years.

Year 2005 through 2009:

VOC_E = .016 * Trips
NOx_E = .015 * Trips
PM_{10E} = .0022 * Trips
CO_E = .262 * Trips

Year 2010 and beyond:

VOC_E = .012 * Trips
NOx_E = .013 * Trips
PM_{10E} = .0022 * Trips
CO_E = .262 * Trips

To convert from pounds per day to tons per year:

$$VOC\ (tons/year) = VOC_E * DPY_{II}/2000$$
$$NOx\ (tons/year) = NOx_E * DPY_{II}/2000$$
$$PM_{10}\ (tons/year) = PM10_E * DPY_{II}/2000$$
$$CO\ (tons/year) = CO_E * DPY_{II}/2000$$

Where:

Commercial construction = total square footage of construction projects to be constructed in the given year of construction

2000 = conversion factor from pounds to tons

DPY_{II} = number of days per year during Phase II construction activities

It was estimated that the total square footage of construction would be 22,975 ft^2. The emission factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (USAF 2003).

Stationary Equipment

Emissions from stationary equipment occur when gasoline-powered equipment (e.g., saws, generators, etc.) are used at the construction site.

Emission Calculations:

$$VOC = .198 * (GRSQFT) * DPY_{II}/2000$$
$$NO_x = .137 * (GRSQFT) * DPY_{II}/2000$$
$$PM_{10} = .004 * (GRSQFT) * DPY_{II}/2000$$
$$CO = 5.29 * (GRSQFT) * DPY_{II}/2000$$
$$SO_2 = .007 * (GRSQFT) * DPY_{II}/2000$$

Where:

GRSQFT = gross ft^2 of commercial buildings to be constructed during Phase II

DPY_{II} = number of days per year during Phase II construction

2000 = conversion factor from pounds to tons

It was estimated that the total square footage of construction would be 22,975 ft^2. The emission factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (USAF 2003).

Mobile Equipment

Mobile equipment (such as forklifts and dump trucks) emissions include pollutant releases generated by the equipment during Phase II construction.

Emission Calculations:

$$VOC = .17 * (GRSQFT) * DPY_{II}/2000$$
$$NO_x = 1.86 * (GRSQFT) * DPY_{II}/2000$$
$$PM_{10} = .15 * (GRSQFT) * DPY_{II}/2000$$
$$CO = .78 * (GRSQFT) * DPY_{II}/2000$$
$$SO_2 = .23 * (GRSQFT) * DPY_{II}/2000$$

Where:

GRSQFT = gross ft^2 of training area to be constructed during Phase II
DPY_{II} = number of days per year during Phase II construction
2000 = conversion factor from pounds to tons

It was estimated that the total square footage of construction would be 22,975 ft^2. The emission factors were derived from the Sacramento Air Quality Management District and South Coast Air Quality Management District (USAF 2003).

Greenhouse Gas Emissions

GHG emissions were calculated for both construction and Guardian activities. Construction calculations assumed the use of 48 pieces of construction equipment that would operate 2,112 hours per year, that is eight hours a day, 22 days per month and twelve months a year), with fuel use of 4 gallons diesel per hour. Utilizing the pounds of CO_2 in diesel (22.4 pounds CO_2 per gallon diesel) CO_2 emissions were calculated.

CO_2 emissions from the construction worker commutes were calculated with the following assumptions. Assuming 45 workers, commuting 30 miles 250 days a year, with gasoline vehicles averaging 22.1 miles per gallon CO_2 emissions were calculated. The CO_2 emissions for gasoline is 19.6 pounds CO_2 per gallon gasoline.

Similarly, CO_2 emissions for the Guardian were calculated based on fuel consumption. Using the time in mode and fuel flow for each mode total amount of fuel was calculated. The CO_2 emitted from aviation gasoline (AVGAS) is 18.4 pounds CO_2 per pound AVGAS. Multiplying the total fuel usage by the emission factor and the number of operations provides the total CO_2 emissions expected from the Guardian operations.

Guardian Emissions

Emissions for the Guardian (Predator B [MQ-9]) were calculated using data from the USAF Institute for Environmental Safety and Occupational Health Risk Analysis (IERA) Air Emissions Inventory Guidance Document for Mobile Sources at USAF Installations (O'Brien 2003). It was assumed that a total of 166 sorties would occur per year. The following calculations were completed to obtain annual emissions from the Predator B.

Emissions were calculated for each of the criteria pollutants at the different modes (i.e., takeoff and landing, approach, and taxi/idle).

$$\text{Emission}_{x\text{-TIM}} = \text{TIM} * \text{FF} * \text{NE} * \text{EF}_x / 1000$$

Where:

- $\text{Emission}_{x\text{-TIM}}$ = Emissions for 'X' pollutant (pounds/LTO or mode)
- TIM = Time in Mode (minutes)
- FF = Fuel Flow (pounds/minutes)
- NE = Number of Engines (in this case it is 1)
- EF_x = Emission Factor for 'X' pollutant (pounds/1000 pounds fuel)
- 1000 = Conversion from 1000 pounds fuel to pounds (1000 pounds fuel/pounds)

The summation of emissions for all modes for each pollutant provides the emissions expected per sortie.

$$Emission_{Sortie} = \sum Emission_{X\text{-}TIM}$$

Where:

$Emission_{Sortie}$ = Emissions per sortie per criteria pollutant (pounds/sortie)

$Emission_{X\text{-}TIM}$ = Emissions for each criteria pollutant based on aircraft time in mode (pounds/mode)

Finally, annual emissions are calculated with the emissions per sortie and the number of sorties expected per year.

$$Annual\ Emissions = Emission_{Sortie} * N * 0.0005$$

Where:

Annual Emissions = Annual emissions for each criteria pollutant (tons / year)

$Emission_{Sortie}$ = Emissions per sortie per criteria pollutant (pounds/sortie)

N = Number of sorties per year (sorties / year)

0.005 = conversion from pounds to tons (tons / pounds)

National Emissions Inventory

The NEI is operated under the USEPA's Emission Factor and Inventory Group, which prepares the national database of air emissions information with input from numerous state and local air agencies, tribes, and industries. The database contains information on stationary and mobile sources that emit criteria air pollutants and hazardous air pollutants (HAPs). The database includes estimates of annual emissions, by source, of air pollutants in each area of the country on a yearly basis. The NEI includes emission estimates for all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. Emission estimates for individual point or major sources (facilities), as well as county-level estimates for area, mobile, and other sources, are currently available for years 1996 and 1999 for criteria pollutants and HAPs.

Criteria air pollutants are those for which the USEPA has set health-based standards. Four of the six criteria pollutants are included in the NEI database:

- Carbon Monoxide (CO)
- Nitrogen Oxides (NO_x)
- Sulfur Dioxide (SO_2)
- Particulate Matter (PM_{10} and $PM_{2.5}$)

The NEI also includes emissions of VOCs, which are O_3 precursors, emitted from motor vehicle fuel distribution and chemical manufacturing, as well as other solvent uses. VOCs react with NO_X in the atmosphere to form O_3. The NEI database defines three classes of criteria air pollutant sources:

- Point Sources. Stationary sources of emissions, such as an electric power plant, that can be identified by name and location. A "major" source emits a threshold amount (or more) of at least one criteria pollutant and must be inventoried and reported. Many states also inventory and report stationary sources that emit amounts below the thresholds for each pollutant.
- Area Sources. Small point sources such as a home or office building or a diffuse stationary source such as wildfires or agricultural tilling. These sources do not individually produce sufficient emissions to qualify as point sources. Dry cleaners are one example; for instance, a single dry cleaner within an inventory area typically would not qualify as a point source, but collectively the emissions from

all of the dry cleaning facilities in the inventory area may be significant and therefore must be included in the inventory.

- Mobile Sources. Any kind of vehicle or equipment with a gasoline or diesel engine (such as an airplane or ship).

The following are the main sources of criteria pollutant emissions data for the NEI:

- For electric generating units—USEPA's Emission Tracking System/Continuous Emissions Monitoring Data (ETS/CEM) and Department of Energy fuel use data.
- For other large stationary sources—state data and older inventories where state data were not submitted.
- For on-road mobile sources—the Federal Highway Administration's estimate of vehicle miles traveled and emission factors from USEPA's MOBILE Model.
- For non-road mobile sources—USEPA's NONROAD Model.
- For stationary area sources—state data, USEPA-developed estimates for some sources, and older inventories where state or USEPA data were not submitted.
- State and local environmental agencies supply most of the point source data. USEPA's Clean Air Market program supplies emissions data for electric power plants.

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APPENDIX C

UAS PROJECT REQUIREMENTS

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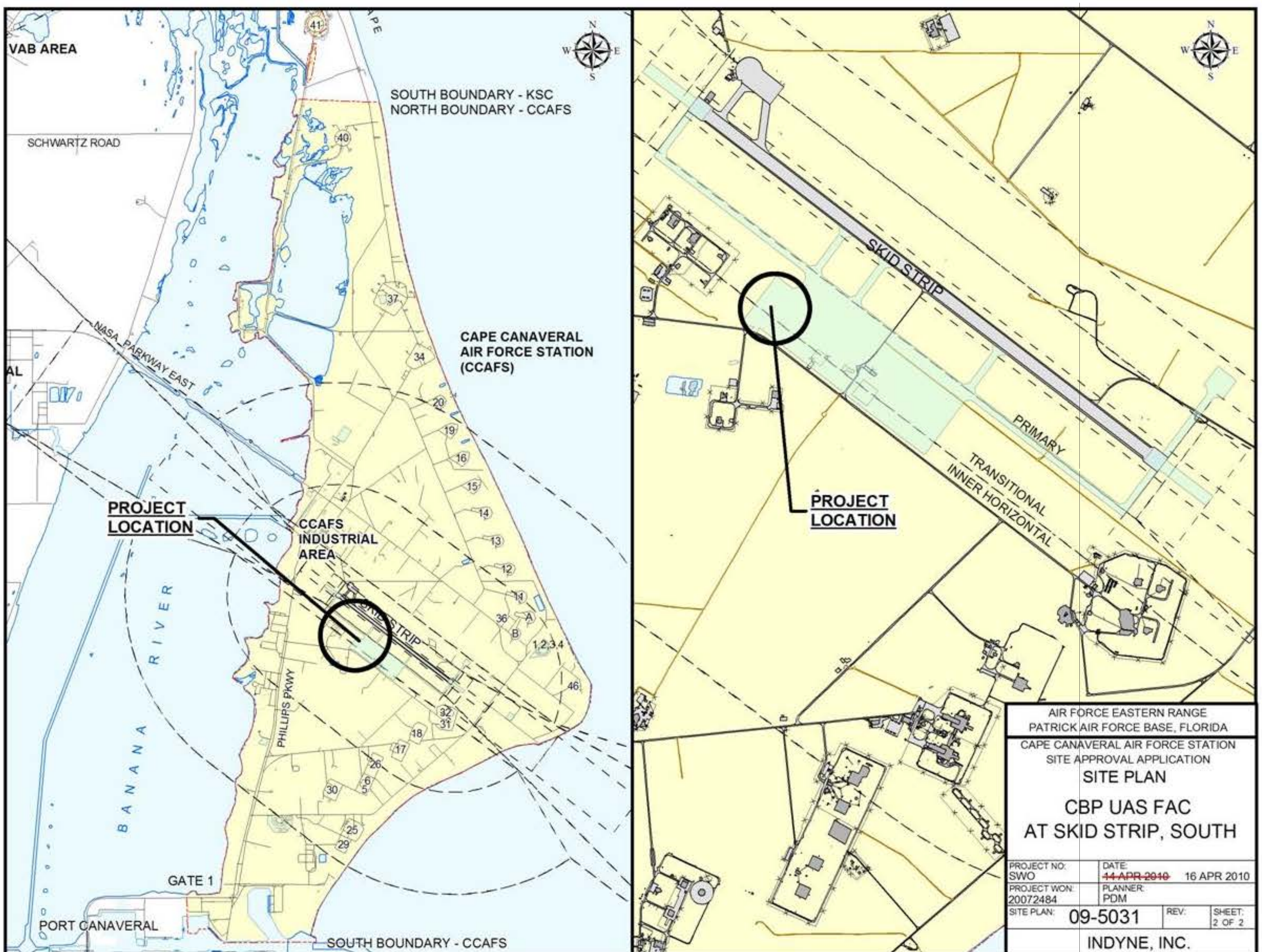
UAS Facility Space Requirements Est.

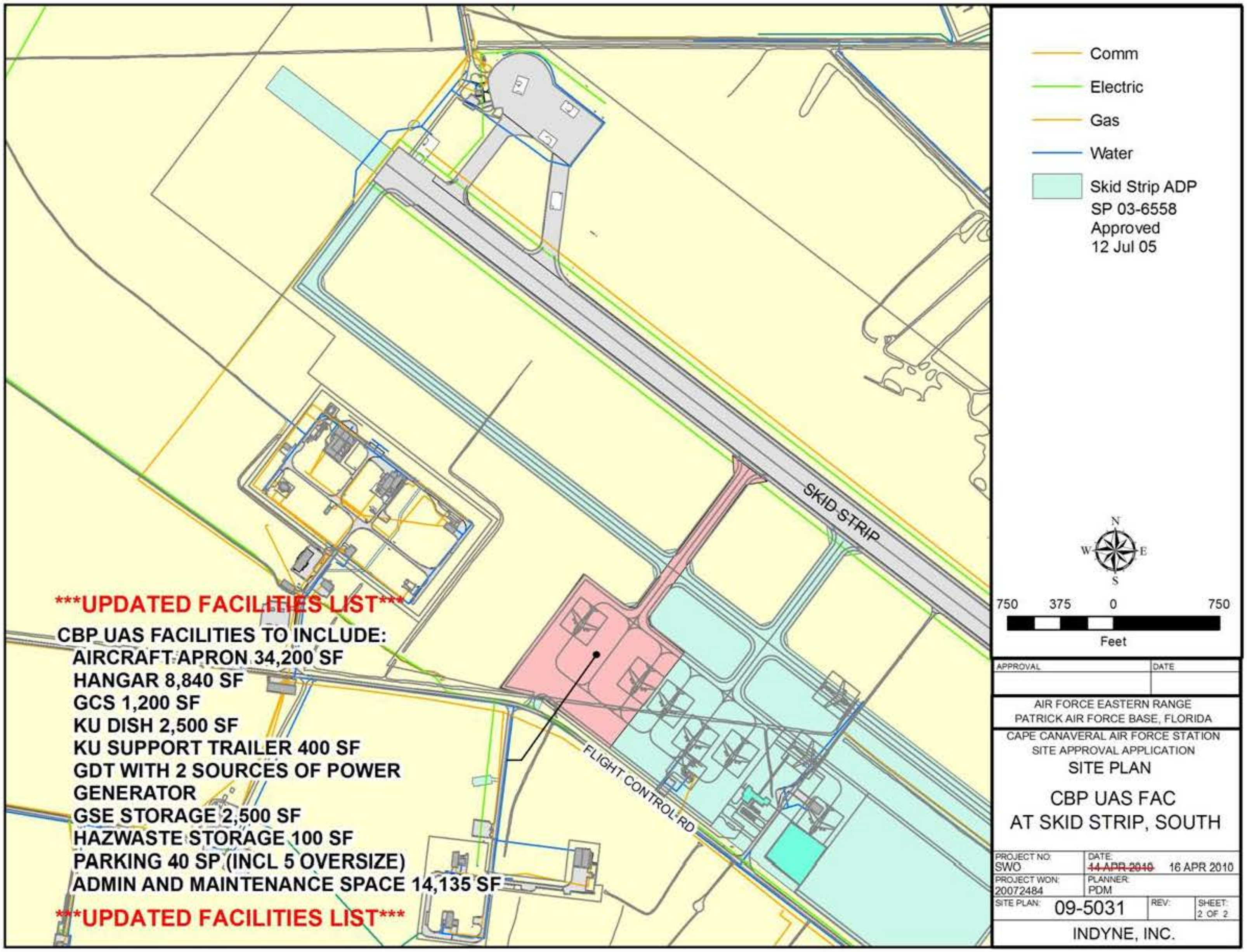
Space Name	SF Req	Comments
Vehicle Parking Sq. Ft. (35 ea)	8120	See Notes #1
Oversize Vehicle Parking Sq. Ft. (5 ea)	1300	See Notes #2
Aircraft Parking Apron in Sq. Ft. (180'x190')	34,200	
External GSE Storage	2500	
External Hazardous Waste Storage	100	
KU Dish	2,500	
KU Dish trailer	400	
GCS Trailer	1200	
Hangar Floor Space		
A/C Hangar Floor Space	6840	See Note #5
Indoor Hangar Storage	2000	
Hangar Floor Space Sub Total/SF	**8,840**	
Air Ops Admin		
Field Director Office	225	1 @ 225sf Office
Small Conference Room	200	1 @ 200sf
Deputy Director Office	180	1 @ 180sf
Aviation Group Supervisor Office (3)	450	3 @ 150sf Office
Aviation Maintenance Officer Office (1)	130	1 @ 130sf Office
Ops/Safety/Training/Intelligence Office (2)	390	2 @ 130sf Office
Budget Officer Office/MPS	150	1 @ 150sf
Flight Duty Personnel Work Space (20)	1280	64sf X 20; Bullpen work spaces
Air Operations Staffing Sub Total/sf	**3,005**	
Common Use Space		
Kitchen	100	sink, prep counter, refrig, micro, dishwasher, ice mach
Break Room	200	Break Room w/ adjoining kitchen space
Ballistic Reception Room	100	
Conference/Training Room	450	
Conference Room Storage	100	
Map Room and Library - Flight Planning	150	
Pred Op Center/WC/Secure Storage	450	
Storage	200	
Women’s Restroom, Showers & Lockers	250	
Women’s Restroom (1)	150	Ladies Room, 1 @ 150sf ea
Men’s Restroom (2)	300	Men's Room, 2 @ 150sf ea
Men’s Restroom, Showers & Lockers	300	
Ammunition and Weapons Storage Room (hardened room)	200	“Secure Area” – 10’ X 20’ Room
LAN/Tele Room	100	Separate A/C
Administrative Supply Room	120	
File Room	150	
Fax, Copier and Printer Area	150	Space for shared office equip
Operations Space Sub-Total/sf	**3,470**	

<u>**Aviation Maintenance Admin Space**</u>		
Contractor Site Supervisor Office	150	1 @ 150sf
Office Manager	150	1 @ 150sf
Copy/Fax Office Equipment area	100	
Quality Assurance Office	220	2 man offices @ 220 sq ft ea
Maintenance/Technical Library	150	150sf ea
Maintenance Records Storage	150	150sf ea
Break/Kitchen/Conf	300	
Janitor Closet	60	60sf for each 10,000sf (Net)
Maintenance Space Sub-Total/sf	**1,280**	
<u>**Maintenance Support Space**</u>		
Supply Clerk Work Area	200	
Supply Storage Area	500	
Supply Shipping & Receiving Area	300	Covered platform/receiving area desired
Special Tool Storage Room	350	
Personal Tool Storage	200	
Battery Repair and Service	100	Battery, 2 @ 50sf ea.
Avionics Shop and Offices	200	
Engine Shop	200	
Women's Restroom, Shower & Locker	120	
Men's Restroom, Shower & Locker	350	
Aircraft Maintenance Sub-Total/sf	**2,520**	
FACILITY SUPPORT SPACES		
Janitor Closet (2)	120	60sf for each 10,000sf (Net)
Security (Equipment) Closet	75	Share room with voice and data
Facility Support Sub-Total	**195**	
TOTAL HANGAR	**8,840**	
TOTAL ADMIN BUILDINGS (NET)	**10,470**	
TOTAL ADMIN BUILDINGS (GROSS)	**14,135**	See Notes #4

Notes:

1. Need parking for 35 vehicles. Assumed 232 SF per vehicle.
2. Need parking for 5 large/oversized utility vehicles. Assumed 260 SF per vehicle.
3. Hangar Bay door opening must be at a minimum 20' ft in height.
4. Assume a net to gross multiplier of 1.35 for circulation
5. A/C maintenance/storage requirements will be based upon planed assigned A/C: 2 MV Predator B


VAB AREA
SOUTH BOUNDARY - KSC
NORTH BOUNDARY - CCAFS
SCHWARTZ ROAD
NASA PARKWAY EAST
CAPE CANAVERAL
AIR FORCE STATION
(CCAFS)
PROJECT
LOCATION
CCAFS
INDUSTRIAL
AREA
BANANA RIVER
PHILLIPS PKWY
GATE 1
PORT CANAVERAL
SOUTH BOUNDARY - CCAFS
SKID STRIP
PRIMARY
TRANSITIONAL
INNER HORIZONTAL
PROJECT
LOCATION
AIR FORCE EASTERN RANGE
PATRICK AIR FORCE BASE, FLORIDA
CAPE CANAVERAL AIR FORCE STATION
SITE APPROVAL APPLICATION
SITE PLAN
CBP UAS FAC
AT SKID STRIP, SOUTH
PROJECT NO: SWO
DATE: 14 APR 2010 16 APR 2010
PROJECT WON: 20072484
PLANNER: PDM
SITE PLAN: 09-5031
REV:
SHEET: 2 OF 2
INDYNE, INC.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Gas
Water
Skid Strip ADP
SP 03-6558
Approved
12 Jul 05
SKID STRIP
FLIGHT CONTROL RD
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Feet
UPDATED FACILITIES LIST
CBP UAS FACILITIES TO INCLUDE:
AIRCRAFT APRON 34,200 SF
HANGAR 8,840 SF
GCS 1,200 SF
KU DISH 2,500 SF
KU SUPPORT TRAILER 400 SF
GDT WITH 2 SOURCES OF POWER
GENERATOR
GSE STORAGE 2,500 SF
HAZWASTE STORAGE 100 SF
PARKING 40 SP (INCL 5 OVERSIZE)
ADMIN AND MAINTENANCE SPACE 14,135 SF
UPDATED FACILITIES LIST
APPROVAL
DATE
AIR FORCE EASTERN RANGE
PATRICK AIR FORCE BASE, FLORIDA
CAPE CANAVERAL AIR FORCE STATION
SITE APPROVAL APPLICATION
SITE PLAN
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SITE PLAN: 09-5031
REV:
SHEET: 2 OF 2
INDYNE, INC.

APPENDIX D

ADDITIONAL REFERENCES (see attached CD)

Skid Strip ADP, Biological Opinion, Skid Strip EA, Southeastern Beach Mouse Study

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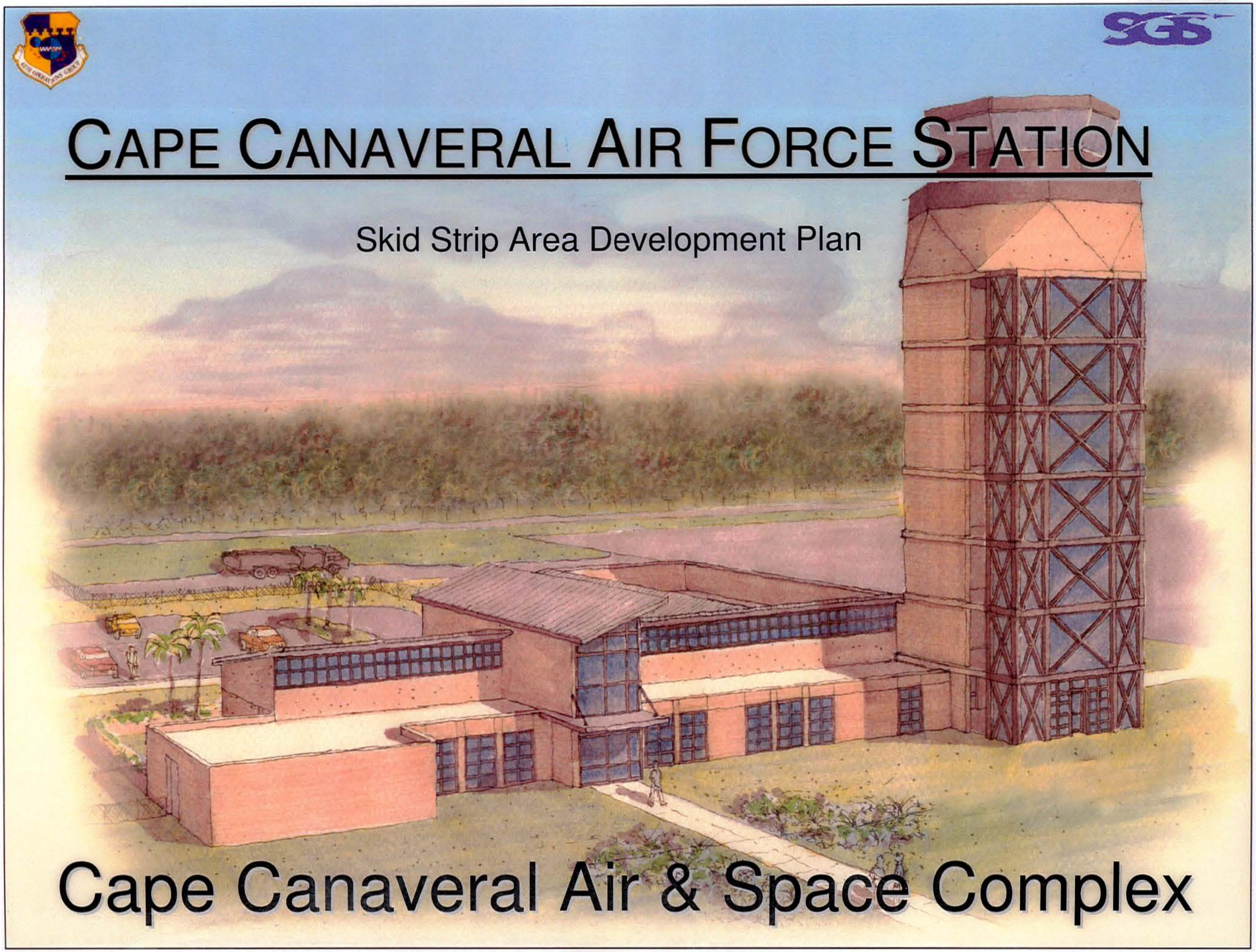
CAPE CANAVERAL AIR FORCE STATION

Skid Strip Area Development Plan



Cape Canaveral Air & Space Complex

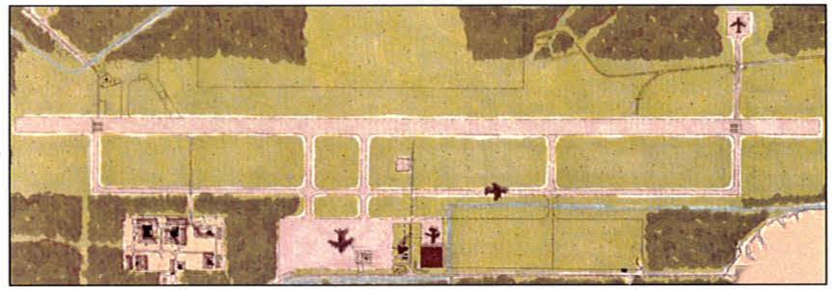
Executive Summary

Through the years the Cape Canaveral Spaceport has been on the leading edge of innovation, but changing technology and aging infrastructure have exposed weaknesses and safety violations that challenge Cape Canaveral Air Force Station's (CCAFS) ability to meet the needs of existing and future missions. The Skid Strip Area Development Plan (ADP) addresses these challenges through a two-phased approach: 1) Capitol Improvements Projects that address short-term and mid-range needs designed to increase safety, and 2) MILCON projects for long term needs, developed to support the existing and future 45th SW missions.

This ADP focuses on the structural condition of the Skid Strip apron, ATCT, and the Ops Flight Planning Facility in order to determine their suitability for the existing and future missions. Apron pavement and sub-base conditions, safety violations, and expansion restrictions reveal the limitations of the apron and adjacent facilities.

Thirty-six projects are recommended in this ADP to address these limitations and enhance safety by reducing violations and building the Cape Canaveral Air & Space Complex. Designed to improve safety and correct facility deficiencies, the Capitol Improvement projects will enhance the existing mission while the MILCON projects build long-term solutions to respond to future mission needs. Thirty short-term projects have been programmed for a total of [redacted] and six long-term MILCON projects have been developed for a total of [redacted] All of the projects recommended in this ADP comply with both the long and short-term visions of the future established in the Cape Canaveral Spaceport Master Plan (CCSMP) and the Cape Canaveral Air Force Station (CCAFS) General Plan.

Positioning CCAFS to meet all future missions will require a proactive stance in a changing environment, which is not possible with the existing facilities. The proposed Cape Canaveral Air & Space Complex includes a new Air Traffic Control Tower (ATCT), Airfield Management Operations building (AM Ops), Aircraft Apron, Parallel Taxiway, Hazardous Cargo Pad, Maintenance Apron and Hangar. The future is transitioning from high-cost, specialized launch pads to reduced-cost, re-usable horizontal launch vehicles. The Pegasus, the Space Shuttle and the X-Prize winner reflect this transition. The Cape Canaveral Spaceport must exploit its unique position as a full-service spaceport and as the only spaceport in the world capable of launching a payload either vertically or horizontally. But, in order to be successful, CCAFS must begin planning and building for tomorrow today.



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1. Introduction

The existing Cape Canaveral Skid Strip and airfield support facilities are not compliant with Air Force instructions or the goals and objectives of the CCSMP and the CCAFS General Plan and are non-compliant with lighting, design and safety regulations found in the following Air Force regulations:

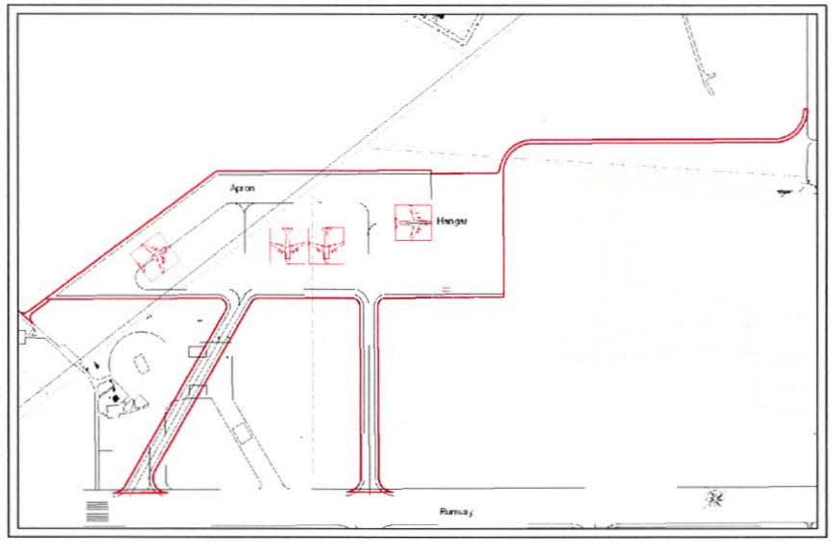
- Unified Facilities Criteria 3-260-01 Airfield and Heliport Planning and Design;
- AFH 32-1084 Facility Requirements Handbook;
- AFMAN 32-1076 Visual Air Navigation Facilities;
- AFI 32-1042 Standards for Marking Airfields;
- FAA Advisory Circular 150/5345-12C Specification for Airport and Heliport Beacon.

This ADP focuses on the non-compliant facilities, and proposes a corrective action plan.

1.1 Background

In 1952 the Skid Strip was built as a Missile Landing and Test Facility (Category Code 390-551). By 1994 it was realized that the Skid Strip was functioning primarily as a runway and should be recognized as such. The real property category code for the Skid Strip was changed to airfield (111-111) and the Skid Strip was evaluated against the appropriate guidance. Serious safety violations were identified and this ADP was developed to correct these deficiencies and brings the Skid Strip into compliance.

Phase I identified approximately 800 obstructions. A thorough analysis was conducted resulting in the immediate correction of some of the obstructions. The remaining obstructions were grouped together and 19 new waiver packages were written and delivered to Air Force Space Command (AFSPC) and approved 09/17/2004. This process also identified the need for an Aircraft Parking Plan, which was developed, approved and installed on the existing Skid Strip Apron. The Aircraft Parking Plan, which allows three C-5's, or Antonov's to park on the Skid Strip apron with a wingtip separation distance of 30 feet was granted an airfield waiver. (The normal wingtip separation distance is 50 feet.)



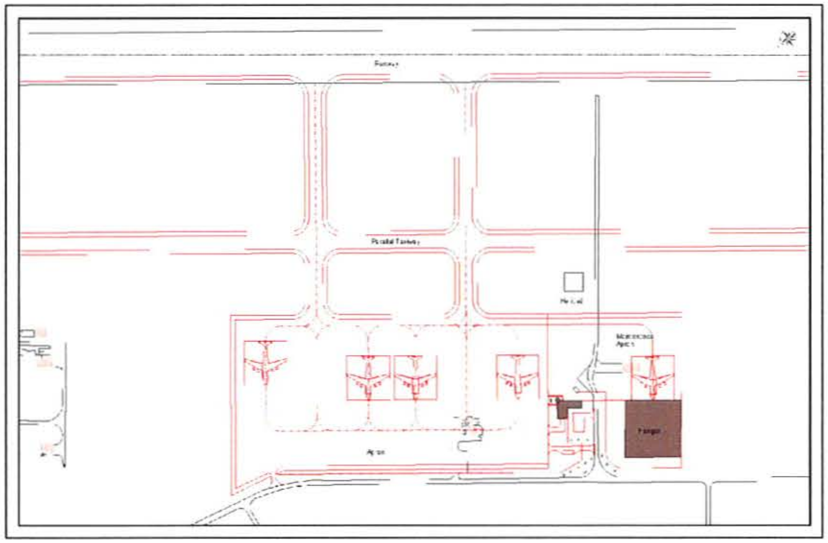
Cape Canaveral Air and Space Complex - North Option

Also during Phase I, two apron and facility layouts were developed. Each layout option complied with the following specifications:

- Apron sized to accommodate four "heavies" (C-5's or Antonov's) with all required minimum clearances,
- AM Ops facility sized for current mission plus space for an Airfield Manager and a private Distinguished Visitor (DV) restroom,
- ATCT size and height per UFC 3-260-01 criteria, and the Facility Requirements handbook (AFH 32-1084).
- An optional hangar and maintenance apron sized for a single Antonov or C-5.

An evaluation of the future land use requirements taken from the CCSMP indicated that neither option would prevent the use of the land surrounding the Skid Strip as a Horizontal Launch, Horizontal Recovery (HLHR) facility.

Further review of the CCSMP and the CCAFS General Plan ensured ADP compliance with all adopted short and long-range planning goals and objectives. The CCAFS General Plan, a short-range planning document, discusses growth and planning strategy for the next 20 years. The CCSMP, a long-range planning document, envisions strategic planning for the next 50 years. Together they provide the basis for the Skid Strip Area Development Plan.



Cape Canaveral Air and Space Complex – South Option

Phase II of the ADP developed an implementation strategy through programmed Capitol Improvement projects (Sustainment, Restoration and Modernization or SRMC) and MILCON construction projects. The first task for Phase II was to evaluate the potential locations for the Cape Canaveral Air & Space Complex and select the best location. The next task was to develop projects and prioritize them using a combination of risk analyses measures, which include:

- Airfield Priority Areas (PA),
- Operational Risk Management Assessment (ORM),
- Risk Assessment Code (RAC),
- Cost Effectiveness Index (CEI),
- Adjusted Priority Number (APN).

A complete discussion of these analyses and the resulting project priorities are covered in Appendix 3.

Through a series of meetings and presentations detailing the opportunities and constraints placed on each of these two sites, Air Force leadership reviewed and evaluated the two locations and has determined that the Cape Canaveral Air & Space Complex - South Option best satisfies the needs of the existing mission while not precluding the established vision of the future.

2. Goals & Objectives

Three major goals have been adopted from the CCAFS General Plan for use in this ADP. These are:

- Continual Improvement Toward Mission Excellence,
- Continual Improvement in Protection of the Natural and Human Environment,
- Continual Quality of Life Improvement.

These goals and their corresponding objectives will enhance safety, meet the needs of the existing mission, and develop CCAFS' image as the world's premier spaceport while allowing CCAFS to successfully meet future missions.

Goal 1 – Continual Improvement Toward Mission Excellence

Objective 1.1 –Site & develop facilities for optimal accomplishment of the launch mission
Objective 1.2 – Improve infrastructure to support mission growth
Objective 1.3 – Improve and modify facilities to better serve future launch customers
Objective 1.4 – Enhance compliance with the 45th SW Facilities Excellence Plan Architecture Guidelines

Goal 2 - Continual Improvement in Protection of the Natural and Human Environment

Objective 2.1 – Pursue all potential pollution prevention opportunities
Objective 2.2 – Minimize the destruction of endangered and/or threatened species habitats

Goal 3 – Continual Quality of Life Improvement

Objective 3.1 – Enhance Safe Working Conditions for the CCAFS work force

United States Department of the Interior

FISH AND WILDLIFE SERVICE
6620 Southpoint Drive, South
Suite 310
Jacksonville, Florida 32216-0912

IN REPLY REFER TO:

FWS Log Number: 41910-2008-F-0148

May 8, 2008

45 SW/CC
Attn: Brigadier General Susan J. Helms
1201 Edward H. White II Street, MS-7100
Patrick AFB, Florida 32925-3299

FWS Log Number: 41910-2008-F-0148

Dear Brigadier Helms:

This document is the U.S. Fish and Wildlife Service's (Service) biological opinion (BO) based on our review of the proposed Skid Strip modification on Cape Canaveral Air Force Station (CCAFS) in Brevard County, Florida, and its effects on the Florida scrub-jay (*Aphelocoma coerulescens*), southeastern beach mouse (*Peromyscus polionotus niveiventris*), eastern indigo snake (*Drymarchon corais couperi*), loggerhead (*Caretta caretta*), green (*Chelonia mydas)*, leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), and Kemp's ridley (*Lepidochelys kempii*) sea turtles, pursuant to section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your request for formal consultation for these species was received on January 15, 2008.

The 45th Space Wing (SW) has determined that the proposed project may affect and is likely to adversely affect the Florida scrub-jay, southeastern beach mouse and the eastern indigo snake. The Service concurs with your determination. The 45th SW also determined that the proposed project may affect but is not likely to adversely affect the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles. Based on our discussions and review of the project plans, the Service concurs with this determination provided the Light Management Plan for the Skid Strip modification and associated facilities are reviewed and approved by the Service.

This BO is based on information provided in the final Biological Assessment (BA) for the Skid Strip modification received on January 15, 2008, a meeting conducted on July 25, 2006, and March 27, 2007, with representatives from the 45th SW, and the Service, email correspondence on February 12, 2008, and March 10, 2008, with Angy Chambers, a representative of the 45th

SW, and other sources of information. A complete administrative record is on file at the Ecological Services Office in Jacksonville, Florida.

CONSULTATION HISTORY

On July 20, 2001, the Service received a letter requesting informal consultation on the installation of three electronic wind indicators near the east and west terminus and mid-point of the CCAFS existing Skid Strip. In accordance with the CCAFS Scrub Habitat Compensation Plan, compensation for the loss of 25 acres was completed through the restoration (cutting/burning) of 100 acres of mature scrub located on the south portion of CCAFS.

On July 25, 2006, the Service met with representatives of the 45th SW to discuss another project. At that meeting, the Skid Strip was briefly discussed. On March 27, 2007, the Service met with representatives from CCAFS to discuss the Skid Strip. At that meeting, the Service discussed with representatives of the 45th SW the impacts of the proposed project on the scrub-jay recovery goals at CCAFS. Clearing the 410.83 acres of scrub-habitat will not remove them from achieving their recovery goals. The proposed restoration will create two scrub-jay corridors and will take place in addition to the 500 acres of scrub restoration per year using mechanical treatment followed by controlled burning as a goal in the Integrated National Resources Management Plan (INRMP).

On January 15, 2008, the Service received the BA initiating formal consultation on the Skid Strip modification.

Scrub management at CCAFS through prescribed burning has its limitations due to the sensitivity of equipment to smoke in the various facilities. A prescribed burn working group has been established at CCAFS to help resolve some of these issues. On March 10, 2008, the Service received an email from Angy Chambers, a representative of the 45th SW, with information on burn restrictions on the skid strip modification and associated facilities. The new facilities are not expected to have any more control burn restrictions than the current facilities. The current facilities have never restricted prescribed burning windows and that is not expected to change.

The Service notified the representatives of the 45th Space Wing that all the necessary information from the Air Force was received to complete the BO.

BIOLOGICAL OPINION

DESCRIPTION OF THE PROPOSED ACTION

The Air Force proposes to modify and expand the Skid Strip (runway/airfield) at CCAFS in Brevard County, Florida. The Skid Strip at CCAFS was originally constructed in 1952 as a missile Landing Facility. Aircrafts used the runway for take-offs and landings. In 1994, property category code change and application of guidance occurred for the skid strip. Operational deficiencies were found and an initial phase of corrective actions was taken to eliminate immediate concerns. Remaining deficiencies and longer term projects to support growth and planning strategies were developed.

The proposed action consists of several projects schedules to begin in the fiscal year 2008 and end in the fiscal year 2017. These projects consist of construction of a new apron, air traffic control tower, airfield operations building, and removal of vegetation that currently violates airfield criteria. The vegetation located within the airfield surface zone must be removed to bring the airfield into compliance with certain criteria that require no obstructions to be located within a certain distance around the entire airfield, as well as the approach and departure zones. The new facilities are meant to bring the airfield up to current standards.

The action area (area including all direct and indirect effects), for the purpose of this consultation, will include all of CCAFS. The perimeter of the airfield is located in the central portion of CCAFS. Currently, regularly mowed and maintained grasses are found approximately 500 feet from the centerline of the runway. The remaining vegetation beyond this is forested and categorized as coastal/oak scrub. Along the southeastern side of the airfield, the coastal strand indicator species such as wax myrtle (*Myrica cerifera*) are found in higher densities. The vegetation types have developed into a closed canopy, and tree heights are typical in a xeric hammock. Fifty years of fire suppression at CCAFS has created this expansive hammock scrub.

The coastal/oak scrub around the airfield consists of oaks with a maximum height of approximately 25 feet to 30 feet. Tree-sized cabbage palms (*Sabal palmetto*) and red bays (*Persea borbonia*) are interspersed with shrubby saw palmetto (*Serenoa repens*), wax myrtle, tough buckthorn (*Bumelia tenax*), nakedwood (*Myrsianthes fragrans*) and rusty lyonia (*Lyonia ferruginea*). All areas surrounding the airfield, excluding treated scrub and some disturbed areas, range from 5 feet to 30 feet in height. The extreme western edge of the airfield is the only area that has undergone scrub restoration treatment. The canopy of these areas is low-stature, averaging approximately 5 feet to 15 feet.

The clearing of vegetation around the airfield will be phased over several years, with the first proposed project to begin in the later part of 2008. The total clearing of the vegetation around the airfield will result in the removal of just over 373 acres. The construction of the new facilities proposed will occur in fiscal year 2012 and will result in the removal of approximately 37 acres if vegetation.

Table 1. Acreage and location of vegetation removal for Skid Strip modification on CCAFS.

Area	**Acreage**	**Land Management Units Impacted (LMU)**	**Proposed fiscal year**
Area 1	57.27	72, 73	2009
Area 2	56.57	38, 39, 49	2010
Area 3	27.07	73	2010
Area 4	20.61	70, 72	2010
Area 5	26.30	75	2011
Area 6	37.94	65, 70, 71	2012

Area 7	37.00	66	2012
Area 8	26.30	75	2013
Area 9	46.68	66	2014
Area 10	32.04	47	2015
Area 11	18.31	66	2016
Area 12	24.74	48	2017
TOTAL ACREAGE 410.83			

The amount of scrub habitat or degraded scrub habitat to be removed for the proposed project is 410.83 acres. All of this habitat was or is oak scrub.

Currently, LMU 38, 39, 66, 48 and 49 is occupied by scrub-jays. This includes five groups of scrub-jays totally 12 individual birds documented in these areas.

Conservation measures agreed to by CCAFS include restoration of the following LMUs:

Table 2. Proposed Restoration acreage for each LMU.

Area	**Land Management Units Impacted (LMU)**	**Proposed fiscal year**	**Proposed Restoration LMUs**	**Proposed Restoration Acreage**
Area 1	72, 73	2009	72, 89	121.66
Area 2	38, 39, 49	2010	40, 36, 37, 38	178.98
Area 3	73	2010	74	68.74
Area 4	70, 72	2010	65	46.05
Area 5	75	2011	76	54.48
Area 6	65, 70, 71	2012	70	165.89
Area 7	66	2012	67, 78	54.91
Area 8	75	2013	78	63.75
Area 9	66	2014	66, 79	61.20
Area 10	47	2015	55, 36	103.98
Area 11	66	2016	33	71.06
Area 12	48	17	84, 48	166.78
TOTAL ACREAGE 410.83			**TOTAL RESTORATION ACREAGE 1157.48**	

The Air Force proposes to restore unoccupied scrub-jay habitat at a ratio of 3:1. Before any clearing is conducted on scrub-jay occupied areas, the LMU adjacent to the impacted area proposed for restoration will be conducted. The proposed areas to be restored will help create two scrub-jay corridors. The first will connect the population of scrub-jays along Phillips Parkway and Pier Road with the population to the north. The second will connect the population along Phillips Parkways to that along Pier Road. A combination of mechanical treatments and prescribed burning will be used to restore the habitat.

The new facilities associated with the skid strip are not expected to have any more burn restrictions than the current facilities on CCAFS. The current facilities have never restricted prescribed burning and this is not expected to change with the additional facilities.

Skid Strip Overview Map

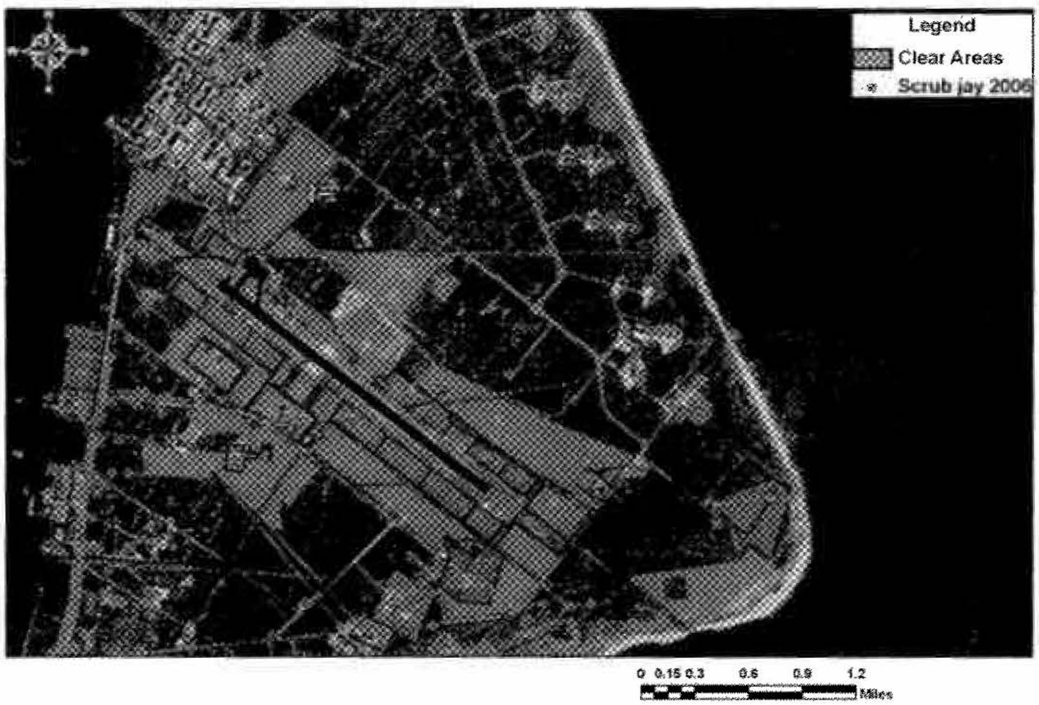


Figure 1. Overlay of Skid Strip and scrub-jay occupied areas on CCAFS.

STATUS OF THE SPECIES/CRITICAL HABITAT

This section provides pertinent biological and ecological information for the Florida scrub-jay, southeastern beach mouse, and eastern indigo snake, as well as information about their status and trends throughout their entire range. We use this information to assess whether a federal action is likely to jeopardize the continued existence of the above-mentioned species. The "Environmental Baseline" section summarizes information on status and trends of the Florida scrub-jay, southeastern beach mouse, and eastern indigo snake specifically within the action area. These summaries provide the foundation for our assessment of the effects of the proposed action, as presented in the "Effects of the Action" section.

FLORIDA SCRUB-JAY (*APHELOCOMA COERULESCENS*)

Species/Critical Habitat Description

Florida scrub-jays are about 10 to 12 inches long and weigh about 3 ounces. They are similar in size and shape to the blue jay (*Cyanocitta cristata*), but differ significantly in coloration (Woolfenden and Fitzpatrick 1996a). Unlike the blue jay, the scrub-jay lacks a crest. It also lacks the conspicuous white-tipped wing and tail feathers, black barring, and bridle of the blue jay. The Florida scrub-jay's head, nape, wings, and tail are pale blue, and its body is pale grey on its back and belly. Its throat and upper breast are lightly striped and bordered by a pale blue-grey "bib." Scrub-jay sexes are not distinguishable by plumage, and males, on the average, are only slightly larger than females (Woolfenden 1978). The sexes may be differentiated by a distinct "hiccup" call vocalized only by females (Woolfenden and Fitzpatrick 1986). Scrub-jays that are less than about five months of age are easily distinguishable from adults; their plumage is smokey grey on the head and back, and they lack the blue crown and nape of adults. Molting occurs between early June and late November and peaks between mid-July and late September (Bancroft and Woolfenden 1982). During late summer and early fall, when the first basic molt is nearly done, fledgling scrub-jays may be indistinguishable from adults in the field (Woolfenden and Fitzpatrick 1984). The wide variety of vocalizations of the scrub-jay is described in detail in Woolfenden and Fitzpatrick (1996b).

No critical habitat has been designated for this species; therefore none will be affected by the proposed project.

Life History/Population Dynamics

Scrub-jays are non-migratory, extremely sedentary, and have very specific habitat requirements (Woolfenden 1978). They usually reside in oak scrub vegetated with sand live oak, myrtle oak, inopine oak, and Chapman oak, along with saw palmetto, scrub palmetto, scattered sand pine, and rosemary. Such habitat occurs only on fine, white, drained sand, along the coastlines in Florida, and in dunes deposited during the Pleistocene, when sea levels were much higher than at present (Laessle 1958, 1968). Scrub-jays are rarely found in habitats with more than 50 percent canopy cover over three meters in height (U.S. Fish and Wildlife Service 1990). The habitat required for the scrub-jay greatly restricts the bird's distribution. Active management either through burning or mechanical clearing is necessary to maintain optimum conditions. In general, scrub-jay habitat consists of dense thickets of scrub oaks less than nine feet tall, interspersed with bare sand used for foraging and storing of acorns (U.S. Fish and Wildlife Service 1990).

Florida scrub-jays are monogamous and remain mated throughout the year (Sprunt 1946; Woolfenden 1978). Scrub-jays have a social structure that involves cooperative breeding, a trait that the other North American species of scrub-jays do not show (Woolfenden and Fitzpatrick 1984). Scrub-jays live in families ranging from two birds (a single mated pair) to extended families of eight adults and one to four juveniles. Fledgling scrub-jays stay with the breeding pair in their natal territory as "helpers, forming a closely-knit cooperative family group. Pre-breeding numbers are generally reduced to either a pair with no helpers or families of three to four individuals (a pair plus one or two helpers). The presence of helpers generally increases reproductive success and survival within the group, which naturally causes family size to increase (Woolfenden and Fitzpatrick 1978).

Scrub-jays have a well-developed intrafamilial dominance hierarchy with breeder males most dominant, followed by helper males, breeder females, and finally, female helpers (Woolfenden and Fitzpatrick 1977). Helpers take part in sentinel duties (McGowan and Woolfenden 1989), territorial defense, predator-mobbing, and the feeding of both nestlings (Stallcup and Woolfenden 1978) and fledglings (McGowan and Woolfenden 1990). The well-developed sentinel system involves having one individual occupying an exposed perch watching for predators or territory intruders. When a predator is seen, the sentinel scrub-jay gives a distinctive warning call, and all family members seek cover in dense shrub vegetation (Fitzpatrick *et al.* 1991).

Florida scrub-jay pairs occupy year-round, multi-purpose territories (Woolfenden and Fitzpatrick 1984; Fitzpatrick *et al.* 1991). Territory size averages 22 to 25 acres, with a minimum size of about 12 acres. The availability of territories is a limiting factor for scrub-jay populations. Because of this limitation, non-breeding adult males may stay at the natal territory as helpers for up to five years, waiting for either a mate or territory to become available (Fitzpatrick *et al.* 1991). Birds may become breeders in several ways: (1) by replacing a lost breeder on a non-natal territory (Woolfenden and Fitzpatrick 1984); (2) through "territorial budding," where a helper male becomes a breeder in a segment of its natal territory (Woolfenden and Fitzpatrick 1978); (3) by inheriting a natal territory following the death of a breeder; (4) by establishing a new territory between existing territories (Woolfenden and Fitzpatrick 1984); or (5) through "adoption" of an unrelated helper by a neighboring family followed by resident mate replacement (B. Toland, USFWS, pers. comm. 1996). Territories can also be created by restoring habitat through effective habitat management efforts in areas that are overgrown (Thaxton and Hingtgen 1994).

To become a breeder, a scrub-jay must find a territory and a mate. Evidence presented by Woolfenden and Fitzpatrick (1984) suggests that scrub-jays are monogamous. The pair retains ownership and sole breeding privileges in its particular territory year after year. Courtship to form the pair is lengthy and ritualized, and involves posturing and vocalizations made by the male to the female (Woolfenden and Fitzpatrick 1996b). Copulation between the pair is generally out of sight of other scrub-jays (Woolfenden and Fitzpatrick 1984). These authors also reported never observing copulation between unpaired scrub-jays or courtship behavior between a female and a scrub-jay other than her mate. Age at first breeding in the scrub-jay varies from one to seven years, although most individuals become breeders between two and four years of age (Fitzpatrick and Woolfenden 1988). Persistent breeding populations of scrub-jays exist only where there are scrub oaks in sufficient quantities to provide an ample winter acorn supply, cover from predators, and nest sites during spring (Woolfenden and Fitzpatrick 1996a).

Nesting is synchronous, normally occurring from 1 March through 30 June (Woolfenden and Fitzpatrick 1990; Fitzpatrick *et al.* 1991). On the Atlantic Coastal Ridge and southern Gulf coast, nesting may be protracted through the end of July (B. Toland, USFWS, pers. comm.. 1996; J. Thaxton, Uplands, Inc., pers.comm. 1998). In suburban habitats, nesting is consistently initiated earlier (March) than in natural scrub habitat (Fleischer 1996), although the reason for this difference is unknown.

Clutch size ranges from 1 to 5 eggs, but is typically 3 or 4 eggs. Clutch size is generally larger (up to 6 eggs) in suburban habitats, and the birds try to rear more broods per year (Fleischer 1996). Eggs are incubated for 17 to 18 days, and fledging occurs 16 to 21 days after hatching (Woolfenden 1974, 1978; Fitzpatrick *et al.* 1991). Only the breeding female incubates and broods eggs and nestlings (Woolfenden and Fitzpatrick 1984). Annual productivity must average at least two fledged per pair for a population of scrub-jays to support long-term stability (Woolfenden and Fitzpatrick 1990; Fitzpatrick *et al.* 1991).

Fledglings depend upon adults for food for about 10 weeks, during, which time they are fed by both breeders and helpers (Woolfenden 1975; McGowan and Woolfenden 1990). Survival of scrub-jay fledglings to yearling age class averages about 35 percent in optimal scrub, while annual survival of both adult males and females averages about 80 percent (Fitzpatrick *et al.* unpubl. data). Data from Archbold Biological Station, however, suggest that survival and reproductive success of scrub-jays in sub-optimal habitat is substantially lower (Woolfenden and Fitzpatrick 1991). These data help explain why local populations inhabiting unburned, late successional habitats become extirpated. The longest observed lifespan of a Florida scrub-jay is 15.5 years at Archbold Biological Station in Highlands County (Woolfenden and Fitzpatrick 1996b).

Scrub-jays are nonmigratory and permanently territorial. Juveniles stay in their natal (Woolfenden and Fitzpatrick 1984). Once scrub-jays pair and become breeders, they stay on their breeding territory until death. In suitable habitat, fewer than five percent of scrub-jays disperse more than five miles (Fitzpatrick *et al.* 1991). All documented long distance dispersals have been in unsuitable habitat such as woodland, pasture, or suburban plantations. Scrub-jay dispersal behavior is affected by intervening land uses. Protected scrub habitats will most effectively sustain scrub-jay populations if they are located within surrounding habitat types that can be used and traversed by scrub-jays.

Brushy pastures, scrubby corridors along railways and road rights-of-way, and open burned flatwoods offer links for colonization among scrub-jay subpopulations. Stith *et al.* (1996) believed that a dispersal distance of five miles is close to the biological maximum for scrub-jays.

Scrub-jays forage mostly on or near the ground, often along the edge of natural or man-made openings. They visually search for food by hopping or running along the ground beneath the scrub or by jumping from shrub to shrub. Insects, particularly orthopterans (e.g., locusts, crickets, grasshoppers, beetles) and lepidopteran (e.g., butterfly and moth) larvae, form most of the animal diet throughout most of the year (Woolfenden and Fitzpatrick 1984). Acorns are the most important plant food (Fitzpatrick *et al.* 1991). From August to November each year, scrub-jays may harvest and cache 6,000 to 8,000 oak acorns throughout their territory . It is estimated that 1/3 of these acorns are later recovered and eaten. Caching allows scrub-jays to eat acorns every month of the year. This reliance on acorns and caching may constitute a major reason for the scrub-jay's restriction to the oak scrub and sandy ridges within Florida (Fitzpatrick *et al.* 1991).

Status and Distribution

The Florida scrub-jay is found exclusively in peninsular Florida, and is restricted to scrub habitat (U.S. Fish and Wildlife Service 1990). The Florida scrub-jay was listed as a threatened species on June 3, 1987 (52 FR 20715-20719). The main causes responsible for the decline were as follows:

<u>The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range:</u> The existence of scrub-jays throughout their range depends on the existence of a particular seral stage of oak scrub habitat with unvegetated openings in sandy soils. This habitat occurs naturally only in localized patches associated with recent or ancient shoreline deposits. By the time of listing, large proportions of these habitat patches had been converted for human use, or were slated for imminent conversion. Most of the coastal scrub habitat had already been cleared for beachfront hotels, houses, and condominiums, and much of the central Florida scrub had been converted to citrus groves, housing developments, and commercial real estate. It was estimated that 40 percent of occupied scrub habitat had already been converted to other uses, and total population of the species had declined by at least half. As a result of rapid increase in human population numbers throughout central Florida, the pace of housing and agricultural development had accelerated since the 1960s, and it showed no signs of slowing.

<u>Overutilization for Commercial, Recreational, Scientific, or Educational Purposes:</u> Reported shooting of scrub-jays and collection of the species as pets were considered threats.

<u>Disease or Predation:</u> Disease and predation were not believed to be major threats at the time of listing.

<u>The Inadequacy of Existing Regulatory Mechanisms:</u> The only laws protecting the Florida scrub-jay prior to the time of listing were the Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. 703 *et seq.*) and Florida State Law (Chapter 68A-27.004, Florida Administrative Code). Neither of these laws protected the birds from habitat destruction, which constituted the major threat to the species.

<u>Other Natural or Manmade Factors Affecting its Continued Existence:</u> Suppression of fire by humans was identified as a factor in species' decline at the time of the listing. Historically, lightning strikes started fires, which maintained the sparse low scrub habitat needed by Florida scrub-jays. Human efforts to suppress these fires to protect human interests allowed the scrub to become too dense and tall to support populations of scrub-jays. Vehicular mortality of scrub-jays due to accidental collisions along roadsides was recognized as a cause of the decline in some parts of the species' range.

Continued and current threats to the species include:

<u>The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range:</u> Scrub habitats continued to decline throughout peninsular Florida since listing occurred, and habitat destruction continues to be one of the main threats to the Florida scrub-jay. Cox (1987) noted local extirpations and major decreases in numbers of scrub-jays and attributed them to the

clearing of scrub for housing and citrus groves. Eighty percent or more of the scrub habitats have been destroyed along the Lake Wales Ridge since pre-human settlement (Fitzpatrick *et al.* 1991). Fernald (1989), Fitzpatrick *et al.* (1991, 1994), and Woolfenden and Fitzpatrick (1996a) noted that habitat losses due to agriculture, silviculture, and commercial and residential development have continued to play a role in the decline in numbers of scrub-jays throughout the state. State-wide, estimates of scrub habitat loss range from 70 to 90 percent (Bergen 1994; Woolfenden and Fitzpatrick 1996a; Fitzpatrick *et al.* unpubl. data).

Toland (1999) estimated that about 85 percent of pre-European settlement scrub habitats had been converted to other uses in Brevard County. This is due mainly to development activity and citrus conversion, which were the most important factors that contributed to the scrub-jay decline between 1940 and 1990. A total of only 10,656 acres of scrub and scrubby flatwoods remain in Brevard County (excluding federal ownership), of which only 1,600 acres (15 percent) is in public ownership for the purposes of conservation. Less than 1,977 acres of an estimated pre-settlement of 14,826 acres of scrubby flatwoods habitat remain in Sarasota County, mostly occurring in patches averaging less than 2.5 acres in size (Thaxton and Hingtgen 1996). Only 10,673 acres of viable coastal scrubby flatwoods remained in the Treasure Coast region of Florida (Indian River, Saint Lucie, Martin, and Palm Beach Counties) according to Fernald (1989). He estimated that 95 percent of scrub had already been destroyed for development purposes in Palm Beach County.

Habitat destruction not only reduces the amount of area scrub-jays can occupy, but also increases fragmentation of habitat. As more scrub habitat is altered, the habitat is cut into smaller and smaller pieces, separated from other patches by larger distances; such fragmentation increases the probability of genetic isolation, which is likely to increase extinction probability (Fitzpatrick *et al.* 1991; Woolfenden and Fitzpatrick 1991; Snodgrass *et al.* 1993; Stith *et al.* 1996; Thaxton and Hingtgen 1996). Dispersal distances of scrub-jays in fragmented habitat are further than in optimal unfragmented habitats, and demographic success is poor (Thaxton and Hingtgen 1996; Breininger 1999).

<u>Overutilization for Commercial, Recreational, Scientific, or Educational Purposes:</u> The Service knows of only a few cases where scrub-jays have been shot. One was in Volusia County which was investigated and prosecuted under the MBTA (J. Oliveros, USFWS, pers. comm.). The Florida Fish and Wildlife Conservation Commission (FWC) investigated a case in which three scrub-jays were shot in Highlands County (N. Douglass, FWC, pers. comm.). It does not seem that the small number and infrequent occurrence of scrub-jays taken in this manner has had an impact on the species.

<u>Disease or Predation:</u> Most Florida scrub-jays mortality probably is from predation (Woolfenden and Fitzpatrick 1996b). The second most frequent cause may be disease, or predation on disease-weakened jays (Woolfenden and Fitzpatrick 1996b). Known predators of Florida scrub-jays are listed by Woolfenden and Fitzpatrick (1990), Fitzpatrick *et al.* (1991), Breininger (1999), and K. Miller (FWC, in litt. 2004); the list includes eastern coachwhip (*Masticophis flagellum*, known to eat adults, nestlings, and fledglings), eastern indigo snake (*Drymarchon corais couperi*, known to eat adults and fledglings), rat snake (*Elaphe obsolete*), and corn snake (*E. guttata*). Mammalian predators include bobcats (*Lynx rufus*), raccoons (*Procyon lotor*),

sometimes cotton rats (*Sigmodon hispidus*, known to eat eggs), and domestic cats (*Felis cattus*, known to eat adults). Franzreb and Puschock (2004) also have documented spotted skunks (*Spilogale putorius*) and grey fox (*Urocyon cinereoargenteus*) as mammalian predators of scrub-jay nests. Fitzpatrick *et al.* (1991) suspect that populations of domestic cats are able to eliminate small populations of scrub-jays. Avian nest predators include great horned owls (*Bubo virginianus*), eastern screech-owl (*Otus asio*), red-tailed hawk (*Buteo jamaicensis*), northern harrier (*Circus cyaneus*), fish crow (*Corvus ossifragus*), boat-tailed grackle (*Quiscalus major*), common grackle (*Q. quiscula*), American crow (*C. brachyrhynchos*), blue jay (*Cyanocitta cristata*), and swallow-tailed kites (*Elanoides forficatus*). Fitzpatrick *et al.* (1991) reported that overgrown scrub habitats are often occupied by the blue jay, which may be one factor limiting scrub-jay populations in such areas. Raptors which seem to be important predators of adult scrub-jays are merlin (*Falco columbarius*), sharp-shinned hawk (*Accipiter striatus*), and Cooper's hawk (*A. cooperii*), and northern harrier. During migration and winter, these four raptor species are present in areas which contain scrub habitat, and scrub-jays may experience frequent confrontations (as many as one pursuit a day) with them (Woolfenden and Fitzpatrick 1990). In coastal scrub, Woolfenden and Fitzpatrick (1996b) report that scrub-jays are vulnerable to predation by raptors in October, March, and April, when high densities of migrating accipiters and falcons are present. Woolfenden and Fitzpatrick (1996b) and Toland (1999) suggest that in overgrown scrub habitats, hunting efficiency for scrub-jay predators is increased. Bowman and Averill (1993) noted that scrub-jays occupying fragments of scrub found in or near housing developments were more prone to predation by house cats and competition from blue jays and mockingbirds. Woolfenden and Fitzpatrick (1996a, 1996b) stated that proximity to housing developments (and increased exposure to domestic cats) needs to be taken into consideration when designing scrub preserves. Young scrub-jays are especially vulnerable to ground predators (e.g., snakes and mammals) before they are fully capable of sustained flight.

The Florida scrub-jay hosts 2 protozoan blood parasites (*Plasmodium cathemerium* and *Haemoproteus danilewskyi*), but incidence is low (M. Garvin pers. comm., cited in Woolfenden and Fitzpatrick 1996b). Several scrub-jays sick from these two agents in March 1992 survived to become breeders. The Florida scrub-jay carries at least 3 types of mosquito-borne encephalitis (St. Louis, eastern equine, and "Highlands jay"; M. Garvin and J. Day pers. comm., cited in Woolfenden and Fitzpatrick 1996b). Of particular concern is the arrival of West Nile virus (the agent of another type of encephalitis) in Florida during 2001; since corvids have been particularly susceptible to the disease in states north of Florida, it is expected that scrub-jays will be affected.

Woolfenden and Fitzpatrick (1996b) noted 3 episodes of elevated mortality (especially among juveniles) in 26 years at Archbold Biological Station. Each of these incidents occurred in conjunction with elevated water levels following unusually heavy rains in the fall, although high mortality does not occur in all such years. During the most severe of these presumed epidemics (August 1979 through March 1980), all but one of the juvenile cohort and almost half of the breeding adults died (Woolfenden and Fitzpatrick 1984; Woolfenden and Fitzpatrick 1990). The 1979-1980 incident coincided with a known outbreak of eastern equine encephalitis among domestic birds in central Florida (J. Day pers. comm., cited in Woolfenden and Fitzpatrick 1996b). From the fall of 1997 through the spring of 1998, the continuing population decline of

Florida scrub-jays along the Atlantic coast and in central Florida may have been augmented by an epidemic of unknown origin (Breininger 1999).

At CCAFS, Stevens and Hardesty (1999) noted a decline in juvenile survival from 60 to 70 percent in the preceding years to only 16 percent in 1997-98. It stayed low (only 25 percent) in 1998-99 before again climbing into the mid-60 percent range. Also, adult survival dropped from 70 to 80 percent survival in the preceding years to 50 to 60 percent in 1997-98. Overall, their annual surveys documented the largest one-year drop (pairs decreased by 17 percent and birds by 20 percent) in this population at the same time as the presumed state-wide epidemic.

In winter-summer of 1973, 15 species of helminth fauna (including 8 nematodes, 5 trematodes, 1 cestode, and 1 acanthocephalan) were found in 45 Florida scrub-jays collected in south-central Florida; the parasite load was attributed to a varied arthropod diet (Kinsella 1974). These naturally-occurring parasites are not believed to have a negative impact on scrub-jay population levels.

Larvae of a fly, *Philornis* (= *Neomusca*) *porteri*, occur irregularly on scrub-jay nestlings. The species pupates in the base of the nest; larvae locate in nares, mouth flanges, bases of remiges, and toes; apparently no serious effect on the scrub-jay host occurs (Woolfenden and Fitpatrick 1996b). Additionally, one indescribable chewing louse (*Myrsidea* sp., R. Price pers. comm., cited in Woolfenden and Fitzpatrick 1996b), one wing-feather mite (*Pterodectes* sp.), two chiggers (*Eutrombicula lipovskyana*), and a flea (*Echidnophaga gallinacea*; J. Kinsella pers. comm., cited in Woolfenden and Fitzpatrick 1996b) occur on some individuals, usually at low densities. Nymphs and larvae of four ticks (*Amblyomma americanum*, *A. tuberculatum*, *Haemaphysalis leporispalustris*, and *Ixodes scapularis*) are known to occur on scrub-jays, as well as the larvae of the tick *Amblyomma maculatum* (L. Durden and J. Keirans pers. comm., cited in Woolfenden and Fitzpatrick 1996b). These naturally occurring parasites are not believed to have a negative impact on scrub-jay population levels.

<u>The Inadequacy of Existing Regulatory Mechanisms:</u> Woolfenden and Fitzpatrick (1996a) state the importance of enforcing existing federal laws regarding the management of federal lands as natural ecosystems for the long-term survival of the Florida scrub-jay. The Service consults regularly on activities on federal lands which may affect scrub-jays and also works with private landowners through section 10(a) (1) (B) incidental take permitting process of the Act when take is likely to occur and no federal nexus is present. Florida's State Comprehensive Plan and Growth Management Act of 1985 is administered mostly by regional and local governments. Regional Planning Councils administer the law through Development of Regional Impact Reviews; at the local level, although comprehensive plans contain policy statements and natural resource protection objectives, they are only effective if counties enact and enforce ordinances. As a general rule, counties have not enacted and/or enforced ordinances that are effective in protecting scrub-jays (Fernald 1989).

The Wildlife Code of the state of Florida (Chapter 68A, Florida Administrative Code) prohibits taking of individuals of threatened species, or parts thereof, or their nests or eggs, except as authorized. The statute does not prohibit clearing of habitat occupied by protected species, which limits the ability of the FWC to protect the Florida scrub-jay and its habitat.

Other Natural or Manmade Factors Affecting its Continued Existence: Human interference with natural fire regimes has continued to play a major part in the decline of the scrub-jay and today may exceed habitat loss as the single most important factor (Woolfenden and Fitzpatrick 1991, 1996a; Fitzpatrick *et al.* 1994). Lightning strikes cause virtually all naturally-occurring fires in south Florida scrub habitat (Abrahamson 1984; Hofstetter 1984). Fire has been noted to be important in maintenance of scrub habitat for decades (Nash 1895; Harper 1927; Webber 1935; Davis 1943; Laessle 1968; Abrahamson *et al.* 1984). Human efforts to prevent and/or control natural fires have allowed the scrub to become too dense and tall to support populations of scrub-jays, resulting in the decline of local populations of scrub-jays throughout the state (Fernald 1989; Fitzpatrick *et al.* 1994; Percival *et al.* 1995; Stith *et al.* 1996; Thaxton and Hingtgen 1996; Woolfenden and Fitzpatrick 1990, 1996a; Toland 1999). Woolfenden and Fitzpatrick (1996a) cautioned, however, that fire applied too often to scrub habitat also can result in local extirpations. Experimental data at Archbold Biological Station (Fitzpatrick and Woolfenden, unpubl. data) show that fire-return intervals varying between 5 and 15 years are optimal for long-term maintenance of productive Florida scrub-jay populations in central Florida. These intervals also correspond with those yielding healthy populations of listed scrub plants (Menges and Kohfeldt 1995; Menges and Hawkes 1998). Optimal fire-return intervals may, however, be shorter in coastal habitats (Breininger and Schmalzer 1990; Schmalzer and Hinkle 1992a, b; Breininger *et al.* 1995, 1998).

Stith *et al.* (1996) estimated that at least 2,100 breeding pairs were living in overgrown habitat. Toland (1999) reported that most of Brevard County's remaining scrub (estimated to be only 15 percent of the original acreage) is extremely overgrown due to fire suppression. He further suggests that the overgrowth of scrub habitats reduces the number and size of sand openings which are crucial to not only scrub-jays, but also many other scrub plants and animals. Reduction in the number of potential scrub-jay nesting sites, acorn cache sites, and foraging sites presents a problem for scrub-jays. Fernald (1989) reported that overgrowth of scrub results not only in the decline of species diversity and abundance but also a reduction in the percentage of open sandy patches (Fernald 1989; Woolfenden and Fitzpatrick 1996b). Fitzpatrick *et al.* (1994) believed that fire suppression was just as responsible as habitat loss in the decline of the scrub-jay, especially in the northern third of its range. Likewise, the continued population decline of scrub-jays within Brevard County between 1991 and 1999 has been attributed mainly to the overgrowth of remaining habitat patches (Breininger *et al.* 2001). Breininger *et al.* (1999a) concluded that optimal habitat management is essential in fragmented ecosystems maintained by periodic fire, especially to lessen risks of decline and extinction resulting from epidemics and hurricanes.

Fitzpatrick *et al.* (1991, 1994) and Woolfenden and Fitzpatrick (1996a) expressed concern for the management practices taking place on federal lands at Ocala National Forest, MINWR/KSC, and CCAFS, all supporting large contiguous populations of Florida scrub-jays. They predicted that fire suppression and/or too frequent fires (on the latter two) and silvicultural activities involving the cultivation of sand pine on Ocala National Forest would be responsible for continuing decline of scrub-jays in these large contiguous areas of scrub. These areas should be those where populations are most secure because of federal agencies' responsibilities under section 7(a) (1) of the Act. Monitoring of scrub-jay populations, demography, and nesting success is ongoing on all of these properties to assess the effectiveness of management practices in meeting scrub-jay recovery objectives.

Housing and commercial developments within scrub habitats are accompanied by the development of roads. Since scrub-jays often forage along roadsides and other openings in the scrub, they are often killed by passing cars. Research by Mumme *et al.* (2000) along a two-lane paved road indicated that clusters of Florida scrub-jay territories found next to the roadside represented population sinks (breeder mortality exceeds production of breeding-aged recruits), which could be supported only by immigration. Since this species may be attracted to roadsides because of the open habitat characteristics, road mortality presents a significant and growing management problem throughout the remaining range of the Florida scrub-jay (Dreschel *et al.* 1990; Mumme *et al.* 2000), and proximity to high-speed paved roads needs to be considered when designing scrub preserves (Woolfenden and Fitzpatrick 1996a).

Another potential problem in suburban areas supporting Florida scrub-jays is supplemental feeding by humans (Bowman and Averill 1993; R. Bowman unpubl. data, cited in Woolfenden and Fitzpatrick 1996a; Bowman 1998). The presence of additional food may allow scrub-jays to persist in fragmented habitats, but recruitment in these populations is lower than in native habitats. However, even though human-feeding may postpone local extirpations, long-term survival cannot be ensured in the absence of protecting native oak scrub habitat, necessary for nesting.

Scrub-jays in suburban settings often nest high in tall shrubbery. During March winds, these nests tend to be susceptible to destruction (R. Bowman and G.E. Woolfenden unpubl data, cited in Woolfenden and Fitzpatrick 1996b; Bowman 1998).

Hurricanes pose a potential risk for Florida scrub-jays, although the exact impact of such catastrophic events remains unknown. Breininger *et al.* (1999b) modeled the effects of epidemics and hurricanes on scrub-jay populations in varying levels of habitat quality. Small populations of scrub-jays are more vulnerable to extirpation where epidemics and hurricanes are common. Storm surge from a category 3 to 5 hurricane could inundate entire small populations of scrub-jays, and existing habitat fragmentation could prevent repopulation of affected areas. However, this model also predicted that long-term habitat degradation had greater influence on extinction risk than hurricanes or epidemics.

Fernald (1989) reported that many of the relatively few remaining patches of scrub within the Treasure Coast region of Florida had been degraded by trails created by off-road vehicles, illegal dumping of construction debris, abandoned cars and appliances, or household waste. The invasion of these areas by exotic species, including Brazilian pepper (*Schinus terebinthifolius*), cypress pine (*Callitris* sp.), and Australian pine (*Casuarina equisetifolia*) also was a problem. Other human-induced impacts identified by Fernald include the introduction of domestic dogs (*Canis familiaris*) and cats, black rats (*Rattus rattus*), greenhouse frogs (*Eleutherodactylus planirostris*), giant toads (*Bufo marinus*), Cuban tree frogs (*Osteopilus septentrionalis*), brown anoles (*Anolis sagrei*), and other exotic animal species. These exotic species may compete with scrub-jays for both space and food, although scrub-jays sometimes feed on them.

A statewide scrub-jay census was last conducted in 1992-1993, at which time there were an estimated 4,000 pairs of scrub-jays left in the Florida (Fitzpatrick *et al.* 1994). The scrub-jay was considered extirpated in 10 counties (Alachua, Broward, Clay, Dade, Duval, Gilchrist, Hernando, Hendry, Pinellas, and St. Johns), and were considered functionally extinct in an additional 5 counties (Flagler, Hardee, Levy, Orange, and Putnam), where ten or fewer pairs remained. Recent information indicates that there are at least 12 to 14 breeding pairs of scrub-jays located within Levy County, higher than previously though (K. Miller, FWC, pers. comm.. 2004), and there is at least one breeding pair of scrub-jays remaining in Clay County (K. Miller, FWC, pers. comm.. 2004). A scrub-jay has been documented in St. Johns County as recently as 2003 (J.B. Miller, FDEP, in litt. 5/13/03). Populations are close to becoming extirpated in Gulf coast counties (from Levy south to Collier) (Fitzpatrick *et al.* 1994; Woolfenden and Fitzpatrick 1996a). In 1992-1993, population numbers in 19 of the counties were below 30 or fewer breeding pairs. In the past, most of these counties would have contained hundreds or even thousands of groups (Fitzpatrick *et al.* 1994). Based on the amount of destroyed scrub habitat, scrub-jay population loss along the Lake Wales Ridge is 80 percent or more since pre-European settlement (Fitzpatrick *et al.* 1991). Since the early 1980s, Fitzpatrick *et al.* (1994) estimated that in the northern third of the species' range, the Florida scrub-jay has declined somewhere between 25 and 50 percent. The species may have declined by as much as 25 to 50 percent in the last decade alone (Stith *et al.* 1996).

On protected lands, scrub-jays have continued to decline due to inadequate habitat management (Stith 1999). However, over the last several years, steps to reverse this decline have occurred, and management of scrub habitat is continuing in many areas of Florida (Hastie and Eckl 1999; Stith 1999; TNC 2001; A. Birch, Brevard County Environmentally Endangered Lands (EEL), pers. comm.; M. Camardese, CCAFS, pers.comm.).

Analysis of Brevard County historic aerial photography and soil maps suggest that pre-European settlement oak scrub, scrubby pine flatwoods, and coastal scrub/strand covered at least 53,000 acres outside of federal lands (Toland 1999). Assuming average territory size of 25 acres per breeding pair, there were probably originally 2,200 to 2,500 Florida scrub-jay territories within Brevard County. The 1992-1993 statewide survey estimated that on federal lands within Brevard County, there were 860 pairs of Florida scrub-jays remaining; outside of federal lands, 276 breeding pairs of scrub-jays were present (Fitzpatrick *et al.* 1994). The figure on non-federal lands within Brevard County had dropped to 185 in 1999 (Toland 1999), illustrating a precipitous decline of the scrub-jay population within the county. Part of this decline may be attributed to a possible rare epidemic in 1997-1998. A total of 1,620 acres of scrub habitat have been purchased (outside federal ownership) for preservation by Brevard County EEL, the St. Johns River Water Management District (SJRWMD), and the Florida Department of Environmental Protection (FDEP); 2,500 acres more of potential scrub-jay habitat are proposed for acquisition by EEL and the SJRWMD (Toland 1999). All of these parcels need extensive restoration and management to obtain maximum usage by scrub-jays. Over the last several years, an extensive effort to restore and manage these parcels has been undertaken by EEL, the SJRWMD, and FDEP (A. Birch, pers. comm.).

In some areas of the range of the scrub-jay, it appears that the 1992-1993 state-wide census underestimated populations of scrub-jays, especially in areas where little was known about the status of the species. The state-wide census in 1992-1993 estimated about 145 pairs of scrub-jays remained within Sarasota County (Fitzpatrick *et al.* 1994), although Christman (2000) found 196 pairs of scrub-jays. Likewise, Miller and Stith (2002) documented 54 pairs of scrub-jays within the Deep Creek area of Charlotte County, while the state-wide census in 1992-1993 documented only 19 pairs (Fitzpatrick *et al.* 1994). Given that habitat has continued to degrade and development activity has increased in these areas, it is unlikely that these increased numbers reflect a population increase, but rather a greater effort in the survey process over that undertaken in 1992-1993 (Miller and Stith 2002). Two possible reasons that the 1992-1993 state-wide census underestimated some populations are (1) there was inadequate time and/or resources to survey poorly-known areas and (2) scrubby flatwoods were often overlooked because surveyors relied on soil maps, which are not reliable predictors of where scrubby flatwoods occur.

Stith (1999) utilized a spatially explicit individual-based population model developed specifically for the Florida scrub-jay to complete a metapopulation viability analysis of the species. The species' range was divided into 21 metapopulations demographically isolated from each other. Metapopulations are defined as collections of relatively discrete demographic populations distributed over the landscape; these populations are connected within the metapopulations through dispersal or migration (National Research Council 1995). A series of simulations were run for each of the 21 metapopulations based on different scenarios of reserve design ranging from the minimal configuration consisting of only currently protected patches of scrub (no acquisition option) to the maximum configuration, where all remaining significant scrub patches were acquired for protection (complete acquisition option). The assumption was made that all areas that were protected were also restored and properly managed.

Results from Stith's (1999) simulation model included estimates of extinction, quasi-extinction (the probability of a scrub-jay metapopulation falling below 10 pairs), and percent population decline. These were then used to rank the different state-wide metapopulations by vulnerability. The model predicted that five metapopulations (NE Lake, Martin, Merritt Island, Ocala National Forest, and Lake Wales Ridge, see Figure 1) have low risk of quasi-extinction. Two of the five (Martin and NE Lake), however, experienced significant population declines under the "no acquisition" option; the probability for survival of both of these metapopulations could be improved by more acquisitions.

Eleven of the remaining 21 metapopulations were shown to be highly vulnerable to quasi-extinction if no more habitat was acquired (Central Brevard, N Brevard, Central Charlotte, NW Charlotte, Citrus, Lee, Levy, Manatee, Pasco, St. Lucie, and W Volusia). The model predicted that the risk of quasi-extinction would be greatly reduced for 7 of the 11 metapopulations (Central Brevard, N Brevard, Central Charlotte, NW Charlotte, Levy, St. Lucie, and W Volusia) by acquiring all or most of the remaining scrub habitat. The model predicted that the remaining four metapopulations (Citrus, Lee, Manatee, and Pasco) would moderately benefit if more acquisitions were made.

Stith (1999) classified two metapopulations (S Brevard and Sarasota) as moderately vulnerable with a moderate potential for improvement; they both had one or more fairly stable subpopulations of scrub-jays under protection, but the model predicted large population declines.

The rest of the metapopulations could collapse without further acquisitions, making the protected subpopulations there vulnerable to epidemics or other catastrophes.

Three of the metapopulations evaluated by Stith (1999) (Flagler, Central Lake, and S Palm Beach) were classified as highly vulnerable to quasi-extinction and had low potential for improvement, since little or no habitat is available to acquire or restore.

Analysis of the Species/Critical Habitat Likely to be Affected

The Florida scrub-jay's status since it's listing in 1987 has not improved. The above analysis clearly shows two items that are essential for recovery of this species: (1) additional purchase of scrub lands for preservation in key areas and (2) restoration and management of publicly-owned scrub lands already under preservation. Without both, it is unlikely that recovery can be achieved.

SOUTHEASTERN BEACH MOUSE (*PEROMYSCUS POLIONOTUS NIVEIVENTRIS*)

Species/Critical Habitat Description

The southeastern beach mouse was listed as a threatened species under the Act in 1989 (54 FR 20598). Critical habitat was not designated for this subspecies.

Life History/Population Dynamics

The following account is from the South Florida Multi-Species Recovery Plan, Southeastern Beach Mouse Chapter (U.S. Fish and Wildlife Service 1999) and includes minor additions and changes to update the information.

Taxonomy

Peromyscus polionotus is a member of the order Rodentia and family Cricetidae. The southeastern beach mouse (SEBM) is one of 16 recognized subspecies of oldfield mice *P. polionotis* (Hall 1981); it is one of the eight of those subspecies that are called beach mice. The SEBM was first described by Chapman (1889) as *Hesperomys niveiventris*. Bangs (1898) subsequently placed it in the genus *Peromyscus*, and Osgood (1909) assigned it the subspecific name *P. polionotus niveiventris*.

Description

The SEBM is the largest of the eight recognized subspecies of beach mice, averaging 139 mm in total length (range of 10 individuals = 128 to 153 mm), with a 52 mm tail length (Osgood 1909; Stout 1992). Females are slightly larger than males. These beach mice are slightly darker in appearance than some other subspecies of beach mice, but paler than inland populations of *P. polionotus* (Osgood 1909). Southeastern beach mice have pale, buffy coloration from the back of their head to their tail, and their under parts are white. The white hairs extend up on their flanks, high on their jaw, and within 2 to 3 mm of their eyes (Stout 1992). There are no white spots above the eyes as with *P. p. phasma* (Osgood 1909). Their tail is also buffy above and white below. Juvenile *P. p. niveiventris* are more grayish in coloration than adults; otherwise they are similar in appearance (Osgood 1909).

Habitat

Essential habitat of the SEBM is the sea oats *(Uniola paniculata)* zone of primary coastal dunes (Humphrey and Barbour 1981; Humphrey *et al.* 1987; Stout 1992). This subspecies has also been reported from sandy areas of adjoining coastal strand/scrub vegetation (Extine 1980; Extine and Stout; 1987; Rich *et al.* 1993), which refers to a transition zone between the fore dune and the inland plant community (Johnson and Barbour 1990). Beach mouse habitat is heterogeneous, and distributed in patches that occur both parallel and perpendicular to the shoreline (Extine and Stout 1987). Because this habitat occurs in a narrow band along Florida's coast, structure and composition of the vegetative communities that form the habitat can change dramatically over distances of only a few meters.

Primary dune vegetation described from SEBM habitat includes sea oats, dune panic grass (*Panicum amarum*), railroad vine (*Ipomaea pes-caprae*), beach morning glory (*Ipomaea stolonifera*), salt meadow cordgrass (*Spartina patens*), lamb's quarters (*Chenopodium album*), saltgrass (*Distichlis spicata*), and camphor weed (*Heterotheca subaxillaris*) (Extine 1980). Coastal strand and inland vegetation is more diverse, and can include beach tea (*Croton punctatus*), prickly pear cactus (*Opuntia humifusa*), saw palmetto (*Serenoa repens*), wax myrtle (*Myrica cerifera*), rosemary (*Ceratiola ericoides*), sea grape (*Coccoloba uvifera*), oaks (*Quercus sp.*) and sand pine (*Pinus clausa*) (Extine and Stout 1987). Extine (1980) observed this subspecies as far as 1 km inland on Merritt Island; he concluded that the dune scrub communities he found them in represent only marginal habitat for the SEBM. SEBM have been documented in coastal scrub several km from the beach habitat at Kennedy Space Center/Merritt Island NWR and CCAFS (Stout, personal communication, 2004). Extine (1980) and Extine and Stout (1987) reported that the SEBM showed a preference for areas with clumps of palmetto, sea grape, and expanses of open sand.

Within their dune habitat, beach mice construct burrows to use as refuges, nesting sites, and food storage areas. Burrows of *P. polionotus*, in general, consist of an entrance tunnel, nest chamber, and escape tunnel. Burrow entrances are usually placed on the sloping side of a dune at the base of a shrub or clump of grass. The nest chamber is formed at the end of the level portion of the entrance tunnel at a depth of 0.6 to 0.9 m, and the escape tunnel rises from the nest chamber to within 2.5 cm of the surface (Blair 1951). A beach mouse may have as many as 20 burrows within its home range. They are also known to use old burrows constructed by ghost crabs (*Ocypode quadrata*).

Foraging

Beach mice typically feed on seeds of sea oats and dune panic grass (Blair 1951). The SEBM probably also eats the seeds of other dune grasses, railroad vine, and prickly pear cactus. Although beach mice prefer the seeds of sea oats, these seeds are only available as food after they have been dispersed by the wind. Beach mice also eat small invertebrates, especially during late spring and early summer when seeds are scarce (Ehrhardt 1978). Beach mice will store food in their burrows.

Behavior

P. polionotus is the only member of the genus that digs an extensive burrow for refuge, nesting, and food storage (Ehrhart 1978). To dig the burrow, the mouse assumes a straddling position and throws sand back between the hind legs with the forefeet. The hind feet are then used to kick sand back while the mouse backs slowly up and out of the burrow (Ivey 1949). Burrows usually contain multiple entrances, some of which are used as escape tunnels. When mice are disturbed in their burrows, they open escape tunnels and quickly flee to another burrow or to other cover (Ehrhart 1978). Beach mice, in general, are nocturnal. They are more active under stormy conditions or moonless nights and less active on moonlit nights. Movements are primarily for foraging, breeding, and burrow maintenance. Extine and Stout (1987) reported movements of the SEBM between primary dune and interior scrub on Merritt Island, and concluded that their home ranges overlap and can reach high densities in their preferred habitats.

Reproduction and Demography

Studies on *Peromyscus* species in peninsular Florida suggest that these species may achieve greater densities and undergo more significant population fluctuations than their temperate relatives, partially because of their extended reproductive season (Bigler and Jenkins 1975). Subtropical beach mice can reproduce throughout the year; however their peak reproductive activity is generally during late summer, fall, and early winter. Extine (1980) reported peak reproductive activity for *P. p. niveiventris* on Merritt Island during August and September, based on external characteristics of the adults. This peak in the timing and intensity of reproductive activity was also correlated to the subsequent peak in the proportion of juveniles in the population in early winter (Extine 1980). This pattern is typical of other beach mice as well (Rave and Holler 1992).

Sex ratios in beach mouse populations are generally 1:1 (Extine 1980; Rave and Holler 1992). Blair (1951) indicated that beach mice are monogamous; once a pair is mated they tend to remain together until death. He also found, however, that some adult mice of each sex show no desire to pair. Nests of beach mice are constructed in the nest chamber of their burrows, a spherical cavity about 4 to 6 cm in diameter. The nest comprises about one fourth of the size of the cavity and is composed of sea oat roots, stems, leaves and the chaffy parts of the panicles (Ivey 1949).

The reproductive potential of beach mice is generally high (Ehrhardt 1978). In captivity, beach mice are capable of producing 80 or more young in their lifetime, and producing litters regularly at 26-day intervals (Bowen 1968). Litter size of beach mice, in general, ranges from two to seven, with an average of four. Beach mice reach reproductive maturity as early as 6 weeks of age (Ehrhart 1978).

Population Dynamics

Status and Trends

The distribution of the beach mouse is limited due to modification and destruction of its coastal habitats. On the Atlantic coast of Florida, the Anastasia Island beach mouse (*P. p. phasma*) and the SEBM were federally listed as endangered and threatened, respectively, in 1989 (54 FR 20602). One additional Atlantic coast subspecies, the pallid beach mouse (*P. p. decoloratus*), was formerly reported from two sites in Volusia County, but extensive surveys provide substantial evidence that this subspecies is extinct (Humphrey and Frank 1992).

The distribution of the SEBM has declined significantly, particularly in the southern part of its range. Historically, it was reported to occur along about 280 km of Florida's central and southeast Atlantic coast from Ponce (Mosquito) Inlet, Volusia County, to Hollywood Beach, Broward County (Hall 1981). Bangs (1898) reported it as extremely abundant on all the beaches of the east peninsula from Palm Beach at least to Mosquito (Ponce) Inlet. During the 1990s, the SEBM was reported only from Volusia County (Canaveral National Seashore); in Brevard County (Canaveral National Seashore, Kennedy Space Center/Merritt Island NWR, and CCAFS); a few localities in Indian River County (Sebastian Inlet SRA, Treasure Shores Park, and several private properties), and St. Lucie County (Pepper Beach County Park and Fort Pierce Inlet SRA) (Humphrey *et al.* 1987; Robson 1989; Land Planning Group, Inc. 1991; Humphrey and Frank 1992; U.S. Fish and Wildlife Service 1993). The SEBM is geographically isolated from all other subspecies of *P. polionotus*.

Populations of the SEBM are still found on the beaches of Canaveral National Seashore, Merritt Island NWR, and CCAFS in Brevard County, all on federally protected lands. In April 2002, a population of SEBM was documented at the Smyrna Dunes Park, at the north end of New Smyrna Beach (A. Sauzo, personal communication, 2004). Populations from both sides of Sebastian Inlet appear to be extirpated (A. Bard, personal communication, 2004).

The status of the species south of Brevard County is currently unknown. The surveys done during the mid-1990s indicate the distribution of this subspecies in the counties south of Brevard was severely limited and fragmented. There are not enough data available to determine population trends for these populations. These surveys revealed that it occurred only in very small numbers where it was found. In Indian River County, the Treasure Shores Park population experienced a significant decline in the 1990s, and it is uncertain whether populations still exist at Turtle Trail or adjacent to the various private properties (D. Jennings, personal communication, 2004). Trapping efforts documented a decline from an estimated 300 individuals down to numbers in the single digits. No beach mice were found during surveys in St. Lucie County and it is possible that this species is extirpated there. The SEBM no longer occurs at Jupiter Island, Palm Beach, Lake Worth, Hillsboro Inlet or Hollywood Beach (U.S. Fish and Wildlife Service 1999).

The primary reason for the significant reduction in the range of the SEBM is the loss and alteration of coastal dunes. Large-scale commercial and residential development on the coast of Florida has eliminated SEBM habitat in the southern part of its range. This increased urbanization has also increased the recreational use of dunes, and harmed the vegetation essential for dune maintenance. Loss of dune vegetation results in widespread wind and water erosion and reduces the effectiveness of the dune to protect other beach mouse habitat. In addition to this increased urbanization, coastal erosion is responsible for the loss of the dune environment along the Atlantic coast, particularly during tropical storms and hurricanes. The extremely active 2004 hurricane season had a pronounced affect on Florida's Atlantic coast beaches and beach mouse habitat.

The encroachment of residential housing onto the Atlantic coast also increases the likelihood of predation by domestic cats and dogs. A healthy population of SEBM on the north side of Sebastian Inlet SRA in Brevard County was completely extirpated by 1972, presumably by feral cats (A. Bard, personal communication 2004). Urbanization of coastal habitat could also lead to potential competition of beach mice with house mice and introduced rats.

Beach mice along the Gulf Coasts of Florida and Alabama generally live about nine months (Swilling 2000). Field trapping research indicates that 68 percent (average) of mice alive in one month will survive to the next month. Actual survival rates indicate that 18.5 to 87 percent of individuals survive no more than four months and some mice live between 12 and 20 months (Blair 1951; Rave and Holler 1992). Holler *et al.* (1997) found that 44.26 percent of beach mice captured for the first time survived to the next season (winter, spring, summer, and fall). The mean survival rate for mice captured for a second time to subsequent capture was higher (53.90 percent). More than ten percent of mice survived three seasons after first capture, and four to eight percent survived more than one year after initial capture. Mice held in captivity by Blair (1951) and at Auburn University (Holler 1995) have lived three years or more.

Analysis of the Species/Critical Habitat Likely to be Affected

The southeastern beach mouse was listed as an endangered species primarily because of the fragmentation, adverse alteration and loss of habitat due to coastal development. The above analysis shows three items that are essential for recovery of this species: (1) purchase of coastal dune habitat for preservation; (2) removal of predation or competition by animals related to human development (cats and house mice); and (3) increase the regulations regarding coastal development.

EASTERN INDIGO SNAKE (*DRYMARCHON CORAIS COUPERI*)

Species/Critical Habitat Description

The eastern indigo snake is one of eight subspecies of a primarily tropical species; only the eastern indigo and the Texas indigo (*Drymarchon corais erebennus*) occur within the United States (U.S. Fish and Wildlife Service 1982). The eastern indigo snake is isolated from the Texas indigo snake by more than 600 miles (Moler 1992). The eastern indigo snake is the longest snake in North America, obtaining lengths of up to 104 inches (Ashton and Ashton 1981). Its color is uniformly lustrous-black, dorsally and ventrally, except for a red or cream-colored suffusion of the chin, throat, and sometimes the cheeks. Its scales are large and smooth (central 3-5 scale rows are lightly keeled in adult males) in 17 scale rows at midbody. Its anal plate is undivided. Its antepenultimate supralabial scale does not contact the temporal postocular scales.

The eastern indigo snake was listed as a threatened under the Act in 1978 (43 FR 4621). No critical habitat has been designated for this species; therefore none will be affected by the proposed project.

Life History/Population Dynamics

Historically, the eastern indigo snake occurred throughout Florida and into the coastal plain of Georgia, Alabama, and Mississippi (Loding 1922; Haltom 1931; Carr 1940; Cook 1954; Diemer and Speake 1983; Moler 1985a). It may have occurred in South Carolina, but its occurrence there cannot be confirmed. Georgia and Florida currently support the remaining endemic populations of eastern indigo snake (Lawler 1977). In 1982, only a few populations remained in the Florida panhandle, and the species was considered rare in that region. Nevertheless, based on museum specimens and field sightings, the eastern indigo snake still occurs throughout Florida, even though they are not commonly seen (Moler 1985a).

In south Florida, the eastern indigo snake is thought to be widely distributed and probably more abundant than in the northern limits of the range, especially compared to the low densities found in the panhandle of Florida. Given their preference for upland habitats, indigos are not found in great numbers in wetland complexes of the Everglades region, even though they are found in pinelands and tropical hardwood hammocks in extreme south Florida (Steiner *et al.* 1983).

Indigo snakes also occur in the Florida Keys. They have been collected from Big Pine and Middle Torch Keys, and are reliably reported from Big Torch, Little Torch, Summerland, Cudjoe, Sugarloaf, and Boca Chica Keys (Lazell 1989). Given the ubiquitous nature of the eastern indigo throughout the remainder of its range, it is likely that it also occurs on other Keys.

Over most of its range, the eastern indigo snake frequents a diversity of habitat types such as pine flatwoods, scrubby flatwoods, xeric sandhill communities, and tropical hardwood hammocks, edges of freshwater marshes, agricultural fields, coastal dunes, and human altered habitats. Eastern indigo snakes need a mosaic of habitats to complete their annual cycle. Interspersion of tortoise-inhabited sandhills and wetlands improves habitat quality for the indigo snakes (Landers and Speake 1980; Auffenberg and Franz 1982). Eastern indigo snakes require sheltered retreats from winter cold and desiccation (Bogert and Cowles 1947). Whenever the eastern indigo snake occurs in xeric habitats, it is closely associated with the gopher tortoise (*Gopherus polyphemus*), the burrows of which shelter the indigo snakes from the winter cold and desiccating sandhills environment (Bogert and Cowles 1947; Speake *et al.* 1978; Layne and Steiner 1996). This dependence seems especially pronounced in Georgia, Alabama, and the panhandle of Florida, where the eastern indigo snake is largely restricted to the vicinity of the sandhill habitats occupied by gopher tortoises (Diemer and Speake 1981; Moler 1985b; Mount 1975). The high use of xeric sandhill habitats throughout the northern portion of the eastern indigo's range can be attributed primarily to the availability of thermal refuge afforded by gopher tortoise burrows in the winter. No such refugia is widely available off of the sandhills regions of southern Georgia and northern Florida. In wetter habitats that lack gopher tortoises, eastern indigo snakes may take shelter in hollowed root channels, hollow logs, or the burrows of rodents, armadillos (*Dasypus novemcinctus*), or crabs (Lawler 1977; Moler 1985b; Layne and Steiner 1996).

In the milder climates of central and southern Florida, eastern indigo snakes exist in a more stable thermal environment, where the availability of thermal refugia may not be as critical to the snake's survival, especially in extreme southern Florida. Throughout peninsular Florida, the eastern indigo snake can be found in all terrestrial habitats, which have not suffered high urban development. They are especially common in hydric hammocks throughout this region (Moler 1985a). In central and coastal Florida, eastern indigo snakes are typically found in the state's high sandy ridges. In extreme south Florida, these snakes are mainly found in pine flatwoods, pine rockland, tropical hardwood hammock habitats, and in most other undeveloped areas (Kuntz 1977). Eastern indigo snakes also use some agricultural lands (e.g., citrus) and various types of wetlands (Layne and Steiner 1996).

Even though thermal stresses may not be a year-round limiting factor in southern Florida, eastern indigo snakes seek and use underground refugia. On the sandy central and coastal ridges of south Florida, indigo snakes use gopher tortoise burrows (62 percent) more than other underground refugia (Layne and Steiner 1996). Other underground refugia used by indigo snakes include burrows of armadillos, cotton rats (*Sigmodon hispidus*), and land crabs; burrows of unknown origin; natural ground holes; hollows at the base of trees or shrubs; ground litter; trash piles; and in the crevices of rock-lined ditch walls (Layne and Steiner 1996). These refugia sites are used most frequently where tortoise burrows are not available, principally in the low-lying areas off of the central and coastal ridges.

Smith (1987) radio-tagged hatchling, yearling, and gravid eastern indigo snakes and released them in different habitat types on St. Marks National Wildlife Refuge in Wakulla County, Florida, in 1985 and 1986. Smith monitored the behavior, habitat use, and oviposition sites selected by gravid female snakes and concluded that the diverse habitats, including high pineland, pine-palmetto flatwoods, and permanent open ponds were important for the eastern indigo snake's seasonal activity. In this study, habitat use also differed by age-class and season; adult indigo snakes often used gopher tortoise burrows during April and May, while juveniles used root and rodent holes. The indigo snakes used gopher tortoise burrows for oviposition sites in high pineland areas, but stumps were chosen in flatwoods and pond edge habitats (Smith 1987).

Monitoring of radio-fitted indigo snakes on the central ridge of south Florida indicate that snakes in this part of the state use a wide variety of natural, disturbed, and non-natural habitat types throughout the year. On the ridge itself, indigos favor mature oak phase scrub, turkey oak sandhill, and abandoned citrus grove habitats, while snakes found off the sandy ridges use flatwoods, seasonal ponds, improved pasture, and active and inactive agricultural lands. There was no apparent selection for one habitat type over another as the use of habitats closely reflected the relative availability and distribution of the vegetation types in these areas (Layne and Steiner 1996).

In extreme south Florida (the Everglades and Florida Keys), indigo snakes are found in tropical hardwood hammocks, freshwater marshes, abandoned agricultural lands, coastal prairie, mangrove swamps, and human altered habitats (Steiner *et al.* 1983). It is suspected that they prefer hammocks and pine forests since most observations occur there, and use of these areas are disproportionate compared to the relatively small total area of these habitats (Steiner *et al.* 1983).

Reproduction: Most information on the reproductive cycle of the eastern indigo snake is from data collected in northern Florida. Here, breeding occurs between November and April, and females deposit four to twelve eggs during May or June (Moler 1992). Speake (1993) reported an average clutch size of 9.4 for 20 captive bred females. Young hatch in approximately three months, from late May through August. Peak hatching activity occurs during August and September, while yearling activity peaks in April and May (Groves 1960; Smith 1987). Limited information on the reproductive cycle in south-central Florida suggests that the breeding and egg-laying season may be extended in south-central and south Florida. In this region, breeding extends from June to January, laying occurs from April to July, and hatching occurs during mid-summer to early fall (Layne and Steiner 1996).

Female indigo snakes can store sperm and delay fertilization of eggs; there is a single record of a captive snake laying five eggs (at least one of which was fertilized) after being isolated for more than four years (Carson 1945). There is no information on how long eastern indigo snakes live in the wild; in captivity, the longest an eastern indigo snake lived was 25 years, 11 months (Shaw 1959).

Feeding: The eastern indigo snake is an active terrestrial and fossorial predator that will eat any vertebrate small enough to be overpowered. Layne and Steiner (1996) documented several instances of indigos flushing prey from cover and then chasing it. Though unusual, indigo snakes may also climb shrubs or trees in search of prey. An adult eastern indigo snake's diet may include fish, frogs, toads, snakes (venomous and nonvenomous), lizards, turtles, turtle eggs, juvenile gopher tortoises, small alligators, birds, and small mammals (Keegan 1944; Babis 1949; Kochman 1978; Steiner *et al.* 1983). Juvenile indigo snakes eat mostly invertebrates (Layne and Steiner 1996).

Movements: Indigo snakes range over large areas and into various habitats throughout the year, with most activity occurring during summer and fall (Smith 1987; Moler 1985b; Speake 1993). The average home range of an eastern indigo snake is 12 acres during the winter (December - April), 106 acres during late spring early summer (May - July), and 241 acres during late summer and fall (August - November) (Speake *et al.* 1978). Adult male eastern indigo snakes have larger home ranges than adult females and juveniles; their home range may encompass as much as 553 acres in the summer (Moler 1985b; Speake 1993). By contrast, a gravid female may use from 4 to 106 acres (Smith 1987). These estimates are comparable to those found by Layne and Steiner (1996) in south central Florida, who determined adult male home ranges average about 183 acres, while adult females average about 42 acres.

Status and Distribution

As stated earlier, the eastern indigo snake was listed based on population decline caused by habitat loss, over-collection for the pet trade, and mortality from gassing gopher tortoise burrows to collect rattlesnakes (Speake and Mount 1973; Speake and McGlincy 1981). At the time of listing, the main factor in the decline of the eastern indigo snake was attributed to exploitation for the pet trade. As a result of effective law enforcement, the pressure from collectors has declined, but still remains a concern (Moler 1992).

The eastern indigo snake utilizes a majority of habitats available, but tends to prefer open, undeveloped areas (Kuntz 1977). Because of its relatively large home range, this snake is especially vulnerable to habitat loss, degradation, and fragmentation (Lawler 1977; Moler 1985b). Lawler (1977) noted that eastern indigo snake habitat had been destroyed by residential and commercial construction, agriculture, and timbering. He stated that the loss of natural habitat is increasing because of these threats in Florida and that indigo snake habitat is being lost at a rate of five percent per year. Low-density residential housing is also a potential threat to the species, increasing the likelihood that the snake will be killed by property owners and domestic pets. Extensive tracts of wild land are the most important refuge for large numbers of eastern indigo snakes (Diemer and Speake 1981; Moler 1985b).

Additional human population growth will increase the risk of direct mortality of the eastern indigo snake from property owners and domestic animals. Pesticides that bioaccumulate through the food chain may present a potential hazard to the snake as well pesticide use on crops or for forestry/silviculture would propose a pulse effect to the indigo snake (Speake 1993). Direct exposure to treated areas and secondary exposure by ingestion of contaminated prey could occur. Secondary exposure to rodenticides used to control black rats may also occur (Speake 1993).

The wide distribution and territory size requirements of the eastern indigo snake makes evaluation of status and trends very difficult. We believe that activities such as collecting and gassing have been largely abated through effective enforcement and protective laws. However, despite these apparent gains in indigo snake conservation, we believe that the threats described above are acting individually and collectively against the eastern indigo snake. Though we have no quantitative data with which to evaluate trends of the eastern indigo snake in Florida, we surmise that the population as a whole is declining because of continued habitat destruction and degradation. Natural communities continue to be altered for agriculture, residential, and commercial purposes, most of which are incompatible with the habitat needs of the eastern indigo snake (Kautz 1993). Habitat destruction and alteration is probably most substantial along the coasts, Keys, and high central ridges of southcentral Florida, where human population growth is expected to continue to accelerate. Agricultural interests (principally citrus) continue to destroy large expanses of suitable natural habitat in south Florida.

Even with continued habitat destruction and alterations, indigo snakes will probably persist in most localities where small, fragmented pieces of natural habitat remain. Tracts of appropriate habitat of a few hundred to several thousand acres may be sufficient to support a small number of snakes. Unfortunately, we believe that current and anticipated habitat fragmentation will result in a large number of isolated, small groups of indigo snakes. Fragmented habitat patches probably cannot support a sufficient number of indigo snakes to ensure viable populations.

One of the primary reasons for listing of the species was the pressure on wild populations caused by over-collecting for the pet trade and commerce. Since the listing of the species, private collectors have engaged in a very active captive breeding program to fulfill the desires of individuals wanting specimens for personal pets. The Service controls the interstate commerce of the species via a permit program. The Service believes that this has significantly reduced the collection pressures on the species.

Analysis of the Species/Critical Habitat Likely to be affected

The eastern indigo snake was listed in January 1978 as a threatened species primarily due to habitat loss and to over-collecting for the pet trade. The above analysis shows two items that are essential for recovery of this species: (1) acquire and/or manage habitat to maintain viable populations and (2) study their movement, food habitats, and population ecology.

ENVIRONMENTAL BASELINE

Action Area

The action area for this biological opinion is defined as all habitat within the boundaries of CCAFS.

Status of the Species in the Action Area

Florida scrub-jay: The Florida scrub-jay population on CCAFS was approximately 391 birds (126 groups) in 2007. In 2005, the scrub-jay census resulted in 308 birds (103 groups of two or more birds and nine single birds). This represents a slight net increase in groups (6) from the 2004 breeding season. The population on CCAFS was approximately 276 birds (99 groups of two or more birds and seven single birds) in 2003-2004. The number of jays decreased slightly (9 percent) from the previous year. The trend in population size over the last ten years has been downward, with an occasional increase in numbers within the ten-year study. The smaller population size was partly due to low reproductive success in 2002-2003, when breeding pairs fledged at a rate of 40 percent and 44 percent, respectively. Significant numbers of young were lost after they fledged (about 50 percent), likely due to predation. Adult survivorship was 74 percent between 2003 and 2004, which is about average for the eight years of study. Breeder survivorship was slightly higher than average (81 percent), and juvenile survivorship was above average (68 percent). Forty-seven percent of the 91 nesting groups produced young, yielding 73 juveniles by the end of the 2003-2004 breeding season (Stevens and Knight 2004).

The populations of scrub-jays occurring on CCAFS are a subset of the larger MINWR/KSC/ CCAFS metapopulation. Based on the amount of existing and potentially restorable scrub habitat on the stations, CCAFS has responsibility for approximately one-third of the recovery of this metapopulation. The current INRMP for CCAFS has a goal of 300 breeding pairs of scrub-jays to be established; without continued management and restoration of overgrown scrub on the facility, this number will be impossible to reach.

As stated in the cumulative effects analysis provided by the representatives of the 45th SW, CCAFS has approximately 5,175 acres of unoccupied scrub habitat within existing management compartments. Based upon 25 acres/breeding pair of scrub-jays, restoration of these areas could result in habitat for an additional 206 breeding pairs, bringing the total to 312 breeding pairs at CCAFS, if all available habitat could be managed for scrub-jays.

The restoration of the 1157.48 acres (Table 2) will occur as part of the proposed action, which is important to the recovery of the metapopulation, as restoration of this area will link the groups of scrub-jays found at CCAFS and KSC. Fire suppression over the years created an area of unsuitable habitat between CCAFS and KSC, and restoration of this scrub will provide habitat suitable for occupation between the two facilities. Accordingly, restoration of the habitat will allow mixing of the two existing populations, and lead to further expansion and growth of scrub-jays and their territories.

Southeastern beach mouse: The southeastern beach mouse is found along the entire reach of coastline on CCAFS in addition to the KSC and Cape Canaveral National Seashore. The known distribution is a result of cursory surveys and intermittent trapping involving different construction projects. There has been a three-year trapping study done in order to determine the status throughout its range on these Federal lands. The species is found within the action area.

Eastern indigo snake: The eastern indigo snake is likely to occur within the boundaries of the project site due to the presence of suitable habitat, although none have been seen. The eastern indigo snake standard protection measures will be used during the construction of the project.

Factors Affecting Species' Environment within the Action Area

This analysis describes factors affecting the environment for scrub-jays, southeastern beach mice, and eastern indigo snakes in the action area. There are no State, tribal, local, or private actions affecting the species or that will occur contemporaneously with this consultation. Federal actions have taken place within the action areas that have impacted Florida scrub-jays, southeastern beach mice, and eastern indigo snakes. These projects sometimes resulted in incidental take anticipated through section 7 of the Act. The impacts associated with some of these projects resulted in the loss of occupied habitat or habitat suitable for occupation within the action area.

Prescribed burning and restoration of overgrown scrub for the benefit of the scrub-jay have occurred and are ongoing on CCAFS. The Air Force continues to pursue its goal of 300 breeding pairs of scrub-jays, as outlined in their INRMP. The INRMP identifies burning and/or mechanical management of 500 acres per year. In 2007, 1300 acres of habitat were restored through a combination of control burning and mechanical treatment. At this rate of habitat management, we estimate that CCAFS will be able to reach their goal of 300 breeding pairs of scrub-jays. This goal may be achieved more quickly if existing burning constraints are reduced in the future. CCAFS has a prescribed burn working group that deals with issues of burn restrictions on CCAFS. This group meets regularly at CCAFS.

A 5-year study to compare mechanical clearing and burning to effectively manage scrub is underway and is expected to result in development of better management practices in lieu of delayed prescribed burns that have previously led to overgrown scrub-jay habitat.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action on the species and its interrelated and interdependent activities. To determine whether the proposed action is likely to jeopardize the continued existence of threatened or endangered species in the action area, we focus on consequences of the proposed action that affect rates of birth, death, immigration, and emigration because the probability of extinction in plant and animal populations is most sensitive to changes in these rates.

Factors to Be Considered

The effects of the proposed project of the Florida scrub-jay, southeastern beach mouse, and eastern indigo snake may occur as direct and indirect effects.

Direct Effects

The Skid Strip modification and associated facilities may result in the direct "take" of Florida scrub-jays, eastern indigo snakes, and southeastern beach mice as a result of permanent loss of 410.83 acres of sub-optimal scrub habitat. Approximately 20-acres of this are currently occupied by scrub-jays. The probability and level of incidental take is dependent upon the number of Florida scrub-jays, southeastern beach mice, and eastern indigo snakes within the region; their ability to disperse; and the amount and distribution of available suitable habitat. It is possible that as construction proceeds, they will move away from the construction site; however, the Service anticipates that "take" will occur.

The proposed activity will result in the direct permanent loss of approximately 20-acres of scrub habitat occupied by five groups of Florida scrub-jays totaling 12 individual birds. The proposed project will impact a portion of each Florida scrub-jay family's territory in LMU 38, 39, 48, and 49. The proposed activity will result in the direct permanent loss of approximately 410.83 acres of sub-optimal scrub habitat over a nine-year period (FY 2009 to FY 2017) occupied by southeastern beach mice and eastern indigo snakes. The proposed project will permanently impact existing southeastern beach mouse burrows and habitat found within the project area. It is possible that as construction proceeds, they will move away from the construction site; however, the Service anticipates that "take" will occur. Similar direct effects are expected for any eastern indigo snakes occurring within the project site. Impacts to the species will be minimized by restoring 1157.48 acres of potential scrub-jay, beach mouse and eastern indigo snake habitat at CCAFS over a nine-year period.

Indirect Effects

Indirect effects are caused by or result from the proposed action, are later in time, and are reasonably certain to occur. Indirect effects may occur outside of the area directly affected by the action. Indirect effects may include other Federal actions that have not undergone section 7 consultations, but will result from the action under consideration. The indirect effects will occur in two ways: (1) operation of the skid strip will add traffic along roadways adjacent to occupied habitat, possibly resulting in scrub-jays and snakes being struck by vehicles or (2) proposed habitat restoration and management activities are expected to enhance scrub-jay dispersal when complete.

Dreschel *et al.* (1990), Fitzpatrick *et al.* (1991), and Mumme *et al.* (2000) provide the best scientific and commercial data on the likelihood of incidental take as the result of scrub-jays being killed by the vehicles. The only scientific documentation of road-kill mortality in Florida scrub-jays are from jays living in a territory immediately adjacent to a road, not from dispersing some unknown distance across a road to a new territory.

Indirect effects will result from continued loss of foraging habitat for the southeastern beach mouse.

The eastern indigo snake has a high probability of being impacted by increased traffic on the roads. Since a portion of their suitable habitat will be impacted by the proposed development, the snakes may have to go elsewhere and cause them to cross busy roads which could result in road-kill mortality.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

CONCLUSION

After reviewing the current status of the Florida scrub-jay, southeastern beach mouse, and the eastern indigo snake, the environmental baseline for the action area, the effects of the proposed skid strip modification and the cumulative effects, it is the Service's BO that the Skid Strip modification, as proposed, is not likely to jeopardize the continued existence of the Florida scrub-jay, the southeastern beach mouse, and the eastern indigo snake. No critical habitat has been designated for the three species; therefore, none will be affected.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation under section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be implemented by the agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply.

The Federal agency has a continuing responsibility to regulate the activity that is covered by this incidental take statement. If the agency (1) fails to assume and implement the terms and conditions or (2) fails to retain oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the agency must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. (50 CFR 402.14(I) (3))

Sections 7(b) (4) and 7(o) (2) of the Act do not apply to the incidental take of listed plant species. However, protection of listed plants is provided to the extent that the Act requires a Federal permit for removal or reduction to possession of endangered plants from areas under Federal jurisdiction, or for any act that would remove, cut, dig up, or damage or destroy any such species on any State or in the course of any violation of a State criminal trespass law.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service has reviewed the biological information for this species, information presented by the applicant's consultant, and other available information relevant to this action, and based on our review; incidental take in the form of harm or harassment is anticipated for five (5) Florida scrub-jay groups totaling 12 individuals.

The Service expects the level of incidental take of southeastern beach mice and eastern indigo snakes will be difficult to determine for the following reasons: eastern indigo snakes are wide-ranging and elusive; southeastern beach mice are elusive because of their burrowing habits; finding a dead or impaired specimen is unlikely; losses may be masked by predators removing dead or injured animals. The Service has reviewed the biological information for these species, information provided by representatives of the 45th SW, and has determined that incidental take in the form of harm or harassment is anticipated for all the southeastern beach mice and eastern indigo snakes utilizing the 410.83-acre area.

If during the course of this action, the project description changes, this would represent new information requiring review of the reasonable and prudent measures provided. The Federal agency must immediately provide modification of the reasonable and prudent measures.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

REASONABLE AND PRUDENT MEASURES

The Service believes the following reasonable and prudent measures are necessary and minimize impacts of incidental take of Florida scrub-jays, southeastern beach mice, and eastern indigo snakes:

Florida scrub-jay

1. Avoid construction in scrub-jay occupied areas during the nesting season from March 1 through June 30.

2. Notify the Service of any unauthorized take of Florida scrub-jays identified during the construction of the proposed facility.

3. Ensure that prior to clearing of scrub-jay occupied habitat there is suitable habitat within 1200 feet.

4. Restore 1157.48 acres of scrub habitat within LMU 72, 89, 40, 36, 37, 38, 74, 65, 76, 70, 67, 78,66, 79, 55, 36, 33, 84, and 48 by using prescribed burning and mechanical means over the 9-year period (in addition to the 500 acres of prescribed burning per year).

5. Manage the 1157.48 acres for scrub-jays within LMU 72, 89, 40, 36, 37, 38, 74, 65, 76, 70, 67, 78,66, 79, 55, 36, 33, 84, and 48 by using prescribed burning and mechanical means.

6. Conduct scrub-jay monitoring in the restoration areas.

7. A report describing the actions taken to implement the terms and conditions of this incidental take statement shall be submitted to the Service for the proposed work and restoration for each year when the activity has occurred.

Southeastern beach mouse

1. Notify the Service of any unauthorized take of southeastern beach mice identified during the construction activity.

Eastern indigo snake

1. Minimize impacts to eastern indigo snakes from heavy equipment by implementing the standard protection measures.

2. Only individuals with permits should attempt to capture the eastern indigo snakes.

3. If an eastern indigo snake is held in captivity, it should be released as soon as possible in release sites approved by the Service on the CCAFS.

4. Notify the Service of any unauthorized take of eastern indigo snakes identified during the construction of the proposed facility.

TERMS AND CONDITIONS

To implement the above reasonable and prudent measures, the Service has outlined the following terms and conditions for incidental take. In accordance with the Interagency Cooperation Regulation (50 CFR 402), these terms and conditions must be complied with to implement the reasonable and prudent measures for incidental take:

Florida scrub-jay

1. Avoid construction and/or clearing in scrub-jay occupied areas during the nesting season from March 1 through June 30.

2. Unauthorized take of scrub-jays associated with the proposed activity should be reported immediately by calling the Jacksonville Field Office of the U.S. Fish and Wildlife Service in Jacksonville at 904-232-2580. If a dead Florida scrub-jay is found on the project site, the specimen should be thoroughly soaked in water and frozen for later analysis of cause of death or injury.

3. If there is no suitable habitat within 1200 feet of the proposed cleared areas that are occupied by scrub-jays, the 45th SW will conduct restoration in LMUs adjacent to the impact areas prior to any clearing activities.

4. The 45th SW will restore 1157.48 acres of scrub habitat within LMU 72, 89, 40, 36, 37, 38, 74, 65, 76, 70, 67, 78, 66, 79, 55, 36, 33, 84, and 48 by using prescribed burning and mechanical means over the 9-year period (this will occur in addition to the 500 acres of restoration per year using mechanical treatment followed by controlled burning).

5. The 45th SW will manage the 1157.48 acres of scrub habitat for continued scrub-jay use of the created corridors within LMU 72, 89, 40, 36, 37, 38, 74, 65, 76, 70, 67, 78, 66, 79, 55, 36, 33, 84, and 48 by using prescribed burning and mechanical means (this will occur in addition to the 500 acres of restoration per year using mechanical treatment followed by controlled burning).

6. Conduct scrub-jay monitoring to demonstrate that the impacted birds successfully use the restoration areas and these areas are successful in creating corridors and providing habitat for those birds displaced by the proposed project. Color band scrub-jays occupying habitat to be cleared and monitor their dispersal and habitat use following vegetation clearing at impact sites. Monitoring should continue until such time that it is determined that impacted scrub-jays have established new territories, joined scrub-jay families with existing territories, or have died.

7. A report describing the project conducted during the year and actions taken to implement the reasonable and prudent measures and terms and conditions of this incidental take statement shall be submitted to the Service for each year of completing the proposed work and restoration. This report will include acreage cleared, location of clearing, acreage of LMU restored, and a scrub-jay monitoring report in the restoration areas.

Southeastern beach mouse

1. If a dead southeastern beach mouse is found on the project site, the specimen should be thoroughly soaked in water and frozen, and the applicant should notify the Jacksonville Field Office immediately at (904) 232-2580. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

Eastern indigo snake

1. An eastern indigo snake protection/education plan shall be developed by the 45th Space Wing for all construction personnel to follow. The plan shall be provided to the Service for review and approval at least 30 days prior to any clearing activities. The educational materials for the plan may consist of a combination of posters, videos, pamphlets, and lectures (*e.g.*, an observer trained to identify eastern indigo snakes could use the protection/education plan to instruct construction personnel before any clearing activities occur). Informational signs should be posted throughout the construction site and contain the following information:
    a. A description of the eastern indigo snake, its habits, and protection under Federal Law;
    b. Instructions not to injure, harm, harass or kill this species;
    c. Directions to cease clearing activities and allow the eastern indigo snake sufficient time to move away from the site on its own before resuming clearing; and,
    d. Telephone numbers of pertinent agencies to be contacted if a dead eastern indigo snake is encountered. The dead specimen should be thoroughly soaked in water, and then frozen.

2. Only an individual who has been either authorized by a section 10(a) (1) (A) permit issued by the Service, or authorized by the Florida Fish and Wildlife Conservation Commission for such activities, is permitted to come in contact with or relocate an eastern indigo snake.

3. If necessary, eastern indigo snakes shall be held in captivity only long enough to transport them to a release site; at no time shall two snakes be kept in the same container during transportation.

4. An eastern indigo snake monitoring report must be submitted to the Jacksonville Field Office within 60 days of the conclusion of clearing activity. The report should be submitted when any eastern indigo snakes are observed or relocated. The report should contain the following information:
   a. Any sightings of eastern indigo snakes;
   b. Summaries of any relocated snakes if relocation was approved for the project (*e.g.*, locations of where and when they were found and relocated);
   c. Other obligations required by the Florida Fish and Wildlife Conservation Commission, as stipulated in the permit.

5. If a dead eastern indigo snake is found on the project site, the specimen should be thoroughly soaked in water and frozen, and the applicant should notify the Jacksonville Field Office immediately at (904) 232-2580. Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

These reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. The Service believes that no more that five groups of Florida scrub-jays utilizing the 20-acre area will be incidentally taken, and all the southeastern beach mice, and all eastern indigo snakes utilizing the 410.83-acre of sub-optimal scrub habitat will be incidentally taken over the nine-year period. If, during the course of the action, this level of incidental take is exceeded (e.g., burning restrictions placed on scrub habitat adjacent to the skid strip modification and associated facilities, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Federal agency must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

CONSERVATION RECOMMENDATIONS

Section 7(a) (1) of the Act directs Federal agencies to use their authority to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help carry out recovery plans, or to develop information.

1. Leave and use native scrub vegetation in landscaping around the retention areas and the right-of-way to provide scrub habitat for the scrub-jays utilizing the site.

2. Signs should be placed on the fences that explain to the occupants the importance of the onsite and adjacent scrub areas for the listed species.

3. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation measures.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR Section 402.16, reinitiation of formal consultation is required when discretionary Federal agency involvement or control over the action has been retained and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this biological opinion; (3) the Air Force's action is later modified in a manner that causes an effect to the listed species or critical habitat not considered in this biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

For this BO, the incidental take would be exceeded when the take exceeds five (5) groups of Florida scrub-jays utilizing the 20 acres of scrub, and all the southeastern beach mice and eastern indigo snakes utilizing the 410.83 of sub-optimal of scrub habitat over the nine-year period, which is what has been exempted from the prohibitions of section 9 by this opinion. The Service appreciates the cooperation of the Air Force during this consultation. We would like to continue working with you and your staff regarding the Skid Strip modification project. For further coordination please contact Ann Marie Lauritsen at (904) 525-0661 of this office.

Sincerely,

David L. Hankla
Field Supervisor

cc: Mike Jennings-FWS/JAXFO
Downie Wolfe-FWS/JAXLE
Annie Dziergowski- FWS/JAXFO
Ken Graham- FWS/Atlanta RO

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FINDING OF NO SIGNIFICANT IMPACT (FONSI)
AND FINDING OF NO PRACTICABLE ALTERNATIVE (FONPA)
FOR THE SKID STRIP AREA DEVELOPMENT PLAN
AT CAPE CANAVERAL AIR FORCE STATION
OCTOBER 2009

An Environmental Assessment (EA) has been prepared to evaluate potential impacts associated with a number of individual projects planned that would accomplish improvements to the Cape Canaveral Air Force Station (CCAFS) Skid Strip. Since the facility no longer operates as a missile skid strip, it is referred to as the "Airfield" throughout the majority of the EA. Several Sustainment, Restoration, and Modernization Construction (SRMC) projects and four Military Construction (MILCON) projects were evaluated for environmental impacts. These projects are designed to update and eliminate certain safety issues and bring the Airfield into compliance with current U.S. Air Force (USAF) instructions. Program initiation is expected in 2009 with ultimate completion in 2020. Because the entire program extends for 11 years and includes construction, some of the projects may require additional environmental analysis in the future.

The proposed action is a combination of four MILCON projects and several interrelated SRMC projects. The MILCON projects include construction of a parking apron on the south side of the existing runway and associated east and west taxiways that will cover approximately 11 acres; construction of a new 65 foot tall control tower; construction of a new Airfield Manager (AM) Operations Building that would adjoin the new tower; and construction of a new Airfield perimeter fence. Each of these elements of the proposed action is further described in Section 2 of the EA. The MILCON projects will result in the removal of approximately 37 acres of vegetation/habitat.

The SRMC projects consist of the following: clear trees located inside the airfield imaginary clearance surfaces; re-route two ditches; demolish the old tower, airfield operations center and parking apron; relocate gates and bollards; install a rotating beacon; lower or relocate area warning lights; install foundation for a mobile aircraft arresting unit; relocate controlled area signs; grade and sod the lateral clear zone; install paved overruns and correct approach lighting; install apron shoulders; and install concrete runway ends. The SRMC projects will result in the loss of approximately 373 acres of vegetation/habitat.

Although one alternative was identified that would reduce the number of airfield waivers by completion of the SRMC projects, it was eliminated from further discussion because it did not eliminate the hazards to flight safety and did not meet all objectives listed in Sections 1 and 2 of the EA. Therefore, the no action alternative was the only alternative to the proposed action that was identified.

In accordance with the requirements of the National Environmental Policy Act (NEPA), the Council on Environmental Quality (CEQ) regulations and 32 Code of Federal Regulations 989, Air Force Environmental Impact Analysis Process, the EA, hereby incorporated by referenced, evaluated the potential environmental impacts associated with the proposed implementation of the Skid Strip Area Development Plan at CCAFS.

ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION

No significant environmental impacts to the natural or human environment were identified from implementing the proposed action at the Skid Strip that would require the completion of an Environmental Impact Statement (EIS). As part of the EA, the following resource areas were recognized as not being impacted by the proposed action or the no action alternative and were therefore eliminated from further review consideration: land use/visual resources, noise, air quality, hazardous waste/hazardous materials, geology and soils, transportation, health and safety, and socioeconomics. Less than significant impacts for the individual resource areas are summarized below.

Biological Resources

Several threatened and endangered (T&E) species, as well as birds protected under the Migratory Bird Treaty Act, were identified that could be impacted by the proposed action. Upon completion of formal consultation under the Endangered Species Act, the U.S. Fish and Wildlife Service (USFWS) determined that the proposed action may affect but is not likely to adversely affect the loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles. Further, the USFWS determined that the proposed action may affect and is likely to adversely affect the Florida Scrub-jay, Southeastern Beach Mouse, and the Eastern Indigo Snake, but that their continued existence is not likely to be jeopardized if the Air Force employs USFWS mitigation measures." The USFWS has issued an Incidental Take Statement for each of those three species, along with requiring the Air Force to undertake mitigation measures for each species described below. As a result, impact to biological resources is not expected to be significant.

Florida Scrub-jays

The overall impact to T&E species is the result of clearing approximately 411 acres of vegetation that provides habitat to listed species. The federally threatened Florida Scrub-jay occupies approximately 20 of the 411 acres that will be destroyed and, therefore, the USFWS anticipated there would be a "take" of all 12 jays located within the 20 acres. Since the remaining acreage is considered potential jay habitat, compensation is required for the entire acreage. Impacts to Scrub-jays would be minimized by restoring 1157.48 acres of potential scrub-jay habitat at CCAFS over a nine-year period. For each phase of clearing around the airfield, there would be a corresponding project to restore habitat. In addition to this compensation, the Air Force shall also comply with other USFWS requirements, such as avoiding construction and clearing activities in scrub-jay occupied areas during nesting season, conducting Scrub-jay monitoring, and providing reports, among other actions.

Southeastern Beach Mice

The USFWS anticipated a "take" of all southeastern beach mice as a result of the clearing of 411 acres described above, but the USFWS could not quantify the number of mice because of their burrowing habits and elusive nature. However, the impact to the mice would likewise be minimized, as the proposed 1157.48-acre habitat restoration for the Scrub-jay is expected to be beneficial to southeastern beach mice as well. Based on a three-year study recently completed for CCAFS, beach mice benefit from the same land management activities being conducted for Scrub-jays, and the beach mice population is expanding into inland locations. Therefore, the potential exists to create an additional 1,100+ acres of habitat for beach mice. Based on observations by Air Force biologists of small mammal burrows around the current airfield clear zone, the expansion of that zone has the potential to provide additional habitat. The Air Force shall comply with USFWS handling procedures for dead mice found during construction and clearing activities.

Eastern Indigo Snake

The USFWS also anticipated a take of an undetermined number of eastern indigo snakes due to the loss of 411 acres of habitat. The proposed action's impact on the snakes would be minimized by the proposed 1157.48-acre habitat restoration and by implementing standard protection measures, a snake protection and education plan, and monitoring activities, among other USFWS-imposed requirements.

Sea Turtles

Although the proposed clearing and construction of new facilities would not impact the nesting beach, exterior lighting proposed for the new facilities has the potential to be visible from the beach. Disorientation of adult or hatchling sea turtles could result in an indirect take on the adjacent beach. To minimize the impacts to sea turtles from new facility lighting, all exterior lighting proposed for this project will be in accordance with the 45 SW Instruction 32-7001, *Exterior Lighting Management* dated 25 January 2008. Additionally, a Light Management Plan will be required for the new facilities. This Plan would be forwarded to USFWS for review and approval prior to any facility construction.

Construction activities have the potential to cause harm to gopher tortoises during such project activities as ground clearance, grading, and moving equipment. To avoid gopher tortoise mortalities, pre-construction gopher tortoise surveys and relocation of any tortoises within the boundaries of the work area would be conducted prior to any land disturbance or construction activities. Gopher tortoises would be relocated in accordance with gopher tortoise Relocation Permit WR04151c.

Cultural Resources

The 45 SW cultural resources manager has consulted with the State Historic Preservation Office (SHPO). The Proposed Action will take place within two high areas of archaeological potential (AAP) and in low AAP. Ground-disturbing activities in these areas may affect archaeological sites. To minimize impact on those archaeological sites, the Air Force shall monitor for the existence of archaeological sites and perform reconnaissance level survey in low AAP area and a Phase I survey in high AAP areas. A Phase I survey includes a surface reconnaissance and systematic subsurface testing using the standard operating procedures outlined in the Florida Division of Historical Resources Cultural Resource Management Standards and Operation Manual The Air Force shall forward copies of the monitoring and survey reports to SHPO. Since the area is so large and the land clearing projects span nine years, archeological surveys and follow-up consultations will be conducted in phases. As a result of these efforts, impact to cultural resources is not expected to be significant.

Water Resources

The Proposed Action is not expected to adversely impact groundwater quality or alter the hydrogeologic characteristics of the surficial aquifer. The Proposed Action requires that all new clear areas be level and absent of any depressions or mounds to comply with airfield safety standards. As a result, the Proposed Action will affect four short man-made ditches, one of which is considered jurisdictional wetlands. Two of the ditches, which are located close to the Skid Strip, will have to be re-routed or have a culvert installed to partially enclose them to comply with safety standards. According to USACE Nationwide Permit regulations and guidance, modification of the jurisdictional ditch (and non-jurisdictional ditch) will not result in significant impact to wetlands because the jurisdictional ditch is of a size that would NOT be considered a major impact if it were filled or modified according to USACE guidance. This activity would require a USACE Nationwide Permit 39, 41, or 43.

Cumulative Impacts

The Proposed Action would result in positive cumulative impacts for the Florida scrub-jay, southeastern beach mice, and eastern indigo snake. Although the Proposed Action would entail the initial loss of 411 acres that serve as habitat for the three species, the Air Force shall expand their habitat by three-fold, which the Air Force anticipates will assist the base's goal of 300 breeding pairs of Scrub-jays on CCAFS. The net impact would be an increase in habitat for not only the Scrub-jays but also for the southeastern mice and eastern indigo snake, which share the same habitat. Potential cumulative impact on cultural resources would be minimized by accomplishing the Phase I survey mentioned above.

Cumulative impacts on sea turtles have the potential to occur due to increased lighting. The new facilities would result in more exterior lighting than is currently present at existing facilities, which could lead to disorientation on the adjacent beach. Adherence to the 45 SW Light Management Plan and Air Force lighting policies will help reduce these impacts. Modifications to the four ditches, part of one which is a jurisdictional wetland would not cause a negative cumulative impact on wetlands.

CONCLUSION

The draft EA and FONSI/FONPA were made available to the affected public for a 30-day public period beginning 31 May 2009. The affected public was notified by advertisement in the *Florida Today* newspaper. The EA and FONSI were made available by placing on file in the local library of Cape Canaveral and the 45 SW Public Affairs Office. No comments were received. The draft final EA and FONSI/FONPA were sent to the State Clearinghouse for review by all state agencies. Their response letter dated July 6, 2009 is included as Appendix E to the final EA.

FINDING OF NO PRACTICABLE ALTERNATIVE

Executive Order 11990 directs that each agency shall provide leadership and shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing and disposing of Federal lands and facilities; and (2) providing Federally undertaken, financed, or assisted construction and improvements. Due to the need for CCAFS to be in compliance with safety regulations and reduce airfield violations, the proposed action would require rerouting the ditches and/or installation of culverts that would result in unavoidable impacts to wetlands. These impacts would be considered minor and conducted in accordance with USACE permit regulations. Minimization of impacts to wetlands is ensured through the Nationwide Permit process. Expansion of the cleared area, which by regulation must be level and without any depressions or mounds, necessarily will extend over parts of two existing drainage ditches and is unavoidable. Because of the nearby location of the ditches in relation to the Skid Strip area, which needs modifications and upgrades to address safety issues and rectify non-compliant conditions, there was no practicable alternative to constructing in a wetlands

Pursuant to Executive Order 11990, the authority delegated by SAFO 780-1 and 32 CFR part 989 and taking the submitted information into account, I find that there is no practicable alternative to this action that would avoid wetlands during construction activities and the proposed action includes all practicable measures to minimize harm to the environment.

FINDING OF NO SIGNIFICANT IMPACT

Based on a careful review of the analyses and data contained in the attached EA, conducted in accordance with the provisions of NEPA, the CEQ Regulations, and 32 CFR Part 989, I find that the action will have no significant environmental impact, either by itself or cumulatively with other ongoing projects at CCAFS; therefore, an Environmental Impact Statement is not warranted. The signing of this Finding of No Significant Impact completes the environmental impact analysis process.

Carlos R. Cruz-Gonzalez

CARLOS R. CRUZ-GONZALEZ
Colonel, USAF
Deputy Director for Installations

20 Oct '09

Date

FINAL REPORT
2003-2006

UCF Act. No. 24036012

(Formerly UCF Act. Nos. 11-20-6012 and 11-20-561)

THE DISTRIBUTION AND ABUNDANCE OF THE SOUTHEASTERN BEACH MOUSE (Peromyscus polionotus niveiventris) ON THE CAPE CANAVERAL AIR FORCE STATION

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December 19, 2007

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Cooperative Agreement Number:

Patrick Air Force Base Project Managers:

Project Manager:
Principal Investigators:

Field Coordinators:

Date Submitted:

NOTICES

Effort sponsored by the 45th CES/CEV, Patrick AFB, Florida, under Cooperative Agreement Number:.........

THE DISTRIBUTION AND ABUNDANCE OF THE SOUTHEASTERN BEACH MOUSE (Peromyscus polionotus niveiventris) ON THE CAPE CANAVERAL AIR FORCE STATION

Authors

I. Jack Stout
James D. Roth
Christopher L. Parkinson

EXECUTIVE SUMMARY

A series of observations over two years led to the conclusion by staff of Cape Canaveral Air Force Station that mice and most likely beach mice were in residence well inland on the cape and indeed had, in some cases, taken up residence in buildings, hangers, and other man-made structures in the industrial area. None of this made much sense because the world view was that beach mice live on the coastal dunes where sea oats grow and produce a reliable seed crop every year.

A chance phone conversation between Donald George and Jack Stout resulted in a discussion on how to approach these "mice" events given the fact that the subspecies of beach mice (*Peromyscus polionotus niveiventris*), also referenced as the southeastern beach mouse, is listed as threatened under the Endangered Species Act. Ultimately Stout proposed a two-year study to provide a broad-based investigation of beach mouse demography, genetics, food habits, and responses to management of natural lands on Cape Canaveral. Field work would be done by graduate students from the University of Central Florida. Students and faculty would use for the first time on this type of project (1) stable isotopes to determine what plant and animal materials the beach mice were eating coupled with the more conventional analysis of fecal material, (2) genetic analysis with microsatellites and mitochondrial genes to genotype individuals and assess genetic diversity and structure, and (3) conventional grid trapping to document demographic patterns in the landscape. It was also proposed to attempt to carry out a population viability analysis (PVA) of the beach mouse. After the study was underway, it was obvious that ongoing land management practices would need to be investigated from the viewpoint of multiple-species responses. Multiple hurricanes in August and September 2004 were unexpected but in hindsight very timely in that an additional year of funding allowed us to look at population responses across a wider range of habitat conditions than previously studied on Merritt Island and Cape Canaveral.

The most important finding of the grid trapping was the demonstration of southeastern beach mouse in the interior scrub habitats on Cape Canaveral. Given nearly equal trapping efforts within the coastal dune and interior habitats, the three inland grids were populated by 790 individuals and the three beach grids 293 individuals. Over the three years of study, 63.14% (2,683) of the captures (first captures plus all recaptures) were from the inland grids and 36.86% (989) from the beach grids. The trapping survey of the entire coast line of the cape in 2003 revealed the patchy distribution of beach mice. In contrast, most inland sites that were dry and vegetated with oak and palmetto scrub supported beach mice.

Population dynamics of beach mice across all the grids was variable with little evidence of regional or cape-wide patterns. Population features such as age structure, signs of reproductive activity, and seasonal abundance followed somewhat unique trajectories for each grid. The hurricanes of 2004 altered the dynamics of the beach mice in the dune areas but recovery was evident within a few months. Beach grid 3 showed the greatest lag in recovery of beach mice and this may be attributed to the longer duration of flooding on this site with a related delay in plant growth. Beach mice in the interior of the cape did not show clear evidence of population responses to the hurricanes.

Cape Canaveral almost certainly supports the largest and likely most stable population of southeastern beach mice remaining in the historic range. This is largely an area effect because no other capes occur on the central and south Atlantic coastline of Florida. Beach mice in general are somewhat specialized relative to other *Peromyscus* , but exhibit a broad tolerance for habitat conditions if the substrate is suitable for burrowing and free of flooding. Therefore, upland areas of the cape not only support large numbers of beach mice but likely serve as sources of individuals to repopulate coastal dunes and swales following hurricanes events. The most compelling evidence for this process is the lack of genetic structure among the grid populations studied on the cape. The most obvious explanation for the lack of structure is extensive dispersal between and among the habitat fragments of the cape.

We investigated genetic diversity within the southeastern beach mouse (SEBM-*Peromyscus polionotus niveiventris*) and also tested the hypothesis that the subspecies recognition of *P.p. niveiventris*, based on size and color differences, is congruent with this taxon representing a discrete evolutionary lineage. We used ten polymorphic microsatellite loci and mitochondrial cytochrome-*b* gene DNA sequences to investigate genetic diversity and population structure within the SEBM, and to determine the level of divergence between the SEBM and the nearest known inland subspecies of the oldfield mouse (*Peromyscus polionotus rhoadsi*). Moderate genetic distances were observed between the SEBM and the inland oldfield mouse based on microsatellite data, with F_{ST} values ranging from 0.11 to 0.22 between these taxa. Additionally, mitochondrial DNA haplotypes of the SEBM formed a distinct monophyletic group relative to haplotypes sampled from *P. p. rhoadsi*. Based on previous estimates of rates of mitochondrial DNA evolution in rodents, we inferred that Pleistocene sea-level fluctuations are likely responsible for the historical isolation of the SEBM lineage from mainland *P. polionotus*. Our data demonstrate the genetic distinctiveness of the SEBM, justifying the current subspecies designation for the SEBM and its continued protection under the United States Endangered Species Act. We classify the Cape Canaveral and Smyrna Dunes Park populations of SEBM as a single evolutionary significant unit. The two known extant allopatric populations of the SEBM showed some differentiation in microsatellite frequencies and were moderately reciprocally distinguishable based on assignment to distinct genetic clusters by a Bayesian admixture procedure. These results justify the classification of these two extant SEBM populations as distinct management units that should be independent targets of management and conservation attention.

No study of the food habits or trophic position of the southeastern beach mouse had been done prior to this investigation. We used fecal and stable isotope analysis to determine the diet of this subspecies on Cape Canaveral Air Force Station between the autumn of 2003 and the spring of 2005. The diet varied in the amount of ^{13}C consumed between habitats and in the amount of both ^{15}N and ^{13}C consumed among grids within a habitat. There was no significant interaction between habitat and sex in the amount of either ^{15}N or ^{13}C consumed, and sexes also did not differ significantly. Fecal analysis uncovered the dominance in the diet of C_3 plants. Our data refuted the current belief that the southeastern beach mouse prefers beach grass seeds of C_4 plants, e.g., sea oats, which were consumed but not in the frequency or quantity expected.

We also analyzed the diet of *Peromyscus gossypinus*, the cotton mouse, and *Sigmodon hispidus*, the hispid cotton rat, using the two techniques. Both species consumed a combination of plant and arthropod material. Their diets varied between dune/swale and coastal scrub habitats.

All three species' diets were significantly different, with *Peromyscus polionotus niveiventris* and *Peromyscus gossypinus* being the most similar. Both consume a greater proportion of arthropod material compared to the hispid cotton rat. Interspecific competition between the southeastern beach mouse and the cotton mouse may occur in times of limited resources.

Proper habitat management is essential for the survival and reproduction of species, especially those listed under state or federal laws as endangered, threatened or of special concern, and those with small local populations. Land managers use a combination of mechanical cutting and prescribed burning to manage and restore degraded scrub habitat in east central Florida. This approach improves habitat for the endangered Florida scrub-jay (*Aphelocoma coerulescens*), but little is known about its effects on other taxa, especially the threatened southeastern beach mouse (*Peromyscus polionotus niveiventris*). This single species approach may not be beneficial to other taxa, and mechanical cutting and prescribed burning may have detrimental effects on *P. p. niveiventris*. To evaluate the effects of land management techniques on *P. p. niveiventris* at Cape Canaveral Air Force Station, extensive trapping was done in management compartments during 2004-2005. We evaluated the relative abundance and related demographic parameters of small mammal populations under different land management treatments, and investigated the relationship between Florida scrub-jay breeding groups using these compartments and abundance of southeastern beach mice. Our results suggest that *P. p. niveiventris* responded positively to prescribed burning, while the cotton mouse (*P. gossypinus*) responded positively to the mechanical cutting. Reproduction and body mass of southeastern beach mice were similar across land management compartments. Abundance of Florida scrub-jay breeding groups and southeastern beach mice were positively correlated suggesting that both listed species benefited from the same land management activities. A mosaic of burned and cut patches should be maintained to support small mammal diversity. In addition, adaptive management should be used to understand how small mammals, particularly the southeastern beach mouse, respond to land management activities.

Population viability analysis was performed on the cape population of southeastern beach mice to the extent that our field data would support. Our model predicted the population is unlikely to suffer a cape-wide extinction event in the future. The model was constrained by a lack of data on litter size, survival of juveniles and subadults, and dispersal. Conventional grid trapping fails to yield these details unless radio tagging can be used to augment the mark and recapture efforts. Detailed study under natural conditions of reproduction of any species listed under the Endangered Species Act is problematic at best. Further improvements to the PVA would incorporate various management scenarios. For example, it would be useful to contrast mechanical treatment of inland scrub with the use of prescribed fire or a combination of treatments in various seasons.

ACKNOWLEDGEMENTS

We are very grateful for the opportunity to carry out this research in support of the mission of the 45th CES/CEVR Wing, Patrick Air Force Base, on Cape Canaveral Air Force Station. The ready assistance of Donald George, Michael Camardese, Angy Chambers, Ronald Bond, and Clay Gordin (Retired), and Dale Hawkins permitted the field work to go smoothly. The tireless efforts of our graduate students allowed the data collection to occur: Angelique DeLong, Megan Keserauskis, and Alex Suazo. A small army of undergraduates assisted in the field work and lab efforts: in no particular order, Shannon Letcher, Weldon Lavigne, Christi Cullen, Jonathan Kinney, Melissa Gonzalez, Meryl Green, Daniel Smith, Kristyn Feldman, Rebecca Ledesma, Daniel Hernandez, Leila Angelou, Melissa McClain, Jerry Leakey, Angie Ashcraft-Cryder, Kathryn Gillespie, Angelou Claire, April Verpoorten, Alaina Bernard, David Gunderson, Alisha Torrealba, Sara Klco, and Ashley Yankowich. Kathryn Gillespie was in charge of field work in the last year. Jacob "Jack" Degner worked with C. L. Parkinson to produce the genetic data on the southeastern beach mouse. Haakon Kalkvik assisted with field work during the last quarter, proofed the computer data files against the original field records, made the graphic materials for Chapter 1, and performed the PVA analysis. Victoria R. Sowell also proofed the computer data files against the original field records. The food habit studies were reported in a master's thesis by Megan Keserauskis. Alex Suazo wrote a master's thesis on land management practices on the cape and responses of small mammals to these practices. Our colleagues in the Department of Biology, John Fauth and Pedro F. Quintana-Ascencio, gave advice on statistics.

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THE DISTRIBUTION AND ABUNDANCE OF THE SOUTHEASTERN BEACH MOUSE (Peromyscus polionotus niveiventris) ON THE CAPE CANAVERAL AIR FORCE STATION

INTRODUCTION

The purpose of this project is five-fold: 1) to determine where within the Cape Canaveral Air Force Station (CCAFS) the Southeastern Beach Mouse (SEBM) (Peromyscus polionotus niveiventris) occurs and to assess its abundance and dynamics within the occupied habitat; 2) to document its genetic status; 3) to determine its food habits and food resources in various habitat settings, 4) to make management recommendations for immediate and longer term implementation; and 5) to provide a population viability analysis. Field work on the objectives (tasks) began June 30, 2003; lab and field efforts continued into 2006; and analysis and presentation of the results is ongoing. The original study was funded for two years. Another year of funding resulted in the field work continuing until the end of March 2006. This draft report covers all three years of the study.

Two reports have been provided on other work objectives. The first document [An Interim Report on the Responses of Small Mammals to Restoration and Management Techniques of Coastal Scrub at Cape Canaveral Air Force Station dated January 19, 2006] was provided to Mr. Donald George with the understanding that it was a draft and subject to change as some additional statistical treatment was anticipated. A second document [working title: Population Genetics and Conservation of the Threatened Southeastern Beach Mouse (*Peromyscus polionotus niveiventris*): subspecies and evolutionary units] is a manuscript and was provided to Mr. Michael Camardese on or about March 1, 2006. Those documents were in draft form and not for circulation outside the Environmental Planning and Conservation group of the 45th Space Wing.

This report is presented in its final form for the staff at Cape Canaveral Air Force Station. The report is organized around five chapters that vary in origin, style, format, and level of peer review. Chapter 1 is an original effort and lacks peer review. Chapter 2 is the manuscript now published in the journal Conservation Genetics (Degner, J. F., et al. 2007. Conserv Genet 8:1441-1452). Chapter 3 is a master's thesis and has been reviewed by the faculty committee. Likewise, Chapter 4 is a master's thesis and has been reviewed by the faculty committee. Finally, Chapter 5 is an original effort and lacks outside review. For the most part, the chapters stand along and may be read without reference to the rest of the report. The Executive Summary is an effort to summarize the findings within the chapter by editing the abstracts to reduce redundancy yet remain faithful to the interpretations of the original authors.

Chapter 1

POPULATION DYNAMICS OF SOUTHEASTERN BEACH MICE AND OTHER SMALL MAMMALS ON CAPE CANAVERAL

I. Jack Stout and Haakon M. Kalkvik

Introduction

This chapter presents a description of the population dynamics and attributes of southeastern beach mice on Cape Canaveral from November 2003 until the end of March 2006. Specific experiments are not claimed or reported here. These data give context and background for other work being done on the genetics of beach mice and their food habits. The hypothesis that shaped the sampling strategy was beach mice are not restricted to coastal dunes and swales with abundant cover of sea oats. We predicted beach mice are more likely to be limited by substrate and drainage than proximity of coastal dune features.

Prior Studies of the Southeastern Beach Mouse on Cape Canaveral

To the best of our knowledge, the first grid-level trapping of SEBM was done in front of LC-41 during the summer of 1975 (Stout 1979); earlier work reported by Ehrhart (1976) did not encounter the SEBM. Stout (1979) trapped two grids at monthly intervals for one night beginning in July 1976 and continued for 36 months, ending in July 1979. These two grids were in very different habitats. The grid near LC-41 (referenced as the beach grid in Stout 1979) included the primary and secondary dune lines as well as coastal strand vegetation. The second grid (referenced as the dune scrub grid in Stout 1979) was 1.5 km inland from the so called "beach grid" and supported smaller numbers of SEBM over the study period (Stout 1979). The beach grid was last trapped by Stout in September 1979 immediately after Hurricane David passed by the Cape. In 1986, Humphrey et al. (1987) sampled SEBM on transects (Sites MI-1, 2, and 3) on the Cape. Nine, 11 and zero (0) SEBM were captured at sites 1, 2, and 3, respectively. Site MI-3 was an inland location near Stout's dune scrub grid. The capture success in the Humphrey study was based on sightly more that 100 trap nights at each site. Densities of SEBM near LC-40 on CCAFS were estimated around 1990 (by Mark Mercadante); the highest densities were found to be associated with coastal strand vegetation rather than the primary dune. This result was consistent with the analysis of the "beach grid" data (Extine and Stout 1987). In addition, FNAI carried out a survey for small mammals on the CCAFS in 1995 prior to Hurricane Erin. Oddy (2000) established four sampling grids on the south beaches of the CCAFS and sampled quarterly from September 1995 through October 1997. She accumulated 9913 actual trap nights and marked and released 639 individual beach mice. Stout (1998) relocated SEBM from LC-37 prior to construction activities. The original beach grid near LC-41 was trapped again the summer of 2001 and has been monitored since than (D. Oddy personal communication).

Recent Observations of Beach Mice in the Interior of the Cape and in Structures at CCAFS

Beginning in 1989, SEBM were observed up to 1 km from typical primary dune habitat at CCAFS. As noted in the previous section, ruderal areas around several of the launch complexes adjacent to the dune habitat were found to be occupied by SEBM. In 2001, the SEBM was found to be established near the west end of the CCAFS Skid Strip (airfield). Further efforts by CCAFS biologists revealed SEBM at three separate locations 2.5 to 3.5 miles (4.0 to 5.6 km) from primary dune systems. In spite of earlier evidence of SEBM interior to primary dunes (Stout 1979), these collective observations suggested widespread use of open sandy areas within the interior of the cape, which was surprising. What was even more remarkable was the apparent use of buildings and facilities on CCAFS by SEBM. Nothing in the known literature has documented Peromyscus polionotus using buildings as home sites or as a source of food. Burrow building and burrow use has been assumed to be innate. Nonetheless, beginning in 1996, CCAFS biologists confirmed SEBM were to be found in certain buildings at launch complexes adjacent to the dune habitat. In January 2002, mice were reported in a variety of buildings and facilities. Again, the individuals were identified as SEBM. Records of mice associated with buildings and facilities from January through June of 2002 revealed that 40 SEBM and 42 mice (Mus, etc.) were handled. This is a remarkable and unexpected result. Conventional wisdom would have predicted house mice (Mus musculus) and cotton mice (Peromyscus gossypinus) as cohabiting with humans in buildings during winter. The events that resulted in similar behavior on the part of SEBM remain unidentified. [This section is based on notes, observations, and written records accumulated by the 45 Space Wing (45SW).]

Habitat Fragmentation and Beach Mice

The continuity of the vegetative cover of the cape has been altered by past land use practices and since the 1960s by the space program. Roads and other rights of way divide the vegetation into habitat fragments. Many of these fragments now support local populations of SEBM. Taken collectively, the fragments represent the habitat of the species on CCAFS. Population theory suggests that smaller fragments will support local populations that occasionally go extinct (Pulliam 1988). Dispersal of SEBM from nearby and perhaps larger fragments will repopulate these fragments over time (Smith 1968, Garten and Smith 1974, and Oddy et al. 1999). If the SEBM maintains itself in such a patchy habitat by intrinsic or density dependent dispersal, it is acting as a metapopulation (Howe and Davis 1991). The sum of all the populations from all the habitat fragments would represent the metapopulation. Theory suggests that some habitats tend to produce a surplus of individuals that disperse every year (Pulliam 1988). These habitats are called “sources”. Habitats that support populations that do not replace their natural losses are called “sinks”. Dispersal from source to sink habitats maintains the sink populations. Recent experiments reported by Gundersen et al. (2001) demonstrates that source populations may not increase in size because of high loss rate to sink patches. Dias (1996) shows that the status of a particular habitat fragment, i.e., source or sink, may be determined by short term environmental conditions, which might be either favorable or unfavorable. In either case, the population behavior could be expected to reverse itself in the future. Short term studies based only on mark-recapture techniques would not be capable of identifying source-sink habitats with a high level of confidence. A combination of demographic, trophic, and genetic data should overcome many of these problems. Lastly, the implications of source-sink dynamics of one species in a landscape that is being managed for another species has not been studied.

Large scale disturbances could influence multiple habitat patches to include source and sink populations and result in local extinctions over wider areas. Again, at a far greater spatial scale, dispersal from source and sink habitats outside the influence of the disturbance would over time repopulate the impacted areas. Howe and Davis (1991) suggest that in the context of metapopulation dynamics, marginal habitats and marginal (=sink) populations should be included in management planning.

Here we show that southeastern beach mice are found in greater numbers within coastal scrub dominated by oak and palmetto than on the coastal dunes and swales. A clear demostration of source and sink habitats is not made, however.

Methods

Study Area

Primary Dune System

The coastline of the cape was sampled for the presence of the SEBM from the vicinity of the Trident Sub Basin north to the boundary with KSC (ca 24 km). Standard Sherman traps were placed at 15 m intervals in two continuous transects separated by 10-15 meters. Typically transects covered 1,500 meters of coast line each night. All of the small mammal captures were ear tagged and processed to provide hair samples for stable isotope analysis and tissue for later genetic studies. Aerospace operations delayed trapping in the northern sector; however, sampling was completed October 1, 2003.

Compartments

Sampling of burn compartments started in late summer of 2003 (Figure 1). Transects similar to those employed on the primary dune system were installed. Trap stations and transect end points were recorded with a GPS unit. Captures were ear tagged and processed to include the collection of hair and tissue samples.

Grids

Three grids were installed in the primary dune system to track demographic changes in small mammals in what has traditionally been considered the "optimal" or "primary" habitat of the SEBM (Figure 2). Width of the primary and secondary dune lines varied enough to preclude setting up 8 x 8 grids on each site. Each grid was sited in a row and column arrangement to maintain sampling within relatively homogeneous habitat. Row and column details for the grids are as follows: Beach Grid 1: 8 by 8; Beach Grid 2: 4 by 16; and Beach Grid 3: A line: 8; B line 20; C line 18; and D line 18. Each trap station was marked with a pvc pipe approximately 1.5 m in height. A numbered metal tag was attached to the pipe to insure that location of captures and the associated data would be recorded with a minimum of errors with respect to locations.

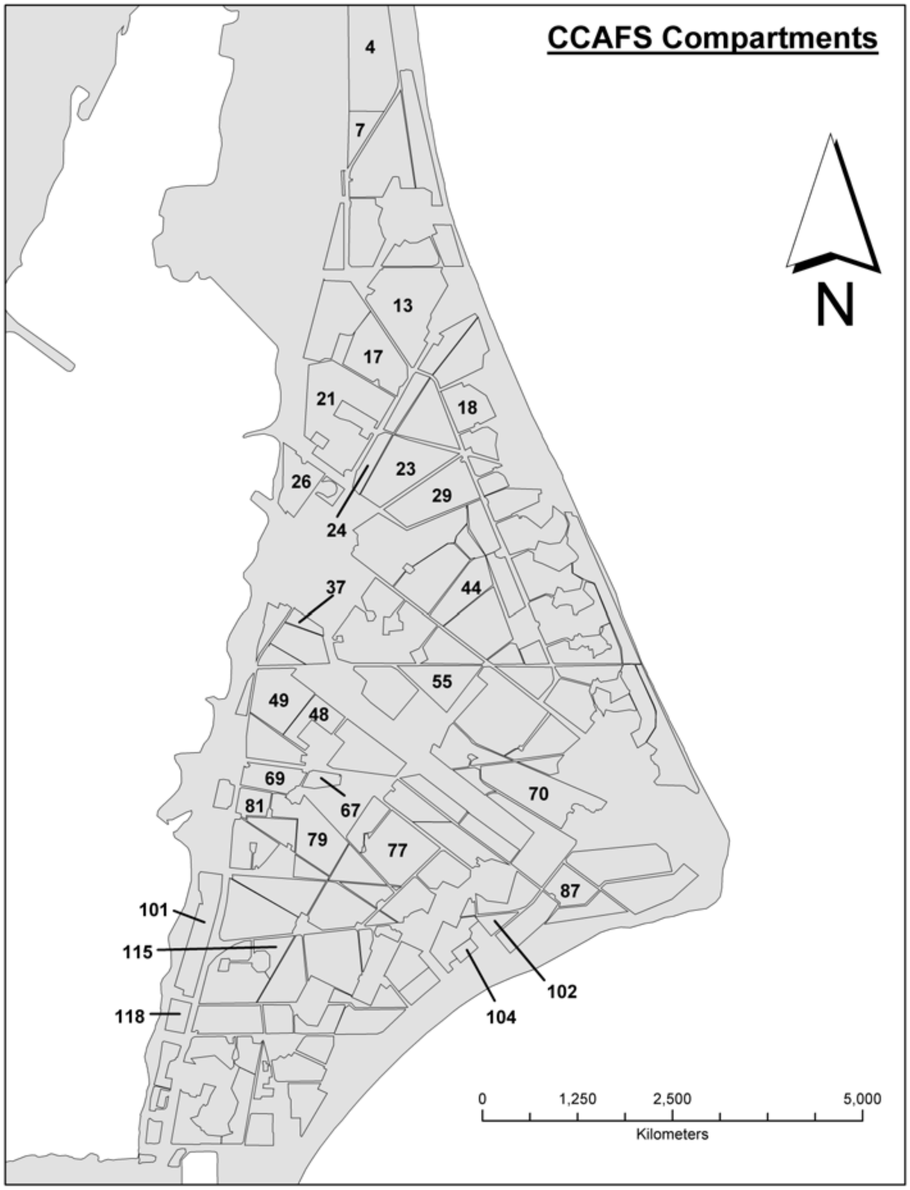

Figure 1. Selected burn compartments on Cape Canaveral Air Force Station where small mammal trapping occurred from July 2003 to the end of March 2006.

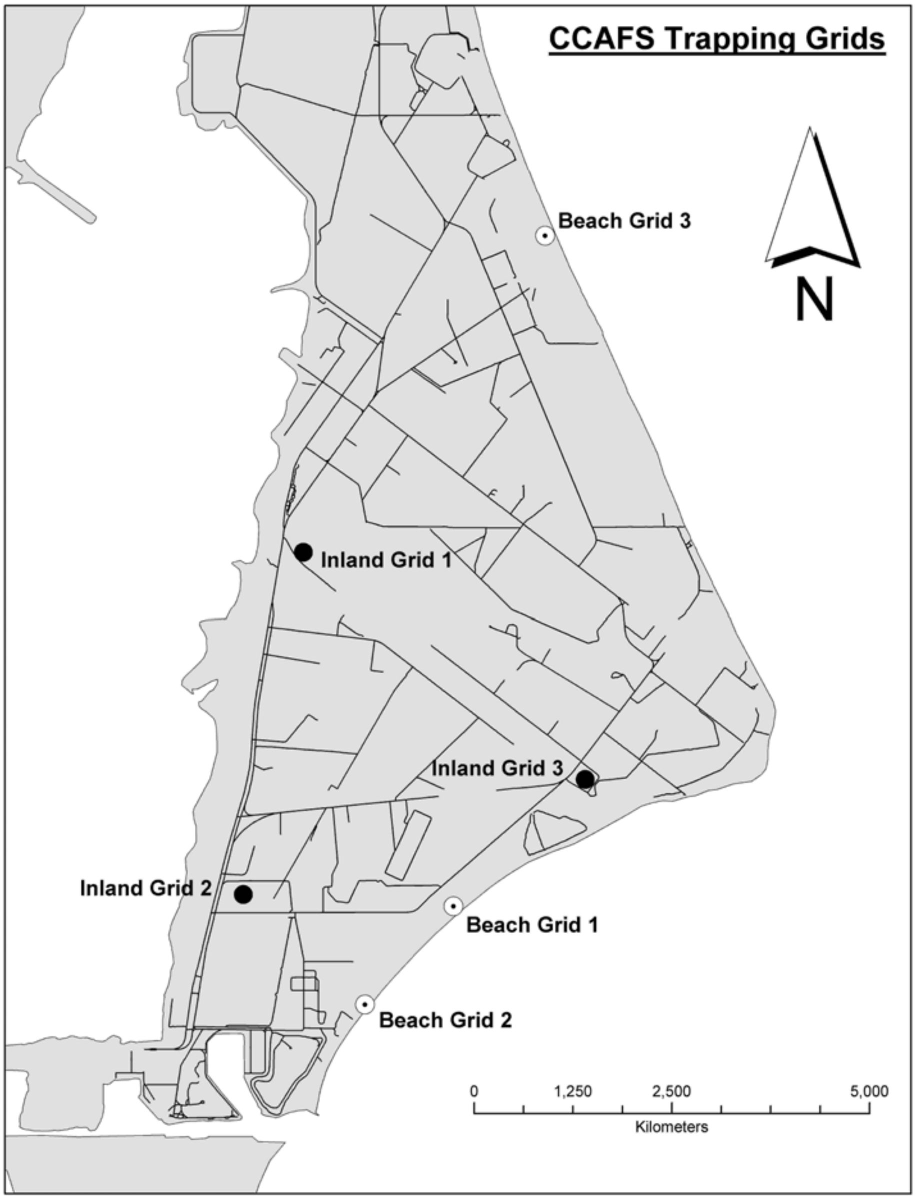

Figure 2. The location of six small mammal trapping grids on Cape Canaveral Air Force Station, 2003-2006.

Two grids were installed in coastal scrub and one in coastal strand to provide demographic data on the small mammals (Figure 2). Each of these grids was comprised of 8 rows and 8 columns to delimit 64 trap stations spaced at 15 m intervals. Grids on the dunes and inland were assumed to sample 1.44 hectares. This area is obtained by adding a buffer that is half a trap interval wide, i.e., 7.5 m, around the "ideal" 8 x 8 m configuration.

Each trap station (inland and coastal) was equipped with a Layne predator excluder (Layne 1987), one ventilated standard Sherman live trap (22.9 x 8.9 x 7.6 cm; H. B. Sherman Traps, Inc., Tallahassee, Florida), and a shade cloth cover. Large sun flower seeds were provided as bait. During the winter, cotton balls were added to allow the captures to make nests. Traps were not opened if night time temperatures were predicted to be below 50 degrees F (Fish and Wildlife Service guidelines for the study of beach mice make this a condition of any field work).

The grids were installed over several months with initial trapping begun in November 2003. Overlap of trapping across all grids did not occur until February 2004. Trap cycles were scheduled to occur at two week intervals with a single night of trapping per cycle. Traps were opened in the afternoon and checked after daylight the following morning.

Captures of small mammals were processed in the field at the site of capture. Captures were identified to species, ear tagged, placed in an age class based on pelage and molt characteristics (juvenile, subadult, or adult), sexed, characterized as to the reproductive condition (males: testes abdominal or descended and females: vagina perforate or imperforate and mammaries developed, hair pulled, or no development), and the body mass taken with a Pesola spring balance. Any female showing signs of pregnancy was recorded. For all first captures, hair was clipped from the hip region for stable isotope analysis, fecal pellets were collected for food habit analysis, and skin from the tip of the tail was collected for genetic study. Recaptured animals were examined for age, sex, reproductive condition, and body weight. Hair was not resampled unless a complete molt was known to have occurred since the last sample. Feces were collected from recaptures. Tissue for genetic study was collected once per individual. Captures were released at the site of capture.

Habitat variables were measured or estimated on each grid during 2005. The local variation in plant species composition, density, canopy coverage, and height was assessed at the scale of individual trap stations. Short line transects were used to measure the variation among trap stations (Jorgensen et al. 2000). One 10 m line transect was randomly located at each trap station on each grid (64 station x 10 m = 640 m of transect per grid). The direction of the transect was based on a random draw from 0 to 360 degrees centered on the trap station. For example, 20 degrees would put the transect in the north east and south west quadrants. The transect was defined with a reel-style metric tape extended 5 m from the center of the hypothetical 15 x 15 m quadrat. Trap stations with dense shrubby cover were studied by extended nested sections of pvc pipe in place of the meter tape.

Population dynamics of the southeastern beach mouse are exhibited as trends in the minimum number known to be alive (MNKA) by grid and time period. Minimum numbers is a count of animals that are alive at each time period. The count is not based on a statistical distribution and a confidence interval cannot be calculated. Minimum numbers is closely correlated with the estimates from mark-recapture methods that include various assumptions, e.g., stationary populations, closed populations, and random captures (Slade and Blair 2000). No assumptions are in play when minimum numbers are calculated.

Survival of southeastern beach mice on the various grids was determined using the program MARK. Additional details on survival calculations are found in Chapter 5.

Our small mammal trapping and processing procedures followed guidelines approved by the American Society of Mammalogists (Animal Care and Use Committee 1998) and the Institutional Animal Care and Use Committee, University of Central Florida. Trapping was done under permits to I. J. Stout by the State of Florida Fish and Wildlife Conservation Commission and the U.S. Fish and Wildlife Service.

Results

Survey of Coastal Dunes of Cape Canaveral

The initial sampling of southeastern beach mice was done during the summer of 2003 on the 24 km coast line from the jetty at the entrance of the turn basin to the boundary with the Kennedy Space Center. Beach mice were not present on many sections of the coast line (Figure 3). Thirty seven individuals, 16 females and 21 males, were captured (Table 1). Other captures included cotton mice (2), cotton rats (10), and spotted skunks (1).

Burn compartments were sampled as part of the survey of the cape during the summer of 2003 (Figure 1). Transects of live traps were placed in compartments 4, 7, 17, 18, 21, 23, 24, 26, 29, 44, and 49. Beach mice were present in compartments 4, 7, and 27. Cotton mice were trapped in 10 of 12 compartments and cotton rats in three. Spotted skunks were found in two compartments.

Two of the beach mice caught during the summer beach survey were later recaptured on Beach Grid 2 and one cotton mouse caught during the summer inland survey was later recaptured on Inland Grid 1.

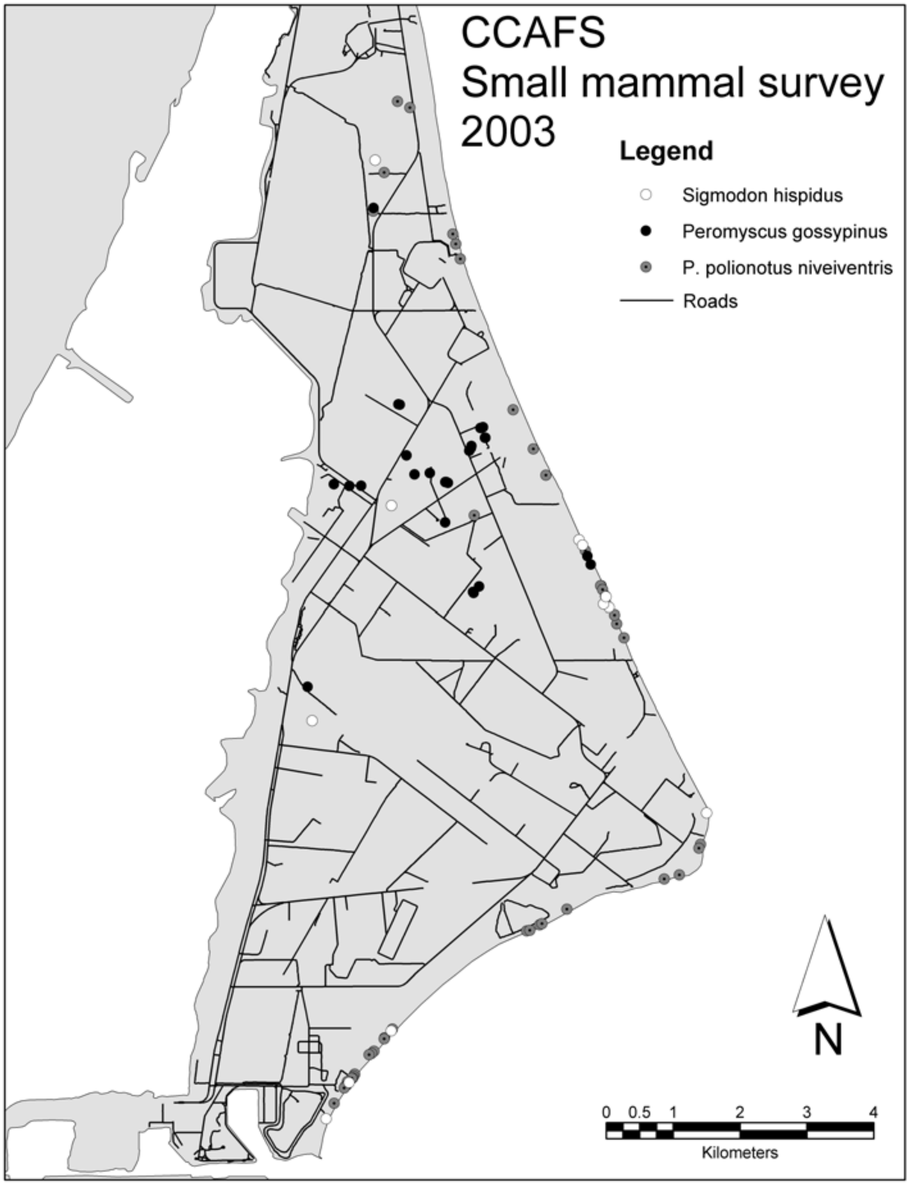

Figure 3. Spatial distribution of captures of small mammals on portions of Cape Canaveral Air Force Station, July-October 2003. The entire 24 km coast line was live trapped as well as selected burn compartments. See the text for details on methods.

Table 1. Species and sex composition of small mammals live trapped on the primary dune system or within burn compartments of Cape Canaveral Air Force Station, summer 2003. Specific locations of the captures are indicated in Figure 3.

Species	Location/Compartment	Female	Male	Total
Peromyscus polionotus niveiventris				
	Beach	16	21	37
	Inland 4	1	2	3
	Inland 7	1	0	1
	Inland 27	0	1	1
Peromyscus gossypinus				
	Beach	1	1	2
	Inland 7	0	1	1
	Inland 17	3	1	4
	Inland 18	4	3	7
	Inland 21	1	1	2
	Inland 23	2	3	5
	Inland 24	1	0	1
	Inland 26	1	0	1
	Inland 29	1	0	1
	Inland 44	1	2	3
	Inland 49	1	0	1
Sigmodon hispidus				
	Beach	8	2	10
	Inland 4	0	1	1
	Inland 24	1	0	1
	Inland 49	1	0	1
Spilogale putorius				
	Beach	na	na	1
	Inland 21	na	na	2
	Inland 29	na	na	1

Beach Grid Trapping Results

Results of trapping three grids positioned on the coastal dunes have been summarized in terms of the number of individual beach mice that were tagged and released alive. One-hundred thirty-nine individuals were released on beach grid 2, 90 on beach grid 1, and 64 on beach grid 3 (Table 2). These individuals were captured on 989 occasions (Appendix 1). Adults dominated the age structure on grids 1 and 2 but not on grid 3. Sex ratios were not significantly different from 1:1($p > 0.05$) on beach grid 1 (chi-square = 0.4), beach grid 2 (chi-square = 0.89), and beach grid 3 (chi-square = 1.0). Trends in the minimum numbers known to be alive revealed the three beach grids followed different trajectories from 2003 into 2006 (Figures 4, 5, and 6).

Beach mice on beach grid 1 increased in numbers from November 2003 until June 2004 when a gradual decline began, which continued through the period of hurricanes (Figure 4). The decline ended in January 2005 and numbers increased until May only to decline until February 2006. Minimum numbers were increasing at the end of the study in March 2006. Minimum numbers of beach mice on beach grid 1 did not suggest a major decline could be associated with the hurricanes in August and September 2004. The age structure of beach mice on beach grid 1 was dominated by adults in most trapping sessions (Figure 7). Subadults were recorded in the February-March of 2004-2006. However, subadults were also found in May and August. Juveniles were seldom trapped but were recorded in April and October. The numbers of males and females at each trap session tended to be closely correlated with some exceptions when males were more numerous, e.g., June 2004 and May 2005 (Figure 8). Trends in body weight of males and females provide indirect evidence of reproduction (Figure 9). For example, mean female body weights increased well beyond the males during the fall and winter of 2003-2004 and again in the fall and winter of 2004-2005. Pregnant females accounted for this deviation (unpublished data); however, these results were in conflict with the lack of juvenile captures (Figure 7) noted earlier. The pattern of heavier females in the fall was absent in 2005.

Minimum numbers of beach mice on beach grid 2 peaked in early 2004 and 2005, whereas the increase in 2006 was very modest (Figure 5). A seven fold increase occurred between December 2003 and February 2004. Thirty or more individuals were present from February through April. Minimum numbers declined steadily from May until November of 2004. The fall decline was associated with the period of hurricanes. A modest recovery of minimum numbers was observed in the period from January to May; thereafter, numbers declined through October 2005. Adult mice dominated the samples at most trap sessions (Figure 10). Near parity between subadults and adults was observed in April 2004. Most of the subadults were present during the spring months. Juveniles were trapped in November 2003 and February-April 2004. Female beach mice dominated the samples from trap sessions during spring and early summer of 2004 (Figure 11). Male and Female numbers were nearly equal during the first five months of 2005. Slightly more males than females were trapped from mid-2005 until March 2006. Body weights of beach mice supported the notion that reproduction was occurring the fall and winter of 2003-2004 (Figure 12). However, male and female weights were strongly overlapping from April to September of 2004. Although the sample size of females was small during the fall and winter of 2004-2005, the weight trends were consistent with another bout of reproduction. Small samples of females from November 2005 until March 2006 suggest heavier individuals were reproductive.

Minimum numbers of beach mice on beach grid 3 peaked at 18 in April 2004 and declined through the hurricane events in August and September (Figure 6). The population remained with two to four individuals throughout 2005 with a modest increase underway in February and March 2006. Sixty-four individuals were marked and released during the study (Table 2). Adults, subadults, and juveniles were present in April 2004 when trapping was begun (Figure 13). Small numbers of adults were present through the summer and fall of 2004. Single subadults were observed in June and August of 2005. Subadults dominated the increasing population in 2006. Males dominated the population from March 2004 until October 2004 (Figure 14). Captures were limited to females from March to June of 2005. Body weights of female beach mice captured in October and November of 2004 were typical of pregnant animals (Figure 15). Females captured in May and June of 2005 were heavy enough to be in reproductive condition or pregnant. Likewise, females captured in February and March of 2006 were likely pregnant.

Estimates of overall survival of beach mice were derived from program Mark (Figure 16). A comparison of the beach grids indicated the highest survival on grid 1, similar but slightly lower survival on grid 2, and the lowest and most variable survival on grid 3.

Table 2. Age and sex composition of southeastern beach mice captured on the beach grids from November 2003 until the end of March 2006. Individuals appear once in these totals.

Grid	Age	Female	Male	Total
Beach 1				
	Adult	26	34	60
	Subadult	14	14	28
	Juvenile	2	0	2
	Total	42	48	90
Beach 2				
	Adult	54	42	96
	Subadult	16	20	36
	Juvenile	2	5	7
	Total	72	67	139
Beach 3				
	Adult	23	15	38
	Subadult	5	20	25
	Juvenile	0	1	1
	Total	28	36	64

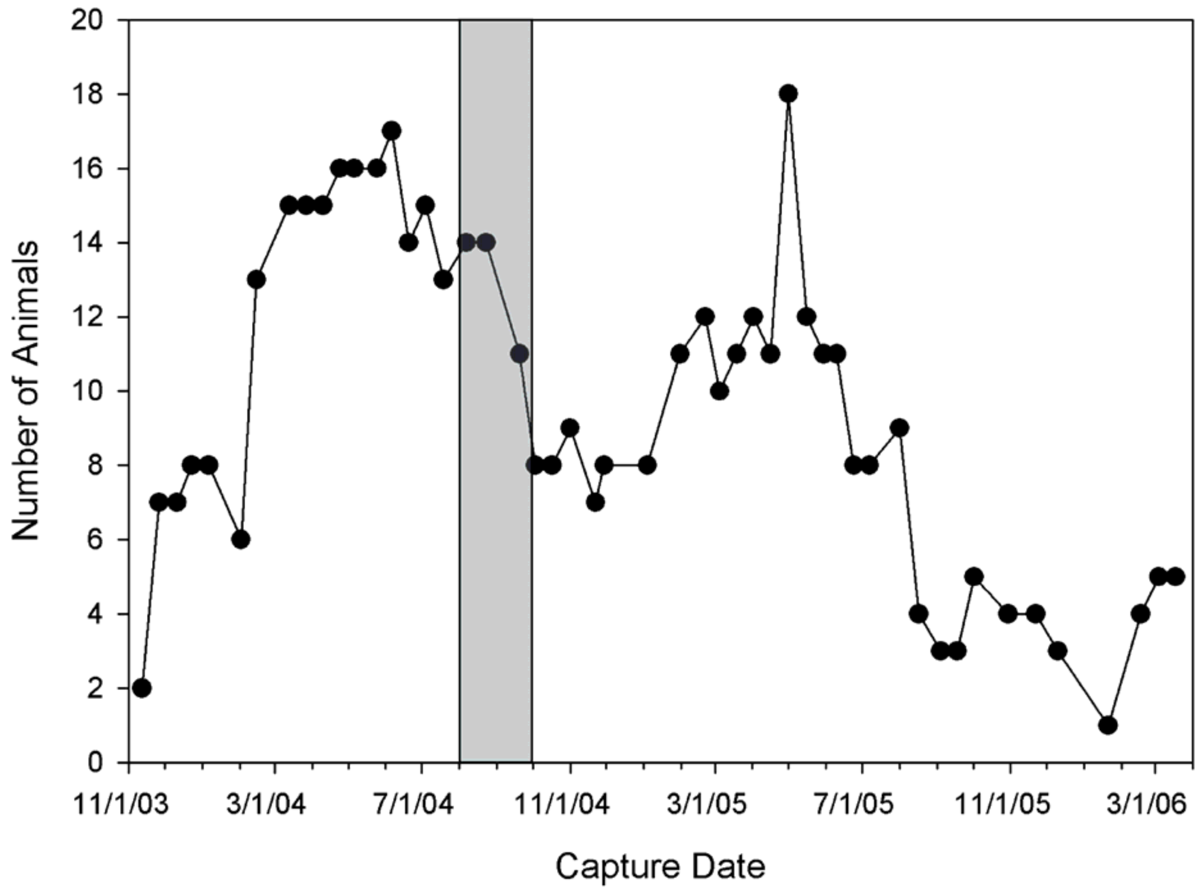

Figure 4. Minimum number known alive of southeastern beach mice on beach grid 1, Cape Canaveral Air Force Station from November 2003 until the end of March 2006 (29 months). Hurricanes Charlie (August 12), Francis (September 4), and Jean (September 25) occurred in 2004 (shaded bar). The dune system was most impacted by Jean.

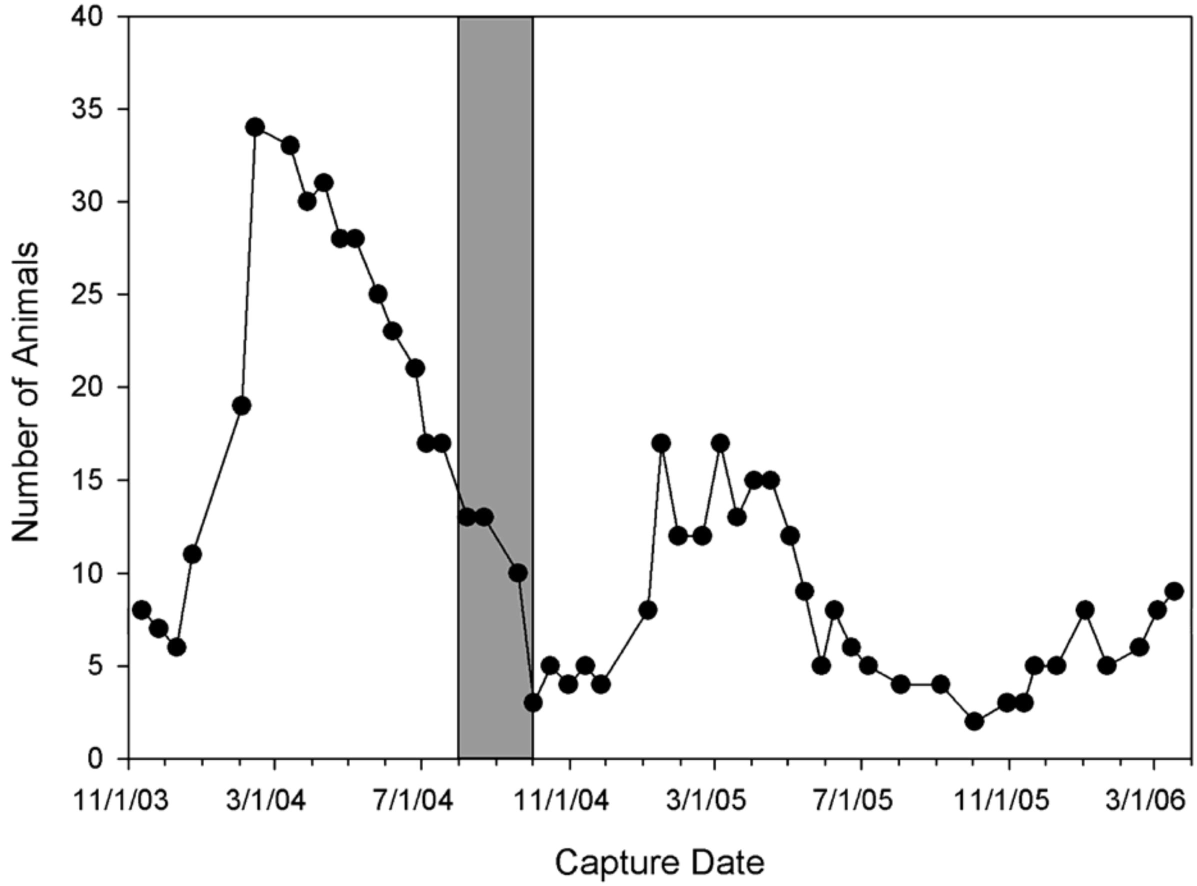

Figure 5. Minimum number known alive of southeastern beach mice on beach grid 2 from November 2003 until the end of March 2006 (29 months). The period of hurricane influence (shaded bar) is explained in Figure 4.

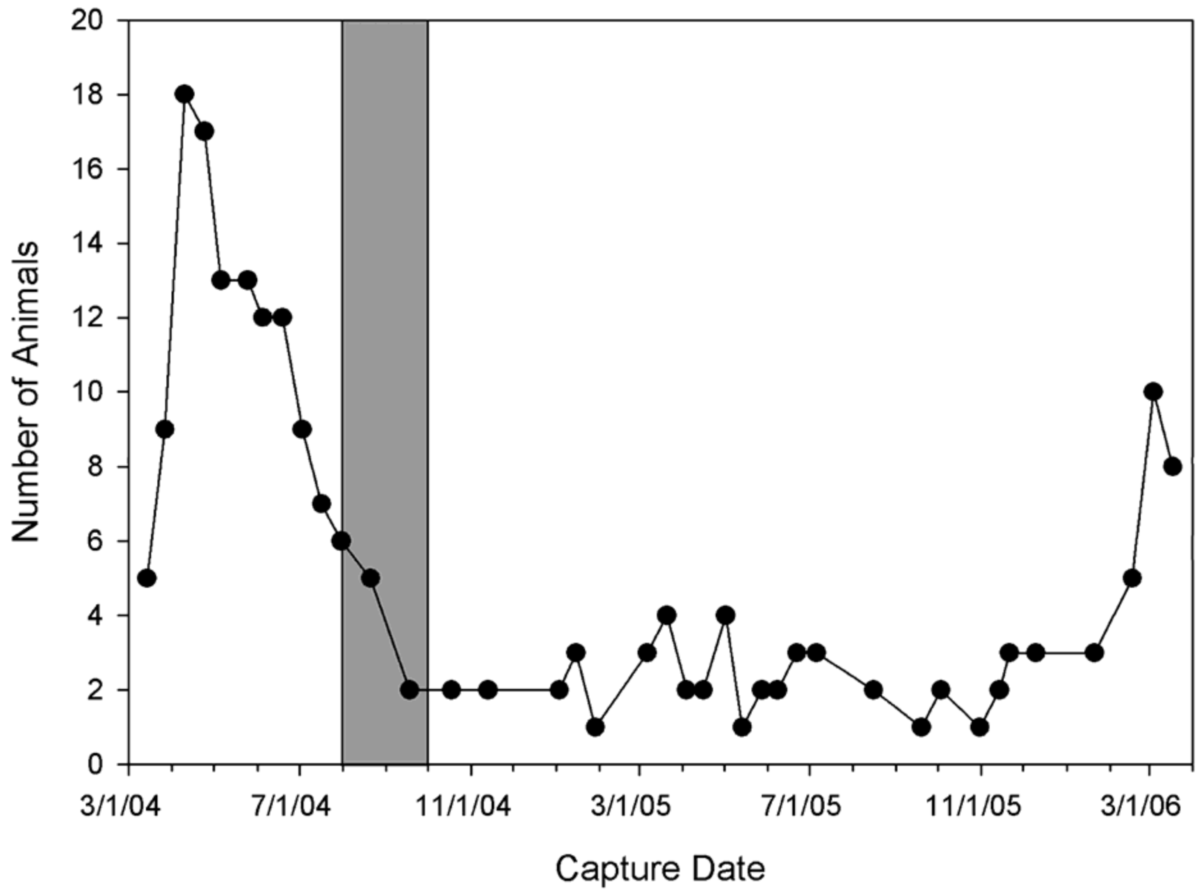

Figure 6. Minimum number known alive of southeastern beach mice on beach grid 3 from April 2004 until the end of March 2006 (24 months). The period of hurricane influence (shaded bar) is explained in Figure 4.

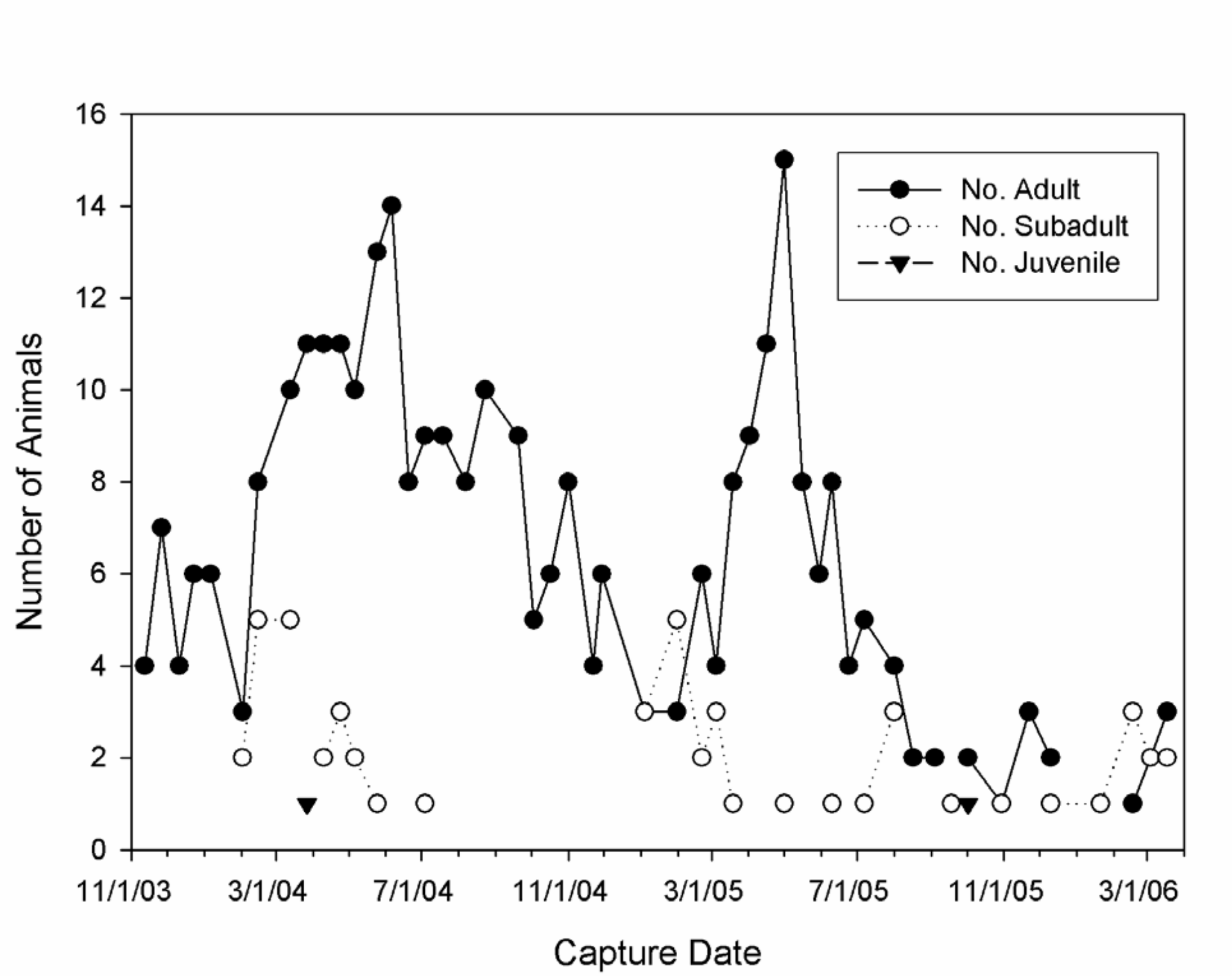

Figure 7. Age classes of captures of southeastern beach mice on beach grid 1 from November 2003 until the end of March 2006.

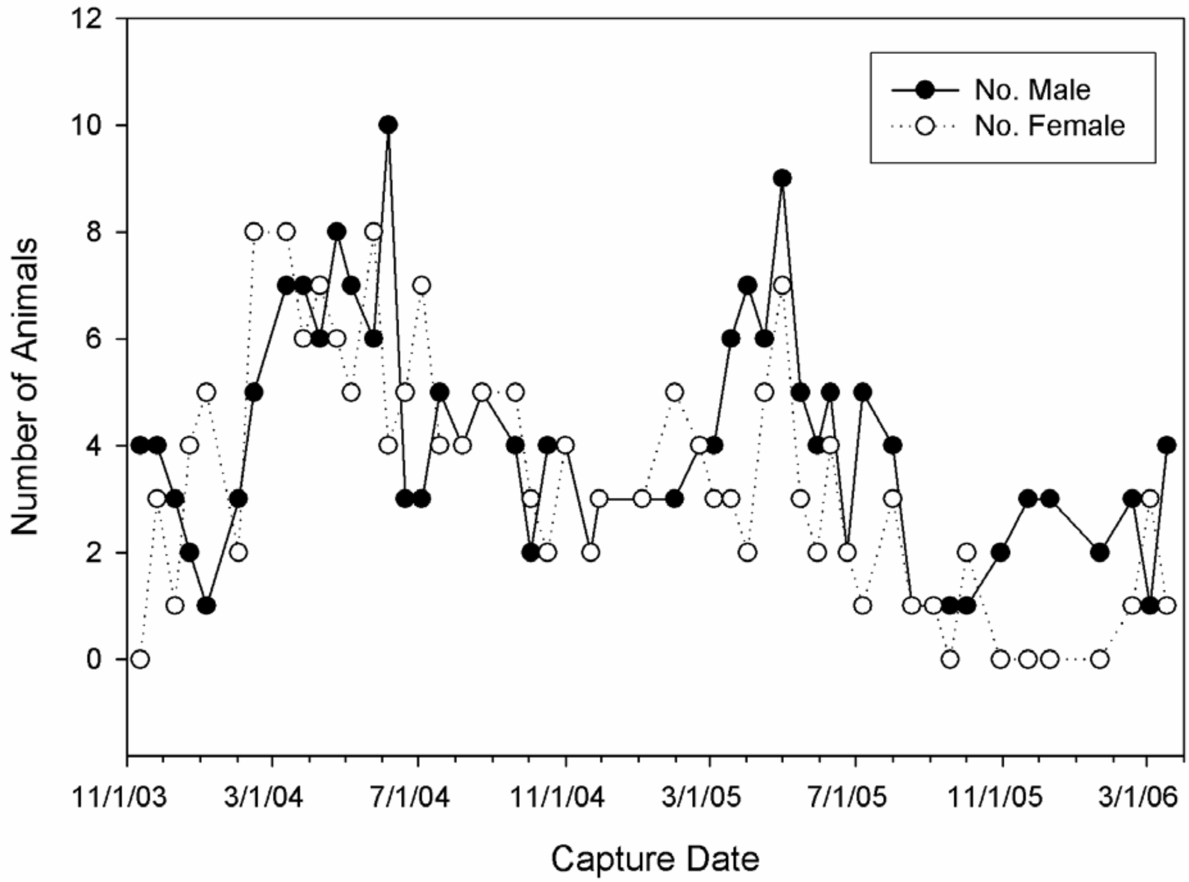

Figure 8. Sex composition of captures of southeastern beach mice on beach grid 1 from November 2003 until the end of March 2006.

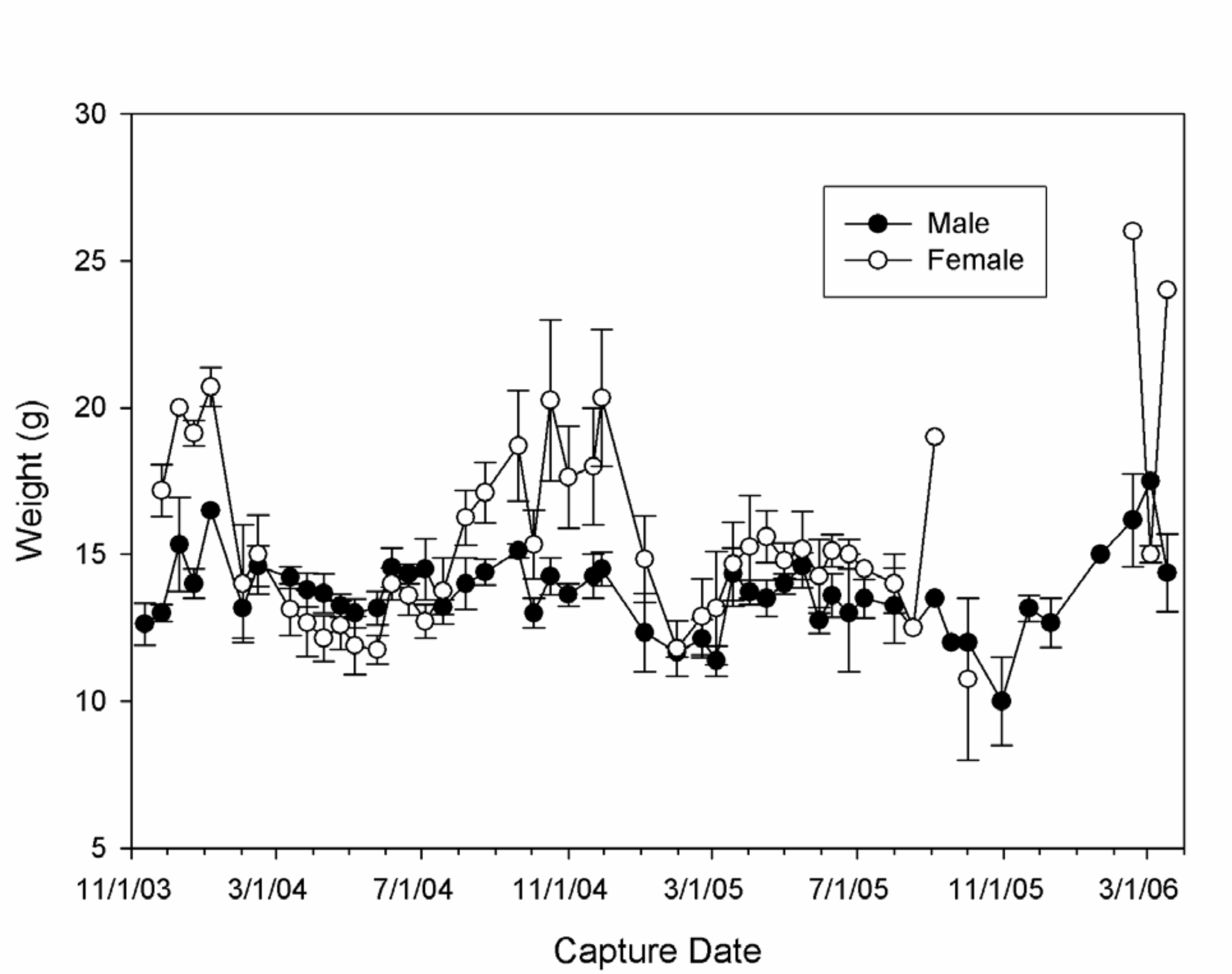

Figure 9. Mean body mass (g) and one standard error of male and female southeastern beach mice captured on beach grid 1 from November 2003 until the end of March 2006.

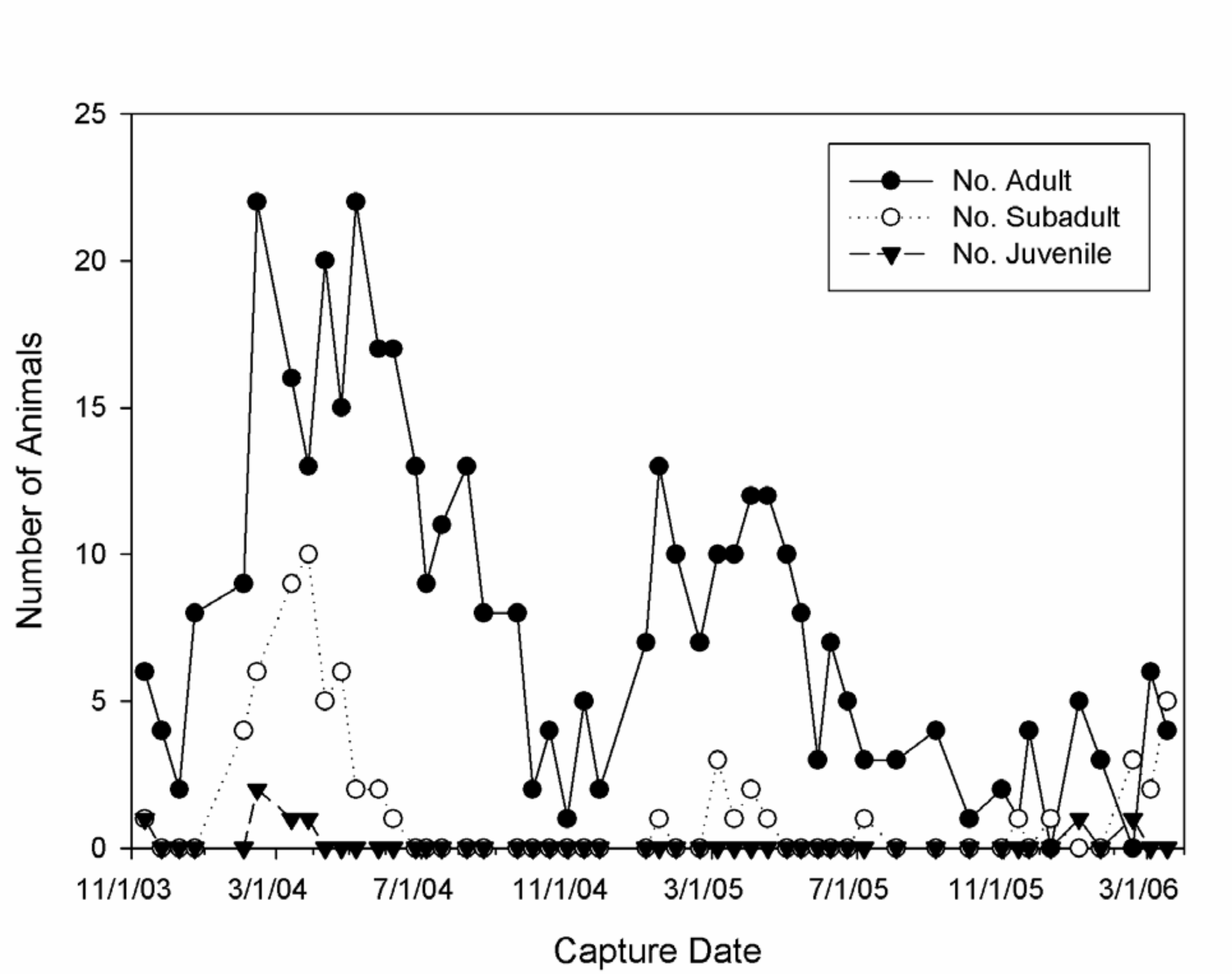

Figure 10. Age classes of captures of southeastern beach mice on beach grid 2 from November 2003 until the end of March 2006.

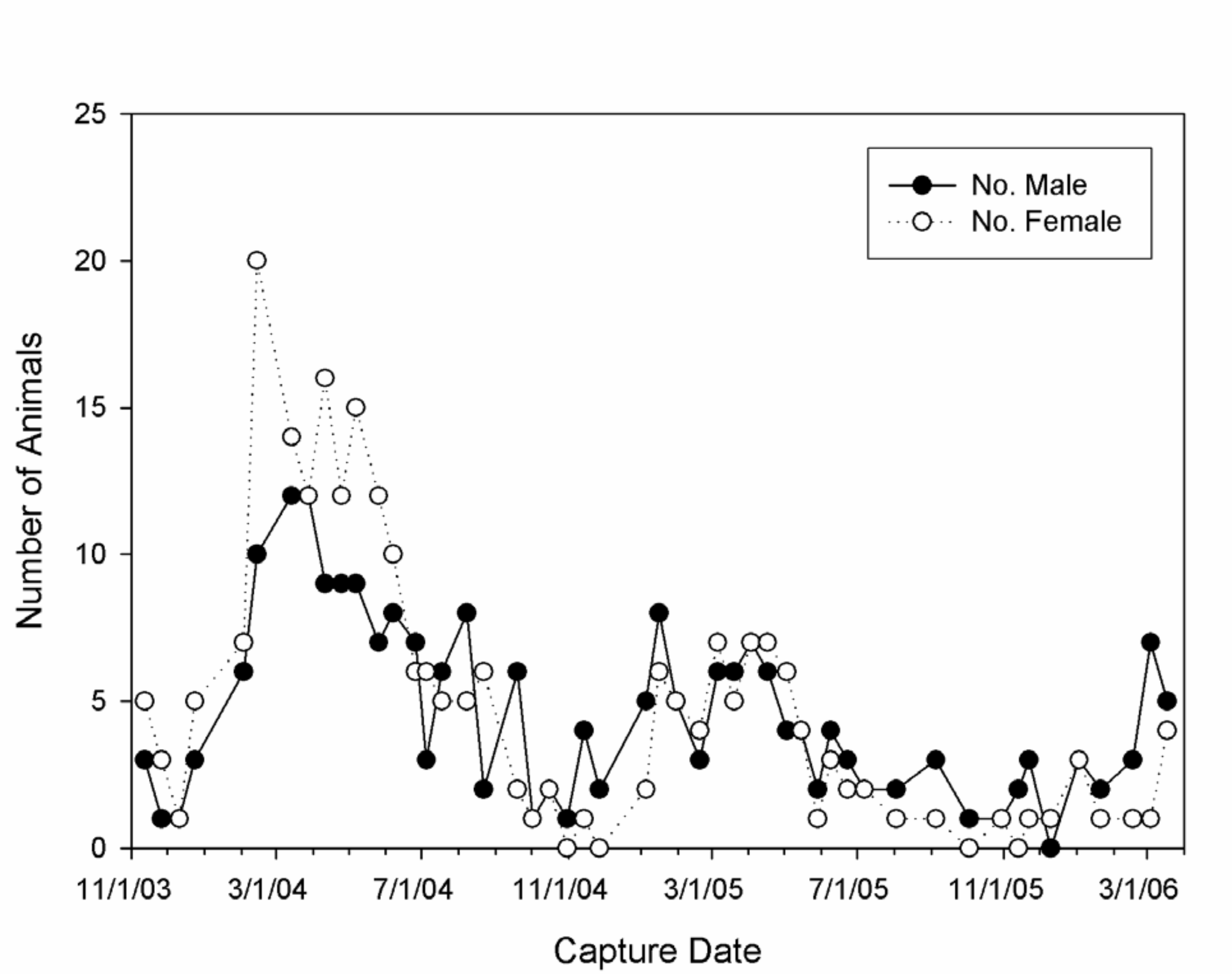

Figure 11. Sex composition of captures of southeastern beach mice on beach grid 2 from November 2003 until the end of March 2006.

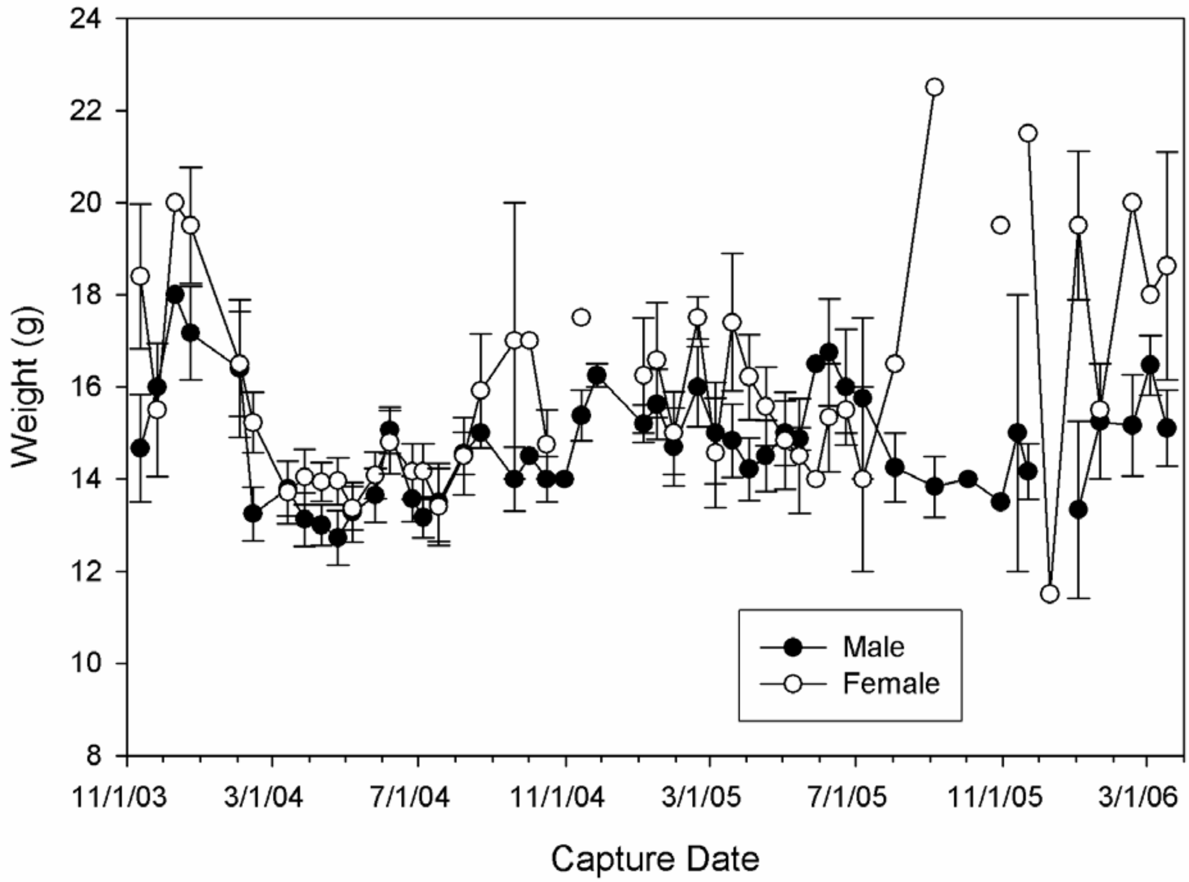

Figure 12. Mean body mass (g) and one standard error of male and female southeastern beach mice captured on beach grid 2 from November 2003 until the end of March 2006.

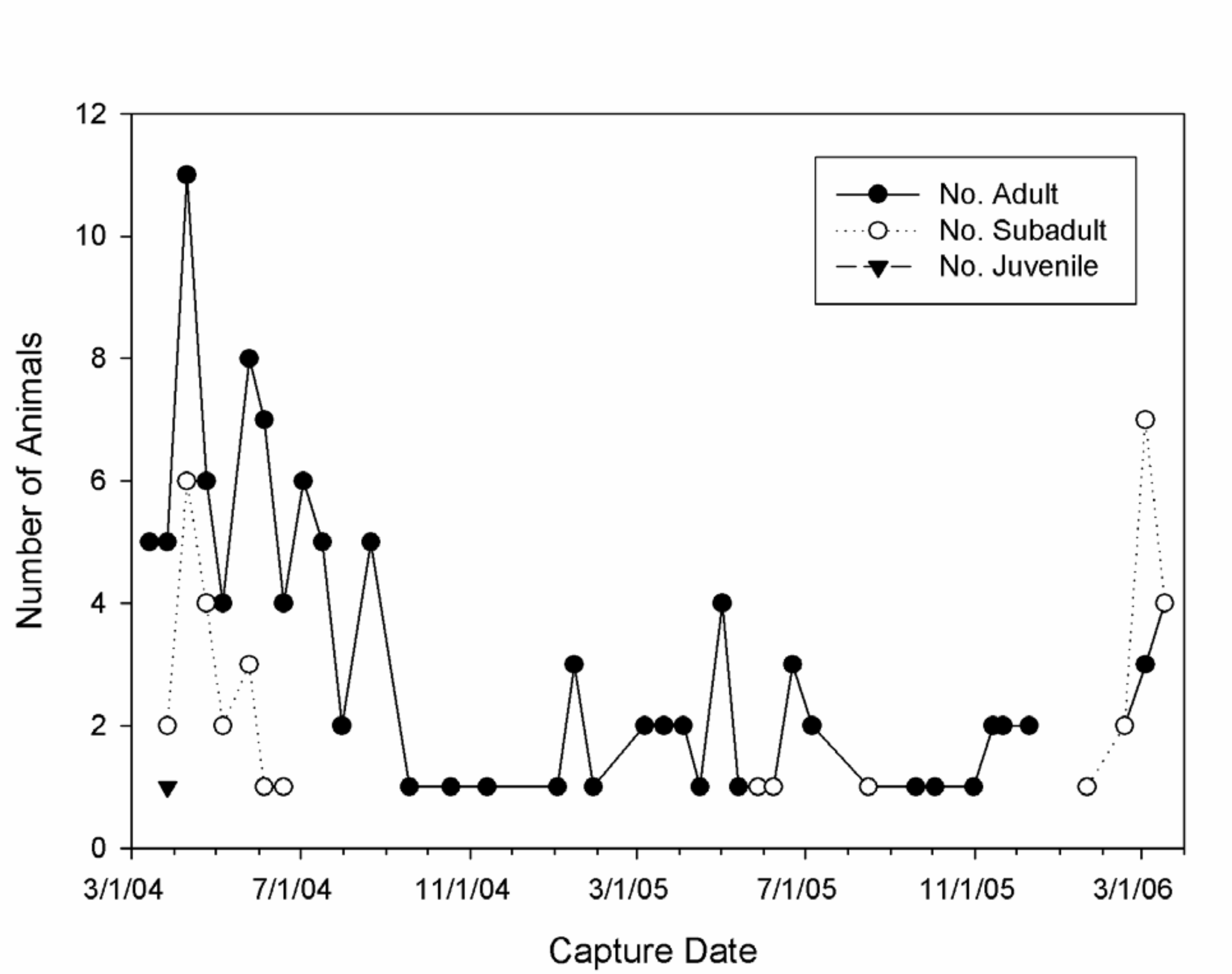

Figure 13. Age classes of captures of southeastern beach mice on beach grid 3 from March 2004 until the end of March 2006.

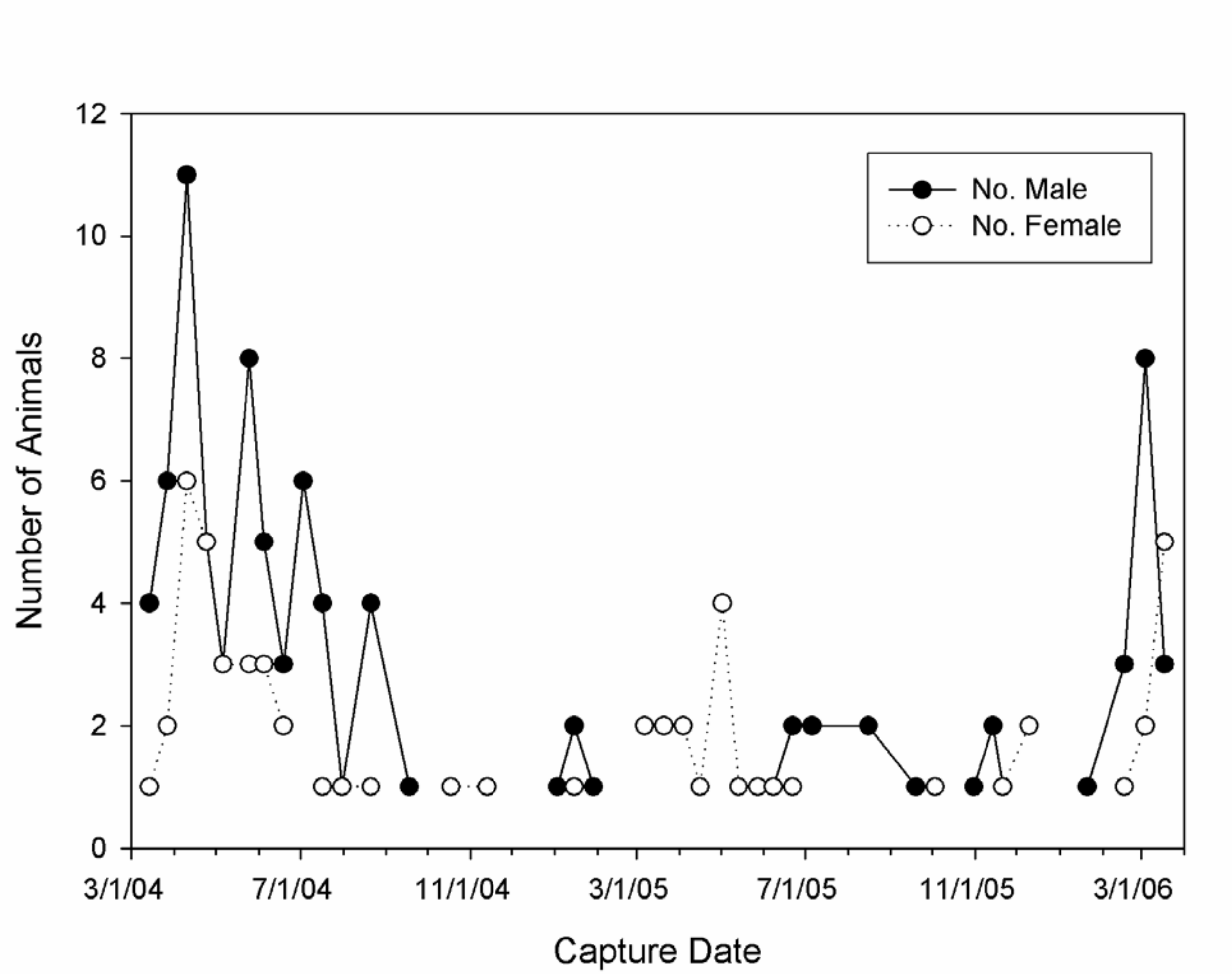

Figure 14. Sex composition of captures of southeastern beach mice on beach grid 3 from March 2004 until the end of March 2006.

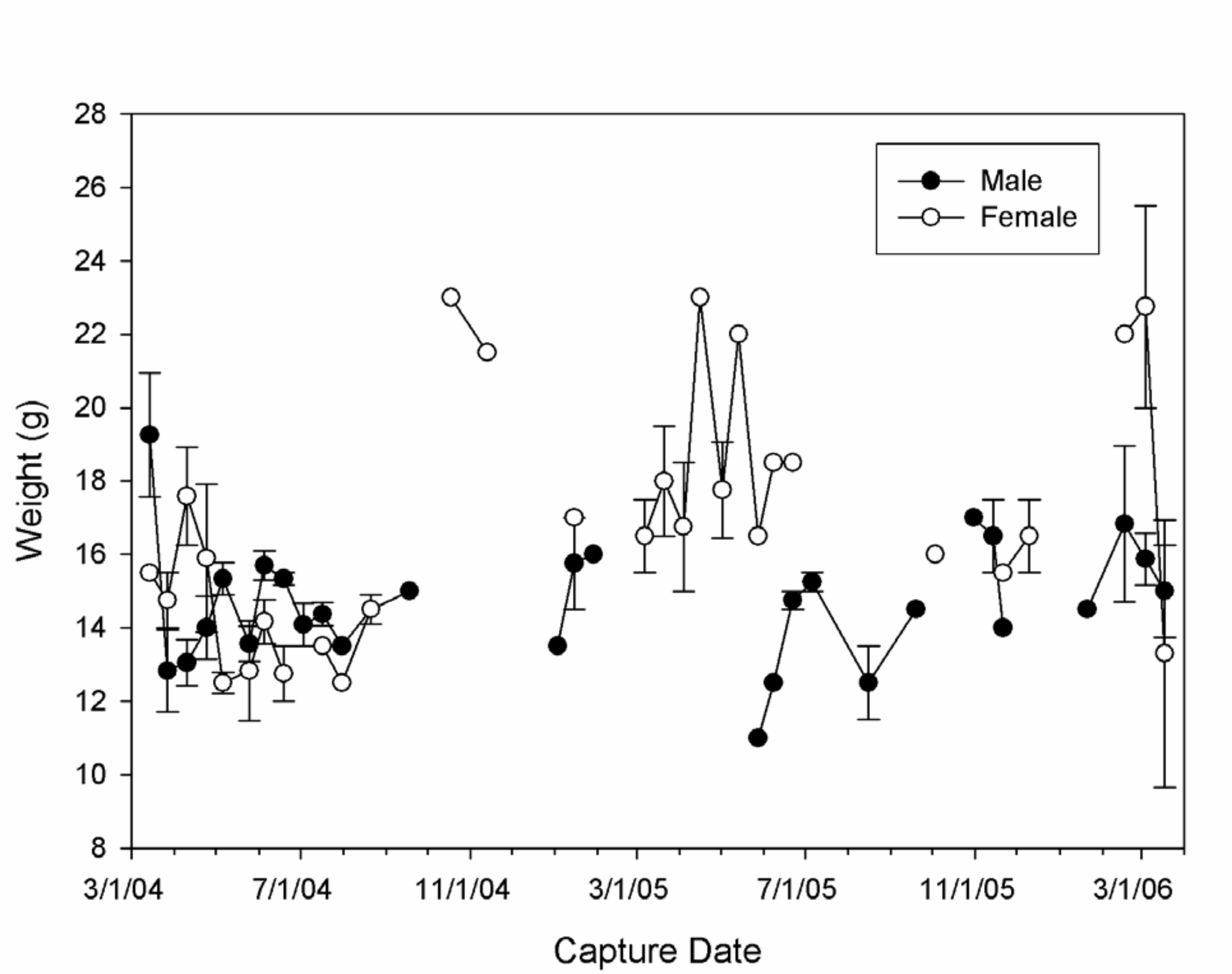

Figure 15. Mean body mass (g) and one standard error of male and female southeastern beach mice on beach grid 3 from March 2004 until the end of March 2006.

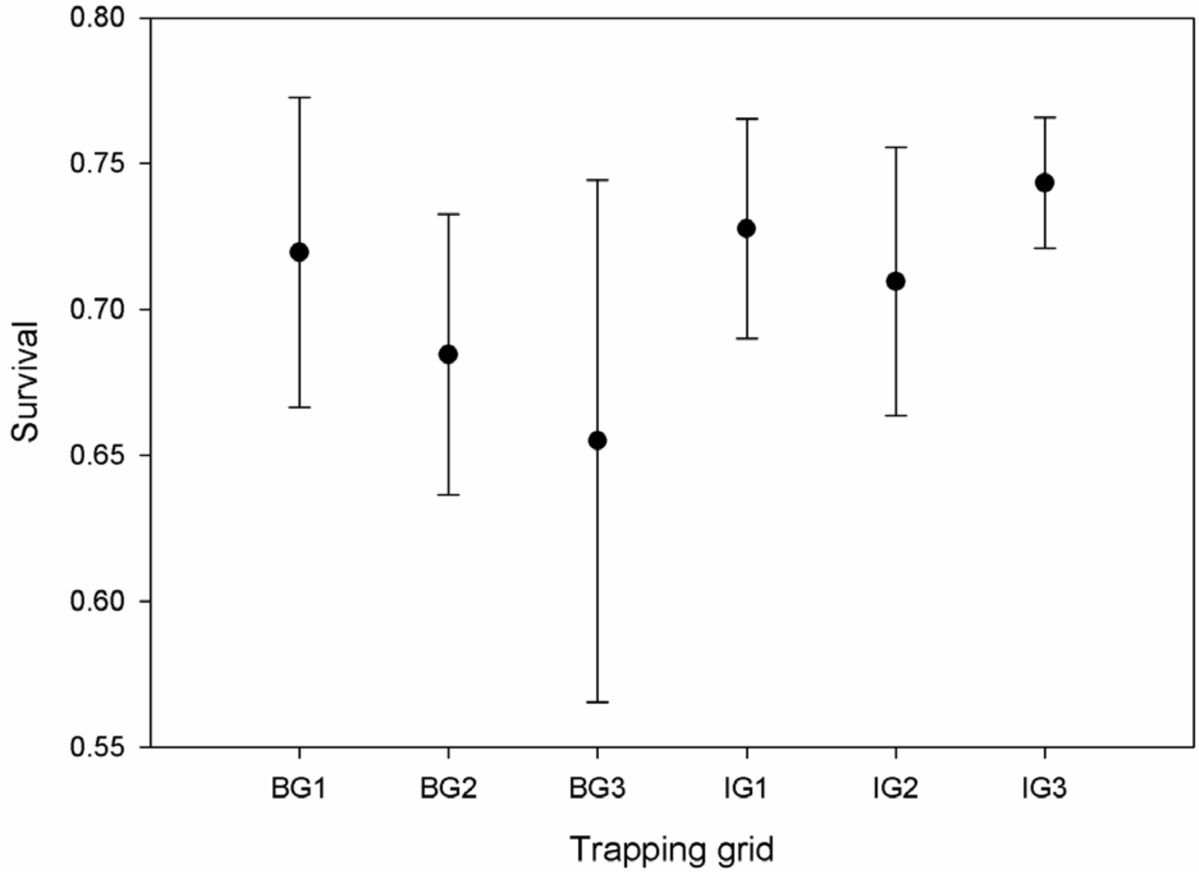

Figure 16. Survival of southeastern beach mice on beach grids 1, 2, and 3 inland grids 1, 2, and 3 based on results from Program Mark (White and Burnham 1999). These results give the mean survival time and +/- 2 standard errors over each grid's period of study. Daily and monthly estimates of survival were not robust based on the results from Program Mark.

Each beach grid had an associated transect with traps and predator excluder cages. These traps were 15 m apart and generally aligned to be parallel to the outer line of a grid. The traps were set when the grids were opened. Transects were ~ 150 m from the nearest grid trap station. Transects were not employed after July 2005.

The dispersal transects yielded many captures of beach mice (n = 101, see Appendix 1) but did not document a significant number of movements of individuals either from transects to the grids or visa versa. Most of the captures on all three transects were adults beach mice with roughly equal numbers of males and females (Table 3). Eighteen of 56 individual beach mice captured on transects were classified as subadults. No juveniles were captured. Recaptures on transects suggested resident animals were being sampled rather than dispersers.

Dispersal events associated with transects and the beach grids were rare. One beach mouse moved from each transect to the associated grid. No mice first captured on the grids were trapped on the associated transects.

Table 3. Age and sex composition of southeastern beach mice captured on transects associated with the beach grids. Transects were installed to detect dispersal movements among the grids and transects.

Transect	Age	Female	Male	Total
Beach 1				
	Adult	7	8	15
	Subadult	4	2	6
	Juvenile	0	0	0
	Total	11	10	21
Beach 2				
	Adult	9	10	19
	Subadult	6	5	11
	Juvenile	1	0	1
	Total	16	15	31
Beach 3				
	Adult	1	2	3
	Subadult	1	0	1
	Juvenile	0	0	0
	Total	2	2	4

Cotton mice were present in very low numbers on the beach grids (Table 4). Seven individuals were captured on beach grid 1 and eight on beach grid 2. Somewhat in contrast to the other beach grids, grid 3 yielded 24 captures of individual cotton mice and 64 captures of individual beach mice (Tables 2 and 4). Among the beach grids, 25 of 39 cotton mice were males.

Table 4. Age and sex composition of captures of cotton mice on the beach grids, Cape Canaveral Air Force Station, November 2003 to the end of March 2006. Individuals are counted once in these summaries.

Grid	Age	Female	Male	Total
Beach 1				
	Adult	3	4	7
	Subadult	0	0	0
	Juvenile	0	0	0
	Total	3	4	7
Beach 2				
	Adult	2	1	3
	Subadult	2	0	2
	Juvenile	2	1	3
	Total	6	2	8
Beach 3				
	Adult	5	16	21
	Subadult	0	1	1
	Juvenile	0	2	2
	Total	5	19	24

Cotton rats were captured with less frequency than beach mice or cotton mice on the beach grids (Table 5). None was captured on beach grid 1, 15 (11 females) on beach grid 2, and 11 (8 females) on beach grid 3.

Table 5. Age and sex composition of cotton rats captured on the beach grids, Cape Canaveral Air Force Station, November 2003 until the end of March 2006. Individuals are counted once in these totals.

Grid	Age	Female	Male	Total
Beach 1				
	Adult	0	0	0
	Subadult	0	0	0
	Juvenile	0	0	0
	Total	0	0	0
Beach 2				
	Adult	9	3	12
	Subadult	1	0	1
	Juvenile	1	1	2
	Total	11	4	15
Beach 3				
	Adult	5	1	6
	Subadult	2	1	3
	Juvenile	1	1	2
	Total	8	3	11

Inland Grid Trapping Results

The number of individuals of beach mice captured on the inland grids is summarized by age and sex in Table 6. These individuals were captured 2,683 times (Appendix 1). Inland grid 3 yielded more than three times the number of individual beach mice relative to grids 1 and 2. Inland grid 1 was represented by 177 individuals with adults (n = 121) most abundant among the age classes. The sex ratio was not significantly different (chi-square = 0.45, $p > 0.05$) from a hypothesized 1:1 ratio. Inland grid 2 produced 117 individuals with adults (n = 101) most frequently represented. A single juvenile was reported from grid 2. More males than females were captured but the ratio was not significantly different from 1:1 (chi-square = 3.08, $p > 0.05$). Four hundred and ninety-six individual beach mice were captured on inland grid 3. The age composition was dominated by adults (n = 350) with lesser numbers of subadults (n = 99) and juveniles (n = 47). The sex ratio was not significantly different from 1:1 (chi-square = 0.80, $p > 0.05$). Trends in the minimum numbers known to be alive on the three inland grids are variable from 2003 to 2006 with unique as opposed to common patterns of change (Figures 17, 18, and 19).

Minimum numbers of beach mice on inland grid 1 continued to increase from November 2003 until July 2004 (Figure 17). The decrease in August and September 2004 is correlated with the hurricane activity on the cape but no physical damage to the habitat was observed. A robust increase in the minimum numbers was observed to begin in October 2004 and to continue until March 2005 only to be followed by a gradual decline. The lowest numbers of beach mice were found in November and December 2005. The minimum numbers were increasing in February and March of 2006. Changes in abundance were largely accounted for by adults with very minor numbers of subadults and juveniles observed throughout the study period (Figure 20). The sex ratio did not differ from 1:1; however, females were more numerous than males during the first half of the study period with later time intervals showing parity between the sexes or slightly more females (Figure 21). Body weights of females were greater than males for the first six months of study and deviated to higher means during fall and winter of 2004-2005 and again from August to December 2005 (Figure 22).

Minimum numbers of beach mice on inland grid 2 were initially quite high (> 40 individuals) but declined from late January until August 2004 (Figure 18). Very modest changes in minimum numbers were associated with the period of hurricanes and the winter months that followed. A few animals continued to be trapped through the remaining months of study. The population dynamics exhibited by beach mice on the grid were unique and unlike the other inland and beach grids. The age structure of beach mice on inland grid 2 was typical in the first three months with adults and subadults present (Figure 23). Thereafter the residents were almost exclusively adults. Males outnumbered females for the first six months of the study period and parity was the rule for the remainder of the time (Figure 24). The body weight distributions of male and female beach mice were overlapping for the first year of study (Figure 25). Female body weights during the period October-December 2004 and from March-May 2005 did suggest reproductive activity.

Minimum numbers of beach mice on inland grid 3 increased rapidly after the onset of trapping in March 2004. Numbers peaked in June 2004 with over 80 individuals known to be alive on the grid (Figure 19). A modest adjustment to ~ 65 individuals followed the period of hurricane activity and minimum numbers increased to >80 in March 2005. After March 2005, numbers declined to ~ 20 in November 2005. A modest increase in minimum numbers characterized the population in 2006. The age structure of the population was dominated by adults over the two years of study (Figure 26). Individuals classified as subadults and to a lesser extent juveniles appeared in most months of the study. This pattern was not detected elsewhere on either the inland or beach grids. The numbers of males and females tended to be relatively balanced throughout the study period (Figure 27). Trends in the body weights of males and females does not reveal a strong signal of reproductive (pregnant) females, which should reach 20 g or more, until the last five months of study (Figure 28).

Survival of beach mice on the inland grids was computed over the entire study period with the program MARK (Figure 16). Survival across the grids was bracketed between 65 and 75%. Among the six grids under study, inland grid 3 had the highest average survival of beach mice.

Table 6. Age and sex composition of southeastern beach mice captured on the inland grids from November 2003 until the end of March 2006. Individuals appear once in these totals.

Grid	Age	Female	Male	Total
Inland 1				
	Adult	63	58	121
	Subadult	18	19	37
	Juvenile	12	7	19
	Total	93	84	177
Inland 2				
	Adult	42	59	101
	Subadult	6	9	15
	Juvenile	1	0	1
	Total	49	68	117
Inland 3				
	Adult	166	184	350
	Subadult	47	52	99
	Juvenile	25	22	47
	Total	238	258	496

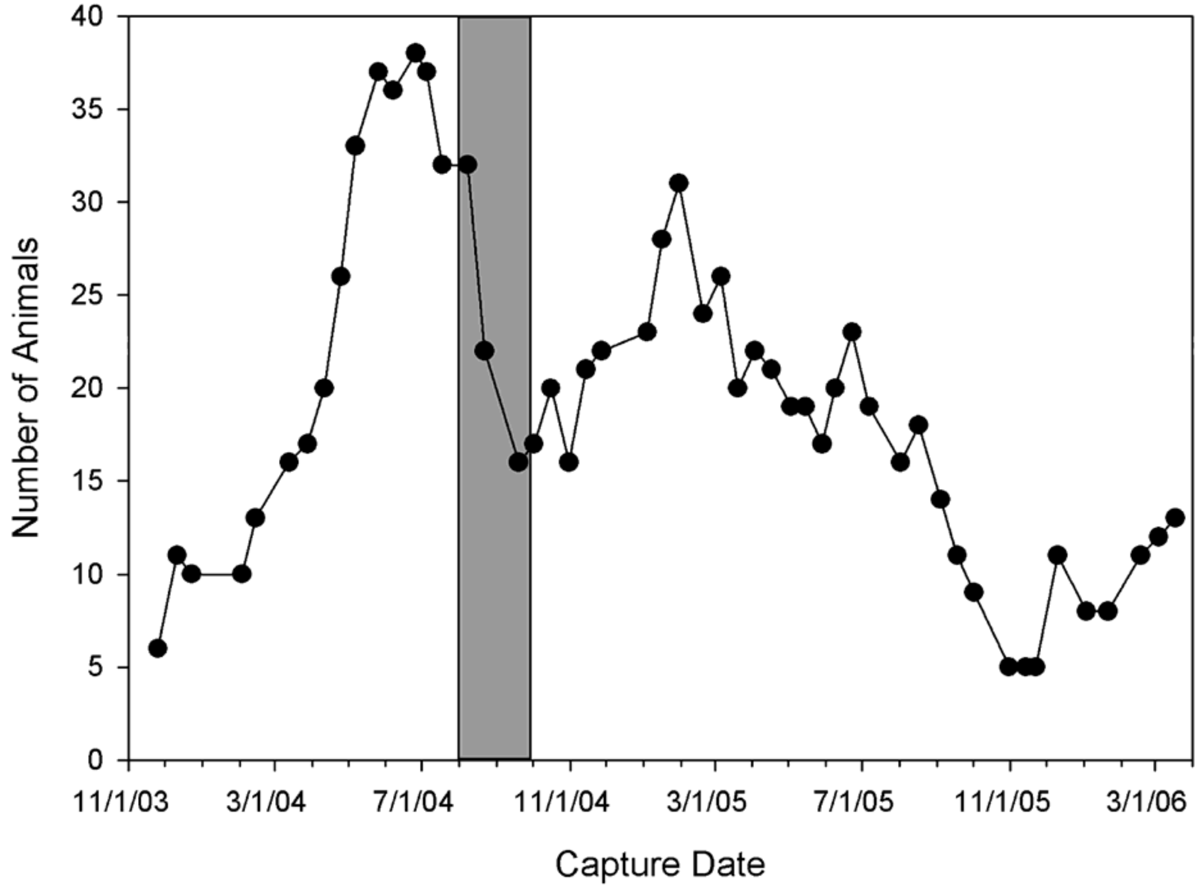

Figure 17. Minimum numbers known alive of southeastern beach mice on inland grid 1 from November 2003 until the end of March 2006 (29 months).

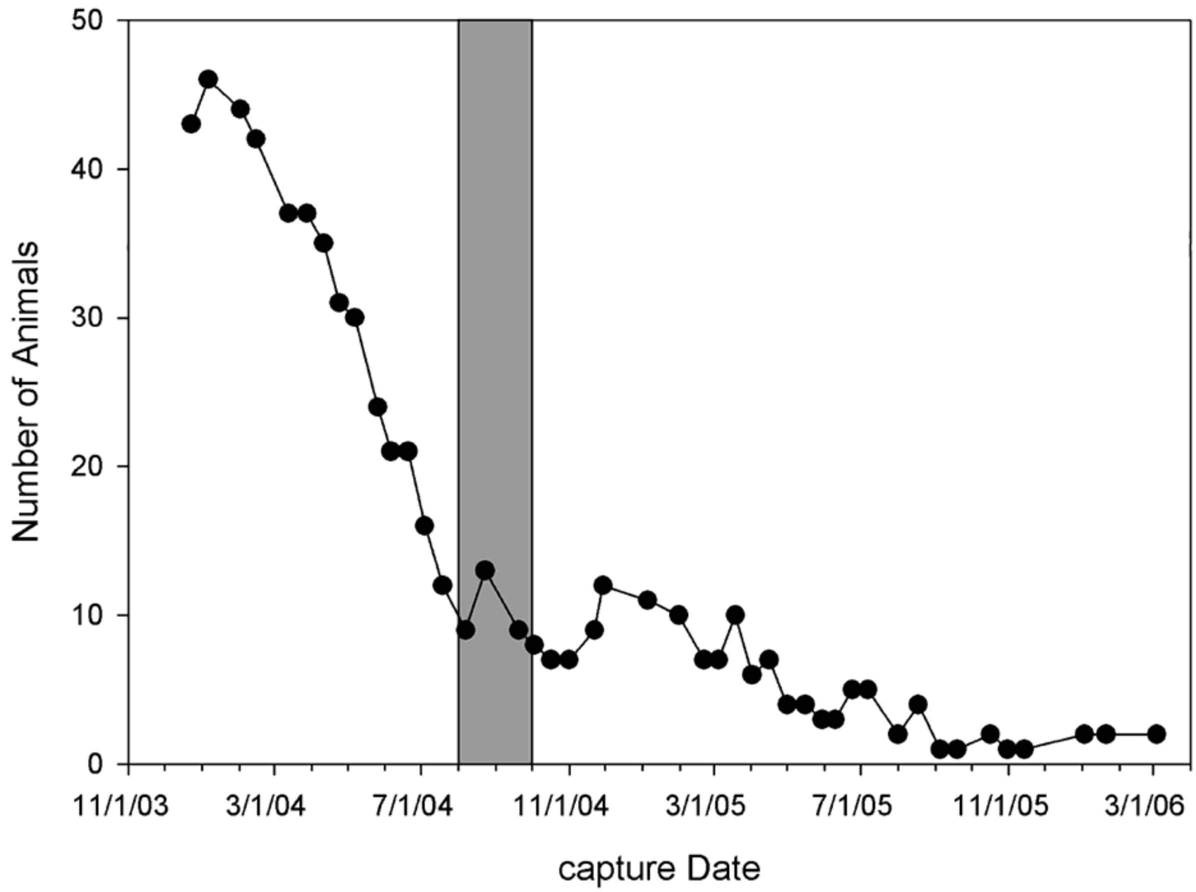

Figure 18. Minimum number know alive of southeastern beach mice on inland grid 2 from December 2003 until the end of March 2006 (28 months).

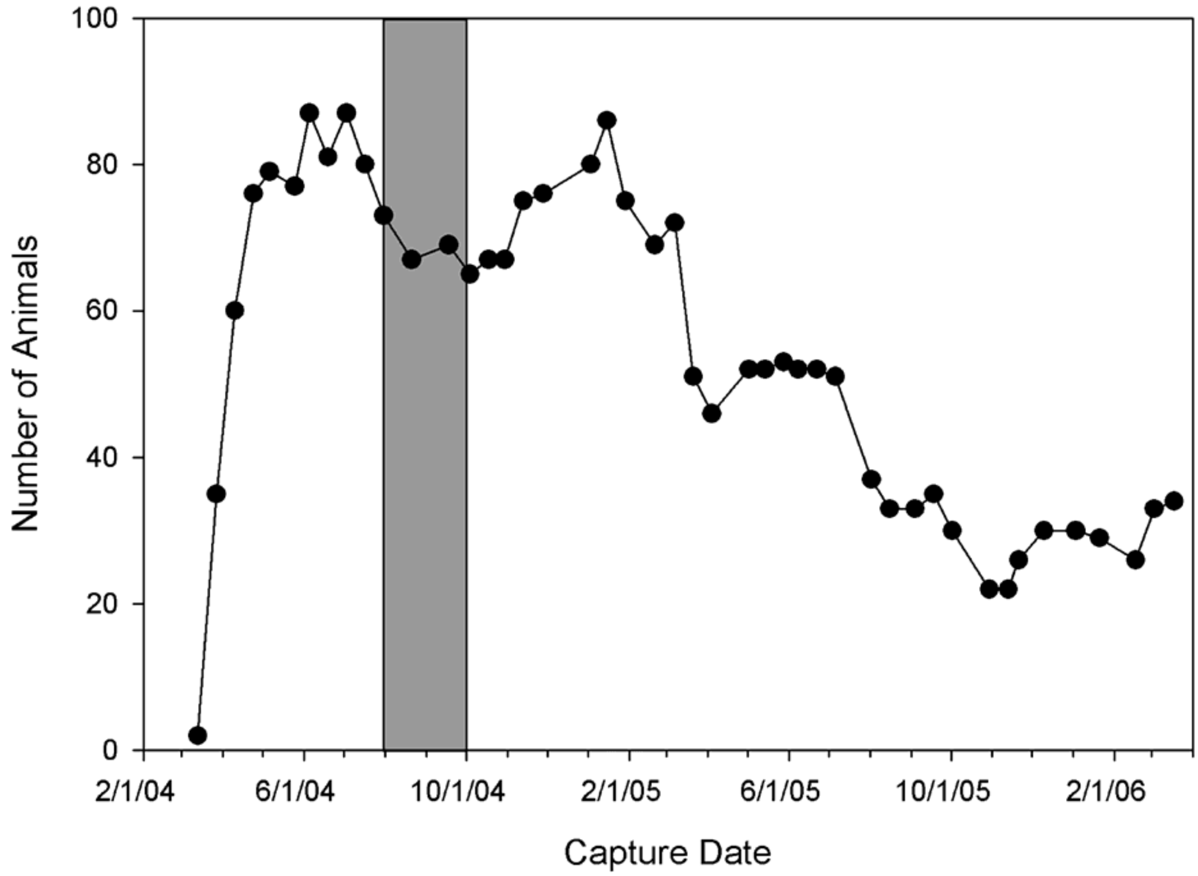

Figure 19. Minimum number known alive of southeastern beach mice on inland grid 3 from March 2004 until the end of March 2006 (25 months).

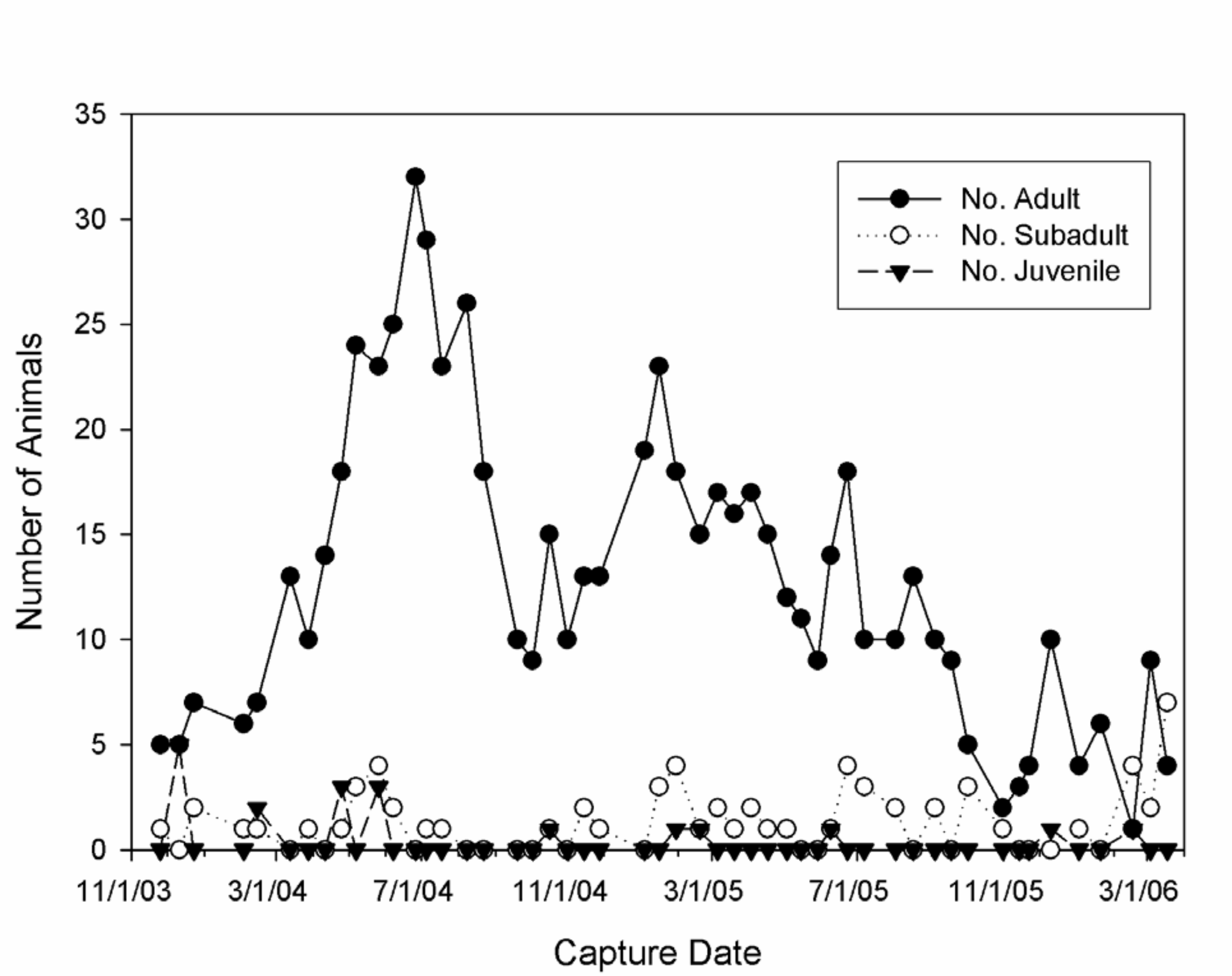

Figure 20. Age classes of captures of southeastern beach mice on inland grid 1 from November 2003 until the end of March 2006.

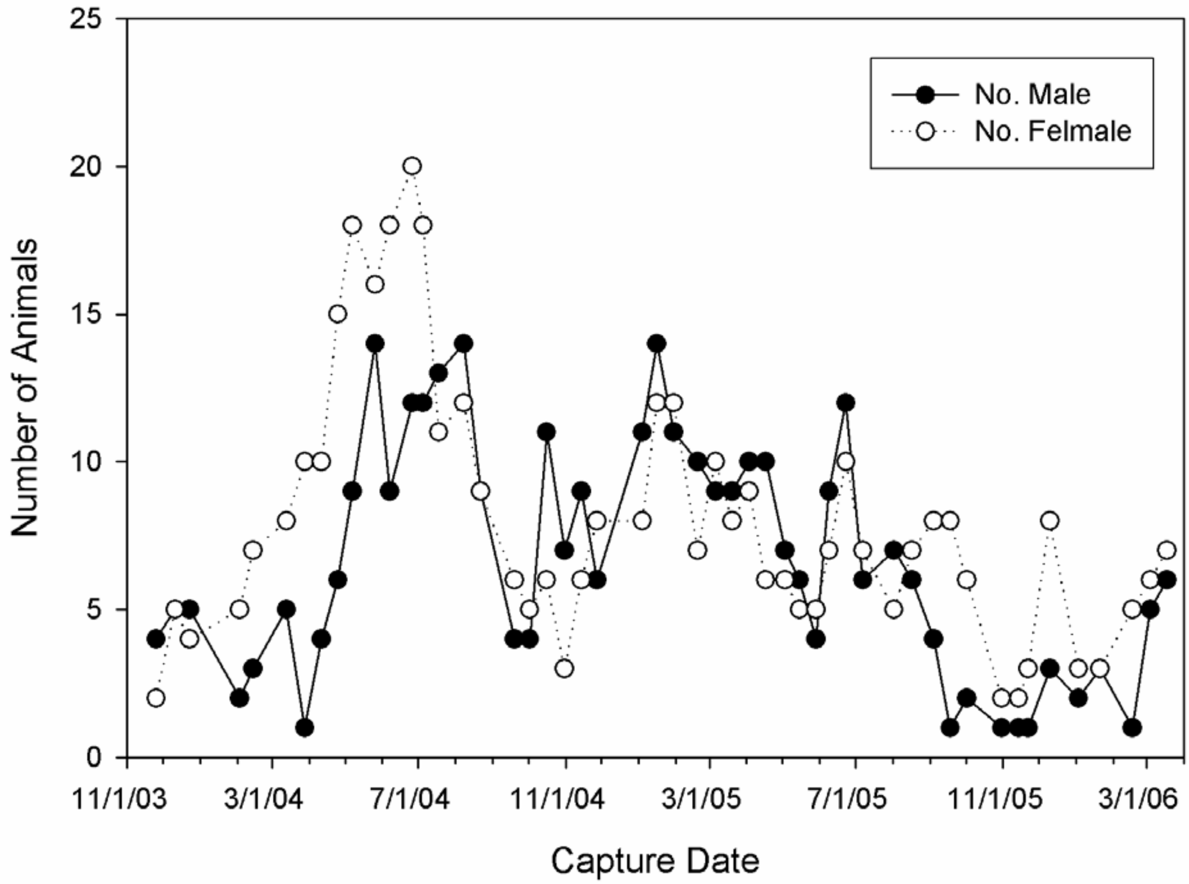

Figure 21. Sex composition of captures of southeastern beach mice on inland grid 1 from November 2003 until the end of March 2006.

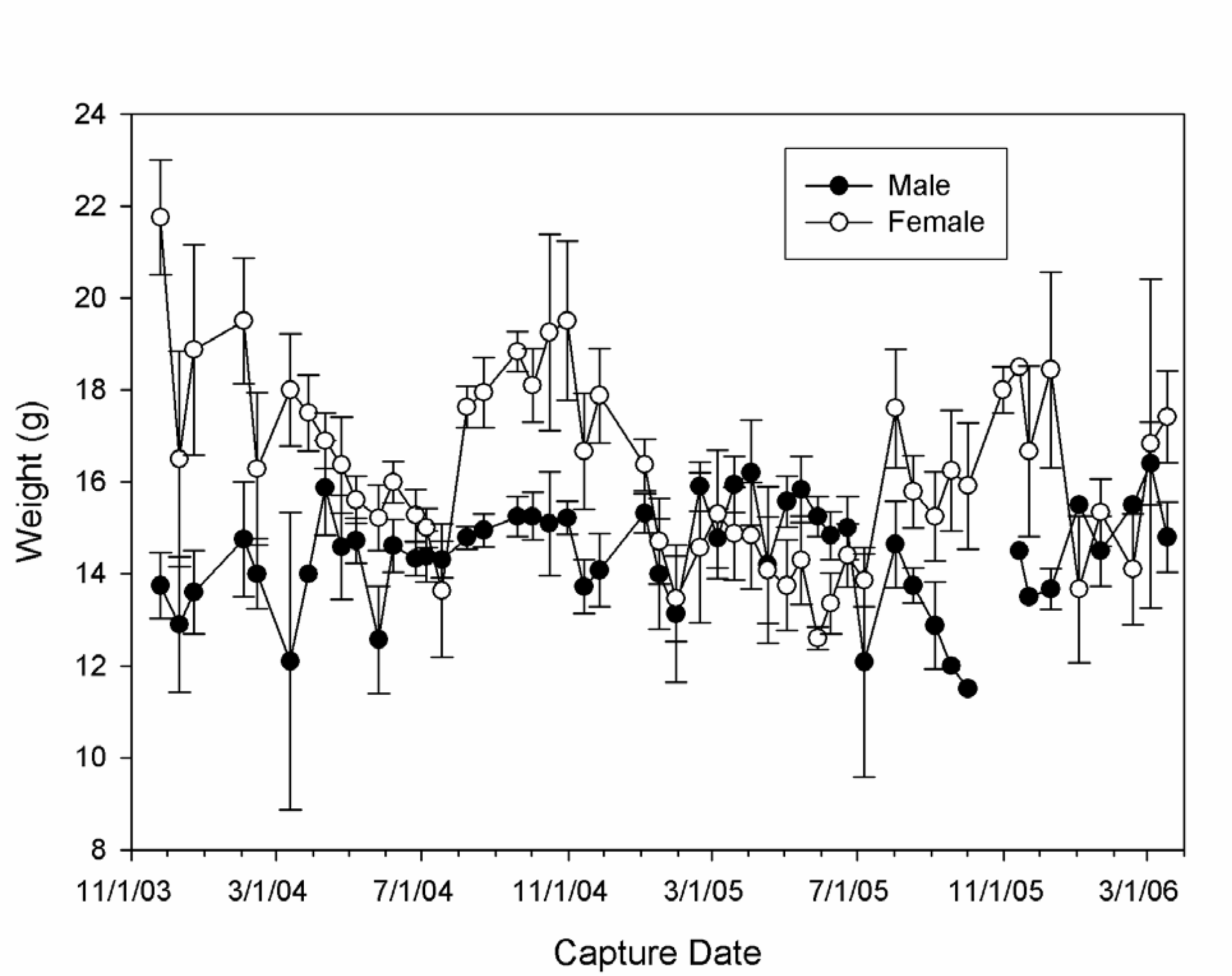

Figure 22. Mean body mass (g) and one standard error of male and female southeastern beach mice captured on inland grid 1, Cape Canaveral Air Force Station from November 2003 until the end of March 2006.

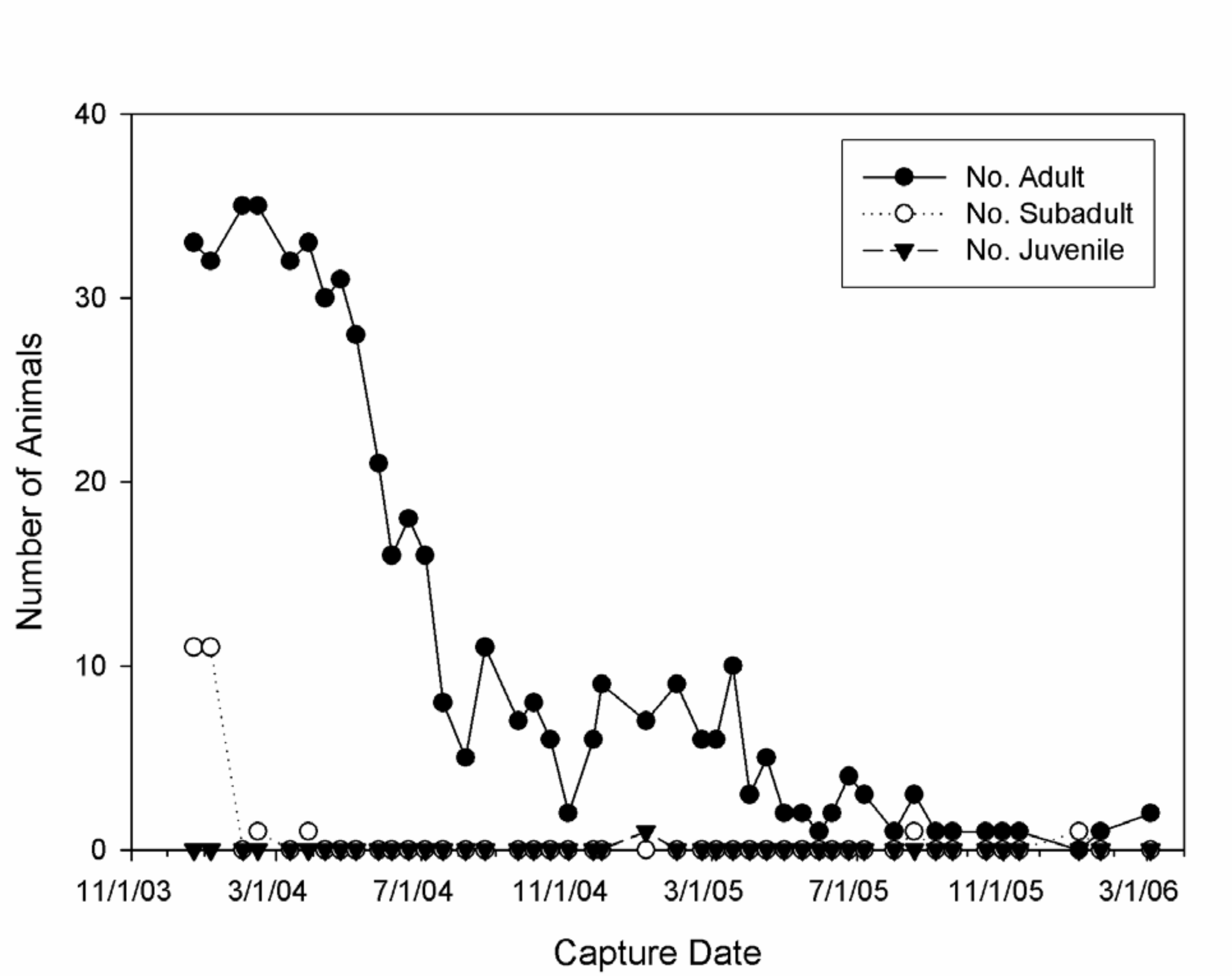

Figure 23. Age classes of captures of southeastern beach mice on inland grid 2 from December 2003 until the end of March 2006.

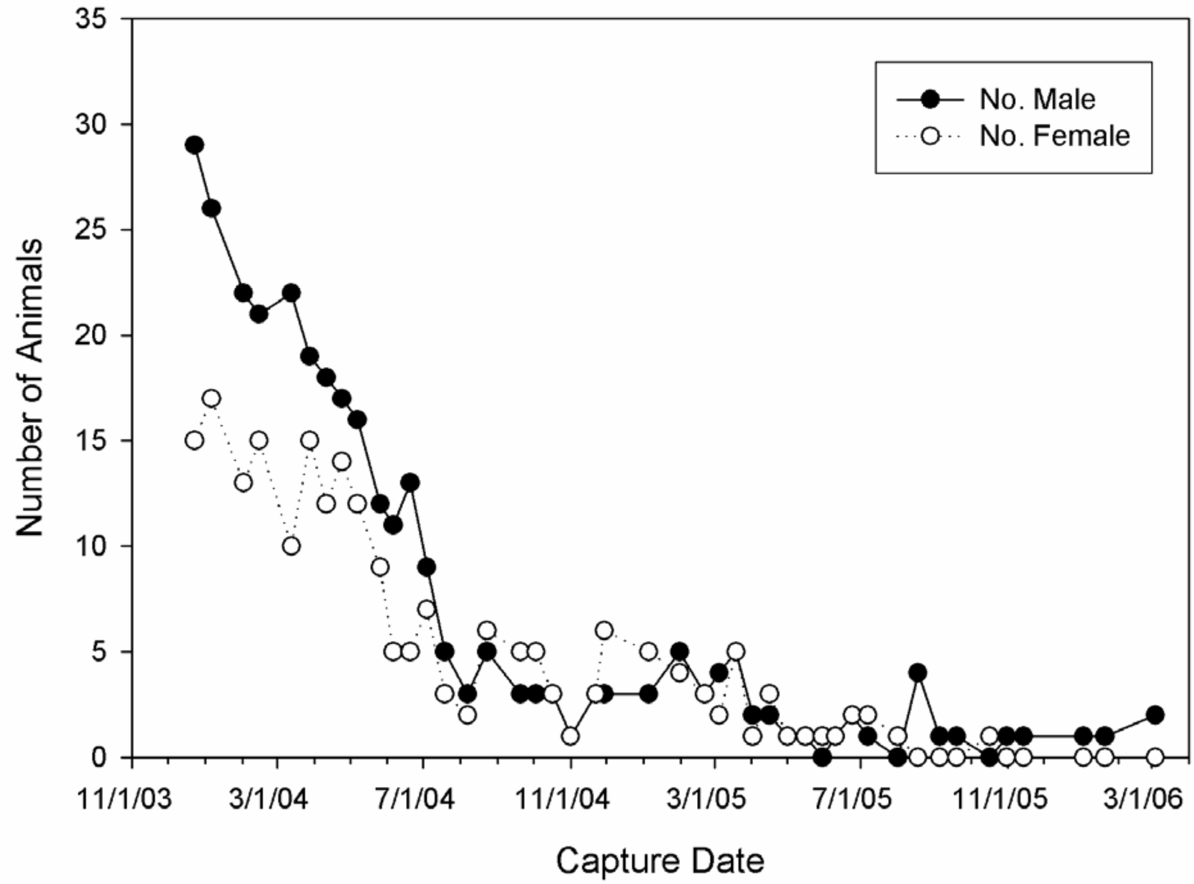

Figure 24. Sex composition of captures of southeastern beach mice on inland grid 2 from December 2003 until the end of March 2006.

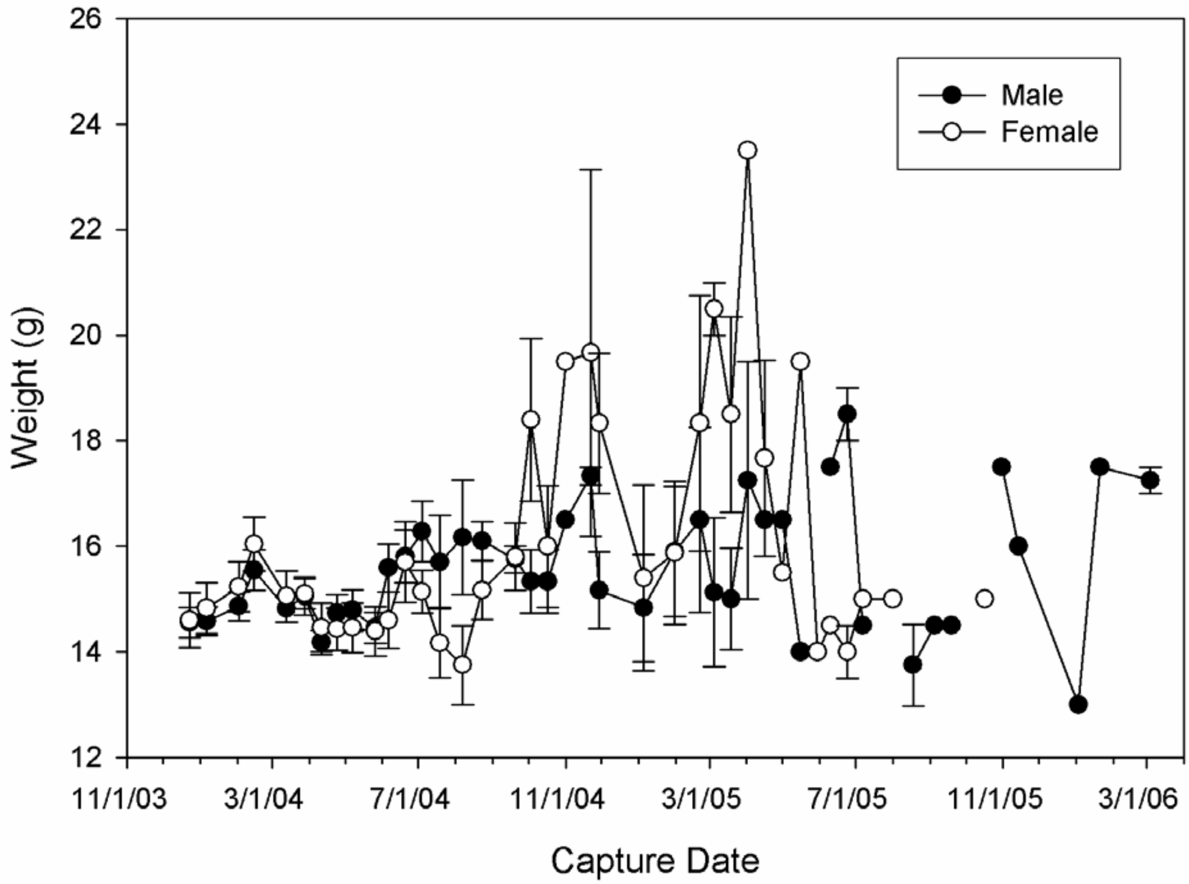

Figure 25. Mean body mass (g) and one standard error of male and female southeastern beach mice captured on inland grid 2, Cape Canaveral Air Force Station from December 2003 until the end of March 2006.

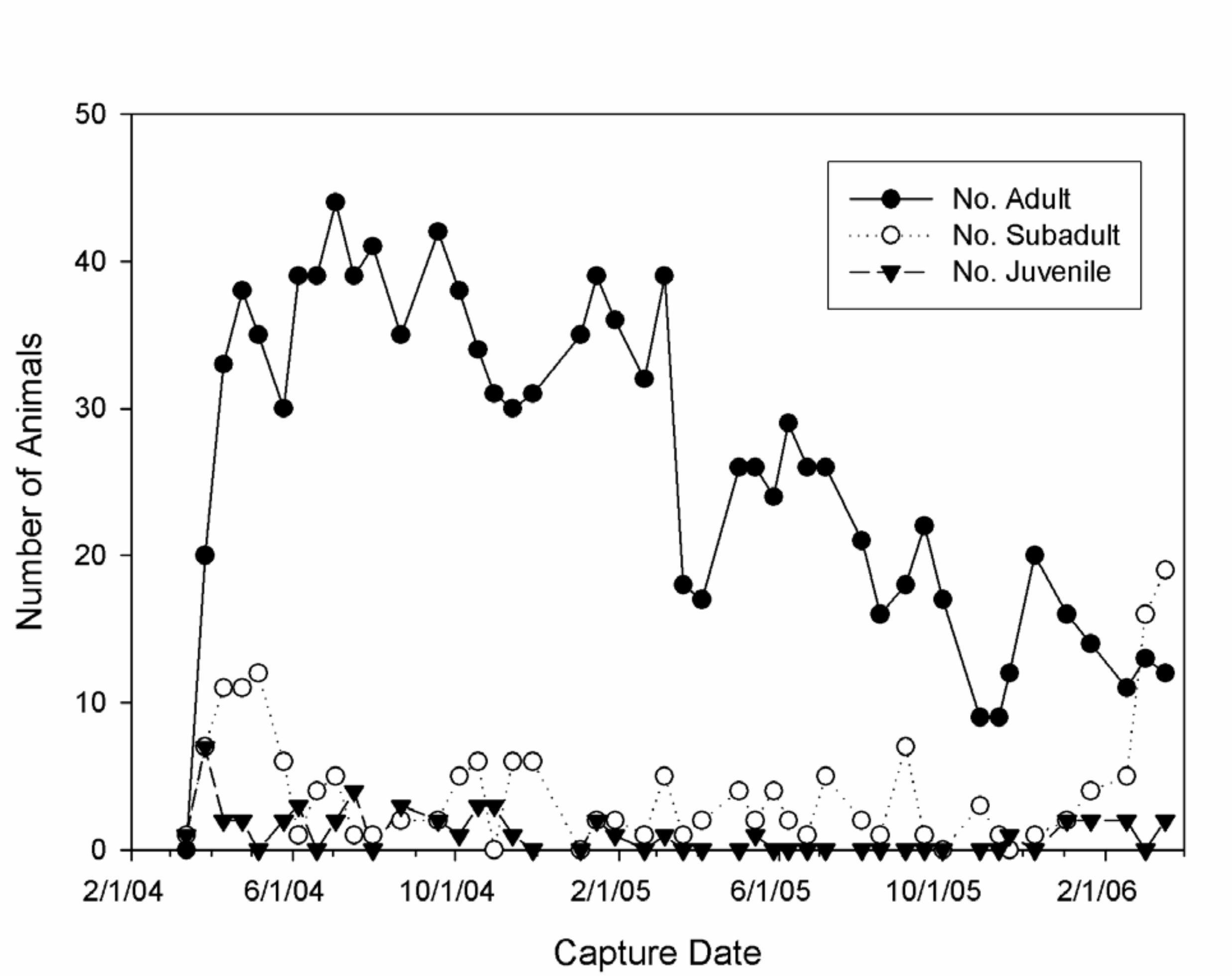

Figure 26. Age classes of captures of southeastern beach mice on inland grid 3 from March 2004 until the end of March 2006.

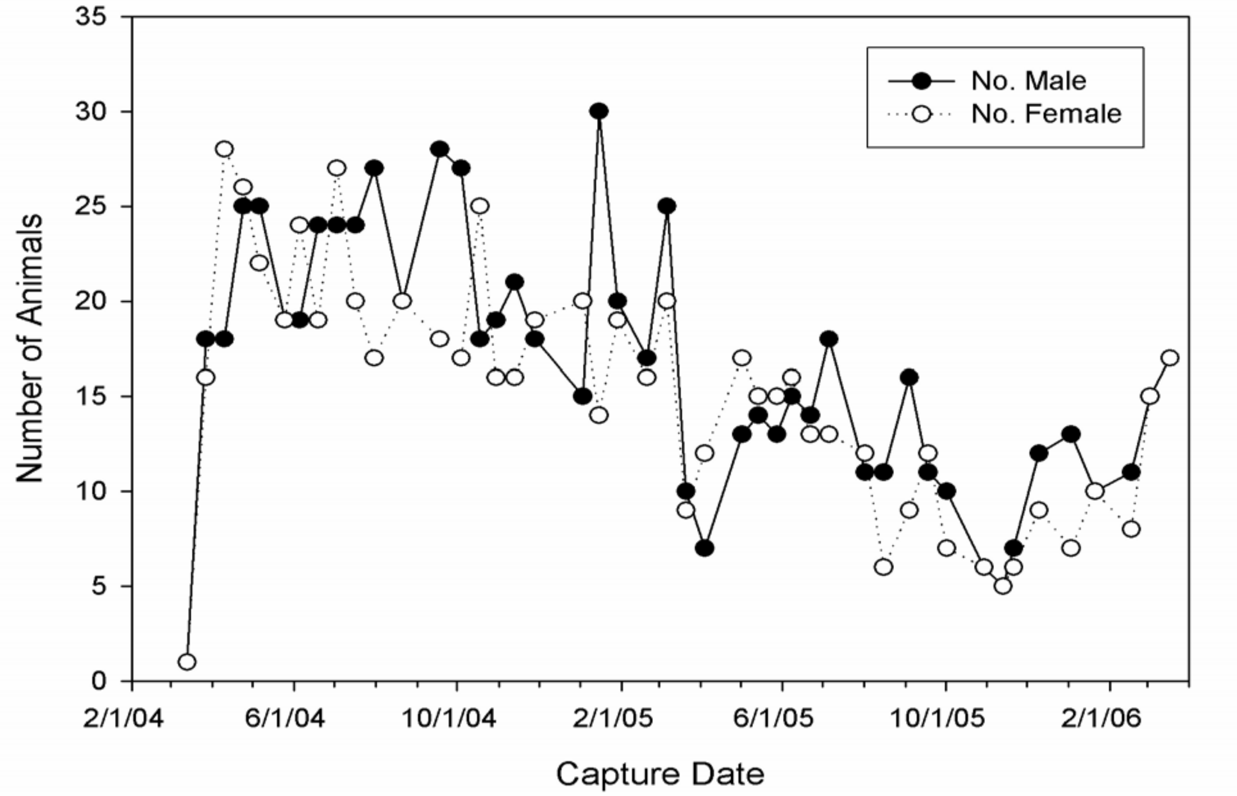

Figure 27. Sex composition of captures of southeastern beach mice on inland grid 3 from March 2004 until the end of March 2006.

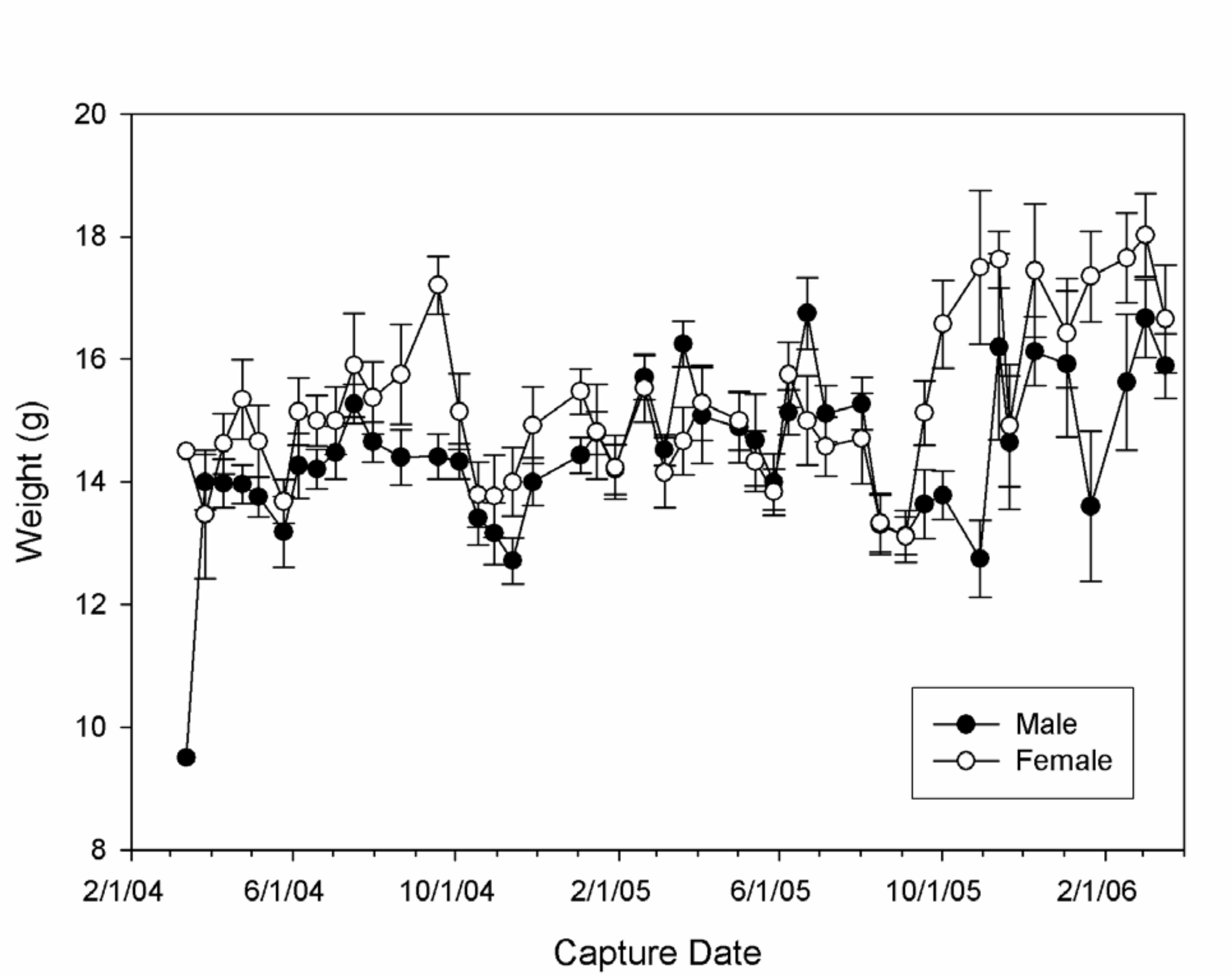

Figure 28. Mean body mass (g) and one standard error of male and female southeastern beach mice captures on inland grid 3, Cape Canaveral Air Force Station, from March 2004 until the end of March 2006.

Transects to detect dispersal events were associated with each of the inland grids. The age and sex composition of beach mice captured on transects is summarized in Table 7. Twenty individuals were captured on inland transect 1, 21 on transect 2, and 28 on transect 3. Nearly equal numbers of males and females were caught across the grids. All the captures were adults (n = 61) with the exception of eight subadults; no juveniles were captured. Recapture of beach mice on transects suggested most individuals were residents. Dispersal by individuals originally marked on the transects was limited to three events. One beach mouse moved from transect 1 to inland grid 1 and two beach mice moved from transect 2 to inland grid 2. The three mice were females and two classified as adults at the time of dispersal. No dispersal events were detected for transect 3 or inland grid 3.

Table 7. Age and sex composition of southeastern beach mice captured on transects associated with the inland grids, Cape Canaveral Air Force Station. The transects were installed to detect dispersal movements among the grids and transects.

Transect	Age	Females	Males	Total
Inland 1				
	Adult	8	9	17
	Subadult	2	1	3
	Juvenile	0	0	0
	Total	10	10	20
Inland 2				
	Adult	7	11	18
	Subadult	2	1	3
	Juvenile	0	0	0
	Total	9	12	21
Inland 3				
	Adult	12	14	26
	Subadult	1	1	2
	Juvenile	0	0	0
	Total	13	15	28

Cotton mice were captured on inland grid 1 with some regularity (n = 33) with less numbers on grid 2 (n = 14) and grid 3 (n = 4) (Table 8). Most of the individuals captured on the inland grids were adults (42 of 51).

Table 8. Age and sex composition of captures of cotton mice on the inland grids, Cape Canaveral Air Force Station, November 2003 to the end of March 2006. Individuals are counted once in these summaries.

Grids	Age	Females	Males	Totals
Inland 1				
	Adult	13	15	28
	Subadult	3	1	4
	Juvenile	0	1	1
	Total	16	17	33
Inland 2				
	Adult	4	7	11
	Subadult	1	1	2
	Juvenile	0	1	1
	Total	5	9	14
Inland 3				
	Adult	2	1	3
	Subadult	1	0	1
	Juvenile	0	0	0
	Total	3	1	4

Nineteen individual cotton rats were captured on the inland grids (Table 9). Five individual cotton rats were captured on inland grid 1, 21 on grid 2, and seven on grid 3. The most varied age structure was observed on grid 2.

Table 9. Age and sex composition of cotton rats captured on the inland grids, Cape Canaveral Air Force Station, November 2003 until the end of March 2006. Individuals are counted once in these totals.

Transects	Age	Females	Males	Totals
Inland 1				
	Adult	1	1	2
	Subadult	2	0	2
	Juvenile	1	0	1
	Total	4	1	5
Inland 2				
	Adult	4	4	8
	Subadult	6	3	9
	Juvenile	4	0	4
	Total	14	7	21
Inland 3				
	Adult	4	2	6
	Subadult	1	0	1
	Juvenile	0	0	0
	Total	5	2	7

Habitat Structure and Habitat Use

The beach grids were established to be replicates of the same biotic and abiotic conditions and yet encompass variation that is present in the primary dune systems of Cape Canaveral. A series of habitat variables were measured or estimated at each trap station on each of the beach grids (Table 10). Mean values of the variables allow the grids to be compared for patterns that may explain the distribution and abundance of the beach mouse in these dune systems. This analysis explored the variables individually.

Seven attributes of the vegetation or habitat of the beach grids were evaluated (Table 10). Coverage of bare ground was similar on grids 1 and 2 and reduced on grid 3. Plant litter was variable among the grids with the lowest coverage value on grid 2. Grasses other than sea oats were less common on beach grid 1. Coverage of sea oats was greatest on grid 1, somewhat less on grid 2 and lowest on grid 3. Woody plant coverage was greatest on grid 2 relative to both grids 1 and 3. Average coverage of herbaceous plants other than grasses ranged from 500 (5%) to nearly 700 cm (7%) across the grids . Vegetation height ranged from 59 cm on grid 1 to 75 cm on grid 3.

Table 10. Summary of habitat variables recorded on line transects on the beach grids, Cape Canaveral Air Force Station, 2005. Values are mean coverage (cm) and the standard errors. Height is in cm. Sample size is 64 for grids 1 and 2 and 57 for grid 3.
Means with the same letters (e.g., A) are not different at $p < 0.05$.

Habitat Variables	Beach Grid 1	Beach Grid 2	Beach Grid 3
Bare ground	366.8 (34.9) A	359.5 (42.0) A	130.8 (34.4) BC
Litter	295.5 (33.5) A	136.9 (32.9) B	237.2 (45.4) AB
Live Plant	537.8 (35.9)	747.9 (32.9)	724.5 (53/6)
Sea Oats	272.4 (29.1) A	205.2 (31.1) A	83.5 (18.2) B
Woody	28.0 (14.4) B	91.0 (27.8) B	17.8 (8.7) B
Non-woody	506.7 (34.2) BC	650.3 (53.6) BA	697.7 (48.5) A
Vegetation height	59.9 (6.3)	67.0 (3.5)	75.1 (6.7)

Habitat variables measured on the inland grids differed from the beach grids (Table 11). Bare ground was most prominent on grid 1, less prominent on grid 3, and least available on grid 2. Woody vegetation did not include cover of oak or palms and was highest in coverage on grid 3 with minor values on grids 1 and 2. Non-woody cover included grasses and herbs and was greatest on grid 3 followed by grids 1 and 2. Saw palmetto was most developed on grid 2 (570 cm) with lesser amounts on grids 1 and 3. Cover of oak species was greatest on grid 2, reduced on grid 1, and least on grid 3.

Table 11. Summary of habitat variables recorded on line transects on the inland grids, Cape Canaveral Air Force Station, 2005. Values are mean coverage (cm) and the standard errors. Height is in cm. Sample size is 64 for each grid. Means with the same letter (e.g., A) are not different at $p < 0.05$.

Habitat Variables	Inland Grid 1	Inland Grid 2	Inland Grid 3
Bare ground	228.2 (31.5) B	61.5 (9.0) C	135.4 (17.7) BC
Woody	75.7 (12.9) B	76.1 (12.2) B	420.6 (33.2) A
Non-woody	186.6 (37.5) D	131.2 (22.9) D	414.5 (28.0) C
Saw palmetto	300.0 (32.8) B	570.1 (26.8) A	344.5 31.2) B
Oak	405.2 (40.2) B	674.3 (56.6) A	160.9 (24.1) C
Height, post 1	103.9 (11.5)	141.7 (7.4)	121.2 (5.6)
Height, post 2	103.1 (11.5)	134.3 (8.2)	104.9 (7.1)

A one-way analysis of variance was carried out on each variable that was quantified in the same way across all the grids (Table 12). Significant heterogeneity was identified among the grids for each variable ($p < 0.0001$).

Table 12. Analysis of variance of habitat variables among the six grids sampled for beach mice on Cape Canaveral Air Force Station.

Variable	df	Sum of squares	Mean squares	F ratio	Probability
Bare ground	5	4.1691	0.8338	18.3101	P<0.0001
Woody cover	5	7.3074	1.4615	58.8140	P<0.0001
Non-woody cover	5	6.6050	1.3210	46.7027	P<0.0001
Height	5	3.7123	0.7425	30.7142	P<0.0001
Course sand	5	0.8375	0.1675	83.6666	P<0.0001

Three of four hurricanes that reached Florida in 2004 impacted the habitat of the beach mouse on Cape Canaveral. The beach grids were altered by flooding, salt spray, and sand deposition. In October 2004, after the last storm, sand deposition was measured at a series of trap stations on each of the beach grids (Table 13). Twenty five to 28 cm of sand was deposited on the first line (A) of trap stations, which parallels the dune crest. Slightly more sand was covering the second series of trap stations (line B), which is parallel to line A and inland 15 m. Sand depth was variable among grids on line C, which is 30 m inland from line A. The sand deposition was reduced on line D and could not be quantified.

Vegetation was buried by the sand or killed by the flooding and salt spray up to 30 m from the frontal dune crests. Photographs were taken to document the extent of habitat damage.

The inland grids were not impacted by the hurricanes in 2004. As a rule, the shrub cover was less than 2 m in height and did not sustain damage. Inland areas with trees in the vicinity of the grids did have damage.

Table 13. Index to sand deposition on beach grids, Cape Canaveral Air Force Station, October 2004, following the hurricane season. Values represent mean sand depth (cm) to pre-storm base of sea oats (standard deviation). Line A was 3-5 m inland of the annual high tide level. Each line was 15 m apart.

Line on Grid	Beach Grid 1	Beach Grid 2	Beach Grid 3
A	28 (6.8)	26 (8.9)	25 (5.0)
B	29 (8.0)	31 (8.4)	30 (4.9)
C	20 *	34 (15.0)	28 (5.5)
D	trace	trace	trace

* n = 2, most stations were not impacted by sand deposition

Discussion

Both extensive trapping of the coastal dunes and swales, numerous burn compartments, and dispersal transects and intensive trapping of beach grids and inland grids revealed the wide distribution of southeastern beach mice on Cape Canaveral. Inland oak-palmetto scrub provides far more area of suitable habitat for beach mice than the coastal dunes and swales, which traditionally have been viewed as the primary habitat. Cape Canaveral specifically and Merritt Island generally offers extensive acreage of inland scrub that is continuous with the coastal dunes. Generally elsewhere within the historic range of the southeastern beach mouse, the species is confined to a narrow strip of coastal habitat easily identified with the extensive stands of sea oats and certain other salt tolerant grasses and herbs. Regardless of the measure, individual or total captures, the interior of the cape produced more beach mice (790 individuals and 2,683 total captures [63.14%]) than the coastal dune and swale habitat (293 individuals and 989 total captures [36.86%]). These results make the case for preservation and management of the coastal strand and interior oak-palmetto scrub even more compelling given the co-occupancy of the habitat by the Florida scrub-jay, gopher tortoise, and indigo snake (Schmalzer and Hinkle 1992, Stout and Marion 1993).

The hurricane season of 2004 was and unanticipated natural experiment. The spatial data on habitat and occupancy rates by beach mice on the six study grids allowed a risk assessment of hurricanes as a threat to the subspecies on the CCAFS. The greatest changes in minimum numbers of beach mice occurred on the beach grids with more modest responses on the inland grids. For example, beach mice of inland grid 3 appeared to show little response to the storms in spite of its close proximity to the coast (Figure 2). In contrast, beach mice on beach grid 3 were greatly reduced in the months after the storms. No evidence of movement by beach mice away from the dune-swale area was detected by the appearance of marked individuals on dispersal transects or inland grids. Storm deposited sand was mostly confined to a zone about 30 meters inland of the high tide line. Salt spray damaged the vegetation not buried by the sand in the same zone. Resident beach mice that remained in burrows during the storm events risked burial as a proximate threat and a longer term loss of seeds still on plants or seeds on or near the soil surface buried by several centimeters of sand. Elsewhere, radio-tagged beach mice have moved inland in response to hurricane impacts on frontal dunes (Swilling et al. 1998). Beach mice live trapped after Hurricane David passed over the cape region did not appear to change their local distribution (Stout unpublished data from September 1979).

At least three hurricanes have passed near or impacted the primary habitat of the SEBM on the cape. Stout (unpublished data) documented the response of a tagged population of SEBM to Hurricane David in September 1979. This storm system passed parallel to the beach but did not result in any significant demographic change in the population based on pre- and post-storm trapping events. Frank (1996) developed a model to study the effects of storms on beach mice. Frequent but less severe storms (Category I and II) were suggested to be a greater threat to population persistence than the more rare Category V hurricanes. Oddy (2000) was able to evaluate the impact of storm systems on SEBM on the lower Cape. The storm surges associated with Hurricanes Erin and Luis and Tropical Storm Jerry in August and September of 1995 inundated most of her grids. The beach mice did not recovery on the grids until several months later. The Alabama beach mouse (*P. p. ammobates*) was the subject of demographic study when

Hurricane Opal made landfall nearby (Swilling et al. 1998). The primary dune line was destroyed by the storm and part of the marked population was displaced to a scrub transition area back of the former dune lines. Collectively these studies suggest that the interior and secondary habitat utilized by the SEBM at CCAFS may on occasion serve as a source population for reinvasion of storm disturbed primary habitat. This view would suggest the secondary habitat is critical for long-term survival of the SEBM at CCAFS.

Population dynamics of southeastern beach mice was unique to each study site regardless of location, that is, coastal dunes and swales or the inland oak and palmetto scrub and coastal strand. Looking across all the grids, population trends were generally down in 2005 and in some cases even into 2006. All of the trends could be correlated with potential lag effects of the hurricane season of 2004. Claiming causation is more challenging in that inland grid 3 proved to be relatively stable in 2005 and 2006. Likewise, beach grids 1 and 2 sustained beach mice as the vegetation recovered from the combined effects of salt spray and sand deposition. Beach grid 3 was inundated in the swale and trappable beach mice were much delayed in reoccupying the area. Inland grid 2 was impacted by mechanical treatment of the scrub shortly after trapping began. Woody plant cover in the mowed strips grew back rather quickly, nonetheless the beach mouse population declined and did not recovery in 2005 or early 2006.

Direct evidence of dispersal was not obtained in spite of the intensive trapping effort. The transects associated with the grids did not yield evidence of frequent movements of marked beach mice. Transects may have been too far (~150 meters) from the grids to intercept movements of, for example, subadults leaving the natal home ranges (Swilling and Wooten 2002). Dispersal distances may be much less than 150 meters. Alternatively, dispersing individuals may be focused on movement and ignore traps in their path of travel. Indirect evidence of the movement of beach mice on Cape Canaveral is offered from the genetic analysis in Chapter 2.

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Appendix 1. Summary of all captures of SEBM on grids and dispersal transects at Cape Canaveral Air Force Station, November 2003 to March 2006.

Grids

	Age	Female	Male	Total
Beach 1				
	Adult	138	174	312
	Subadult	27	26	53
	Juvenile	2	0	2
	Total	167	200	
Beach 2				
	Adult	213	184	397
	Subadult	27	40	67
	Juvenile	2	5	7
	Total	242	229	
Beach 3				
	Adult	49	65	114
	Subadult	9	27	36
	Juvenile	0	1	1
	Total	58	93	
Inland 1				
	Adult	357	302	659
	Subadult	38	30	68
	Juvenile	12	7	19
	Total	407	339	
Inland 2				
	Adult	204	291	495
	Subadult	11	15	26
	Juvenile	1	0	1
	Total	216	306	
Inland 3				
	Adult	573	612	1185
	Subadult	80	100	180
	Juvenile	25	25	50
	Total	678	737	

Transects

	Age	Female	Male	Total
Beach 1				
	Adult	15	22	37
	Subadult	5	4	9
	Juvenile	0	0	0
	Total	20	26	
Beach 2				
	Adult	21	13	34
	Subadult	7	8	15
	Juvenile	1	0	1
	Total	29	21	
Beach 3				
	Adult	1	3	4
	Subadult	1	0	1
	Juvenile	0	0	0
	Total	2	3	
Inland 1				
	Adult	16	22	38
	Subadult	3	1	4
	Juvenile	0	0	0
	Total	19	23	
Inland 2				
	Adult	11	21	32
	Subadult	2	1	3
	Juvenile	0	0	0
	Total	13	22	
Inland 3				
	Adult	19	28	47
	Subadult	1	1	2
	Juvenile	0	0	0
	Total	20	29	

Chapter 2

POPULATION GENETICS AND CONSERVATION OF THE THREATENED SOUTHEASTERN BEACH MOUSE (PEROMYSCUS POLIONOTUS NIVEIVENTRIS): SUBSPECIES AND EVOLUTIONARY UNITS

Running title: Conservation Genetics of Beach Mice

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Article Type: Original Research Paper (in press, Conservation Genetics)

Abstract

We investigated genetic diversity within the southeastern beach mouse (SEBM-*Peromyscus polionotus niveiventris*) and also tested the hypothesis that the subspecies recognition of *P.p. niveiventris*, based on size and color differences, is congruent with this taxon representing a discrete evolutionary lineage. We used ten polymorphic microsatellite loci and mitochondrial cytochrome-*b* gene DNA sequences to investigate genetic diversity and population structure within the SEBM, and to determine the level of divergence between the SEBM and the nearest known inland subspecies of the oldfield mouse (*Peromyscus polionotus rhoadsi*). Moderate genetic distances were observed between the SEBM and the inland oldfield mouse based on microsatellite data, with F_{ST} values ranging from 0.11 to 0.22 between these taxa. Additionally, mitochondrial DNA haplotypes of the SEBM formed a distinct monophyletic group relative to haplotypes sampled from *P. p. rhoadsi*. Based on previous estimates of rates of mitochondrial DNA evolution in rodents, we inferred that Pleistocene sea-level fluctuations are likely responsible for the historical isolation of the SEBM lineage from mainland *P. polionotus*. Our data demonstrate the genetic distinctiveness of the SEBM, justifying the current subspecies designation for the SEBM and its continued protection under the United States Endangered Species Act. We classify the Cape Canaveral and Smyrna Dunes Park populations of SEBM as a single evolutionary significant unit. The two known extant allopatric populations of the SEBM showed some differentiation in microsatellite frequencies and were moderately reciprocally distinguishable based on assignment to distinct genetic clusters by a Bayesian admixture procedure. These results justify the classification of these two extant SEBM populations as distinct management units that should be independent targets of management and conservation attention.

Introduction

Identifying units of conservation is controversial and a methodological consensus has not been reached (Moritz 2002; Gompert et al. 2006). Morphologically-defined taxa continue to be the fundamental biological units for comparative studies across fields of biology, including conservation. As a result, conservation efforts world-wide revolve around the protection of species, subspecies, or discrete population segments that have been defined primarily on the basis of morphological distinctiveness. The reliance on taxon definitions for conservation is particularly the case in the United States where species are afforded conservation attention via the Endangered Species Act (ESA). Be they units of analysis in scientific studies or units of conservation in environmental policy, it is crucial that the operational units used accurately reflect natural (i.e., evolutionary) groupings. That is, it is important that these units represent groups of organisms which have been reproductively isolated long enough to develop unique adaptive potential, and ideally, individuals are more closely related within units than between units (e.g., within versus between species or subspecies). The use of species as units of analysis is often overly broad or even inaccurate, particularly in taxonomic groups where informative morphological taxonomic characters are rare or homoplastic.

When systematic revisions of species or subspecies defined by morphology are performed using alternative methods (e.g., molecular data), it is not uncommon that minor morphological differences observed in nominal taxa, such as color or size, are found to be poor indicators of discrete and exclusive evolutionary lineages (Burbrink et al. 2000, Fritz et al. 2005). Color has been shown to be polymorphic in a variety of organisms, including many species of frogs (Hoffman and Blouin 2000), fishes (Olendorf et al. 2006), and mammals (Hoekstra, et al. 2005). While some studies have supported neutral or weak selection maintaining color variation (e.g., O'Hara 2005, Hoffman et al. 2006) others have suggested that color polymorphisms are under selection and may be poor indicators of shared evolutionary ancestry (Kettlewell 1955, 1956, Hadley et al. 1988, Hoekstra, et al. 2005, 2006). Recently, Hoekstra et al. (2006) determined coat color in beach mice (*Peromyscus polionotus* spp.) from the Gulf Coast of Florida is under selection for crypsis. A single amino acid substitution in the *Mc1r* gene increases the frequency of light morphs in coastal populations compared to inland conspecifics.

Recent studies have dramatically increased our ability to identify meaningful conservation units in cases where clear morphological demarcations do not exist to define discrete evolutionary lineages. In such cases, genetic variation has proved invaluable in the clarification of conservation units. Moreover, as threatened and endangered (T&E) taxa are impacted by landscape fragmentation, a transparent understanding of genetic diversity in T&E populations is crucial (Frankham et al. 2002). Most T&E populations have reduced levels of heterozygosity and have an increased probability of extinction (Spielman et al. 2004 and references therein). Thus, knowledge of population genetic structure within T&E species arms conservation authorities with added data enabling strategic and well-informed management decisions that may effectively conserve biological diversity.

Ryder (1986) introduced the concept of the "evolutionarily significant unit" (ESU) for prioritizing taxa for conservation, and the concept of ESUs has gained widespread use in the literature. There is controversy, however, over what exactly an ESU represents and if the concept of an ESU should continue to bias conservation strategies (Paetkau 1999; Crandall et al. 2000; Kizarian and Donnely 2004). Moritz (1994) proposed a clear and stringent set of criteria for the definition of an ESU by introducing the concept of reciprocal monophyly stating, "ESUs should be reciprocally monophyletic for mtDNA and show significant divergence of allele frequencies at nuclear loci.” However, Moritz (1994) recognized this criterion as potentially overly stringent, and suggested groups that did not show reciprocal monophyly, but did show significant allele frequency divergence, could also be considered ESUs. This ESU qualification has generally been accepted both by the scientific community and regulatory agencies. There are, however, notable exceptions (Paetkau 1999; Crandall et al. 2000; Kizarian and Donnely 2004), and arguments have been made that the inclusion of an ESU *sensu* Moritz (1994) in ESA legislation is problematic (Pennock and Dimmick 1997; Dimmick et al. 1999) and that this definition overlooks nested units of diversity (Paetkau 1999; Crandall et al. 2000; Kizirian and Donnelly 2004), thus negatively impacting the conservation of overall diversity. Many of these problems appear to be overcome with the recent more holistic approach of including both genetic and ecological exchangeability data in defining conservation units (Crandall et al. 2000; Fraser and Bernatchez 2001; Rader et al. 2005).

The oldfield mouse (*Peromyscus polionotus)* is a monogamous, burrow-building species distributed throughout sandy habitats in the extreme southeastern United States of America. Sixteen subspecies have been defined based on pelage and morphological differences (Hall 1981). Beach forms of *Peromyscus polionotus* occur on the dune systems of the Atlantic and Gulf Coasts and are nominally referred to as “beach mice.” Due in part to extensive urban development of coastal habitats, six of seven extant beach subspecies are federally listed as threatened or endangered, and one Atlantic coast subspecies is already believed to be extinct (Ehrhardt 1978; Humphrey and Barbour 1979; Humphrey 1992). The southeastern beach mouse (SEMB, *Peromyscus polionotus niveiventris*) is the largest-bodied subspecies and historically occupied a geographically isolated range along barrier islands and mainland beaches of the east coast of central and south Florida (Stout 1992). Originally described by Chapman (1889; see also Osgood 1909), the SEBM is distinguished from other subspecies by overall size and pelage characteristics (Hall 1981). The historical range of this subspecies once spanned 281 kilometers of coastline. Due to extensive development of Florida’s east coast and loss of coastal habitat, this range was reduced to 64 kilometers of coastline in the northernmost part of its historic range by 1993 (Hall 1981; U.S Fish and Wildlife Service 1993). Since 1993, the range has continued to contract and the only known persistent populations occur within the Merritt Island complex in east-central Florida from Cape Canaveral Air Force Station to Smyrna Dunes Park (approximately 56 kilometers of coastline; Figure 1.) Several individuals have been captured recently at Pelican Island National Wildlife Refuge, but their abundance and distribution there are unknown (J. Van Zant, I. J. Stout, J. D. Roth, C.L. Parkinson, unpublished data). The SEBM was federally listed under the ESA with threatened status in 1989.

We used ten microsatellite loci, together with sequences of the complete mitochondrial cytochrome-*b* gene, to assess genetic diversity, genetic structure, and demographic patterns within the SEMB. Our sampling included individuals from essentially all portions of the known extant range of the SEBM, including the isolated Smyrna Dunes Park population and the Cape Canaveral Air Force Station. This extensive sampling facilitates a nearly complete survey of the genetic diversity, variability, and structure of the SEBM. In addition, we compared the SEBM with the inland *P.p. rhoadsi*, hereafter referred to as the oldfield mouse, to assess the evolutionary distinctness and validity of the subspecies status of the SEBM.

Methods

Field Tissue Collection

Tissue samples from the SEBM were obtained from eight discrete sampling localities located on the Merritt Island complex in 2004 (Figure 1). Tissue samples from the inland oldfield mouse were obtained from Lake Louisa State Park (in 2004 and 2005), the inland population nearest to the sampling locations of SEBM (Figure 1). Specimens were captured using Sherman live traps spaced approximately 15 meters apart. Scissors sterilized with ethanol wipes were used to clip a small portion of skin (2–4 mm) from the tail of each new capture. Immediately, Kwik Stop styptic powder was applied to the wound and pressure was applied until minor bleeding had completely subsided. Mice were marked with a metal ear tag, weighed, sexed, and released at the point of capture. Tail tips were placed in 95% ethanol and transported to the University of Central Florida for genetic analysis.

DNA isolation and microsatellite genotyping

Whole genomic DNA was isolated from tail tips (approximately 30 samples per grid, Table 1) using Qiagen DNeasy tissue purification kits (Qiagen Inc., Hilden, Germany) according to the manufacturer's protocols. A total of 10 microsatellite loci were amplified and scored per individual. Both alleles (diploid co-dominant autosomal markers) were amplified per individual using the polymerase chain reaction (PCR), and the PCR products were sized using automated capillary gel-electrophoresis on a Beckman-Coulter CEQ 8000 Genetic Analysis System (Beckman-Coulter, Fullerton, CA). CEQ 8.0 software was used to automate allele sizing (based on comparisons with Size Standard 400; Beckman-Coulter), although each chromatogram was also manually reviewed for accuracy. PCR reactions were carried out in 10µl volumes. Each 10µl reaction contained 1µl 10 X PCR buffer (Sigma, St Louis Mo), 0.3 Units of taq polymerase (Sigma), 1–10 ng template DNA, 0.2 µM of both forward and reverse primer for one of the loci: pml-11, pml-02, pml-06 (Chirhart et al. 2000), PO-25, PO-105, PO-71, PO3-68, PO3-85 (Prince et al. 2002), PPA-01, or PPA-46 (Wooten and Scribner 1999) and 0.8 mM (combined) DNTPs. Final MgCl concentrations and thermal cycling parameters varied depending on optimal conditions for each primer pair. Forward primers were labeled with WellRED fluorescent dyes D2-PA, D3-PA, or D4-PA (Proligo, Boulder, Colorado). Negative controls were run with each PCR set to control for contamination. Loci PO-25 and PO-71 were amplified jointly; for this combined reaction the concentration of both PO-71 primers was increased twofold.

Capillary electrophoresis of microsatellite PCR product for each individual was performed on the Beckman-Coulter CEQ 8000. Loci pml-06, PO3-68, PO3-85, and pml-02 were amplified separately; PCR product was combined, into a single well on a 96 well PCR plate, in the ratio of 1:1:5:10 by volume, and ethanol precipitated to remove non-DNA PCR components. Ethanol precipitated DNA was dried in a vacuum centrifuge and suspended in 20 µl of deionized formamide with Size Standard 400 (Beckman-Coulter; 0.2 µl per well) and separated on the CEQ 8000 according to slightly modified manufacturers protocols. Likewise, for each individual, loci ppa-46, PO-105, and the combined PCR reaction of loci PO-71 and PO-25 were run together in the ratio of 1.25:1.25:5. Loci ppa-01 and pml-11 were electrophoresed jointly in the ratio of 5:1.25. If problems occurred for individual loci (e.g. non amplification, dye signal out of readable range, extraneous PCR amplification), the problem locus for that individual was re-amplified and run on the capillary electrophoresis system independently of other loci.

To confirm homology among microsatellite loci, the DNA sequence for each locus was determined and compared to previously published data (particularly the non-repetitive regions flanking the microsatellite repeats). PCR products of two individuals for each microsatellite locus were purified using the GeneCleanIII kit (BIO101, Irvine, California). Purified PCR products were then cloned using the TOPO TA Cloning® kit (Invitrogen, Carlsbad, California). Multiple positive clones were grown overnight and plasmid DNA was isolated using the Qiagen Qiaquick miniprep kit. Cloned DNA fragments were sequenced using M13 reverse primers on the Beckman-Coulter CEQ 8000 Genetic Analysis System according to manufacturer's protocols.

The complete DNA sequence of the mitochondrial cytochrome-*b* gene (1139 bp) was obtained for six to fourteen individuals from each discrete population: Cape Canaveral Air Force Station, Smyrna Dunes Park, and Lake Louisa State Park. The cytochrome-*b* gene was amplified as in Herron et al. (2004). Positive PCR products were purified as above and directly sequenced using the Beckman-Coulter CEQ 8000 Genetic Analysis System.

Statistical analysis.- An intraspecific haplotype network was constructed using the algorithm of Templeton et al. (1992). Haplotype connections were made under a 95% connection limit. Statistical parsimony was implemented in TCS 1.21 (Clement et al. 2000). Additionally, phylogenetic relationships among *P. polionotus* haplotypes were assessed using maximum parsimony (MP), maximum likelihood (ML), and Bayesian Markov chain Monte Carlo (MCMC). Phylogenetic analyses were rooted using *P. maniculatus, P. melanotis, P. leucopus,* and *P. gossypinus* cytochrome-*b* sequences obtained from Genbank (accession numbers: DQ385633, DQ385627, DQ000483, DQ385625 respectively). MP and ML methods were implemented in PAUP* v 4.0b10 (Swofford 2002). Nodal support for ML and MP analyses were assessed using nonparametric bootstrapping of 2000 pseudo-replicates of the original sequence alignment. Bayesian phylogenetic analysis was implemented in MrBayes v 3.1 (Ronquist and Huelsenbeck 2003). For Bayesian and ML analysis, ModelTest 3.0 (Posada and Crandall, 1998, 2001) was used to select a model of DNA evolution using Akaike Information Criterion. The General Time Reversible Model with a gamma distributed among-site rate variation (GTR + γ) was preferred. Prior parameter distributions were set to their default values. Four MCMC chains were run starting from different random trees, and parameters were sampled every 100 generations. Each MCMC run was 5 million generations although the first two hundred thousand generations were discarded as burn in. A 50% majority rule consensus phylogram was constructed from posterior distribution of trees in the four MCMC runs after burn in.

Both observed and expected levels of heterozygosity and Hardy-Weinberg Equilibrium expectations per microsatellite locus and per sampling locality were determined using ARLEQUIN version 3.000 (Schneider et al. 2005). In ARLEQUIN, standard errors and significance levels were calculated with a Markov Chain using 100,000 steps. Allelic richness, compensating for sample size effects, was calculated in FSTAT V. 2.9.3 based on a minimum sample size of 18 (El Mousadik and Petit 1996, Goudet 1995). A test for the significance of regional differences among expected heterozygosities and allelic richnesses was performed using a Wilcoxon's signed-ranks test for which the data need not be normally distributed.

Allelic richness and heterozygosity at microsatellite loci were compared among sampling localities (Table 1). The null hypothesis that each population pair had identical allele frequencies was tested for all population comparisons by the method of Raymond and Rousset (1995). The degree of genetic differentiation between all pairs of sampling localities was measured by pairwise F_{ST} (Weir and Cockerham 1984) calculated from raw allelic data in GENEPOP. A Mantel test was conducted, using the web-based program IBDWS (Jensen et al. 2005), to test for a correlation between microsatellite-based genetic distance and geographic distance (i.e. isolation by distance).

A Bayesian admixture procedure (STRUCTURE v2.1; Pritchard et al. 2000) was used to identify the number of genetically distinct clusters (K) in the entire microsatellite data set. This procedure introduces population structure to the data that minimizes Hardy Weinberg or linkage disequilibrium, and produces an estimate of the log probability of the data Pr(X | K) for a specified value of K. Often, the value of Pr(X | K) estimated by STRUCTURE continues to increase with increasing values of K, rendering its maximum a poor criterion for determining the "best" estimate of K. An alternative measure, essentially a second order derivative of Pr(X | K), ΔK, has been shown to successfully identify the highest level of meaningful population structure under a wide variety of simulation scenarios (Evanno et al. 2005). Thus, we used the modal value of ΔK to determine the number of clusters that best explain the highest level of population structure in our data.

In STRUCTURE, we set most parameters to their default values as suggested by the user manual. We chose a model allowing admixture and correlated allele frequencies between populations. We let α, the degree of admixture, be inferred from the data. The parameter of the distribution of allele frequencies (λ) was set to one. The first 100,000 generations of data were discarded as burn-in, and data were collected for 1,000,000 generations thereafter. A visual inspection of Pr(X | K) plotted against the number of generations, and consistency (i.e., convergence) across runs, supported 100,000 generations as more than a sufficient amount of burn-in. For each value of K (1 to 6), twenty independent STRUCTURE runs were conducted to obtain precise estimates of the variance among runs (as these pooled data were used to calculate ΔK). To determine the behavior of Pr(X | K) beyond this K (K > 6), three runs were carried out for each value of K up to K = 10. For the K that was determined to be the best-fit, membership coefficients of each individual in each of the population clusters were plotted.

Results

Polymorphism, genetic variation and heterozygosity within the SEBM

The DNA sequence obtained for each microsatellite locus was compared to previously published *Peromycus polionotus* sequences obtained from Genbank. In all cases, the regions flanking the microsatellite repeat motif were identical to previously published data, suggesting that we had succeeded in amplifying homologous microsatellite loci in this study.

Microsatellite genotypes and allele frequencies were determined for a total of 305 individuals, from nine trapping localities, at ten microsatellite loci (Table 1). All loci were found to be polymorphic. Generally, heterozygosities conformed to Hardy-Weinberg Equilibrium (HWE) expectations (Table 1). After sequential Bonforoni correction for multiple comparisons, there were five significant deviations from HWE. Each significant deviation from HWE was due to a heterozygote deficiency, and six out of nine sampling localities exhibited lower than expected average heterozygosity (Table 1). Two sampling localities, Cape Canaveral Grid (CCG) 6 and CCG7, deviated from HWE at two loci. At CCG4 and Lake Louisa, the PO-25 locus was significantly heterozygote deficient. All other significant deviations were not repeated across multiple sampling localities or loci. As the majority of populations adhered to HWE for any given locus, all loci and populations were included in subsequent analyses.

Estimates of expected heterozygosity and allelic diversity were significantly higher for the inland population of oldfield mouse compared to the SEBM (Wilcoxon's signed-ranks test; $P = 0.0006$ and $P = 0.0001$, respectively). For the SEBM, the expected proportions of heterozygous individuals (mean $H_E = 0.74$) for all grids on Cape Canaveral were very similar, but significantly higher than heterozygosities for the animals at Smyrna Dunes Park ($H_E = 0.56$; $P = 0.003$). Also, the allelic richness per locus was significantly higher for the grids on Cape Canaveral compared to the Smyrna Dunes Park (Table 1; $P = 0.002$).

Unique cytochrome-*b* sequences were deposited in Genebank under accession numbers EF216336-EF216347. A single cytochrome-*b* haplotype was observed in all seven individuals sequenced for the Smyrna Dunes Park population (labeled haplotype A). This haplotype was also found in the Cape Canaveral population, along with two other rare haplotypes (B, C; Figure 1 and 4). The fourteen individuals sequenced for cytochrome-*b* from the inland population of oldfield mouse yielded nine observed haplotypes, none of which were shared with the SEBM. However, given that 64 % of oldfield mouse haplotypes were unique, it is likely that additional un-sampled haplotypes exist. Kimura 2-parameter pairwise sequence divergences between haplotypes within the SEBM were at most 0.2%, while pairwise sequence divergence between haplotypes within the oldfield mouse were from 0.1 to 0.9%. Sequence divergence between haplotypes of the oldfield mouse and the SEBM ranged from 0.3% to 1.0%. The intraspecific haplotype network as well as Bayesian, MP, and ML phylogenetic analyses supported the monophyly of SEBM haplotypes (Figure 1 and 4). Utilizing four *Peromyscus* species as outgroups (*maniculatus, melanotis, leucopus,* and *gossypinus*) the SEBM and the inland oldfield mouse haplotypes were not reciprocally monophyletic (Figure 4). The 50% majority rule phylogram indicates that the SEBM haplotypes are nested within the inland oldfield mouse haplotypes. Although, the nodal support values are very low for this clade.

Genetic structure (microsatellites)

An exact test of genetic differentiation (Raymond and Rousset 1995) revealed that allele frequencies were significantly different for all pairwise population comparisons. Generally, the level of differentiation for sampling localities within Cape Canaveral was slight (yet significant), with pairwise F_{ST} values ranging from 0.001 to 0.03 (Table 2). Pairwise F_{ST} values between Cape Canaveral and Smyrna Dunes Park populations were much larger (0.11 to 0.15). Pairwise F_{ST} values between Cape Canaveral and the oldfield mouse ranged from 0.11 to 0.13. The greatest genetic distance was observed between oldfield mouse and the Smyrna Dunes Park population of SEBM ($F_{ST} = 0.22$). A Mantel test showed that geographic distance and genetic differentiation (based on microsatellite data) were positively correlated (Figure 2), implying some effect of geographic distance in genetically isolating populations.

The Bayesian admixture procedure implemented in STRUCTURE (Pritchard et al. 2000) showed large incremental increases in the likelihood [Pr(X | K)] as the number of genetic clusters in the model increased from 1 to 4. Thereafter, there continued to be slight increases in the likelihood as the number of clusters used in the model increased to K = 10 (Figure 3A). Following the method of Evanno et al. (2005), we determined the distribution of ΔK to have a strong modal value at K = 2 (Figure 3A) indicating that the highest level of population structure exists between two genetic clusters. The membership coefficients of each individual in these clusters, along with the corresponding collecting localities, are shown in Figure 3B. The separation of these two genetically-defined population-clusters clearly corresponds to the separation of the SEBM and the oldfield mouse. Furthermore, the continued large incremental increases in likelihood up to K = 4 suggest that secondary levels of structure exist below the level separating the SEBM and the oldfield mouse, within the SEBM. Allowing for an additional genetic cluster (K = 3) clearly separates the Smyrna Dunes population from the Cape Canaveral population of SEBM. Using a critical membership coefficient of 90% for inclusion in a cluster, the majority of SEBM individuals from New Smyrna and the inland oldfield mouse are assigned correctly. We found that 19 of 19 individuals genotyped from New Smyrna were included in the 'New Smyrna cluster' and 24 of 25 individuals genotyped from the inland oldfield mouse fall in the 'oldfield mouse cluster'. Adding this additional cluster causes the individuals genotyped from Cape Canaveral to show more mixed ancestry. At a 90% critical value, 19 of 231 individuals that were captured at Cape Canaveral were included in the 'New Smyrna cluster,' and only 45 of 231 individuals fall exclusively into the 'Cape Canaveral cluster.' The admixture seen at the 'Cape Canaveral cluster' is almost exclusively between the two populations of SEBM with 229 of 231 individuals having combined membership coefficients of greater than 90% in the two SEBM clusters (Figure 3C). Adding a fourth genetic cluster (K = 4) increases the likelihood, but does not, however, separate individuals according to discrete sampling location (*i.e.,* at K = 4, two genetic clusters completely overlap geographically).

Discussion

Does Peromyscus polionotus niveiventris *represent a distinct evolutionary lineage?*

Our analysis comparing the SEBM and the oldfield mouse demonstrates significant divergence between these taxa based on both mitochondrial and microsatellite data. Analyses of mitochondrial cytochrome-*b* haplotypes suggest that the SEBM represents a monophyletic lineage, and shares no haplotypes with the oldfield mouse, although it is likely that unsampled haplotypes exist in the oldfield mouse, and these could correspond to SEBM haplotypes. The sequence divergence between haplotype groups representing these two taxa were low (0.3–1.0 % Kimura two-parameter corrected pairwise divergence). This observed level of sequence divergence in the cytochrome-b gene is typical of intra-specific variation in other *Peromyscus* species, and is markedly lower than the typical level of divergence observed between sister-taxa (Bradley and Baker 2001, 2006).

The Bayesian admixture procedure implemented in STRUCTURE (Pritchard et al. 2000), based on microsatellite data, clearly separated the oldfield mouse from the SEBM (Figure 3B). Using a 90% membership coefficient cutoff for inclusion in a cluster, all individuals of oldfield mice genotyped fall in the 'oldfield mouse cluster' (N = 25) and 247 of 250 individuals of SEBM fall into the 'SEBM cluster.' The remaining three individuals of SEBM could represent individuals sharing recent co-ancestry (i.e., within the last several generations) or this result could be the explained by genotyping errors (e.g., PCR contamination). Regardless of these three outliers, the STRUCTURE analysis demonstrates undeniable allelic differentiation between the two taxa. Estimates of heterozygosity and allelic diversity were significantly higher for the inland population of oldfield mouse, compared to the SEBM (Table 1). These trends of reduced genetic diversity in the range-restricted SEBM are consistent with founder effects and/or genetic drift in smaller populations of the SEBM

Several studies have employed rates of molecular evolution to estimate divergence times in rodents (Smith and Patton 1993, Lessa and Cook 1998, Jaarola and Searle 2002, Brunhoff et al. 2003, Van Zant 2006). Incorporating the broadest consensus of evolutionary rate estimates across studies provides a range of 2–10% per Myr (Jaarola and Searle 2002, Brunhoff et al. 2003, Van Zant 2006). Applying this broad range of estimated evolutionary rates to our estimate of net nucleotide substitutions per site from the cytochrome-*b* data (Da = 0.23%) yields an estimated range of 23,000 to 115,000 years ago for the divergence between the SEBM and the inland oldfield mouse. While the absence of a single reliable taxon- specific mutation rate limits the precision of our estimates of time-since-divergence, applying this very broad range of potential rates clarifies the probable causes of isolation of these two taxa.

Florida's geology has changed dramatically in response to variable sea levels during the Pleistocene Epoch (1.8 MYA to 10,000 YA, Webb 1990). These dynamics have undoubtedly resulted in major changes in distribution of viable habitat for *P. polionotus*. Oldfield mice and beach mice inhabit sandy upland soils where water-tables are low enough year-round to support dry burrows several feet below ground (Gentry and Smith 1968). Throughout the Pleistocene, sea-levels rose and fell such that shorelines and dune systems on the Atlantic coast of the Florida peninsula dramatically advanced and receded on the order of hundreds of kilometers. During periodic glacial minima, the Florida peninsula was restricted to what is now the Lake Wales Ridge and associated uplands. During glacial maxima, eastern shores of the Florida peninsula were farther east, and the total land area of the Florida peninsula was much greater than at present (Webb 1990). Our data superimposed on the historical biogeography of the region support a scenario in which the most recent Pleistocene fluctuations in sea levels caused the isolation of SEBM from ancestral inland populations. Perhaps an ancestral SEBM population was isolated on the Atlantic Coastal Ridge or on upland habitat islands such as exist today and has subsequently remained isolated, leading to the evolutionary lineage that is now known as *P. p. niveiventris*.

Our data indicate that the SEBM fits a majority of the criteria for classification as an ESU. This taxon shows strong nuclear allelic differentiation (compared to the inland oldfield mouse), and is monophyletic based on current mitochondrial DNA data. Further, the morphological distinctions by which the SEBM was originally defined (overall larger size and lighter coat color) is consistent with this taxon showing ecological non-exchangeability (see Crandall et al. 2000). Coat color, in particular, may be a specific adaptation for crypsis in coastal habitats (Hoekstra et al. 2006), and the differences observed in the SEBM may be indicative of a unique adaptive potential or evolutionary trajectory distinct from the inland oldfield mouse. Based on our limited sampling of *P. polionotus* populations, we can not thoroughly evaluate the reciprocal monophyly of the SEBM relative to other *P. polionotus* subspecies, although this work is currently underway (J. Van Zant, I. J. Stout, J. D. Roth, C.L. Parkinson, unpublished data). Our phylogenetic analyses suggest that the inland oldfield mouse and the SEBM are currently not reciprocally monophyletic, albeit with low nodal support. However, all the evidence taken together supports the recognition of SEBM as an ESU.

Genetic evidence for multiple conservation units within the SEBM

The STRUCTURE analyses conducted to determine the optimal number of genetically-definable populations clearly indicated that the highest level of genetic structure occurred between the SEBM and the oldfield mouse (Figure 3A). Based on a model assuming two genetically-defined populations (K = 2), the vast majority of individuals had over 90% membership coefficient in either the SEBM cluster or the oldfield mouse cluster (Figure 3B). The STRUCTURE analyses also showed a large increase in likelihood going from K = 2 to K = 3 (Figure 3) suggesting two genetically distinct clusters within the SEBM, one composed of individuals from Cape Canaveral, and one of individuals from Smyrna Dunes Park, although more individuals belonging to these clusters showed significant mixed membership between these two clusters (Figure 3C). Pairwise F_{ST} values calculated from microsatellite data, however, showed similar levels of divergence between the two subspecies (SEBM and the inland oldfield mouse; $F_{ST} = 0.11 – 0.22$) compared to the divergence observed between populations of SEBM ($F_{ST} = 0.11 – 0.15$).

The STRUCTURE analysis using K = 3 assigned all individuals captured at New Smyrna to the 'New Smyrna' cluster. However, 19 individuals captured at Cape Canaveral were also assigned to this 'New Smyrna' cluster (Figure 3C). One might take this mixed cluster as evidence that the New Smyrna population represents merely a subset of the genetic diversity seen at Cape Canaveral; however, each of these discrete populations of the SEBM contained unique (i.e., endemic) microsatellite alleles. Mitochondrial cytochrome-*b* haplotypes also appear to show different relative frequencies between the two populations, although our sampling of mitochondrial haplotypes is insufficient to precisely characterize these differences. Lower values of heterozygosity, haplotype diversity, and allelic richness observed in the smaller Smyrna Dunes Park population (relative to the Cape Canaveral population) may be causally related to the elevated impact of founder effects and/or drift in this smaller and isolated population. From a conservation perspective, we recommend that these two populations (Smyrna Dunes Park and Cape Canaveral) be managed separately in order to maintain local genetic diversity based on evidence of unique microsatellite alleles observed in both populations.

Conservation and management

In the Alabama beach mouse (*P. p. ammobates*), Swilling and Wooten (2002) found that 55 % of mice remained philopatric, while 45% dispersed greater than one home range from their natal site, with the average dispersal distance being only ~160 m. This limited dispersal capability agrees with our demonstration that geographic distance is a contributing factor acting to isolate sub-populations of the SEBM within the Merritt Island complex, with F_{ST} increasing with geographic distance between samplinc localities. To conserve the high levels of polymorphism observed within the SEBM Cape Canaveral population, habitat connectivity should be maintained so that individual populations of beach mice are not isolated and subjected to elevated levels of inbreeding and the increased effects of genetic drift.

Overall heterozygosity and allelic richness in the SEBM were significantly lower than values observed in our sample of the inland oldfield mouse. Additionally, the New Smyrna population of the SEBM showed significantly lower heterozygosity and allelic richness compared to the Cape Canaveral population. These findings suggest that genetic diversity is diminished in the SEBM (especially in the New Smyrna population). Higher levels of heterozygosity, allelic diversity, and numbers of alleles per locus suggest that the SEBM population inhabiting Cape Canaveral is larger (consistent with the geographic area) and more genetically diverse than the Smyrna Dunes Park population. These data, in turn, suggest that the Cape Canaveral population is exceedingly important for the sustained survival of the SEBM and would be the best candidate for a source population for potential reintroduction programs. Each smaller peripheral population, however,is important for maintaining the level of genetic diversity within this evolutionarily distinct subspecies. We found unique alleles in both New Smyrna Park and Cape Canaveral, as well as strong evidence for overall genetic differentiation between SEMB populations (based on STRUCTURE results), suggesting both populations contain endemic patterns of genetic diversity. Therefore we suggest treating these populations as two separate conservation management units while striving to conserving SEMB throughout its entire current range. Collectively, our results support the continued recognition of the SEBM as a unique taxon and the importance of its protection under the United States Endangered Species Act.

Acknowledgements
Funding for this study was provided by Patrick Air Force Base, Florida. We thank the personnel of the 45th CES/CEVR wing and especially Mr. Donald George for support. We would like to thank Hopi Hoekstra, Alice Bard, Jane Provancha, Alex Suazo, Angie DeLong, Megan Keserauskis, and Donna Oddy, along with field assistants Shannon Letcher, Kasey Gillespie, Meryl Green, David Gunderson, April Verpoorton, Daniel Smith, Weldon Lavigne, and Angie Ashcraft-Cryder, for collecting the tissue samples used in this study. We thank Todd Castoe, Jeff Van Zant, and Eric Hoffman for comments that greatly improved this manuscript and Lisa McCauley for help with Figure 1. This work was conducted under permit 12-09-04-01 issued by Florida Department of Environmental Protection Division of Recreation and Parks, WV04065 issued by the Florida Fish and Wildlife Conservation Commission, TE105642-0 issued by USFWS, and Animal Project # 03-13W from the IACUC, University of Central Florida.

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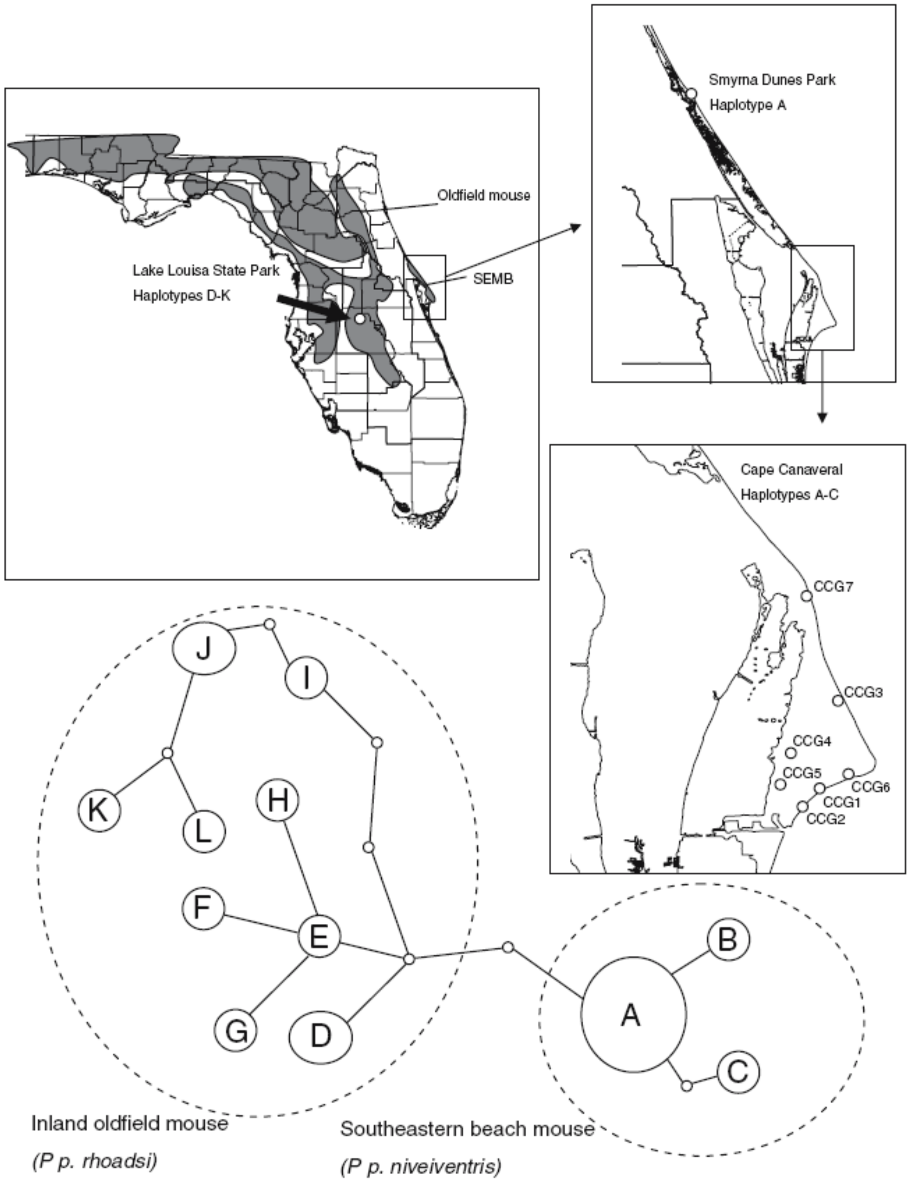

Figure 1. The current range of the southeastern beach mouse (*Peromyscus polionotus niveiventris*) and the inland oldfield mouse (*Peromyscus polionotus rhoadsi*). Sampling localities for the oldfield mouse (Lake Louisa State Park) and the SEBM (Cape Canveral grids 1-7, and Smyrna Dunes Park), observed mitochondrial haplotypes (per locality or group of localities), and statistical parsimony haplotype network are additionally shown. In the haplotype network, each indicated step (circle) represents single nucleotide differences in the cytochrome-*b* gene. The size of the circle is scaled to represent the relative frequency of that haplotype in the total sample, and the smallest circles represent inferred unsampled haplotypes.

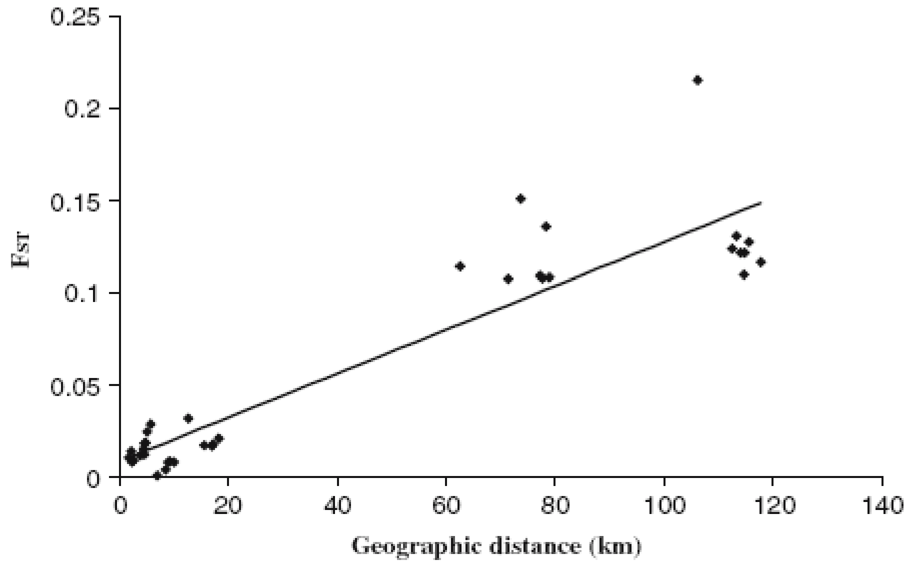

Figure 2. Plot of F_{ST} values (based on microsatellite data) versus geographic distance among all sampling localities indicating evidence for isolation by distance. F_{ST} values are plotted against corresponding straight-line geographic distances (d) between sites. The equation of the best fit line (shown) is $F_{ST} = 0.0012d + 0.0086$ (Mantel Test, r = 0.92, one-sided P = 0.006 from 1000 randomizations)

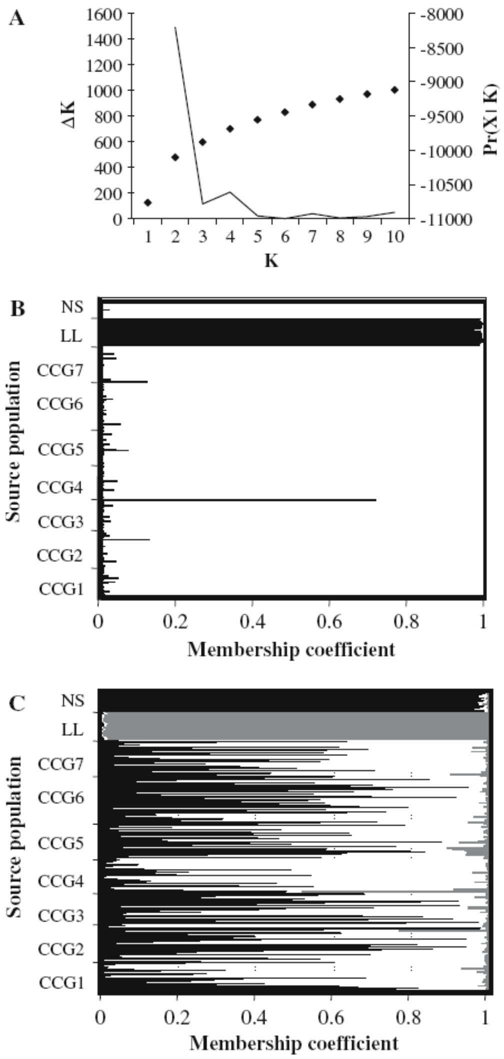

Figure 3. The results of the analyses of population structure using the method of Pritchard et al. (2000), implemented in the program STRUCTURE. Data shown here represents the pooled results of 3 to 20 independent MCMC runs (see text for details). **(A)** Plot of the number of genetically discrete populations (K) versus the two optimality criteria: the raw average Ln liklihood indicated by diamonds and scaled to the right vertical axis, and ΔK (described in Evanno et al. 2005) indicated by solid line and scaled to the left vertical axis. The confidence intervals among 3–20 runs were too narrow to be visible if displayed graphically. **(B)** Estimated membership coefficients based on admixture analyses for K = 2 genetically defined populations for each individual sampled. Vertical axis labels indicate the source population of each individual plotted, and the horizontal axis indicates the membership coefficient in the 'oldfield mouse' genetic cluster. **(C)** Estimated membership coefficients based on admixture analyses for K = 3 genetically defined populations for each individual sampled. Vertical axis labels indicate the source population of each individual plotted, and the horizontal axis indicates the membership coefficient in each of the 'New Smyrna cluster' (black bars), 'oldfield mouse cluster' (grey bars), and 'Cape Canaveral cluster' (White bars).

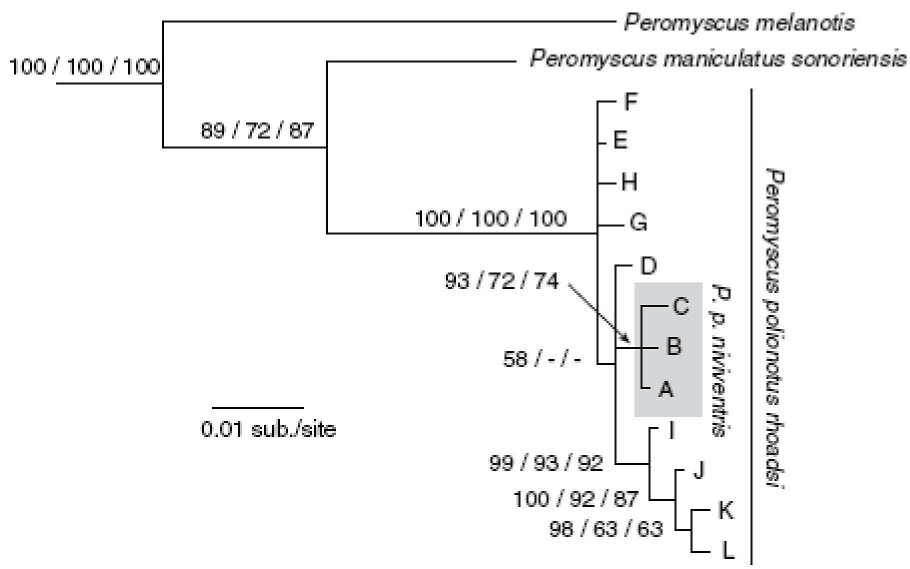

Figure 4. Inferred phylogenetic relationships among haplotypes of SEBM (*Peromyscus polionotus niveiventris*) and the inland oldfield mouse (*Peromyscus polionotus rhoadsi*). *Peromyscus maniculatus, melanotis, leucopus,* and *gossypinus* were used to root this phylogeny (*leucopus,* and *gossypinus* are not shown). Nodal support displayed is Bayesian posterior probability/ML bootstrap support/MP bootstrap support, dash (-) indicates lower than 50%. SEBM haplotypes are shaded, while all other haplotypes were sampled from the inland oldfield mouse.

Table 1. Population, sample size (n), number of alleles per locus (A), allelic richness compensating for sample size, average observed (H_O) and expected (H_E) heterozygosity for each sampling location. Lake Louisa State Park samples represent inland oldfield mouse (*Peromyscus polionotus rhoadsi*) all other sampling locations represent the southeastern beach mouse (*Peromyscus polionotus niveiventris*).

Population	n	A	Allelic Richness	H_O	H_E
Cape Canaveral Grid 1	31.0 ± 0.0	8.9 ± 0.99	8.03 ± 0.87	0.72 ± 0.07	0.76 ± 0.06
Cape Canaveral Grid 2	34.0 ± 0.0	8.8 ± 1.08	7.66 ± 0.93	0.75 ± 0.07	0.73 ± 0.07
Cape Canaveral Grid 3	26.2 ± 0.2	8.8 ± 1.27	7.96 ± 1.10	0.71 ± 0.06	0.76 ± 0.6
Cape Canaveral Grid 4	32.0 ± 0.0	7.6 ± 0.92	6.82 ± 0.81	0.72 ± 0.09	0.72 ± 0.07
Cape Canaveral Grid 5	30.0 ± 0.0	8.6 ± 1.14	7.70 ± 0.93	0.69 ± 0.07	0.74 ± 0.06
Cape Canaveral Grid 6	44.9 ± 0.1	9.1 ± 1.20	7.83 ± 0.94	0.71 ± 0.08	0.74 ± 0.06
Cape Canaveral Grid 7	42.1 ± 0.4	8.7 ± 0.93	7.29 ± 0.78	0.69 ± 0.09	0.75 ± 0.06
Smyrna Dunes Park	18.5 ± 0.2	4.2 ± 0.42	4.17 ± 0.42	0.59 ± 0.07	0.56 ± 0.07
Lake Louisa	23.5 ± 0.4	11.7 ± 1.11	11.00 ± 0.95	0.81 ± 0.03	0.88 ± 0.01

Table 2. *Pairwise matrix of genetic distances F_{ST} (Weir and Cockerham 1984) below diagonal and geographic distances (km) above diagonal between all pairs of sampling localities.*

	CCG1	**CCG2**	**CCG3**	**CCG4**	**CCG5**	**CCG6**	**CCG7**	**NS**	**LL**
CCG1	-	1.65	8.53	4.86	2.67	2.34	17.10	78.33	114.61
CCG2	0.011	-	9.99	5.75	2.13	3.94	18.29	78.89	114.04
CCG3	0.004	0.008	-	5.10	9.21	6.94	8.90	71.33	117.77
CCG4	0.019	0.029	0.025	-	4.42	4.62	12.64	73.60	113.30
CCG5	0.009	0.014	0.009	0.016	-	4.61	17.02	77.12	112.52
CCG6	0.008	0.012	0.001	0.019	0.012	-	15.68	77.70	115.49
CCG7	0.018	0.028	0.008	0.032	0.017	0.017	-	62.57	114.83
SDP	0.136	0.108	0.107	0.15	0.109	0.108	0.114	-	106.11
LL	0.111	0.122	0.117	0.131	0.124	0.128	0.122	0.215	-

Chapter 3

TROPHIC STATUS OF A SMALL MAMMAL ASSEMBLAGE ON CAPE CANAVERAL AIR FORCE STATION WITH AN EMPHASIS ON *PEROMYSCUS POLIONOTUS NIVEIVENTRIS* (SOUTHEASTERN BEACH MOUSE)

Megan M. Keserauskis, James D. Roth, and I. Jack Stout

ABSTRACT

Successful translocation of a listed species into an area of previous occupation requires knowledge of the habitat needs. The presence of the necessary food items is critical to the successful establishment of a new population; this information is unknown for *Peromyscus polionotus niveiventris*, the southeastern beach mouse, a threatened subspecies on the east coast of Florida. I used fecal and stable isotope analysis to determine the diet of this subspecies at Cape Canaveral Air Force Station, Brevard County, Florida, between the autumn of 2003 and the spring of 2005. Six trapping grids were established, three in the dune/swale and three in the coastal scrub communities. Fecal and hair samples were collected and analyzed. The diet varied in the amount of ^{13}C consumed between habitats and in the amount of both ^{15}N and ^{13}C consumed among grids within a habitat. There was no significant interaction between habitat and sex in the amount of either ^{15}N or ^{13}C consumed, and sexes also did not differ significantly. Fecal analysis uncovered the dominance in the diet of C_3 plants. My data refuted the current belief, that the southeastern beach mouse prefers beach grass seeds of C_4 plants, which were consumed but not in the frequency or quantity expected.

I also analyzed the diet of *Peromyscus gossypinus*, the cotton mouse, and *Sigmodon hispidus*, the hispid cotton rat, using the two techniques. Both species consumed a combination of plant and arthropod material. Their diets varied between dune/swale and coastal scrub habitats.

All three species' diets were significantly different, with *Peromyscus polionotus niveiventris* and *Peromyscus gossypinus* being the most similar. Both consume a greater proportion of arthropod material compared to the hispid cotton rat. Interspecific competition between the southeastern beach mouse and the cotton mouse may occur in times of limited resources.

INTRODUCTION

Habitat loss and degradation are among the primary causes of species' listing by state or federal governments as endangered or threatened (Noss et al. 1997). For each listed species, a recovery plan requires an increase in the population size and number of viable populations within the historical range. Establishing new populations with individuals from a source population can be problematic when loss of habitat caused the original decline, making reintroduction sites scarce. Public land within the historical range is less likely to be developed, but still may be unsuitable if the necessary resources (e.g., food) are unavailable. Thus, understanding the diet of the animal is important prior to translocation.

Interspecific resource competition is another consideration in translocations, especially in times of limited resources due to drought or disturbances such as hurricanes. Either a native competitor or an invasive exotic can thwart reintroduction efforts if they out-compete the species of concern (Griffith et al. 1989). Dietary overlap in areas of suitable habitat may indicate the potential for competition. Informing land managers of the food requirements and potential for competition will help them manage the habitat appropriately.

The southeastern beach mouse (*Peromyscus polionotus niveiventris*) is found in close association with sea oats (*Uniola paniculata*) and other grasses, which are assumed to be significant food sources (USFWS 1993). The southeastern beach mouse is one of seven extant subspecies of *Peromyscus polionotus* known as beach mice which occur in dune/swale habitats. The diet of the southeastern beach mouse is thought to be similar to other subspecies of beach mice, with possible exceptions where the distribution of food plants does not overlap with the ranges of all the subspecies (USFWS 1993). Another assumption is that beach mice only consume arthropods when plant material is not plentiful, i.e., the winter months (Ehrhart 1978). However, the only direct research on beach mouse diet is a single Masters thesis on three of the subspecies residing in the panhandle of Florida and adjacent Alabama (Moyers 1996). All other information has its foundation based on isolated field observations and assumptions. No dietary estimate of southeastern beach mice currently exists.

In this thesis I estimated the diet of *P. p. niveiventris* using stable isotope analysis and fecal analysis. I also estimated the diets of two rodents that are locally sympatric with *P. p. niveiventris*, and therefore, potential competitors, the cotton mouse (*Peromyscus gossypinus*) and the hispid cotton rat (*Sigmodon hispidus*), using the same techniques. Finally, I estimated dietary overlap of all three species and discussed the possibility of competition among these three small mammals found on Cape Canaveral Air Force Station, Brevard County, Florida, including the potential impact on the survivorship of the threatened *P. p. niveiventris* and possible management implications.

BIOLOGY OF THE STUDY ANIMALS

The historic range of *P. p. niveiventris* included the primary dune/swale area of 280 km of the Atlantic coastline between Southern Volusia and Broward Counties (Hall 1981). However, due to loss of habitat to coastal development, the current range has declined to approximately 64 km of primarily public lands, including Canaveral National Seashore, Merritt Island National Wildlife Refuge, and Cape Canaveral Air Force Station (USFWS 1993). Research on *P. p. niveiventris* has focused on population dynamics, dispersal, and habitat use (Kiem 1979; Extine 1980; Extine and Stout 1987; Efron 1999; Oddy 2000; Weidlich 2002). All research to date on *P. p. niveiventris* has occurred in Brevard (Cape Canaveral Air Force Station and Merritt Island National Wildlife Refuge) and Indian River Counties (Archie Carr National Wildlife Refuge). The diet of this animal is currently unknown and assumed to be similar to other omnivorous subspecies of *P. polionotus* (Gentry and Smith 1968; Frank 1996; Moyers 1996). However, because *P. p. niveiventris* is the only beach mouse subspecies that occupies inland scrub as well as dune/swale habitats (Extine and Stout 1987), the assumption that its diet is identical to that of other beach mice is suspect.

Cotton mice and hispid cotton rats are both widely distributed in the southeastern United States (Burt 1980). Cotton mice occupy forested wetlands, wooded areas, old fields, hammocks, and dune/swale and coastal scrub, whereas hispid cotton rats are strongly associated with grasslands, pine flatwoods, and to a lesser extent dune/swale and coastal scrub (Burt 1980). Cotton mice are omnivores and consume seeds, flowers and fruit as well as arthropods (Martin et al. 1951; Wolfe and Linzey 1977), although the importance of arthropods in the diet is not well studied. Hispid cotton rats are herbivores and consume primarily grasses and other green herbaceous plant material (Martin et al. 1951; Fleharty and Olson 1969; Cameron and Spencer 1981; Randolph et al. 1991; Randolph et al. 1995; Randolph and Cameron 2001; Cameron and Kruchek 2005). Seeds and fruit are eaten, whereas arthropods are scarcer or absent in the diet.

Based on the information available for these rodents, I predicted that in areas of local sympatry:

(1) Grasses are the most significant component of the diet of *P. p. niveiventris*
(2) *P. p. niveiventris* and *P. gossypinus* are omnivorous, whereas *S. hispidus* is exclusively herbivorous, but all three consume a variety of food species and, therefore, are generalists,
(3) the dietary overlap between *P. p. niveiventris* and *P. gossypinus* is greater than the overlap between *S. hispidus* and either *Peromyscus* species.
(4) the diets of all three species vary by habitat due to differences in food availability
(5) males and females differ for all three species due to differing nutritional needs during pregnancy and lactation

MATERIALS AND METHODS

Study Sites

The study was conducted in habitat types where *P. p. niveiventris* has been trapped (Stout 1979). I constructed six trapping grids on Cape Canaveral Air Force Station, three in the dune/swale and three in the coastal scrub (Figure 1).

The dune/swale ecosystem consists primarily of beach grass including *Panicum amarum*, *Uniola paniculata*, *Sporobolus virginicus*, and *Distichlis spicata*. Other woody and herbaceous plants included *Coccoloba uvifera*, *Serenoa repens*, *Smilax auriculata*, *Physalis walteri*, and *Scaevola plumieri* (Johnson et al. 1990).

The coastal scrub ecosystem consists primarily of salt-pruned shrubby oaks, including *Quercus virginiana*, *Q. geminata*, *Q. chapmanii*, and *Q. myrtifolia*. Saw palmetto, *Serenoa repens*, is also dominant (Johnson et al. 1990). Coastal scrub grid 3 falls in the category of coastal strand, an ecosystem commonly found between the dune/swale and coastal scrub ecosystems, but the dominant vegetation is similar to that found within the coastal scrub. Table 1 contains a complete list of plants observed in the study sites.

Field Methods

Each grid consisted of 64 Sherman live traps (HB Sherman Traps, Tallahassee, FL) at 15 m intervals, plus an additional trap line located 150 m away from the grid with 10 traps at 15 m intervals. I opened the traps for one night every two weeks from June 2003 – May 2005. Captured rodents were tagged with a numbered monel ear tag, and a small hair sample (~2 mg) was clipped from the rump region with scissors for stable isotope analysis. Body masses were determined with a Pesola scale, sex, relative age (juvenile, sub-adult, adult), and pelage status (molting, saddle-molt, prime) noted. Fecal matter was collected if present in the trap, and traps were cleaned after every capture. Ear tag number identified recaptured animals, which were sexed, classified as to their reproductive status, body mass, pelage status, and age.

To investigate seasonality in food availability, plants on the grids and transects were monitored each month to document flowering, fruit set, and the vegetative state (i.e., only leaves and stems) (Appendix 4). I collected tissues (leaves, flowers, fruits) of potential food species from each grid each season for use as reference material in the fecal analysis (samples were frozen or dried until processed). I also used sticky traps and small pitfall traps to sample arthropods on or near the soil surface. Sticky traps, #10 coffee can lids with a sticky nontoxic substance (Tanglefoot® bird repellent) spread on the upper surface, were placed at 16 haphazardly chosen trap stations on each grid, plus three on each transect, and attached to vegetation by string. Pitfall traps consisted of 10.5 oz (300g) soup cans (6 per grid) buried with the tops flush with the ground surface, with a "roof" to reduce disturbance from wind-driven sand and animals, raised sufficiently above the top of the can to allow passage of ground-dwelling/crawling arthropods. A small amount of soapy water or nontoxic antifreeze placed in the cans acted as a trapping agent. After one week in the field, sticky traps and pitfall traps were collected and brought back to the lab.

Fecal Analysis

Fecal analysis (Dusi 1949) provides a relatively complete list of the specific plants consumed, but the success of this technique depends on particle size and the effect of digestion on particle content (Vavra and Holechek 1980). The method requires comparing the cellular structure of the plant fragments to the cellular structure of the reference slides derived from plants taken from the study area.

I randomly selected 10 fecal samples per season per grid for *P. p. niveiventris* (five females and five males, if possible) and ten fecal samples each for *P. gossypinus* and *S. hispidus* (division of samples into five of each sex was impossible due to lack of sample size for each sex) using a random number generator. Sample preparation followed the methods of Hansen (1971). Feces were ground with a mortar and pestle, placed onto a slide (two slides per sample), and covered with Hertwig's solution (a clearing solution consisting of crystalline chloral hydrate, glycerin, and hydrochloric acid). I heated the slides over an ethanol burner until most of the solution had boiled off, added Permount® mounting solution and a cover slip, and reheated until the solution had just begun to boil. I then removed the slide from the flame, quickly wiped the underside with a cool, damp cloth to remove air bubbles, and placed the slides in a drying oven for three days at 55˚C. Voucher slides of the plant reference material collected in the field were prepared in the same manner as the fecal slides to illustrate the identifying cell structures.

I examined the slides under a microscope with an attached digital camera and the program Magnafire. I analyzed the entire slide under the microscope at the magnification required to see cellular structure. Digital images of cell structures in the voucher slides (leaf, stem, flower, and fruit) were prepared and compiled in reference book to assist in identifying the plant fragments on the fecal slides. Digital images of the fecal slide contents were then printed and examined for the presence/absence of plant species. Plant identification in the fecal material was to species level or the lowest taxonomic level possible. I compared the number of plant species consumed per mouse (*P. p. niveiventris* only) using JMP Least Squares Analysis (SAS 2004), with sex, habitat, and grid (nested within habitat) as the independent variables. The number of plant species consumed will provide an indication of whether the three species are food specialists or generalists.

Plant material digestibility varies with cellulose content (Vavra and Holechek 1980). Therefore, as much as fifty percent of fecal contents may be unidentifiable because the cell structure is not visible or is so thoroughly digested that what remains is amorphous. Further, when dealing with fragment size, the parts of one species may be indistinguishable from another species. In many cases the similarities among plant parts, i.e. flowers from different species of the same genus, make it impossible to identify fragments to specific species.

To identify arthropods in feces, I randomly chose mice from the group chosen for plant identification in fecal samples for a separate analysis since the fecal slide preparation procedure reduced arthropod fragments to unrecognizable pieces. Fecal material from 150 southeastern beach mice, 10 cotton mice, and 10 hispid cotton rats were analyzed for the presence/absence of arthropods. I placed one fecal pellet in a vial, added water, and gently shook the vial to soften the pellet. Once the pellet had completely dissolved, I added isopropyl alcohol to prevent further decomposition and poured the liquid into a grid etched Petri dish for observation under a dissection microscope. A research entomologist with the University of Central Florida identified the arthropod fragments and compiled a species list for each sample.

I used the arthropod samples from sticky traps and pitfall traps to identify the arthropods present in the study area. Sticky traps were soaked in mineral spirits until the arthropods and the sticky solution floated free of the lids. I preserved the arthropods from both types of traps in 75% propanol, and I then had them identified to the lowest taxonomic level possible.

Arthropods observed to be vulnerable to potential capture by *P. p. niveiventris* and those observed in fecal slides were collected, if possible, from the grids for stable isotope analysis.

Stable Isotope Analysis

Stable isotope analysis is a widely used technique for investigating diet (Anderson and Polis 1998; Drever et al. 2000; Stapp and Polis 2003a,b). This method compares the stable isotope ratios ($^{15}N/^{14}N$ and $^{13}C/^{12}C$) of an animal's tissues to those of potential food sources to provide an estimate of the animal's diet at the time that tissue was grown (DeNiro and Epstein 1978, 1981; Roth and Hobson 2000). Since different photosynthetic pathways incorporate the stable isotopes of carbon in different ratios, measuring these signatures in an animal's tissues can indicate the plant types consumed (C_3 vs. C_4/CAM) (DeNiro and Epstein 1978), and thus can reflect the amount of grass vs. forbs or woody vegetation in the diet (Cerling et al. 2006). For nitrogen, the heavy isotope (^{15}N) is preferentially incorporated into the tissues of the consumer from the diet, resulting in a systematic enrichment in nitrogen-isotope ratios with each trophic level (DeNiro and Epstein 1981). Thus, stable nitrogen isotope ratios reflect the trophic position of an organism within a food web, with carnivorous animals being most enriched in ^{15}N, followed by omnivores, and with primary producers having the least ^{15}N (Stapp and Polis 2003a). In combination, measurement of these stable isotope ratios provides a powerful tool for understanding feeding relationships and tracing the flow of energy and nutrients.

I measured stable isotope ratios in hair from all three rodent species and from plants and arthropods that were potential foods. To prepare samples for analysis (see Appendix 3 for greater detail), hair samples were cleaned with soap and water to remove surface oils, dried at 90°C, and homogenized with scissors. Plants and arthropods were freeze-dried for 48 hrs and pulverized with mortar and pestle. The carbon isotope ratios of lipids differ substantially from other compounds (DeNiro and Epstein 1978; Tieszen et al. 1983), and variations in lipid concentration can significantly influence $\delta^{13}C$ measurements (Rau et al. 1992). Therefore, I removed lipids from arthropod samples using a Soxhlet apparatus with petroleum ether solvent for at least 8 hours, and then evaporated the solvent in a drying oven.

Stable isotope ratios of subsamples (3 mg of plants, 1 mg of arthropods and rodent hair) were measured on a continuous flow isotope ratio mass spectrometer at the University of Central Florida. Stable isotope signatures are expressed as parts per thousand (‰) relative to a standard as follows: $\delta X = [(R_{sample}/R_{standard}) - 1] \times 10^3$, where X is ^{13}C or ^{15}N and R is the corresponding ratio $^{13}C/^{12}C$ or $^{15}N/^{14}N$. The standards for ^{13}C and ^{15}N are Pee Dee Belemnite and atmospheric N_2, respectively. Measurement precision was within 0.1‰ for carbon and 0.2‰ for nitrogen.

I analyzed the $\delta^{13}C$ and $\delta^{15}N$ values of the three rodents (710 beach mice, 51 cotton mice, and 31 cotton rats) using JMP Least Squares (SAS 2004) to determine whether there were differences in sex (male versus female), habitat type (dune/swale versus coastal scrub), an interaction between habitat and sex, and grids within a habitat type. I also used the stable carbon isotope ratios of the plants and arthropods to assign each species to either the C_3 or C_4 photosynthetic pathway. $\delta^{13}C$ values between -19 and -6‰ were designated as part of the C_4 photosynthetic pathway; those between -34 and -24‰ were considered part of the C_3 photosynthetic pathway (Smith and Epstein 1971).

I used the $\delta^{13}C$ and $\delta^{15}N$ stable isotope ratios of rodent hair, plants, and arthropods in a multi-source mixing model (program IsoSource; Phillips and Gregg 2003) to determine the contribution of various food sources in the hair of the rodents sampled (Phillips et al. 2005). The rodent samples were corrected for trophic enrichment (3‰ for nitrogen and 1‰ for carbon;

DeNiro and Epstein 1978, 1981) and averaged by habitat type for each species. The model compared the averaged rodent data to the average C_3 plants, C_4 plants, C_3 arthropods, and C_4 arthropods in each habitat type; aggregating food sources into these functional groups allowed a much narrower range of potential solutions (Phillips et al. 2005). The model output consisted of a range of possible proportions (minimum, maximum, mean) of each food group in the overall hair average.

To assess the likelihood of competition among the three co-occurring small mammals, I analyzed the stable isotopic data using JMP Least Squares and Cluster Analysis (SAS 2004).

RESULTS

Fecal Analysis

Of the 50 plant species identified in the study area, *P. p. niveiventris* consumed 41, 11 were consumed by *P. gossypinus*, and 13 were consumed by *S. hispidus* (Table 1). Most of the plant fragments observed on the fecal slides belonged to the C_3 plant type. Due to the varying effect of digestion on the plant material consumed, a portion of the material was not identifiable beyond plant part (i.e. flower, berry, stem, leaf, and seed). These are represented at the bottom of Table 1 and comprise a large proportion of the diets of all three species. The diet of *P. p. niveiventris*, the portion composed of plant material identified to a specific plant, was composed of 93% C_3 plants (non-grass material) and 7% C_4 plants (grass material) within the dune/swale habitat, and 99% C_3 plants and 1% C_4 plants within the coastal scrub habitat. Grass species were difficult to distinguish due to the minute fragment size.

There was no significant difference in the composition of plant species found in the fecal samples of beach mice between habitats ($F_{1,224}$=0.93, p=0.39) or sex ($F_{1,224}$=1.00, p=0.32), but grids differed within habitat ($F_{4,224}$=10.4, $p<0.0001$).

Arthropod material was present in feces in both habitats (Table 2). Forty-six percent of the dune/swale samples and fifty-six percent of the coastal scrub samples of *P. p. niveiventris* contained arthropod fragments. The difference in the presence/absence of arthropods between the two habitats was found to be non-significant when analyzed using a 2x2 Contingency Table (unadjusted χ^2=1.27, adjusted χ^2=0.93). I found arthropods from eight orders in *P. p. niveiventris* feces (Table 2), two orders in *P. gossypinus* feces (Hymenoptera & Coleoptera), and two orders in *S. hispidus* feces (Diptera & Lepidoptera). I found no overlap in the insect orders consumed by these last two species.

Stable Isotopes

Plants in both habitats clearly separated into the two $\delta^{13}C$ categories, C_3 and C_4/CAM (Figure 2). More of the plant species belonged to the C_3 photosynthetic pathway, although the biomass of C_4 species appeared greater in the dune/swale habitat than in the coastal scrub where C_3 plants dominated. Nitrogen values fell within the expected range. The C_3 plants did not differ significantly between the two habitats in $\delta^{13}C$ ($F_{1,98}$=0.002, p=0.97); however the plants did differ significantly in $\delta^{15}N$ ($F_{1,98}$ =7.95, p=0.01).

Arthropods also clearly separated into those feeding primarily in the C_3 or C_4/CAM food chains. Most arthropods collected from the dune/swale and coastal scrub habitats fed on C_3 plants, although my sample of arthropods that may be potential food items was small (Figure 3).

Beach mice from the dune/swale habitat were enriched in ^{13}C compared to those from the scrub ($F_{1,698}$=11.52, p=0.02), but $\delta^{15}N$ values did not differ ($F_{1,698}$=1.43, p=0.30). Within habitats, beach mice differed among grids in both $\delta^{13}C$ ($F_{4, 698}$=6.22, p<0.0001) and $\delta^{15}N$ ($F_{4, 698}$=32.62, p<0.0001). There were no significant sex differences for $\delta^{13}C$ ($F_{1, 698}$=0.67, p=0.41) or $\delta^{15}N$ ($F_{1, 698}$=1.11, p=0.29), and no interaction between sex and habitat for $\delta^{15}N$ ($F_{1, 707}$=2.83, p=0.09) or $\delta^{13}C$ ($F_{1, 707}$=1.12, p=0.29).

$\delta^{13}C$ and $\delta^{15}N$ values for beach mice and arthropods derived from coastal scrub sites are predominantly clustered in the C_3 carbon ratio (<-24), which suggests consumption of C_3 plants (Figure 4). A few beach mouse samples reflected a diet largely restricted to C_4 plants (C_4/CAM $\delta^{13}C$ = -19 to -6). The majority of the arthropod samples appear to reflect arthropods that fed on C_3 plants. There are some intermediate points representing mice between the C_3 and C_4 regions of the beach habitat. These points likely represent mice consuming both C_3 and C_4 plant matter, resulting in intermediate $\delta^{13}C$ values. The range of $\delta^{15}N$ values in beach mice suggests they are not strictly herbivorous, but rather are omnivorous, and also indicates that not all of the animals eat the same proportion of plant and arthropod matter.

Cotton mice and cotton rats appeared to consume foods primarily from the C_3 food chain but acted as omnivores in both habitats (Figure 5). Cotton mouse stable isotope ratios did not differ between habitats for either carbon ($F_{1,39}$=0.12, p=0.73) or nitrogen ($F_{1,39}$=0.91, p=0.38). Cotton rat $\delta^{15}N$ values did not differ between habitats ($F_{1,19}$=0.47, p=0.51), but rats from dune/swale habitats were enriched in ^{13}C compared to rats from coastal scrub habitats ($F_{1,19}$=6.69, p=0.05). Within habitats, cotton mice differed among grids for nitrogen ($F_{4,39}$=5.65, p=0.001) but not carbon ($F_{4,39}$=0.91, p=0.47), and cotton rats differed among grids for carbon ($F_{1,19}$=8.91, p=0.0003) but not nitrogen ($F_{1,19}$=2.74, p=0.06). Sex did not differ for either cotton mice (nitrogen $F_{1,39}$=2.35, p=0.13; carbon $F_{1,39}$=0.70, p=0.41) or cotton rats (nitrogen $F_{1,19}$=0.28, p=0.60; carbon $F_{1,19}$=2.44, p=0.13). The interaction between sex and habitat was not significant for either cotton mice (nitrogen $F_{1,48}$=1.14, p=0.29; carbon $F_{1,48}$=2.05, p=0.16) or cotton rats (nitrogen $F_{1,28}$=0.92, p=0.35; carbon $F_{1,28}$=0.00, p=1.00).

The results from the mixing models clearly indicate that *P. p. niveiventris* in the dune/swale habitat consumed a greater amount of plants and arthropods with a C_3 signature, whereas plants and arthropods with a C_4 signature consistently occurred in minimal amounts (Figure 6). In the coastal scrub, C_3 arthropods made up the largest proportion of the beach mouse diet, followed by C_3 plants (Figure 6). Cotton mice in both habitats consumed mainly C_3 plants and C_3 arthropods (Figure 6); this species was captured only on two coastal scrub grids. Cotton rats in the dune/swale and coastal scrub had diets comprised mainly of C_3 plants, though C_4 plants were a more significant component of the diet in the dune/swale compared to either *P. p. niveiventris* or *P. gossypinus* (Figure 6). However, the sample size of this species on all grids was quite low.

The three rodent species differed significantly in both $\delta^{15}N$ ($F_{2,784}$=11.9, p<0.0001) and $\delta^{13}C$ ($F_{2,784}$=3.86, p=0.022) (Figure 7). $\delta^{15}N$ did not differ significantly between *P. p. niveiventris* and *P. gossypinus*, but both differed significantly from *S. hispidus* (Tukey HSD, p<0.05). Turkey HSD also verified that $\delta^{13}C$ did not differ significantly among the three species.

I performed a cluster analysis on the $\delta^{15}N$ and $\delta^{13}C$ values of all three rodent species in each habitat type, and used the results to construct a dendrogram to display the relative differences among rodent groups graphically (Figure 8). The diet of *P. gossypinus* in the two habitats was most similar, and *S. hispidus* in the dune swale, as the last group to cluster with the other 5 groups in the dendrogram, was the most dissimilar in diet. Overall, rodent diets were more similar in the scrub than in the dune/swale habitats (Figure 8).

DISCUSSION

A significant result of my study is the demonstration that *P. p. niveiventris* occupies a much broader feeding niche than had been assumed from casual observations. I found this subspecies to utilize two-thirds of the plants found on the grids as well as many kinds of arthropods. These results suggest plans for future translocations should consider the need for a diverse mix of plant species and life forms in the site selection process. Selection of a site with a highly diverse flora may mitigate interspecific competition with other small mammals, which cannot be assumed to be absent.

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P. p. niveiventris is omnivorous and in this aspect is similar to the subspecies studied by Moyers (1996) and Sneckenberger's (2001) as well as the subspecies known as old-field mice (Gentry and Smith 1968). The difference lies in the proportion of grass in the diet. The plant material consumed by mice residing along the primary dunes in northwest Florida and Alabama was mainly grass seed. The mice trapped in the scrub (their scrub is different from the coastal scrub in which I trapped) consumed mainly acorns (*Quercus sp.*), gopher apple (*Licania michauxii*), and *Polygonella sp.* In contrast, *P. p. niveiventris*' diet includes much smaller amounts of grass. The majority of the diet is comprised of non-grass material and arthropods which feed on non-grass material. The reason for this is currently unknown and warrants further study.

The ratios derived from the stable isotope analysis of the plant food sources were expected and were consistent with the findings of DeNiro and Epstein (1978), who stated that C_3 plants fall within the <-28 range of $\delta^{13}C$ values. Though the values in Figure 2 fall between -30 and -23, variability is expected. Marine inputs ($\delta^{13}C$ values between -12 & -13) could be an influence even though a kilometer or two inland from the coast.

I expected habitat differences in the diets of the small mammals. The habitat types where I trapped the mice differ in plant composition, plant density, proximity to the ocean, and other abiotic features. This expectation was verified by the different $\delta^{13}C$ values of mice in the two habitats. The $\delta^{15}N$ values were similar between the two habitats. This similarity may mean that the mice were consuming the same trophic levels regardless of habitat. Another possibility is because the plants in the dune/swale had higher $\delta^{15}N$ values than those of the coastal scrub, mice in the coastal scrub had to consume a greater proportion of arthropod material to achieve the same $\delta^{15}N$ values as the mice on the dune/swale. No sex differences were detected. The foods are apparently nutritionally adequate for both reproductive and non-reproductive mice. Grids nested within habitats did show a significant difference in $\delta^{13}C$ and $\delta^{15}N$ values; I expected this variation since the three grids in each habitat were not identical to one another in plant composition and, therefore, the arthropod composition. Anderson and Polis (1998) analyzed a variety of arthropods using stable isotopes along the coast and more inland on an island in the Gulf of California. They did not break the arthropods into carbon categories, but rather averaged the values collected. Along the coast, the arthropods averaged around -20 and -24 more inland. $\delta^{15}C$ was -23 along the coast and -15 more inland (Anderson and Polis 1998).

The diet of *P. gossypinus* was consistent with the literature. The cotton mouse is omnivorous. The plant material consumed is similar to the beach mouse, comprised primarily of C_3 plant material. Unlike the beach mouse, the cotton mouse's diet did not change between the two habitats. The cotton mouse consumed the same plant material and trophic levels regardless of habitat. There was a significant difference in the $\delta^{15}N$ values among the grids nested within a habitat. The explanation for this difference could be local variation in food availability (plant vs. arthropod), but warrants further study.

The diet of *S. hispidus* differed from that stated in the literature. The cotton rats on Cape Canaveral Air Force Station are omnivorous. The literature lists them as herbivorous, but there is currently no report of their diet in dune/swale and/or coastal scrub. Diet may be habitat specific and warrants further study in other coastal settings. Habitat differences were expected, and were observed in the $\delta^{13}C$ values. Cotton rats consumed a greater proportion of C_4 plant material on the dune/swale compared to those trapped in the coastal scrub. There was also carbon differences among the grids nested within a habitat. The differing plant compositions may explain this difference.

The comparison of all three species indicated significant differences for both $\delta^{13}C$ and $\delta^{15}N$ values. The beach mouse consumed a greater variety of C_3 and C_4 plant and arthropod material. The cotton mouse consumed more C_3 plant and arthropod material. The cotton rat consumed more C_3 and C_4 plant material in the dune/swale and C_3 plant and arthropod material in the coastal scrub. These results confirmed the scatterplots. The beach mouse and cotton mouse consumed a greater proportion of arthropod material compared to the cotton rat.

IsoSource confirmed the stable isotope and fecal analysis findings. The model confirmed the results of two techniques with biases. The cluster analysis also confirmed the stable isotope analysis that confirms that there is no difference between the habitat types for the cotton mouse and that the diet of all three rodents is most similar in the coastal scrub.

Seasonality was an objective of the study originally and the reason the plants' reproductive state was monitored monthly (Appendix 1). However, since *Peromyscus* sp. can molt both annually as well as between life stages, and since the season the hair grew in could not be determined, the seasonal aspect of the study had to be abandoned until the monthly determination can be made.

CONCLUSION

Peromyscus p. niveiventris mouse is a food generalist and consumes plant and animal material. As long as the land managers manage the habitat properly and continue to have a diversity of plants thriving within the area, the mice will have a food source. The beach mice in this study consumed a variety of food sources, mainly C_3 plant material. If C_3 plants are present so should C_3 arthropods, another important food source. Of additional importance is the fact that the beach mice are widespread in coastal scrub, increasing the amount of potential land for future translocations. Thus, based on habitat use and diet, *P. p. niveiventris* does not restrict itself to the sea oats zone as originally claimed by Bangs (1898).

Local co-occurrence of two omnivorous species, namely, cotton mice and cotton rats, with the southeastern beach mouse suggests that interspecific competition is possible if food sources become limited. This potential may be greater in the coastal scrub where the diets are the most similar and less likely in coastal dunes and swales.

Those in charge of state and federal lands tasked with the preservation of threatened and endangered biota should consider seasonal or annual monitoring programs to avoid undetected negative trends in populations of southeastern beach mice. Active management of coastal scrub will be necessary (Suazo 2007).

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APPENDIX A: FIGURES

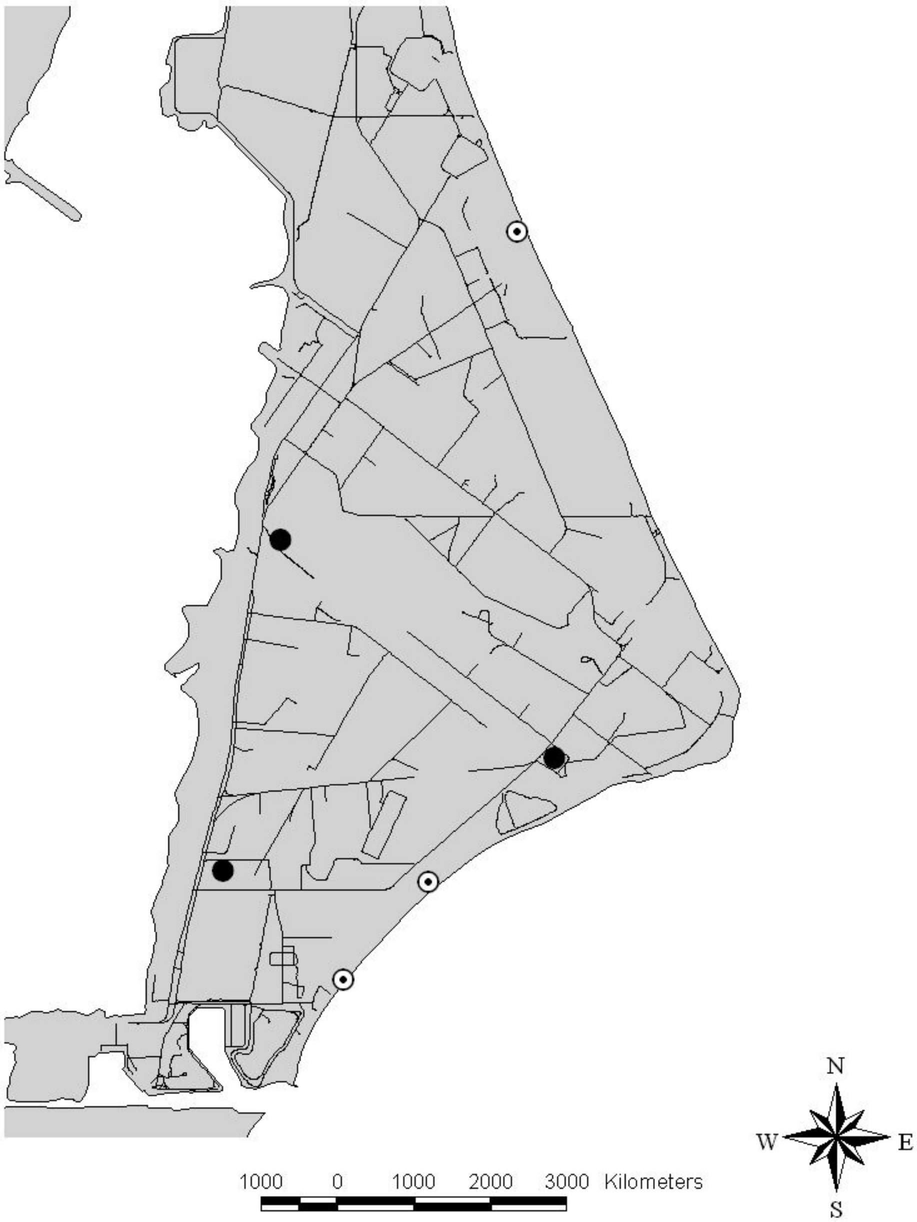
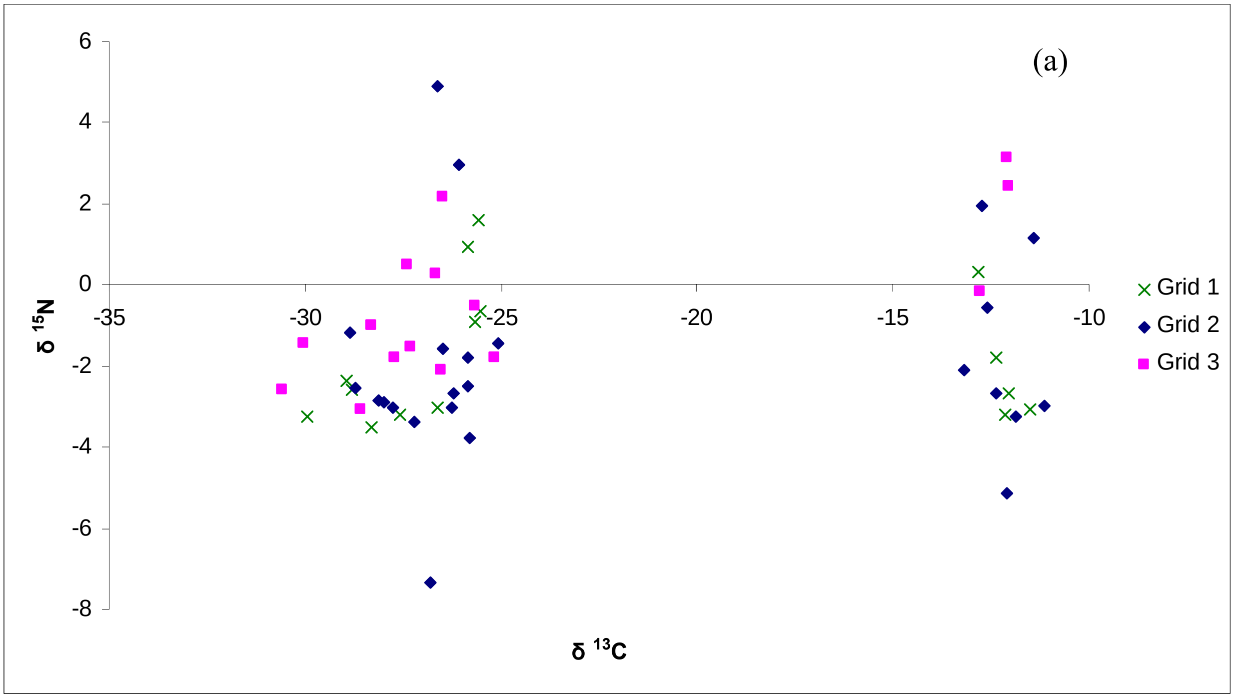


Figure 1. Aerial of the study site, Cape Canaveral Air Force Station, with grid locations labeled. Solid black dots represent coastal scrub grids and white dots with black centers represent dune/swale grids.



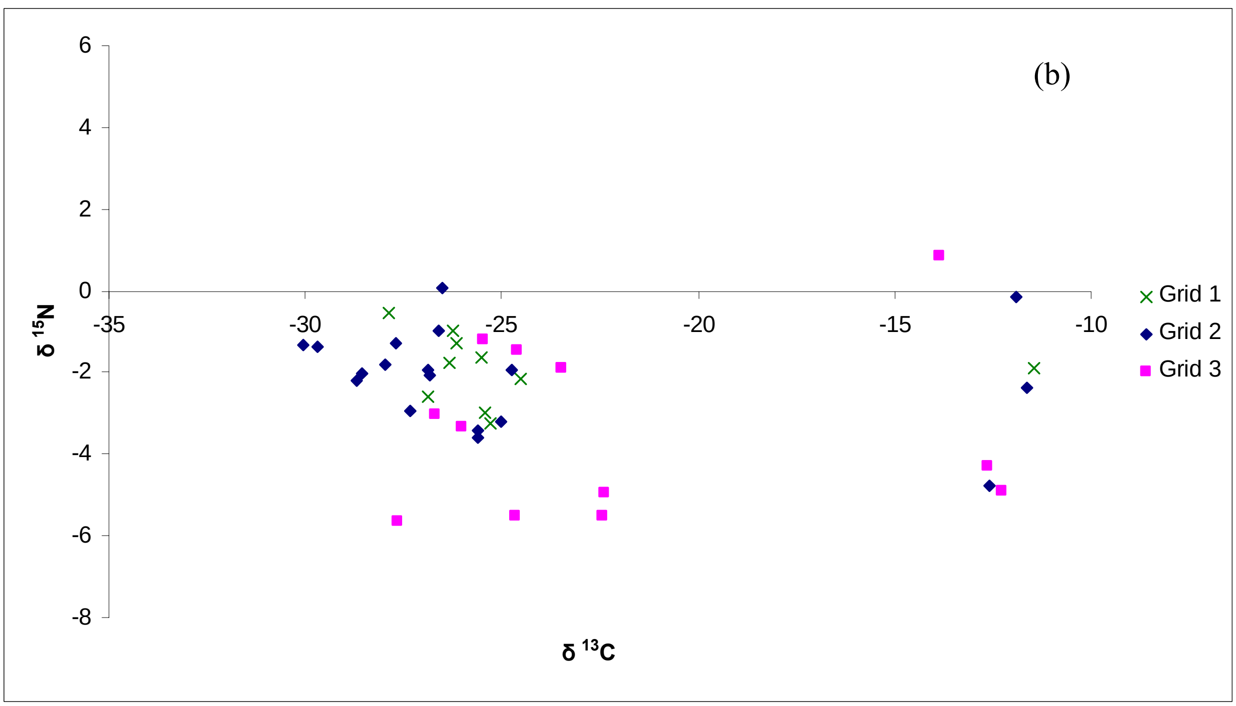


Figure 2. Stable isotope ratios of plants collected from (a) the dune/swale and (b) the coastal scrub grids, Cape Canaveral Air Force Station, FL.

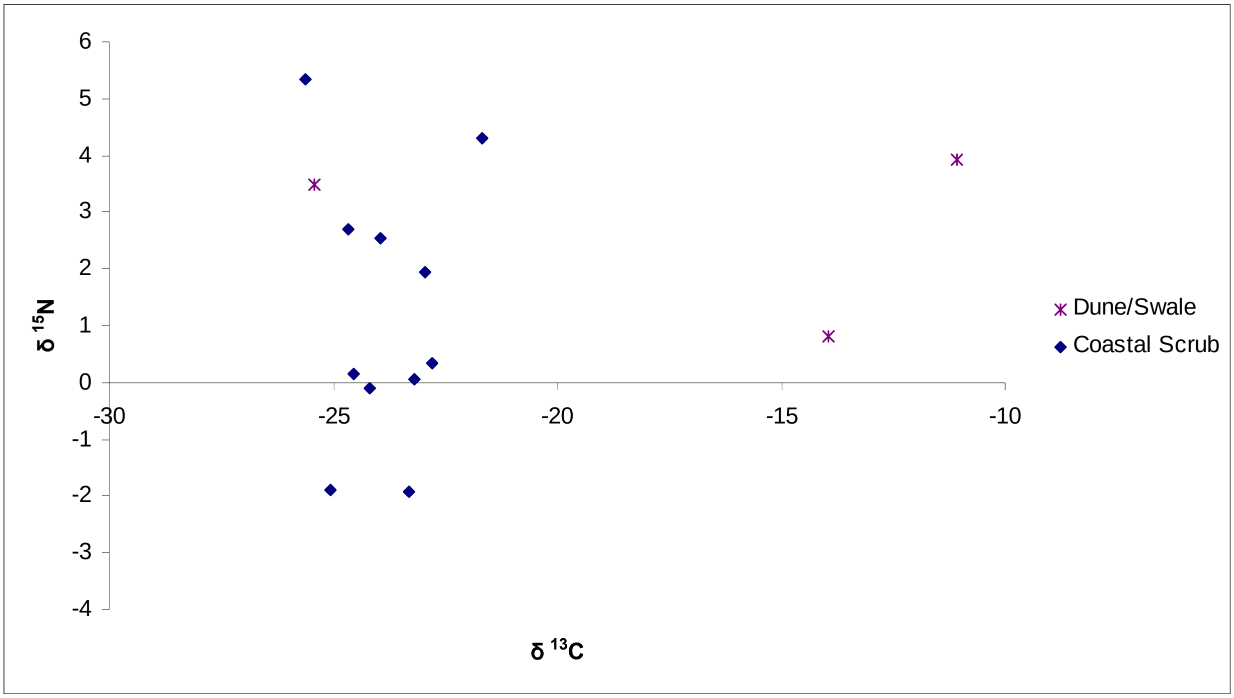


Figure 3. Stable isotope ratios of arthropods collected from the dune/swale and the coastal scrub grids, Cape Canaveral Air Force Station, FL.

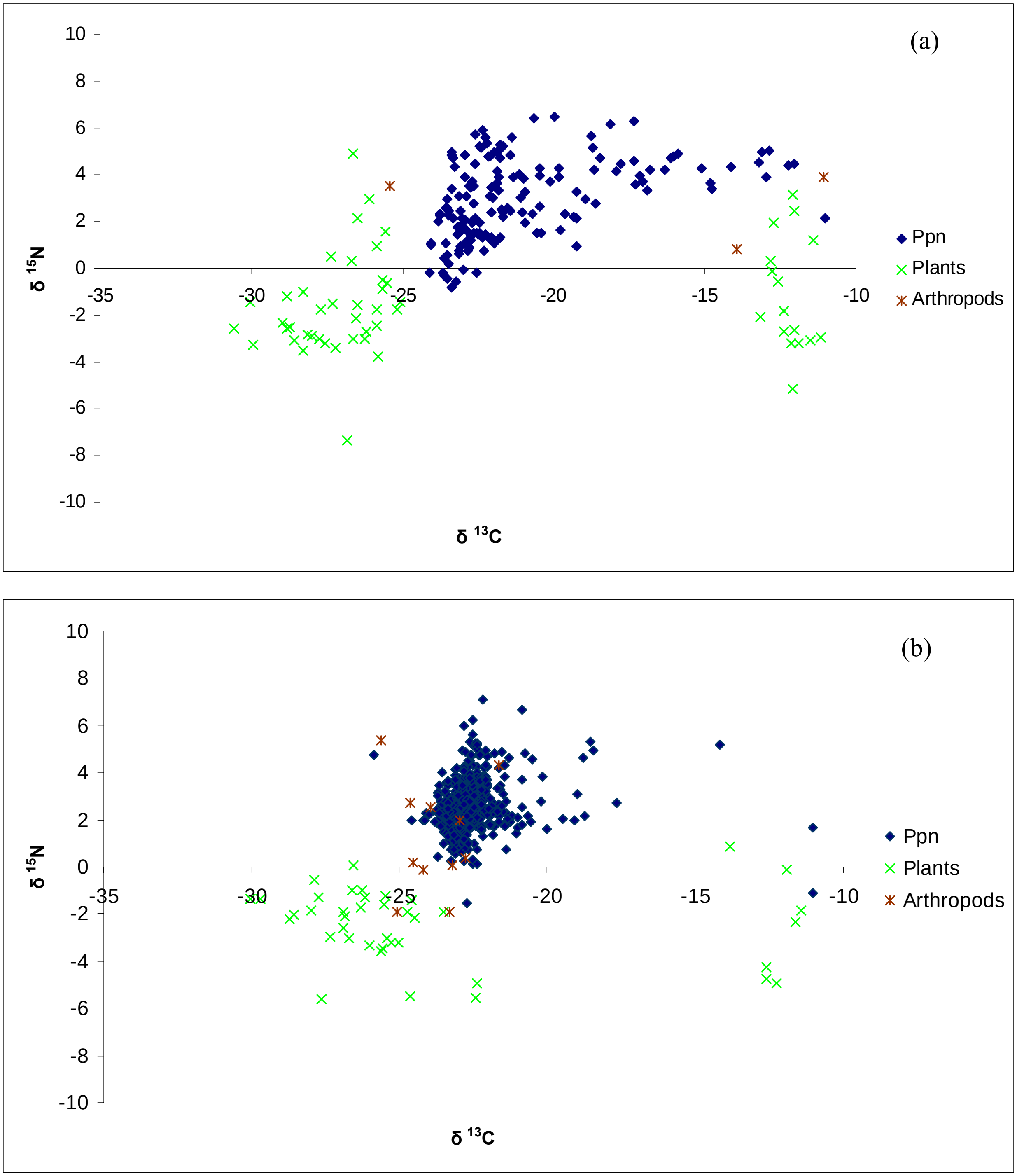


Figure 4. Stable isotope ratios of *P. p. niveiventris* (Ppn), plants, and arthropods collected from (a) the dune/swale and (b) the coastal scrub grids, Cape Canaveral Air Force Station, FL.

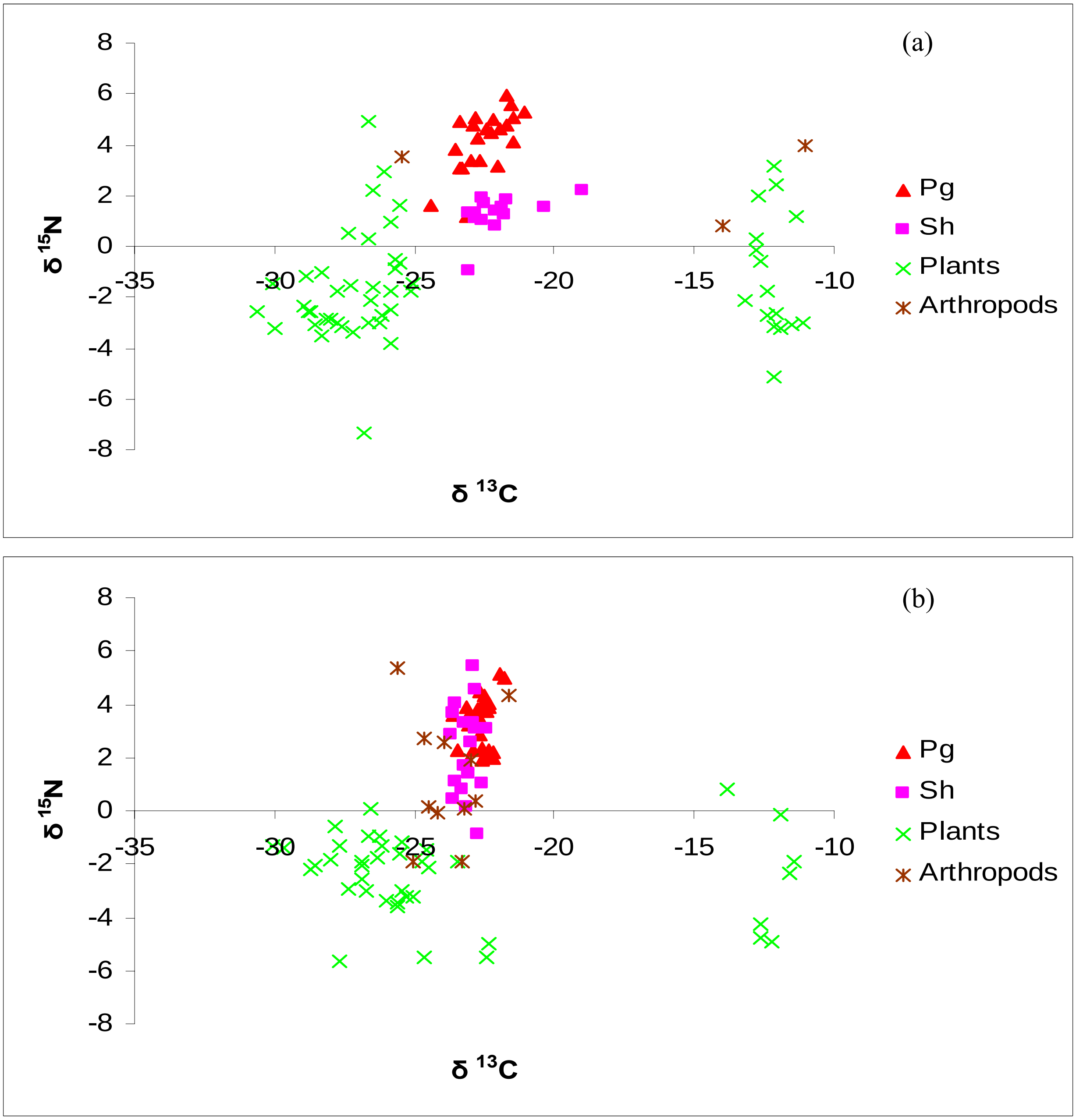
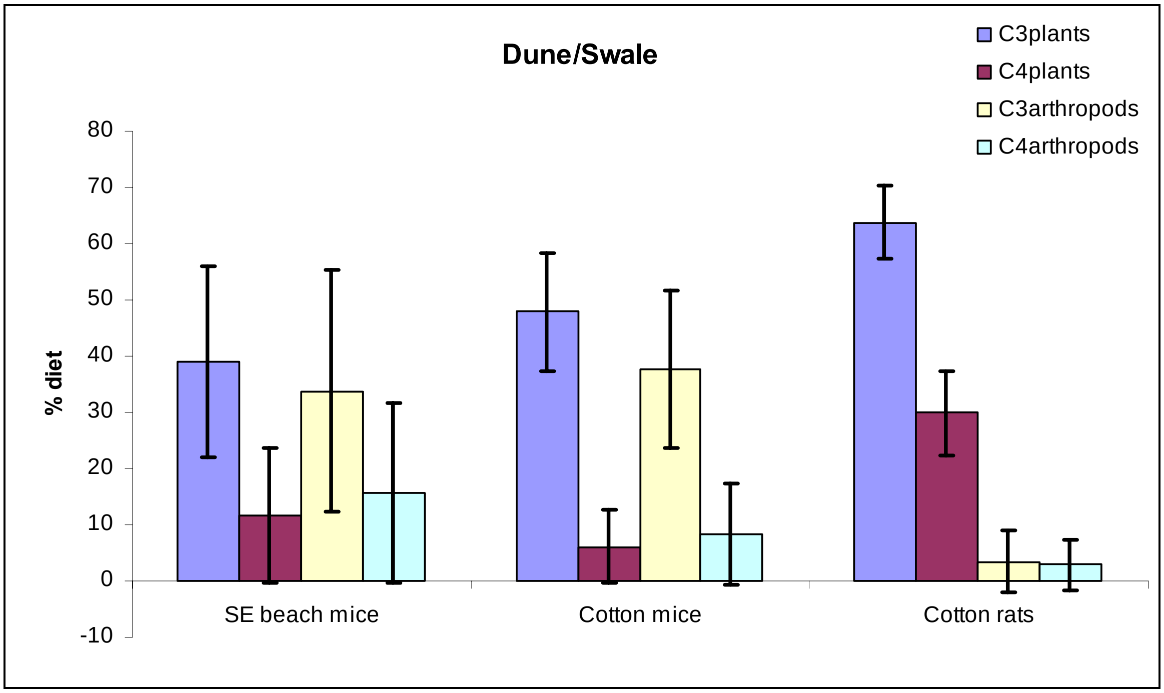


Figure 5. Stable isotope ratios of *P. gossypinus* (Pg), *S. hispidus* (Sh), plants, and arthropods collected from (a) the dune/swale and (b) the coastal scrub grids, Cape Canaveral Air Force Station, FL.



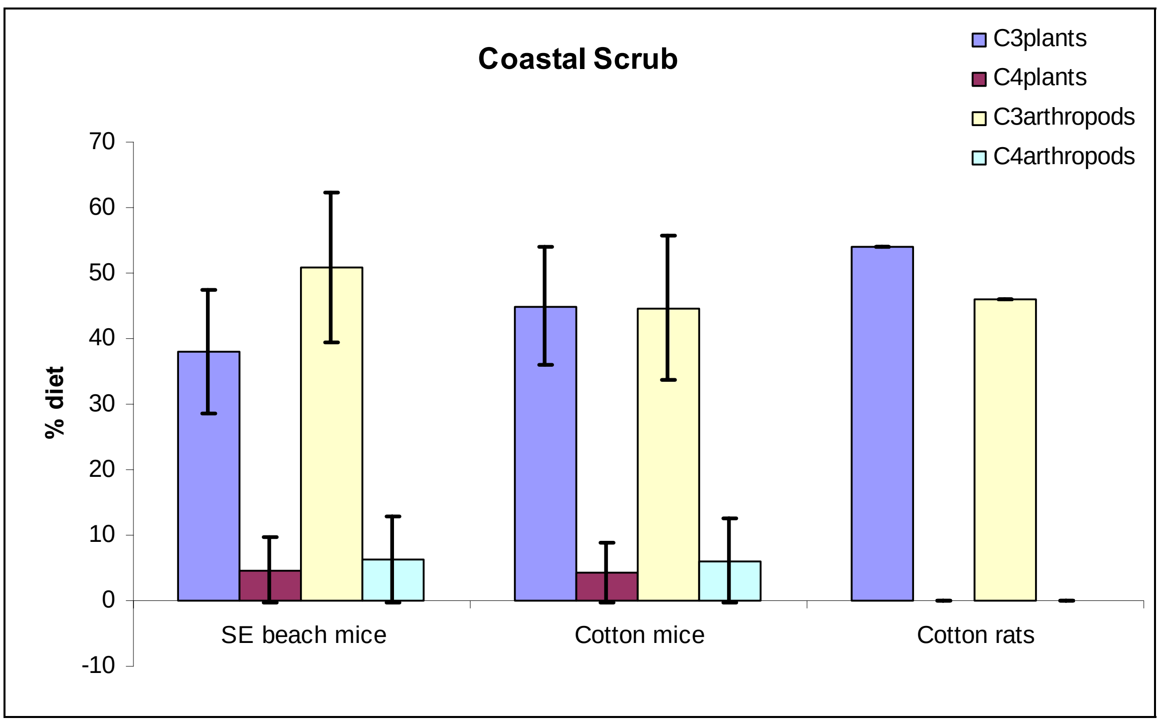


Figure 6. Diets of the three rodent species in dune/swale and coastal scrub, estimated by IsoSource. The columns reflect the mean percentages, whereas the error bars reflect the minimum and maximum in the range of proportion of each food type in the overall diet.

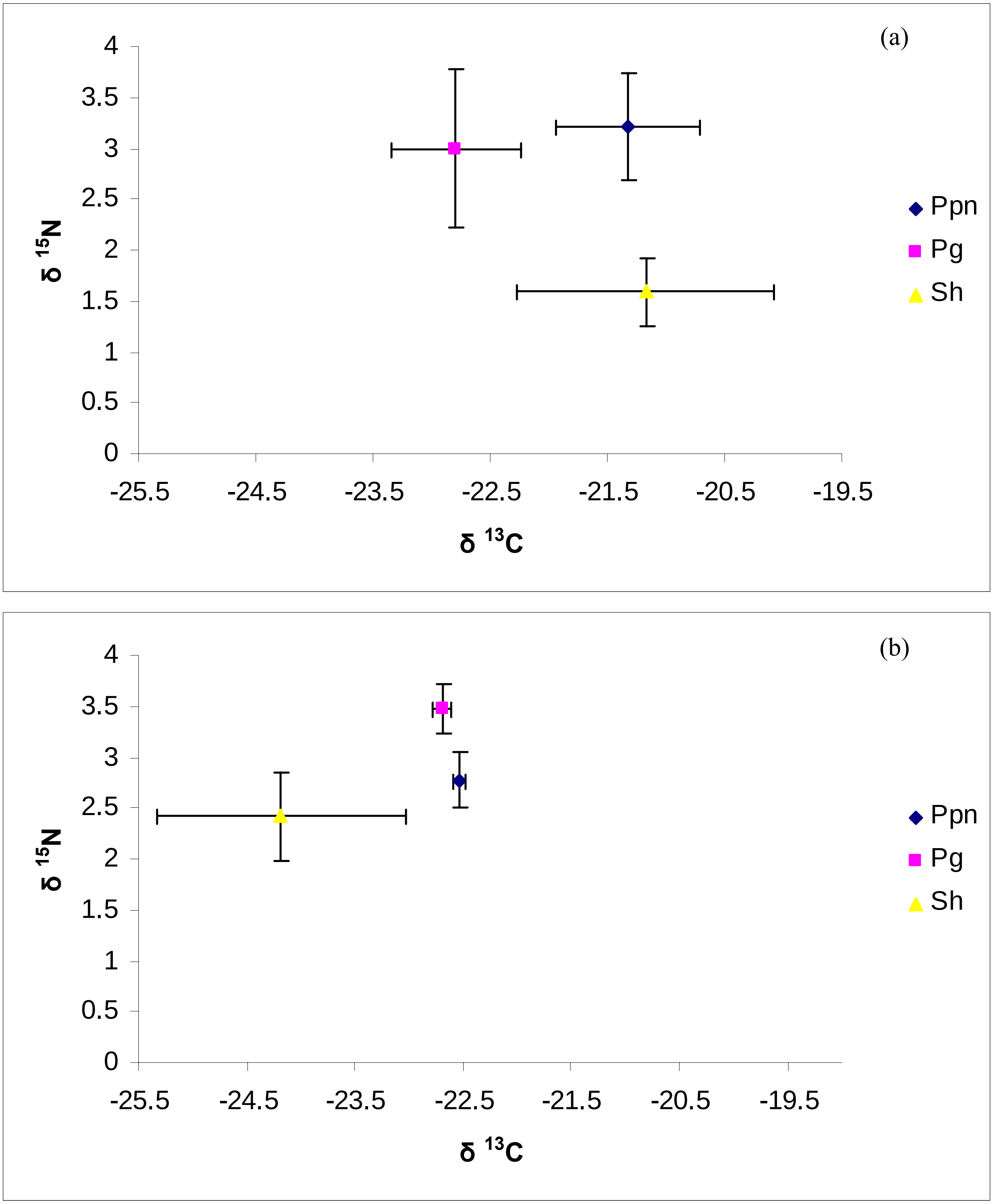


Figure 7. Stable isotope ratios (mean + SE) of *P. p. niveiventris* (Ppn), *P. gossypinus* (Pg), and *S. hispidus* (Sh) in the (a) dune/swale and (b) coastal scrub habitat.

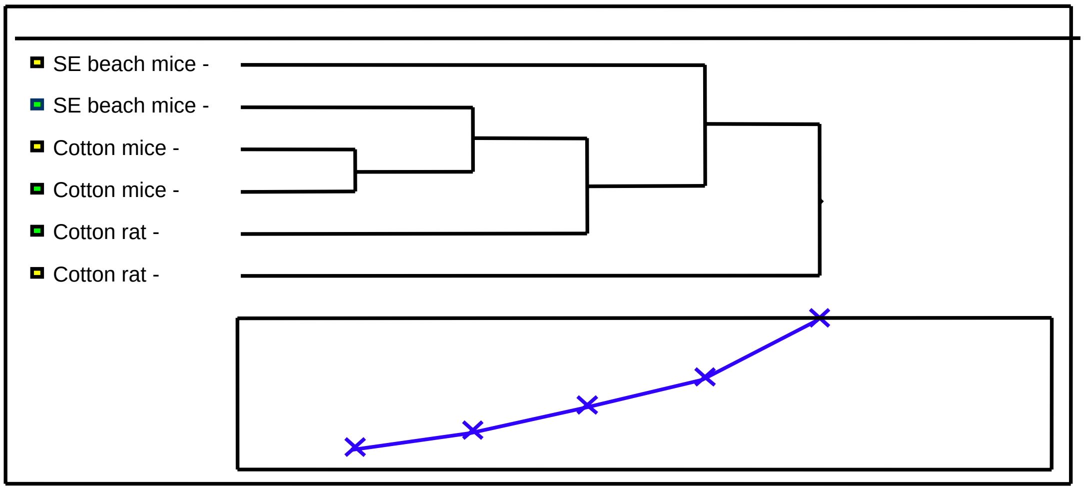


Figure 8. Dendrogram for cluster analysis on rodent species by habitat. The green squares indicate animals from the coastal scrub habitat, and the yellow squares indicate animals from the dune/swale habitat.

APPENDIX B: TABLES

Table 1. Plants occurring in each habitat type and the relative frequency of occurrence in the feces of each species.

			Present within habitat		*P.p.niveiventris*		*P.gossypinus*		*S.hispidus*	
Scientific Name	**Common Name**	**Carbon Pathway**	**Dune/Swale**	**Coastal Scrub**	**Dune/Swale**	**Coastal Scrub**	**Dune/Swale**	**Coastal Scrub**	**Dune/Swale**	**Coastal Scrub**
Ambrosia artemisiifolia	Ragweed	C_3	X	X	0.08	0.20	0.80	0.29	0.60	0.14
Atriplex cristata	Crested atriplex	C_3	X	O	0.07					
Baccharis halimifolia	Saltbush	C_3	X	X	0.29	0.14			0.20	0.29
Calicarpa americana	Beautyberry	C_3	O	X						
Cakile lanceolata	Coastal searocket	C_3	X	O	0.03					
Canavalia rosea	Beach pea	C_3	X	O	0.33					
Chamaesyce mesembrianthemifolia	Coastal beach sandmat	C_3	X	O						
Coccoloba uvifera	Sea grape	C_3	X	X						
Crotalaria pumila	Low rattle-box	C_3	X	O						
Croton punctatus	Beach tea	C_3	X	O	0.07		0.20	0.00	0.80	
Cyperus pedunculatus	Beach star	C_3	X	O						
Dactyloctenium aegyptium	Crowfootgrass	C_4	X	O						
Distichlis spicata	Saltgrass	C_4	X	O						
Dodonaea viscosa	Varnish leaf	C_3	X	X	0.27	0.18				
Eustachys glauca	Saltmarsh fingergrass	C_4	X	X						
Forestiera segregata	Florida swampprivet	C_3	X	X	0.01	0.01				
Helianthus debilis	Beach sunflower	C_3	X	X	0.62	0.70	0.80	0.86	0.60	0.71
Heterotheca subaxillaris	Camphorweed	C_3	X	X	0.01	0.11				
Ilex vomitoria	Yaupon holly	C_3	O	X		0.01				
Ipomoea imperati	Beach morning-glory	C_3	X	O	0.19					
Ipomoea pes-caprae	Rail-road vine	C_3	X	O						
Licania michauxii	Gopher apple	C_3	O	X						
Muhlenbergia capillaris	Muhly grass	C_4	X	X	0.03	0.03				
Myrcianthes fragrans	Simpson's stopper	C_3	O	X						
Myrica cerifera	Wax myrtle	C_3	X	X	0.01					
Oenothera humifusa	Seabeach eveningprimrose	C_3	X	O	0.03					
Opuntia stricta	Erect pricklypear	CAM	X	X	0.18	0.05	0.00	0.14	0.60	0.29
Panicum amarum	Dune panic grass	C_4	X	O	0.02					
Passiflora incarnata	Maypop	C_3	X	X						
Persea borbonia	Red bay	C_3	O	X						

X = Presence

O = Absence

Table 1. continues

			Present within habitat		***P.p.niveiventris***		***P.gossypinus***		***S.hispidus***	
Scientific Name	**Common Name**	**Carbon Pathway**	**Dune/Swale**	**Coastal Scrub**	**Dune/Swale**	**Coastal Scrub**	**Dune/Swale**	**Coastal Scrub**	**Dune/Swale**	**Coastal Scrub**
Phyllanthus urinaria	Chamber bitter	C_3	X	X	0.04	0.05				
Physalis walteri	Ground cherry	C_3	X	X	0.27	0.18	0.4	0.43	1	
Polygala violacea	Showy milkwort	C_3	X	X	0.16	0.02			0.2	
Quercus chapmanii	Chapman's oak	C_3	O	X						
Quercus geminata	Sand live oak	C_3	O	X						
Quercus myrtifolia	Myrtle oak	C_3	X	X	0.02	0.54		0.43		0.71
Quercus sp.	Oak	C_3	X	X	0.05	0.11	0.4	0.29		0.29
Quercus virginiana	Live oak	C_3	O	X						
Scaevola plumieri	Inkberry	C_3	X	O	0.03					
Serenoa repens	Saw palmetto	C_3	X	X	0.02					
Sesuvium portulacastrum	Sea pickle	C_3	X	O	0.2	0.02			0.4	
Smilax auriculata	Greenbriar	C_3	O	X						
Spartina patens	Marshhay cordgrass	C_4	X	O						
Sporobolus virginicus	Virginia dropseed	C_4	X	O						
Uniola paniculata	Sea oats	C_4	X	O	0.01					
Vaccinium myrsinites	Shiny blueberry	C_3	O	X						
Vitis munsoniana	Muscadine	C_3	O	X						
Ximenia americana	Hog plum	C_3	O	X						
	Grass	C_4	X	X	0.7	0.6	0.8	0.29	1	0.86
	Fruit		X	X	0.96	0.94	1	0.86	1	1
	Flower		X	X	0.65	0.67	0.8	0.71	0.6	0.43
	Leaf		X	X	0.08	0.041	0.2	0	0.4	0
	Stem		X	X	0	0.041	0	0.14	0.2	0

X = Presence

O = Absence

Table 2. Relative frequency of occurrence of arthropod orders in the fecal samples of *P. p. niveiventris* from both habitats.

Order	***P. p. niveiventris***	
	Dune/Swale	**Coastal Scrub**
Coleoptera	0.10	0.25
Diptera	0.08	
Lepidoptera	0.14	0.11
Hymenoptera	0.07	0.20
Acarina		0.01
Orthoptera		0.04
Araneae	0.03	0.04
Dictyoptera		0.03
Arthropod	0.18	0.15

APPENDIX C: STABLE ISOTOPE PREPARATION METHODOLOGY

Hair

I removed approximately 1 mg of hair with scissors, placed in a small Ziploc bag, and stored in a freezer until processed. I stored each hair sample in a four milliliter scintillation vial as the sample was prepared for analysis. I washed each sample with soapy water to remove dirt, oil, and other debris. The vial was agitated to "wash" the hair and then the vial contents emptied into a sieve. I rinsed the vial and any remaining hair was added to the sieve. I applied cool water to rinse the hair until all remains of the soap had disappeared. I transferred the hair from the sieve to the vial, returned to the vial without a lid, and placed in a drying oven for twenty four hours at about 35 degrees Celsius. Sharp fine point scissors finely minced the dried hair. The scissors reduced the hair to small enough fragments to easily fit into the tin cup that holds the sample as it is processed in the mass spectrometer. Between 0.6 and 1 mg of minced hair went into a 3.5 x 5 mm tin cup. Samples with weights in this range were heavy enough to provide reliable values. Folding the cup in on itself insured that the hair stayed within the cup as it moved through the mass spectrometer. Hair that had a final weight < 0.6 mg did not yield reliable outputs.

Plants

Plant tissue for isotopic analysis was freeze dried to remove all water. A mortar and pestle pulverized the dry plant tissue before I transferred it to tin cups, identical to the ones described in the section on hair. A minimum of about 3 mg of plant material in each tin cup was necessary to give reliable results on the mass spectrometer. Once the isotopic data were gathered, I graphed the ratios to determine which plants belonged to the C_3 or C_4 photosynthetic pathway. If the carbon ratios fell between -19 and -6 the plant utilizes the C_4 photosynthetic pathway. If the carbon ratios fell between -34 and -24 the plant utilizes the C_3 photosynthetic pathway (Smith and Epstein 1971).

Arthropods

All arthropods samples were freeze dried for 48 hours and the lipids removed with petroleum ether for 12 hours. I further dried the lipid-free samples in a drying oven for 24 hours and reduced to powder using a mortar and pestle. I transferred the samples in the weight range 0 .6-1 mg to 3.5 X 5 mm tin cups. I folded the cups to insured the sample remained inside the cup once placed into the mass spectrometer. If the carbon ration fell between -15 and -12 the arthropod consumed a plant that utilized the C_4 photosynthetic pathway. If the carbon ratios fell between -25 and -21 the arthropod consumed a plant that utilized the C_3 photosynthetic pathway.

APPENDIX D: PLANT SEASONALITY AT CAPE CANAVERAL AIR FORCE STATION

Dune/Swale

Scientific Name	Common Name	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Canavalia rosea	Beach pea												
Ipomoea imperati	Beach morning-glory												
Helianthus debilis	Beach sunflower												
Heterotheca subaxillaris	Camphorweed												
Crotalaria pumila	Low rattle-box												
Oenothera humifusa	Seabeach eveningprimrose												
Polygala violacea	Showy milkwort												
Uniola paniculata	Sea oats												
Sesuvium portulacastrum	Sea pickle												
Atriplex cristata	Crested atriplex												
Ipomoea pes-caprae	Rail-road vine												
Cyperus pedunculatus	Beach star												
Distichlis spicata	Saltgrass												
Chamaesyce bombensis	Dixie sandmat												
Dodonaea viscose	Varnish leaf												
Andropogon sp.	Bluestem												
Serenoa repens	Saw palmetto												
Coccoloba uvifera	Sea grape												
Muhlenbergia capillaris	Muhly grass												
Phyllanthus urinaria	Chamber bitter												
Chamaecrista fasciculata	Partridge pea												
Opuntia stricta	Erect pricklypear												
Myrica cerifera	Wax myrtle												
Smilax auriculata	Greenbriar												
Scaevola plumieri	Inkberry												
Ambrosia artemisiifolia	Ragweed												
Sporobolus virginicus	Virginia dropseed												
Croton punctatus	Beach tea												

Dune/Swale cont.

Scientific Name	Common Name	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Cakile lanceolata	Coastal searocket												
Panicum amarum	Dune panic grass												
Physalis walteri	Ground cherry												
Spartina patens	Marshhay cordgrass												
Eustachys glauca	Saltmarsh fingergrass												
Dactyloctenium aegyptium	Crowfootgrass												
Passiflora incarnata	Maypop												

Vegetated
Flower
Fruit
Dead Plant

Coastal Scrub

Scientific Name	Common Name	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Physalis walteri	Ground cherry	Vegetated	Vegetated	Fruit	Fruit	Fruit	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated
Dodonaea viscosa	Varnish leaf	Fruit	Fruit	Fruit	Flower	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
Quercus myrtifolia	Myrtle oak	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
Quercus geminata	Sand live oak	Fruit	Vegetated	Vegetated	Flower	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Fruit
Quercus virginiana	Live oak	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Vegetated	Fruit	Fruit	Fruit	Fruit	Fruit
Myrica cerifera	Wax myrtle	Vegetated	Fruit	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Fruit
Calicarpa americana	Beautyberry	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Vegetated
Vitis munsoniana	Muscadine	Vegetated	Vegetated	Vegetated	Flower	Vegetated	Fruit	Fruit	Vegetated	Vegetated	Vegetated	Fruit	Vegetated
Smilax auriculata	Greenbriar	Fruit	Fruit	Vegetated	Flower	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
Chamaecrista fasciculata	Partridge pea	Vegetated	Vegetated	Vegetated	Vegetated	Flower	Flower	Flower	Fruit	Fruit	Fruit	Fruit	Vegetated
Serenoa repens	Saw palmetto	Vegetated	Flower	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Vegetated
Phyllanthus urinaria	Chamber bitter	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
Vaccinium myrsinites	Shiny blueberry	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Fruit	Fruit	Fruit	Vegetated	Vegetated	Vegetated	Vegetated
Heterotheca subaxillaris	Camphorweed	Flower	Flower	Vegetated	Vegetated	Vegetated	Vegetated	Flower	Vegetated	Flower	Flower	Flower	Flower
Andropogon sp.	Bluestem	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Flower	Flower	Flower	Flower	Flower
Opuntia stricta	Erect pricklypear	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
Ximenia americana	Hog plum	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Fruit	Fruit	Vegetated
Licania michauxii	Gopher apple	Vegetated	Vegetated	Vegetated	Flower	Flower	Flower	Flower	Fruit	Fruit	Vegetated	Vegetated	Vegetated
Persea borbonia	Red bay	Vegetated	Vegetated	Fruit	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Vegetated	Vegetated	Vegetated
Baccharis halimifolia	Saltbush	Fruit	Fruit	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Flower	Flower	Flower	Flower
Quercus chapmanii	Chapman's oak	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Fruit	Fruit
Passiflora incarnata	Maypop	Vegetated	Vegetated	Vegetated	Vegetated	Fruit	Flower	Fruit	Vegetated	Vegetated	Fruit	Vegetated	Vegetated
Eustachys glauca	Finger grass	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit	Fruit
Forestiera segregate	Florida swampprivet	Vegetated	Vegetated	Vegetated	Fruit	Fruit	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated
Helianthus debilis	Beach sunflower	Vegetated	Vegetated	Vegetated	Flower	Flower	Vegetated	Flower	Flower	Flower	Flower	Flower	Flower
Myrcianthes fragrans	Simpson's stopper	Vegetated	Vegetated	Vegetated	Vegetated	Flower	Fruit	Fruit	Fruit	Fruit	Vegetated	Vegetated	Vegetated
Coccoloba uvifera	Sea grape	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated
Polygala violacea	Showy milkwort	Flower	Flower	Flower	Flower	Flower	Flower	Flower	Flower	Flower	Flower	Flower	Flower
Muhlenbergia capillaris	Muhly grass	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Vegetated	Flower	Flower	Flower

Vegetated | Fruit | Flower

Chapter 4

RESPONSES OF SMALL RODENTS TO RESTORATION AND MANAGEMENT TECHNIQUES OF FLORIDA SCRUB AT CAPE CANAVERAL AIR FORCE STATION, FLORIDA

Alexis A. Suazo, I. Jack Stout and James D. Roth with technical assistance from John Fauth

ABSTRACT
Proper habitat management is essential for the survival and reproduction of species, especially those listed under state or federal laws as endangered, threatened or of special concern, and those with small local populations. Land managers use a combination of mechanical cutting and prescribed burning to manage and restore degraded scrub habitat in east central Florida. This approach improves habitat for the endangered Florida scrub-jay (*Aphelocoma coerulescens*), but little is known about its effects on other taxa, especially the threatened southeastern beach mouse (*Peromyscus polionotus niveiventris*). This single species approach may not be beneficial to other taxa, and mechanical cutting and prescribed burning may have detrimental effects on *P. p. niveiventris*. To evaluate the effects of land management techniques on *P. p. niveiventris*, I live trapped populations at Cape Canaveral Air Force Station (CCAFS) near Titusville, Florida during 2004-2005. I evaluated the relative abundance and related demographic parameters of small mammal populations trapped in compartments under different land management treatments, and investigated the relationship between Florida scrub-jay breeding groups using these compartments and abundance of southeastern beach mice. My results suggest that *P. p. niveiventris* responded positively to prescribed burning, while the cotton mouse (*P. gossypinus*) responded positively to the mechanical cutting. Reproduction and body mass of southeastern beach mice were similar across land management compartments. Abundance of Florida scrub-jay breeding groups and southeastern beach mice were positively correlated suggesting that both listed species benefited from the same land management activities. A mosaic of burned and cut patches should be maintained to support small mammal diversity. In addition, adaptive management should be used at CCAFS to understand how small mammals, particularly the southeastern beach mouse, respond to land management activities.

INTRODUCTION

Changing patterns of land use worldwide have resulted in the loss and fragmentation of natural habitats. These changes alter community structure and landscape configuration, and modify the rates and intensities of many natural processes essential for ecosystems to retain their integrity (Lambeck 1997). All ecosystems are currently being managed or will need some form of management in the future; science-based land management is essential for these efforts to be successful (Duncan et al. 1999). Land managers must determine strategies that best maintain biological diversity and biological processes within a specific habitat. Making such decisions is not easy; several shortcuts have been proposed whereby protecting single species also shelters others (Simberloff 1998). There has been considerable debate in the ecological literature about whether the requirements of single species should serve as the basis for defining conservation requirements or whether analysis of landscape patterns and processes should underpin conservation planning (Franklin 1993; Hansen et al. 1993; Orians 1993; Franklin 1994; Hobbs 1994; Tracy and Brussard 1994). Species-based approaches have been criticized because they do not provide whole-landscape solutions to conservation problems, cannot be conducted fast enough to deal with the urgency of threats, and consume a disproportionate amount of conservation funding (Franklin 1993; Hobbs 1994; Walker 1995; Roemer and Wayne 2003). Consequently, critics of single-species management called for approaches that consider higher organizational levels, such as ecosystems and landscapes (Noss 1983; Noss and Harris 1986; Noss 1987; Gosselink et al. 1990). However, conservation based on single species likely will continue to be important foci of inventory, monitoring, and assessment efforts because managing single species is more straightforward and easier to evaluate than managing a complex of amorphous, abstract ecosystems (Noss 1990 and Rubinoff 2001). Furthermore, laws such as the U.S. Endangered Species Act (ESA) mandate species-level management (Noss 1990; Rubinoff 2001). Often the animals managed as single species are legislatively protected species, mostly vertebrates (Andelman and Fagan 2000).

My thesis research seeks to evaluate the effects of multiple habitat restoration techniques on a federally listed species as a result of a single species management philosophy.

Florida scrub is a rare and declining ecosystem (Myers 1990; Menges 1999) that often is managed to benefit the endangered Florida scrub jay (*Aphelocoma coerulescens*, FSJ), a scrub dependent species. Presence of the FSJ is indicative of well managed scrub habitat, which is assumed to benefit other scrub dependent species (Duncan et al. 1999). Suitable FSJ habitat consists of scrub vegetation dominated by oaks (*Quercus* sp.) with open sandy spaces, few or no trees, and shrub heights of 1 to 2 m (Westcott 1970; Breininger 1981; Cox 1984; Woolfenden and Fitzpatrick 1984). Florida scrub jays are very habitat specific (Woolfenden and Fitzpatrick 1984) and the remaining patches of scrub along the central east coast of Florida are being managed exclusively to maintain suitable habitat for one of the three core populations of FSJs (Stith et al. 1996). More than 50 % of this ecosystem has been lost to land use conversion (Fernald 1989; Bergen 1994), and remaining patches are typically fragmented, isolated and overgrown (Myers 1990). A number of threatened and endangered plant and animal species also inhabit scrub communities (Christman and Judd 1990; Stout and Marion 1993; Stout 2001), and management of remaining scrub is critical to the survival of these species (Schmalzer et al. 2003). Scrub communities are well adapted to fire and other natural disturbances (Abrahamson 1984; Myers 1990; Schmalzer and Hinkle 1992). In the absence of lightning ignited fires, prescribed burning is the primary management technique applied in scrub communities (Menges 1999). However, scrubs that have not been properly managed (e.g., lack of fire) may become fire resistant and require a combination of mechanical cutting and prescribed burning for restoration and management (Schmalzer and Boyle 1998; Schmalzer and Adrian 20001). Such management techniques have successfully restored long-unburned scrub vegetation to a habitat more suitable for scrub-dependent species (Schmalzer et al. 2003). However, the current focus of land managers is the FSJ, and the consequences of scrub management and restoration for other species is poorly documented (Stevens and Knight 2004). Despite the frequency and importance of fire in managing habitats in the southeastern U. S., little is known about its effects on non-target species, especially small mammals (Arata 1959; Robbins and Myers 1992).

Beach mice are coastal subspecies of the old field mouse *(Peromyscus polionotus)*, which is endemic to the southeastern coastal plain (Hall 1981). Beach mice inhabit coastal scrub (Blair 1951; Humphrey and Barbour 1981; Hollliman 1983; Extine and Stout 1987; Rave and Holler 1992), and two extant sub-species, the Anastasia Island beach mouse (*P. p. phasma*) and the southeastern beach mouse (*P. p. niveiventris*), occur on the east coast of Florida. Thesee sub-species are listed under the Endangered Species Act of 1973 as endangered and threatened, respectively (U.S. Fish and Wildlife Service 1993). Extensive coastal development has fragmented beach mouse habitat and left most remaining populations small and isolated (Oli et al. 2001).

Blair (1951) suggested that primary beach mouse habitat was the beach dune system where sea oats *(Uniola paniculata)* and open sandy patches were the main habitat. However, Stout (1979) captured *P. p. niveiventris* in areas (e.g., coastal scrub) more than 3 km inland from the primary beach dune system on Cape Canaveral. In the only study of habitat selection by *P. p. niveiventris*, Extine and Stout (1987) suggested *P. p. niveiventris* preferred habitats interior to the beach dune system. However, interior habitat has been considered of lesser quality, and therefore, given little consideration as a major component of requirements when making management decisions about *P. p. niveiventris*. This is exemplified in the current management of scrub at Cape Canaveral Air Force Station (CCAFS), where scrub management focuses on the habitat needs of the FSJ. Cape Canaveral Air Force Station harbors a suite of endangered and threatened species (Breininger et al. 1998); therefore, when making land management decisions, managers should incorporate as many species as possible (i.e., they should follow a multi-species approach).

Florida scrub historically was maintained by intense fire (Schmalzer et al. 2003). Therefore, scrub endemics are assumed to have had the time to adapt to natural disturbances typical of their environment (Hunter 1993). Disturbance events such as naturally occurring fires (e.g., wildfires) or applied fires (e.g., prescribed burning) can affect some small mammal populations (Cook 1959; Harty et al. 1991). Fire (hereafter, prescribed burning), can affect small mammals directly or indirectly; an obvious direct effect is mortality (Harty et al. 1991). However, changes in small mammal abundance after fire are assumed to be caused by changes in vegetation structure (Kaufman et al. 1983; Monamy and Fox 2000). For example, the deer mouse (*Peromyscus maniculatus*) responded positively to the mosaic created by prescribed burns on the Konza Prairie (Kaufman et al.1983, 1990). These fires burned live and dead vegetation and created patches of exposed soil that *P. maniculatus* exploited (Kaufman et al. 1988a). Based on long-term studies on fire and the responses of small mammals, *P. maniculatus* has been classified as a fire positive species, its abundance increases after fire (Kaufman et al. 1988b). Responses of other small mammal species to fire are less well understood. For instance, *P. polionotus* has mixed responses to fire. Odum et al. (1973) reported low numbers after fire; while Boyer (1964) reported increased number of *P. polionotus* after fire, and Arata (1959) found a neutral response to fire: populations did not increase or decrease.

In restoring overgrown scrub, clearcutting is often the first step and such a strategy may alter small mammal population dynamics. Few studies document the effects of clearcutting in forest biota in general and small mammals in particular (Sullivan et al. 1999). Small mammal relative abundance tends to increase after clearcutting especially abundance of *Peromyscus* spp. (Kirkland 1990). For example, *Peromyscus maniculatus* preferred clearcut-burned sites in boreal forest harvested by clearcutting. Their density was higher on clearcut-burned sites than on forest and clearcut sites (Sullivan et al. 1999). In the southeastern United States, little attention has been given to the effects of clearcutting on small mammal communities (Constantine et al. 2004), but clearcutting can substantially change the structure of small mammal assemblages (Kirkland 1990). For example, the cotton mouse (*Peromuscus gossypinus)*, a common small mammal of southeastern habitats, was significantly more abundant in areas with substantial downed logs, and branches (Loeb 1999).

My study evaluates responses of small mammals, particularly the southeastern beach mouse, to land-management techniques currently employed on CCAFS. My data include the relative abundances of small mammal populations inhabiting patches of coastal scrub subjected to mechanical cutting and prescribed burning. My objectives were to quantify small mammal responses and related demographic parameters, and document whether management of FSJ (i.e., single species) benefits small mammal populations.

METHODS

Study Area

Merritt Island is a complex barrier island that includes Cape Canaveral, Merritt Island National Wildlife Refuge (MINWR), Kennedy Space Center (KSC) and Cape Canaveral Air Force Station (CCAFS) (Fig.1). This area is a biogeographic transition zone with floral and faunal assemblages derived from temperate Carolinian and tropical subtropical Caribbean biotic provinces (DeFreese 1995). Its wildlife diversity results from many types of upland and wetland habitats and from a large number of migratory birds (Breininger and Smith 1990). A strip of coastal dune occurs adjacent to the Atlantic Ocean (Breininger et al. 1998), but scrub and pinelands are the dominant natural upland communities (Breininger et al. 1995), the dominant scrub type is oak-saw palmetto. Dominant species include myrtle oak (*Quercus myrtifolia*), sand live oak (*Q. geminata*), Chapman oak (*Q. chapmanii*), saw palmetto (*Serenoa repens*), and ericaceous shrubs (e.g., *Lyonia* spp.) (Schmalzer and Hinkle 1992).

At CCAFS, scrub has been divided into several management compartments to facilitate restoration and management. Land management compartments are divided by fire breaks, power lines, service roads and canals (Fig. 2). Compartments vary in size and stage of vegetation recovery. Although the ideal land management strategy is to clearcut overgrown scrub and follow with a prescribed burn treatment, managers are not always able to conduct the necessary burns to keep up with the acreage of scrub cut. Prescribed burning occurs opportunistically due to non-ecological issues (e.g., CCAFS policy, smoke-sensitive space equipment and location of launch pads), so mechanical treatments are applied more frequently.

Sampling

I assessed the responses of small mammals to current management techniques by collecting data on their abundance (number of mice/trap night), in 18 land management compartments located throughout CCAFS (Fig. 3). I selected compartments based on land management activities: five compartments (87, 37, 115, 7, and 4) were recently prescribed burned, six compartments (13, 102, 104, 79, 48, and 67) were recently cut, and four compartments (101, 118, 81, and 69) were checkerboarded (i.e., prescribed burn and cut). I also selected three compartments (55, 70, and 77) without these management techniques as fire-suppressed controls.

I set up one transect line in each compartment to obtain data on the relative abundance of small mammals. Transects were positioned toward the center of each compartment to minimize edge effects. Transects consisted of 10 large Sherman live traps (7.6 x 8.9 x 22.9 cm, H. B. Sherman Traps Inc., Tallahassee, Florida) spaced 15 m apart. I opened traps late in the afternoon, baited them with sunflower seeds, and checked for captures the following morning. All small mammals captured were marked with a numbered ear tag, identified to species, sexed, and checked for reproductive condition, male mice were reproductive if testes were descended into the scrotal sack, and female mice were reproductive if their mammaries were enlarged or hair was pulled away and their vaginas were perforated. Age class (juvenile, subadult and adult) was determined by pelage coloration and mass (Layne 1968), which was obtained using a Pesola spring scale accurate to the nearest 0.5 g. I surveyed compartments three times each season (spring: March-May, summer: June-August, fall: September-November, winter: December-February). I pre-baited live traps approximately 2 weeks before trapping commenced, and trapping periods were conducted at 2 week intervals. All captured small mammals were released at the point of capture.

I followed guidelines on trapping methodology and handling of small mammals by the American Society of Mammalogists (1980) and IACUC project # 03-13 issued to the Department of Biology at the University of Central Florida. I also followed Florida Fish and Wildlife Conservation Commission's (FFWCC) small mammal trapping protocol, and conducted all live trapping under permit number WV04065 issued to I. Jack Stout by FFWCC.

Data Analysis

I used Repeated Measures Analysis of Variance (RM-ANOVA) to test whether mean relative abundance of small mammals and body mass differed among management treatments. I calculated small mammal abundance as the number of first captures trapped during each trapping period, and used only the number of first captures of individuals in compartments to test for treatment and seasonal effects. I used time (seasons) as the repeated measure, and management treatment was the between-subject variable. The independent measure of analysis was mean small mammal relative abundance and body mass in burned ($n = 5$), cut ($n = 6$), checkerboard ($n = 4$) and fire-suppressed ($n = 3$) management compartments. I performed RM-ANOVAs for southeastern beach mouse and cotton mice individually. When a significant effect was found, I performed a Bonferroni Multiple Comparison Tests to discern differences among means, and adjusted the degrees of freedom to meet the assumption of sphericity. I constructed 2 x 4 contingency tables to evaluate demographic parameters of reproduction for southeastern beach mice and cotton mice. I used a G-test to test for differences on the frequency of observed male and female beach mice in reproductive condition among land management treatments and seasons.

I used Pearson correlation coefficients to explore relationships between Florida scrub-jay breeding groups and first captures of southeastern beach mice in surveyed compartments to demonstrate the efficacy of land management techniques on these two listed species. These data met assumptions for parametric analysis. I also present numeric data on Florida scrub-jay in land management compartments. All tests were significant if $P<0.05$. Analyses were conducted using SPSS 11.5 (SPSS Inc., Chicago, Illinois).

RESULTS

I captured three species of small mammals during the study southeastern beach mouse, cotton mouse, and cotton rat (*Sigmodon hispidus*). In 1,975 trap nights, I trapped 315 *P. p. niveiventris*, 300 *P. gossypinus*, and 39 *S. hispidus* on multiple occasions, and 146 southeastern beach mice, 130 cotton mice and 33 cotton rats were captured only once. The three species were captured in all compartments I trapped but their relative abundance varied by season and land management practice (Fig. 4). *Peromyscus polionotus niveiventris* and *P. gossypinus* were relatively abundant during all seasons, while *S. hispidus* were seldom captured. Relative abundance of *Peromyscus polionotus niveiventris* and *P. gossypinus* varied among management treatments (Fig. 5). Relative abundance of *P. p. niveiventris* appeared to be higher in compartments that were burned relative to other treatments. In contrast, the relative abundance of *P. gossypinus* appeared to be greater in compartments that were cut relative to other treatments (Fig. 5).

Southeastern beach mice

Mean number of first captures was highest in burned (4.15 ± 0.68, Mean ± 1 SE, herein after) and lowest in fire suppressed (0.16 ± 0.11) compartments. Mean number was significantly different among treatments (RM- ANOVA, $F_{3, 14}$= 4.79, P = 0.017, Fig. 6). A Bonferroni multiple comparison test indicated that the mean number of first captures trapped in burned compartments was significantly different from cut and fire suppressed (Fig. 6). Mean number of first captures of *P. p. niveiventris* varied between seasons and management treatment (Fig. 7). Mean number was significantly different between seasons, RM-ANOVA, $F_{3, 42}$ = 5.49, P = 0.003, and the interaction between season x treatment also was significant, RM-ANOVA, $F_{9, 42}$ = 2.66, P = 0.01, Fig. 7). However, Bonferroni multiple comparison tests failed to detect differences in seasonal means.

Mean body masses of the small rodents were slightly different across land management compartments under different treatments (Table 1) and seasons (Table 2).
There were no significant differences in the mean body mass of *P. p. niveiventris* ($F_{3, 42}$ = 0.89, P = 0.45) among land management treatments (Fig. 8), and the interaction between treatment and season also was not significant ($F_{9, 42}$ = 1.43, P = 0.20, Fig. 8).

There were no significant differences in the frequency of male (G = 1.538, d. f. = 3, P > 0.05, Fig. 9) or female (G = 2.224, d. f. = 2, P = 0.05, Fig. 10) *P. p. niveiventris* in breeding condition among land management treatments. There was no significant differences in the frequency of male (G = 4.753, d. f. = 3, P > 0.05, Fig. 11) *P. p. niveiventris* in breeding condition among seasons, but the frequency of female (G = 8.148, d. f. = 3, P < 0.05) *P. p. niveiventris* in breeding condition among seasons was significantly different (Fig. 12). Numbers of females showing signs of being reproductive were highest during fall, but reproductive characters were dominant throughout the seasons.

Cotton mice

Mean number of first captures did not differed among land management treatments (RM-ANOVA, $F_{3, 14}$ = 1.54, P = 0.24), and the interaction between treatments and seasons also was not significant ($F_{9, 42}$ = 1.63, P = 0.13, Fig. 13). Mean body mass of *P. gossypinus* did not differed significantly among land management treatments (burned, 22.48 ± 0.75, cut, 23.44 ± 0.62, checkerboarded, 21.11 ± 1.11 and fire suppressed, 23.33 ± 1.43, Mean ± SEg, Fig. 14). The frequency of male (G = 1.758, *d. f.* = 3, P > 0.05, Fig. 15) and female *P. gossypinus* in breeding condition did not differ among land management treatments (G = 4.644, *d. f.* = 3, P > 0.05, Fig 16), but there were significant differences in the frequency of male (G = 17.886, *d. f.* = 3, P < 0.05, Fig. 17) cotton mice in reproductive condition among seasons with all captured males non-reproductive in summer while reproductive condition of females did not differ among seasons (G = 6.578, *d. f.* = 3, P > 0.05, Fig. 18).

Cotton rat responses

In contrast to *P. p. niveiventris* and *P. gossypinus,* mean relative abundance of *S. hispidus* was unaffected by management treatments (Fig. 5). Low sample sizes of *S. hispidus* at some sites precluded statistical analysis, but mean body mass of males was 119.12 ± 8.25 g and for females was 118.25 ± 9.52 g in burned and 113.00 ± 26.56 g for males and 148.40 ± 13.41 g for females in cut compartments. No males were captured in checkerboarded compartments. Body mass of female cotton rats in checkerboarded compartments was 115.00 ± 20.8 g. In fire suppressed compartments, body mass of male cotton rats was 190.00 ± 0.00g and 94.00 ± 33.53 g for female cotton rats (Fig. 19). Most *S. hispidus* showed no signs of reproduction, 14 males had non-descended testicles and only one had descended testicles. A similar pattern was observed in female *S. hispidus:* 17 females were non-reproductive, while seven were reproductively active as their mammaries were observed to be enlarged.

Florida scrub-jays

Total number of Florida scrub-jay breeding pairs was relatively higher in burned (n = 22) than in cut (n = 12) or checkerboarded (n = 13) compartments, but the number of successful fledglings was higher in cut (n = 15) compartments. Total number of first captures of southeastern beach mice was highest in burned (n = 83) and extremely low in fire suppressed (n = 2) compartments, while the Florida scrub-jay did not use any of the fire suppressed compartments (Table 3). Moreover, the relationship between Florida scrub-jays breeding pairs and southeastern beach mice were positively correlated (Pearson correlation, r = 0.51, P < 0.05) and breeding groups explained 26% of the variation in first captures of southeastern beach mice in land management compartments (Fig. 20).

DISCUSSION

The Department of Defense is the second largest land steward in the United States and oversees 10.4 million ha, much of which is managed as wildlife habitat (Cohn 1996). Military bases support many listed species, and CCAFS harbors four federally listed species and one species of special concern (Breininger et al. 1998). However, the presence or protection of habitat is insufficient to ensure survival of many species. The interruption of fire regimes and ecosystem fragmentation has contributed greatly to the ecological degradation of many habitats; therefore, active management of critical habitats and species is necessary.

Land management activities at CCAFS influenced all three small mammal species that I studied. The threatened southeastern beach mouse was significantly more abundant in compartments that had been prescribed burned, suggesting that populations responded positively to this treatment. Boyer (1964) found a similar response by *P. polionotus* to fire while Odum et al. (1973) found that its density remained low after fire, and Arata (1959) found no response in mainland Florida. Inconsistent responses of *P. polionotus* to fire make it difficult to generalize these findings. Therefore, whether prescribed burning stimulates abundance of *P. p. niveiventris* by manipulating some aspect of its habitat requires further study. Other small mammal species respond positively to fire. For example, relative abundance of deer mouse (*P. maniculatus*) increased after prescribed fires in tallgrass prairie in Kansas (Kaufman et al. 1988b), and kangaroo rats (*Dipodomys* sp.) preferred microhabitats created by fire in southern Idaho (Halford 1981). *Peromyscus polionotus* is associated with open spaces and perhaps could exploit the habitat mosaic created by fire.

Prescribed burning at CCAFS created heterogeneous habitat conditions; winter and summer burns reduced plant cover by 40% and exposed 20% more soil (Foster and Schmalzer 20003). In my study, the relative abundance of *Peromyscus polionotus niveiventris* in burned compartments was significantly higher than in cut compartments in fall and winter, suggesting that *P. p. niveiventris* may use open patches of exposed soil created by fires. *Peromyscus polionotus niveiventris* is thought to prefer structurally open ground sites (Davenport 1964). However, my study showed that *P. p. niveiventris* was not confined to the sea oats–dune system that presumably is its preferred habitat. Instead, I trapped *P. p. niveiventris* in densely vegetated sites more than 1.5 km inland, suggesting that it tolerates various vegetation structures. Extine and Stout (1987) suggested that *P. p. niveiventris* preferred closed habitats on CCAFS; mainland populations of *P. p. subgriseus* inhabiting scrub habitat on the Archbold Biological Station can also tolerate closed habitats (Packer and Layne 1990). Therefore, CCAFS managers need to incorporate management of scrub as beach mouse habitat and conduct studies designed to examine habitat use and persistence of *P. p. niveiventris* in scrub habitat.

Body mass of southeastern beach mice was not affected by land management treatments. Animals maintained their body mass within their range (10.0 to 17.0 g, Hall 1981) suggesting that food was available. Old-field mice are omnivores capable of ingesting a very diverse food items (Gentry and Smith 1968). In dune habitat, beach mice food consumption was primarily determined by seasonal changes in food availability (Moyers 1996). Data from management compartments are necessary to fully evaluate the effects of management practices on food availability to the small mammal rodent community.

Management treatments did not have an effect on the number of male beach mice with descended testes most males were observed to be in a non-reproductive condition. Fall and spring, are times that have been determined as peak breeding period for beach mice (Blair 1951), but male southeastern beach mice did not follow this reproductive pattern. Female southeastern beach mice, contrary to males, followed this seasonal pattern, and their reproductive condition differed among seasons. Number of female southeastern beach mice in reproductive condition was particularly high in the fall during which 90 % (10/11) of the population was observed having developed mammaries. In burned compartments, the number of female southeastern beach mice showing signs of being reproductive was 57 % (21/37), while in cut compartments, 75 % (6/8) had developed mammaries. However, land management treatments did not have a significant effect on reproductive condition; nonetheless, future management plans should incorporate studies of reproductive performance to further evaluate whether land management activities improve the habitat of the small mammal community.

Although not statistically significant, responses of *P. gossypinus* to mechanized cutting was similar to that reported by Loeb (1999), who found increased abundance in southeastern forest plots where downed woody debris was high. Downed woody debris from logging activities create complex habitats that *P. gossypinus* exploits. In addition, adult female *P. gossypinus* had greater survival and were more likely to be in reproductive condition (Loeb 1999).
In my study, I found no association between land management treatment and reproduction suggesting that land management treatments did not significantly improve the quality of the habitat. It appears that cotton mice are responding positively to the cutting treatment, as a result, cutting may have improved some aspect of its habitat, but this numeric response is not a good indicator of habitat quality (Van Horne 1983). Therefore, a good understanding of the population dynamics and demographic parameters are essential in order to assess the quality of habitats in areas with different structural characteristics. I did not record quantitative data on vegetative structural changes that may have been created by the management treatments, but it appears that they created complex conditions (Fig. 21) favorable to *P. gossypinus*. McCay (2000) documented a variety of microhabitats utilized by *P. gossypinus*; 69% used stumps, 14 % were under upturned root boles, 7% were shallow burrows not associated with woody debris, 6% were in brush piles, and 4% were under fallen logs. Thus, 100 of 108 microhabitat sites were associated with some form of woody debris.

I could not evaluate population trends of *Sigmodon hispidus* because few individuals were captured. In general, *S. hispidus* was less abundant than the other species throughout the study. They tended, however, to be relatively more abundant during summer in burned compartments. Their body mass in burned compartments was recorded well within the range for the species (110 to 225 g for males and 100 to 200 g for females, Chipman 1965). Typical habitat of *S. hispidus* is characterized by well-developed herbaceous ground cover and an open tree layer, although it also occurs in habitats ranging from sparsely vegetated dunes to dense mesic forests (Cameron and Spencer 1981). It usually nests on the ground in dense vegetation but may construct burrows (Shump 1978). *Sigmodon hispidus* responds to habitat changes in some situations. For example, relative abundance of *S. hispidus* in clearcuts is greater than in uncut forests in South Carolina (Constantine et al. 2004), and they respond positively to prescribed fires in eastern Kansas (Rehmeier et al. 2005).

My study is the first detailed comparison of small mammal populations in replicated burned, cut, burned–cut, and fire suppressed coastal scrub habitats in east central Florida. The number of replicates and temporal component included in the data set allow me to make strong inferences about responses of small mammals to land management techniques. However, it is possible that the variation in rodent captures among periods following land management activities may result from natural fluctuations or other factors confounded with compartment history. Periodic, cyclic fluctuations in abundance of some small mammal populations are common (Krebs 1966). Therefore, long-term field studies of these small mammal populations are essential for establishing general patterns of population abundance (Rehmeier et al. 2005). Short-term projects may allow detection of variability in abundance, but long-term ecological studies are necessary to investigate potential factors affecting variability (Matlack et al. 2002) and to help avoid erroneous conclusions about complex systems (Swihart and Slade 1990).

Results of my study can be used to aid in designing and implementing a long-term, science-based land management program that would favor multiple species. My study showed that *Peromyscus polionotus niveiventris*, a federally listed threatened species inhabits scrub areas that are not designated as beach mouse habitat. Therefore, land managers should take the steps necessary to designate these areas as beach mouse habitat, and manage such habitat as required by the Endangered Species Act. Current management activities designed to improve habitat for Florida scrub-jay also benefits *P. p. niveiventris*. Conducting experimental tests of management practices is a science-based action that will contribute to recovery of *P. p. niveiventris*.

CONCLUSIONS

Results from my study suggest that responses of the small mammal species, southeastern beach mice positively responded to prescribed burning while cotton mice appears to positively respond to mechanical cutting, to land management activities are species-specific. I suggest that best management practices will maintain a mosaic of burned and cut compartments. This strategy will maintain small mammal species diversity and benefit the greatest mix of federally-threatened species. Current land management techniques benefits Florida scrub-jay, and the number of nesting pairs (n = 16) was numerically higher in compartments managed with fire than in compartments that were cut (n = 7) or checkerboarded (n = 5). However, number of fledglings (n= 15) was greatest in cut compartments. The southeastern beach mouse also responded favorably to the same management practices. Number of individual southeastern beach mice in burned compartments was significantly higher than in cut or fire suppressed treatments. Therefore, consistent application of prescribed burns is imperative to maintain habitat characteristics preferred by these two federally listed species. In addition, a long term small mammal study should be established to investigate temporal patterns and recovery mechanisms of small mammals to the land management treatments.

APPENDIX: FIGURES AND TABLES OF RESULTS

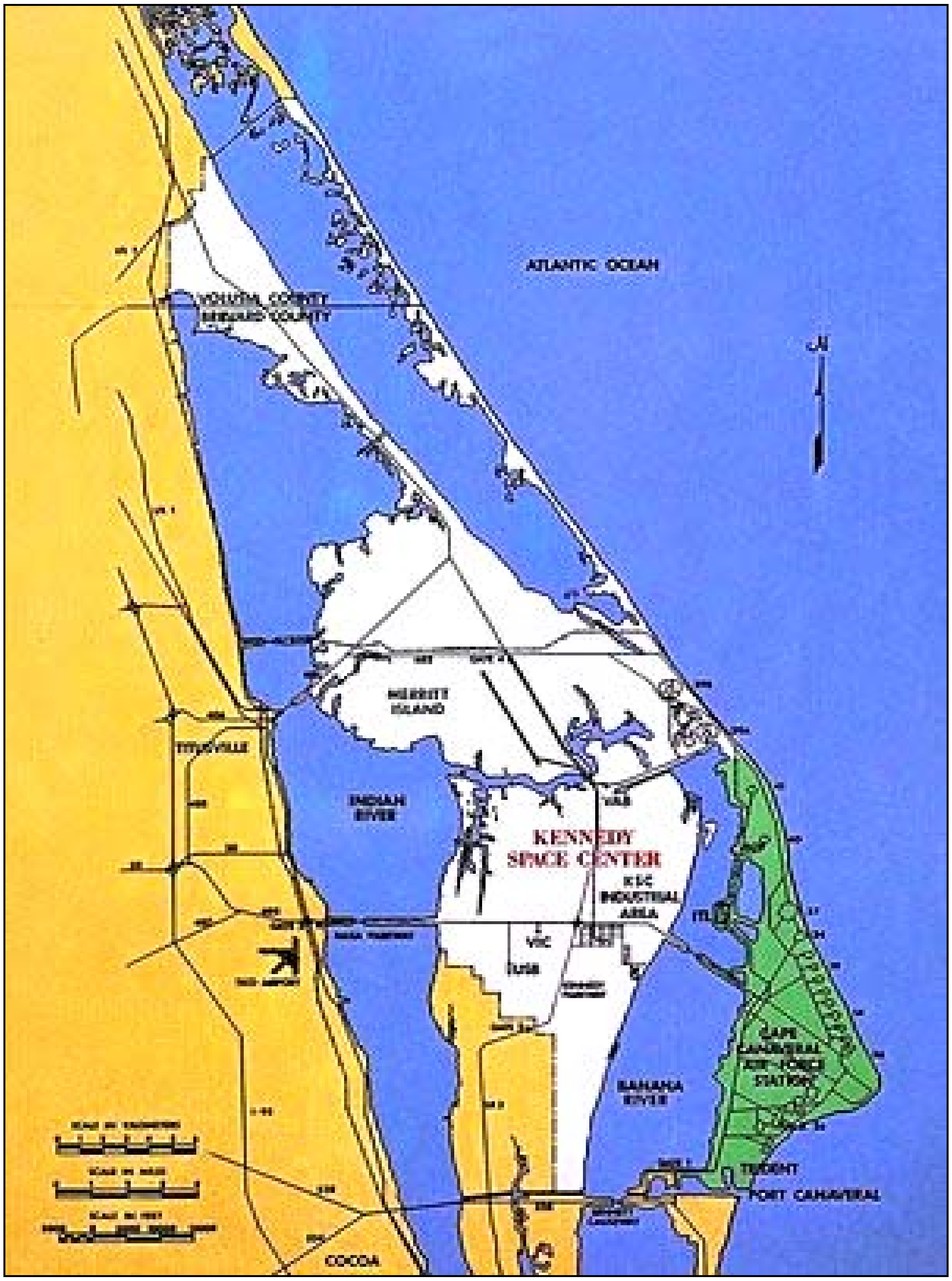


Fig. 1—Florida scrub management strategies were evaluated at Cape Canaveral Air Force Station (CCAFS) (Latitude 28.48, Longitude -80.59) during fall 2004 – summer 2005. Cape Canaveral Air Force Station is part of the Merritt Island Complex located in east Central Florida, Titusville, USA.

Fig. 2— Compartmentalization of study area by roads ( ) driveways ( ) and buildings ( ). Linear features such as roads are used as fire breaks during prescribed burns.

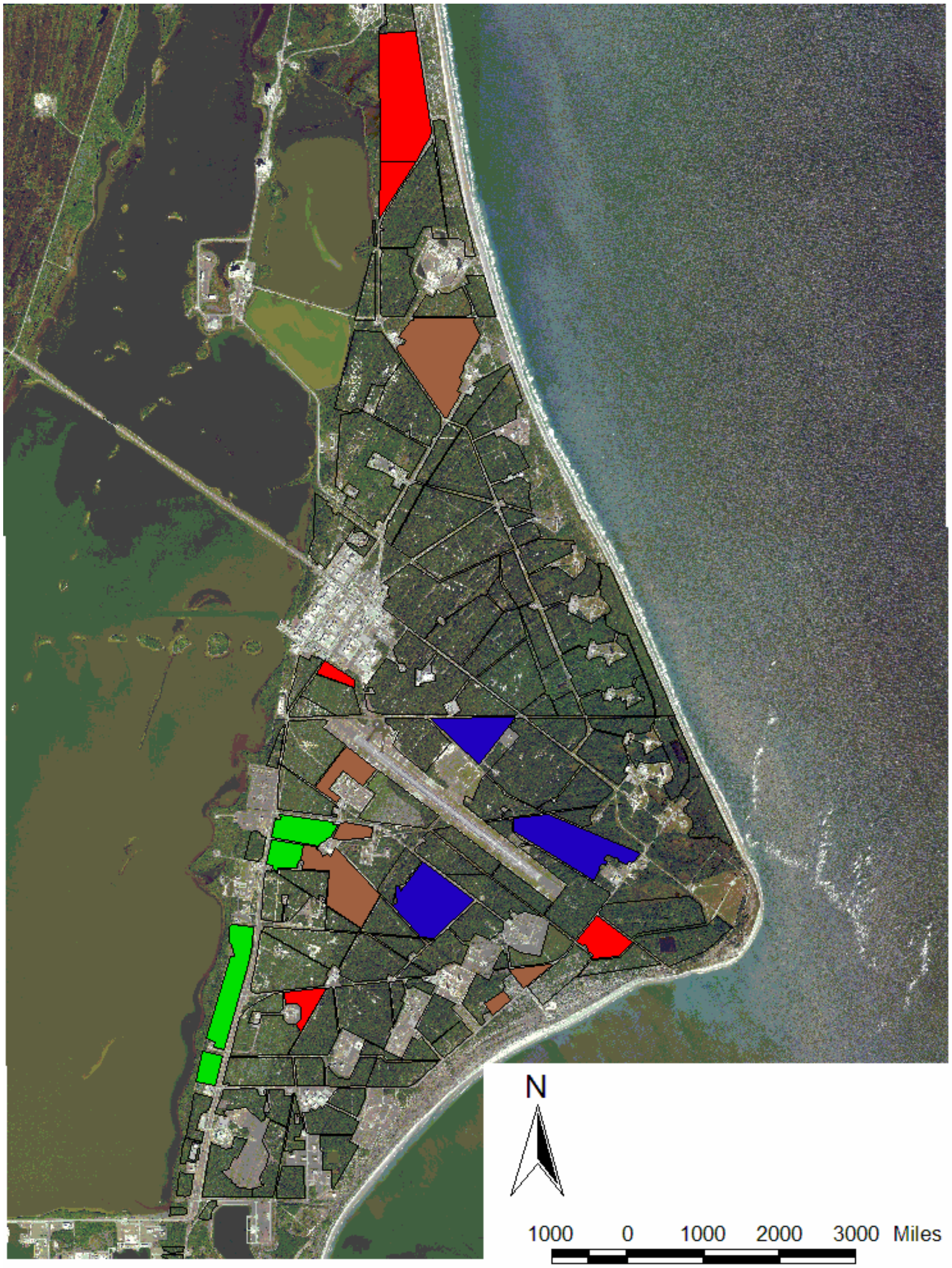


Fig. 3— Location of burned ( ), cut ( ), checkerboarded ( ) and fire suppressed ( ) compartments used to evaluate rodent responses to land management strategies at CCAFS.

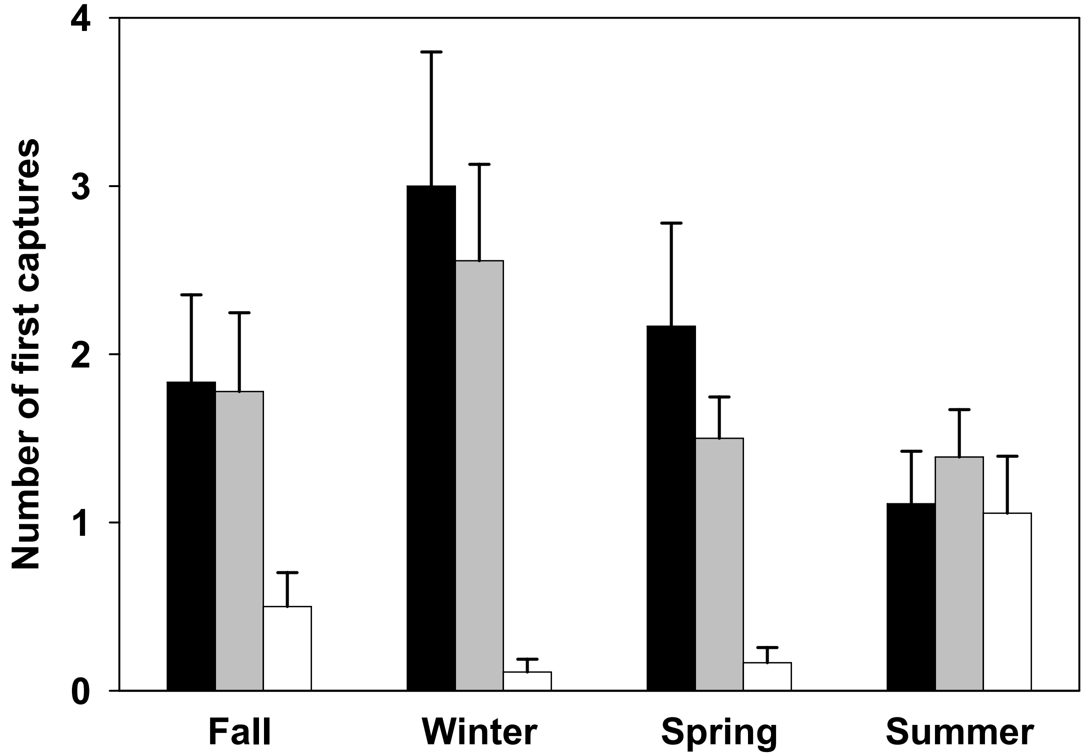


Fig. 4— Mean (± 1 SE) number of first captures of small mammal species (●) *Peromyscus polionotus niveiventris*, (◉) *P. gossypinus*, (○) *Sigmodon hispidus* during the 2004 – 2005 field season in Florida scrub land management compartments at Cape Canaveral Air Force Station, Titusville, Florida USA.

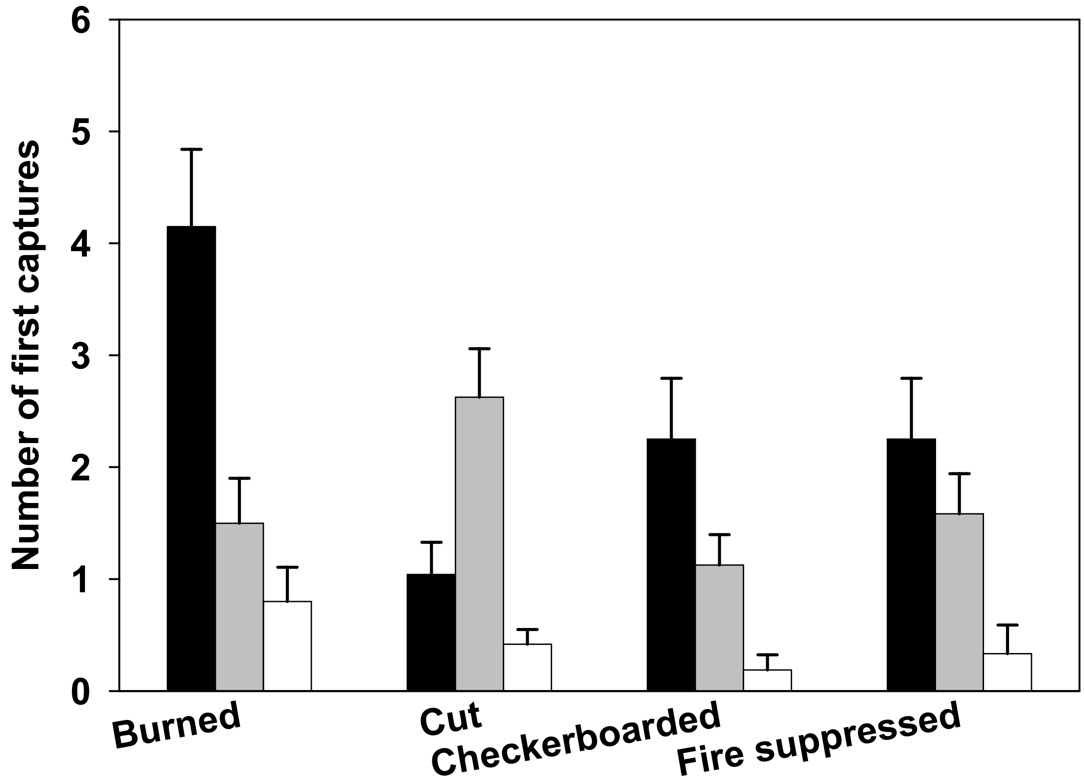


Fig. 5— Mean (± 1 SE) number of first captures (■) *P. p. niveiventris*, (▨) *P. gossypinus* and (□) *S. hispidus* in Florida scrub management compartments under different management strategies. Rodent populations were sampled during 2004-2005 field season at Cape Canaveral Air Force Station, Titusville, Florida, USA.

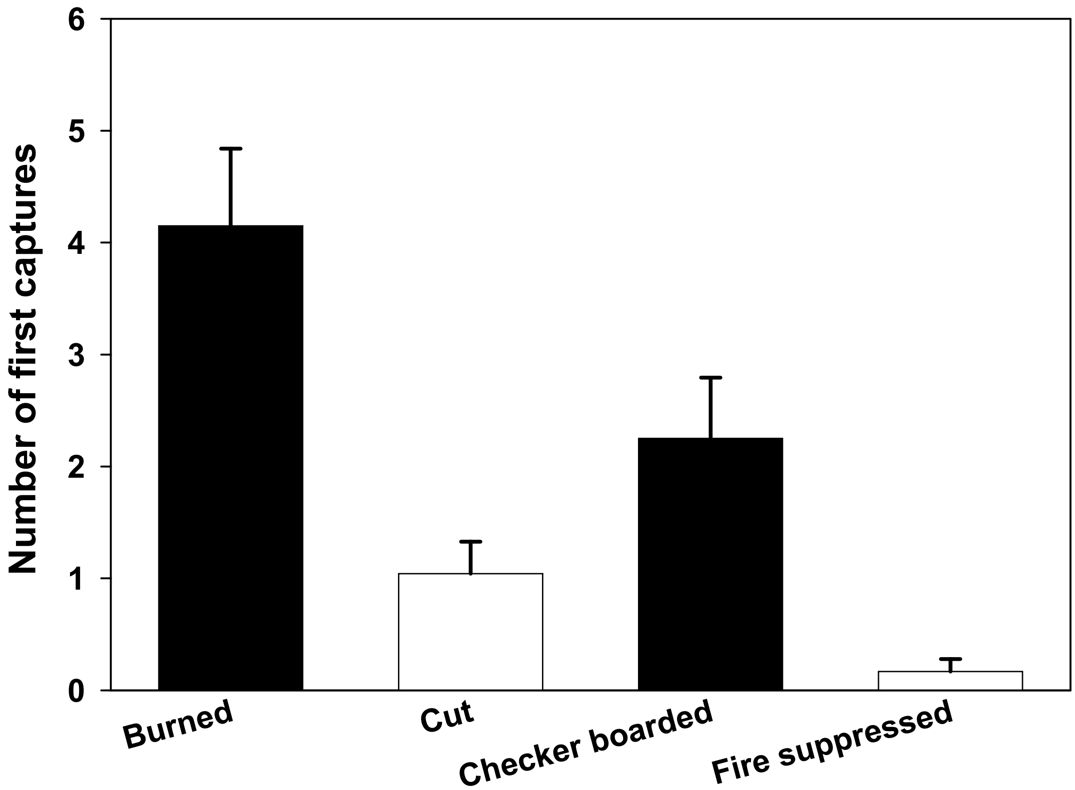


Fig. 6— Mean number (± 1 SE) of first captures *Peromyscus polionotus niveiventris* trapped in land management compartments during the study. Land management treatment had a significant effect, (RM-ANOVA, $F_{3, 14} = 4.793$, $P = 0.017$). Bonferroni multiple comparison tests indicated that the mean number of first captures trapped in burned compartments was significantly different from cut and fire suppressed, $P < 0.05$.

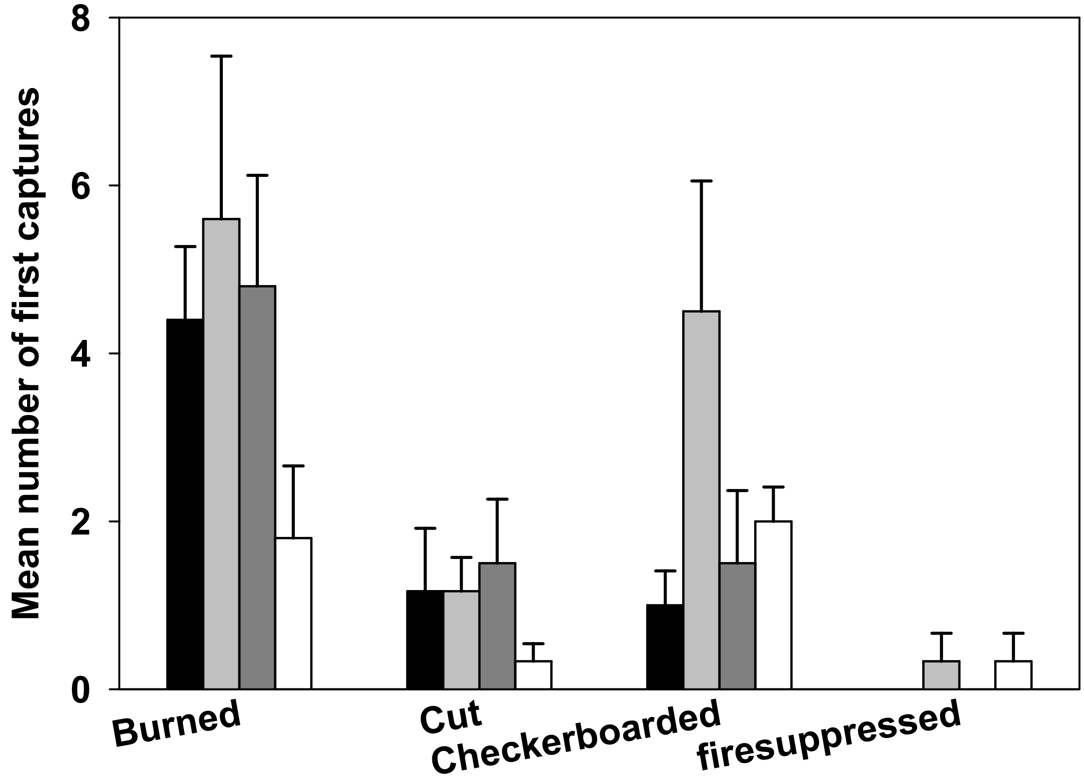


Fig. 7— Mean (± 1 SE) number of first captures *P. p. niveiventris* trapped during (■) fall, (■) winter, (■) spring and (□) summer in compartments under different management treatments (burned = 5, cut = 6, checkerboarded = 4 and fire suppressed = 3). Mean number differed significantly among seasons, (RM-ANOVA, $F_{3, 42} = 5.5$, $P < 0.003$), and the interaction between treatment and season also was significant (RM-ANOVA, $F_{9, 42} = 2.66$, $P < 0.01$). However, Bonferroni Multiple Comparison Tests failed to identify significantly different groups.

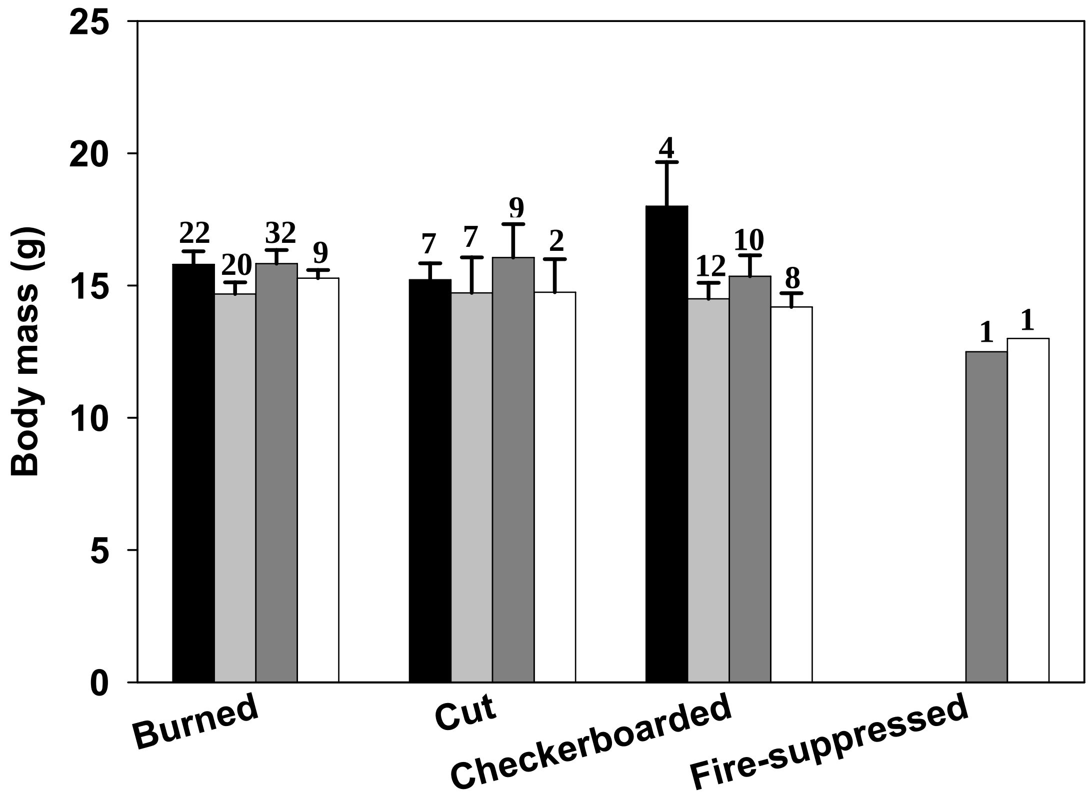


Fig. 8—Mean (± 1 SE) body mass of first captures *P. p. niveiventris* in land management compartments (burned = 5, cut = 6, checker boarded = 3 and fire-suppressed = 3) at CCAFS during (■) fall, (■) winter, (■), spring, and (□) summer. No significant differences in body mass were found, (RM-ANOVA, $F_{3, 42} = 0.89$, $P = 0.45$) No *P. p. niveiventris* were live trapped in fire-suppressed compartments during fall and winter. Numbers above error bars are sample size.

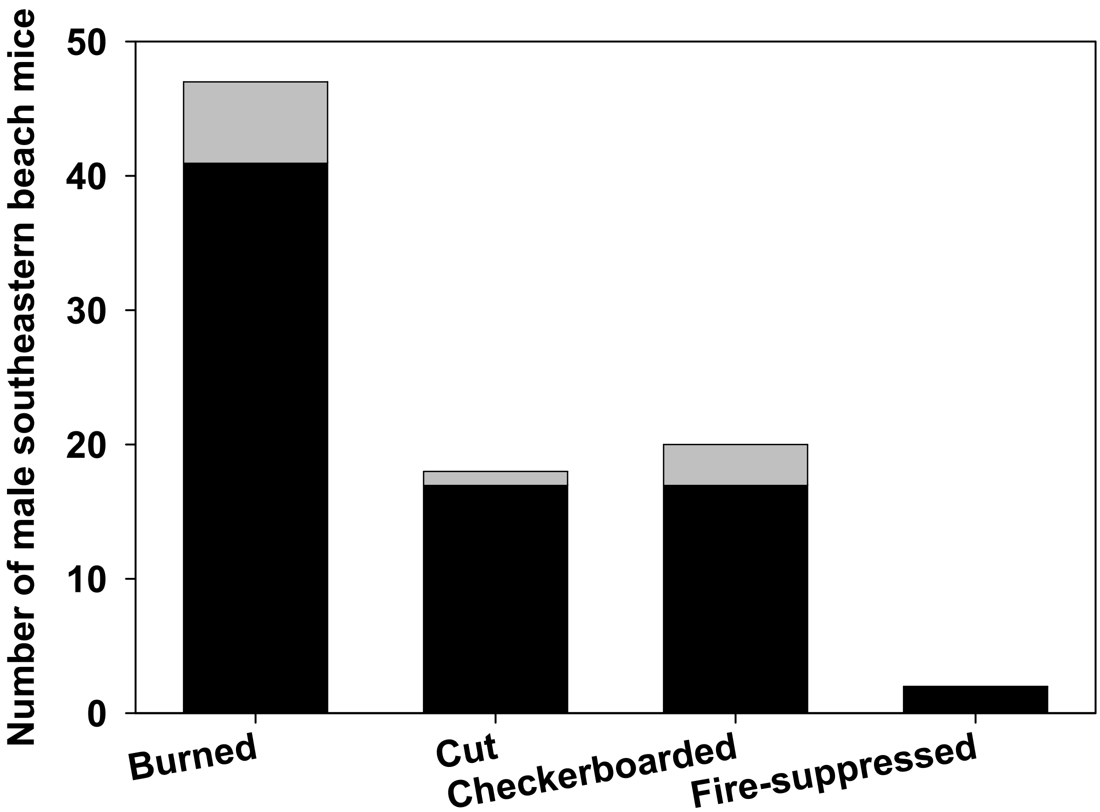


Fig. 9— Number of male *P. p. niveiventris* with descended ( ) and non-descended ( ) testes at CCAFS, Florida, was independent of land management (G = 1.538, *d. f.* = 3, P > 0.05).

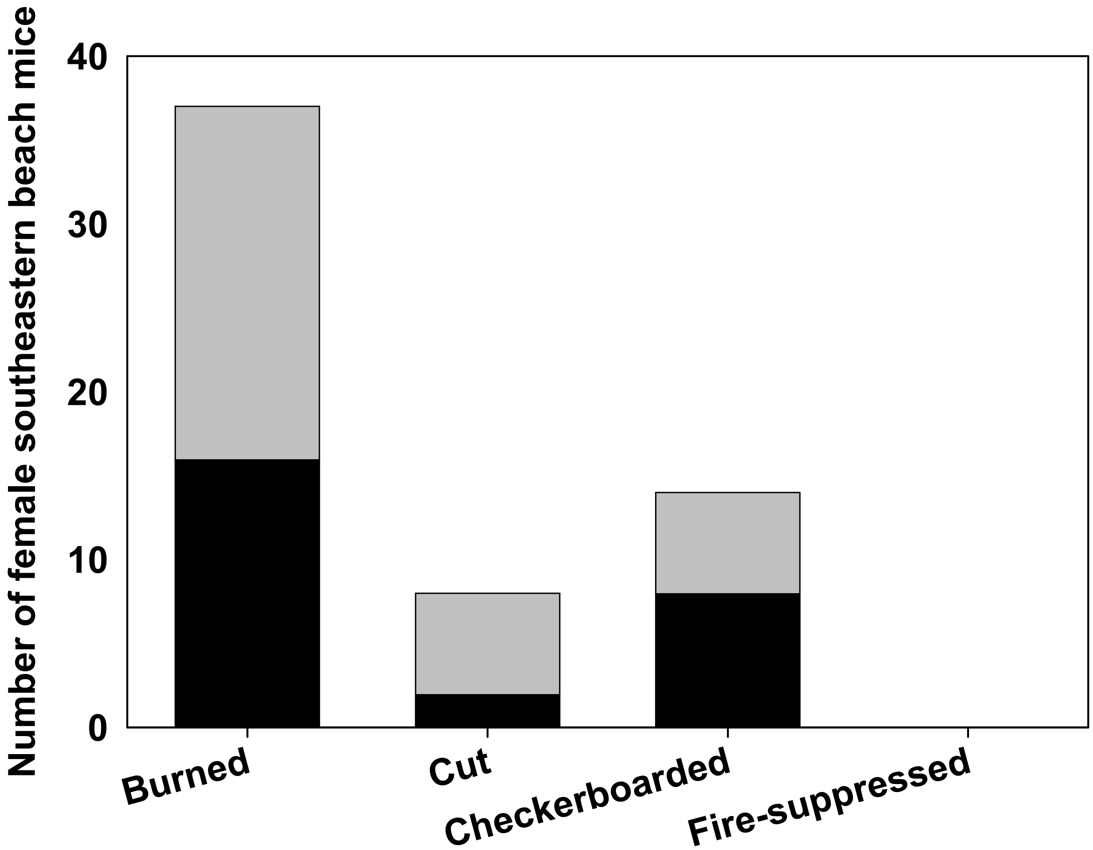


Fig.10— Number of female *P. p. niveiventris* with developed mammaries and hair pulled away from mammaries (▩), and with no reproductive signs (■) in land management compartments at CCAFS, Florida during 2004-2005. No female *P. p. niveiventris* were trapped in fire-suppressed compartments. Reproductive condition was independent of land management treatments, ($G = 2.224$, *d. f.* = 2, $P > 0.05$).

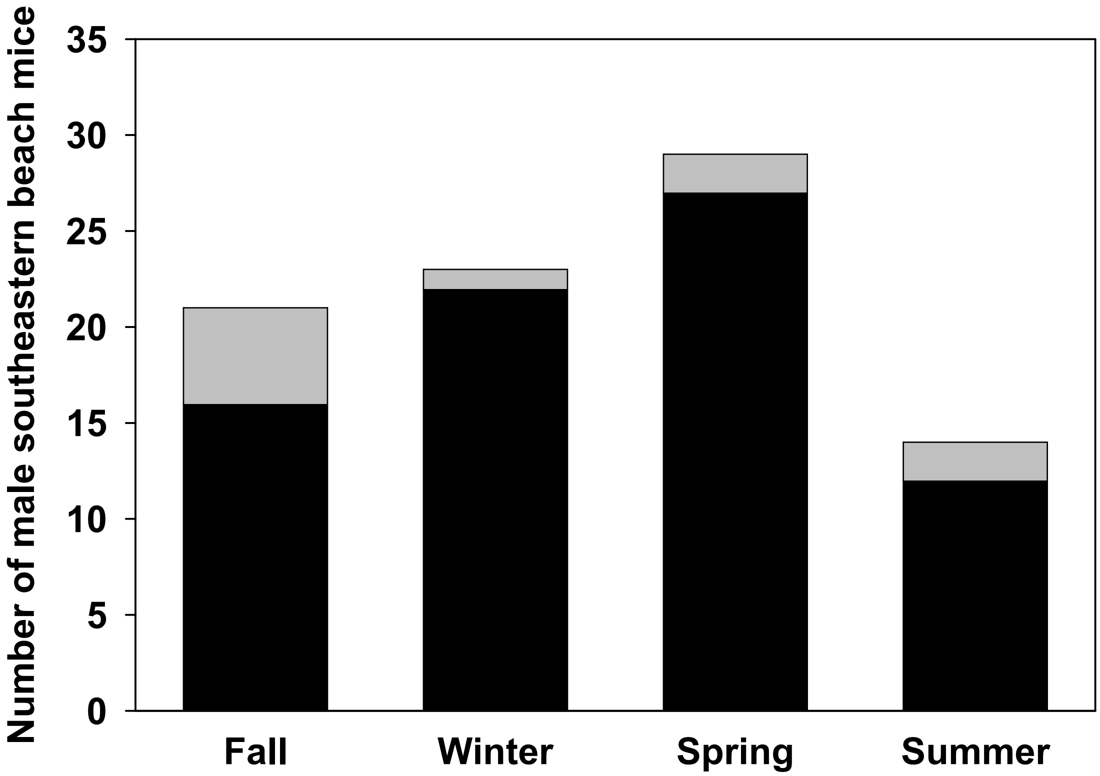


Fig. 11— Number of male *P. p. niveiventris* with descended ( ) and non-descended ( ) testes during seasons at CCAFS, Florida. Breeding condition and season were independent, (G = 4.753, *d. f.* = 3, P > 0.05).

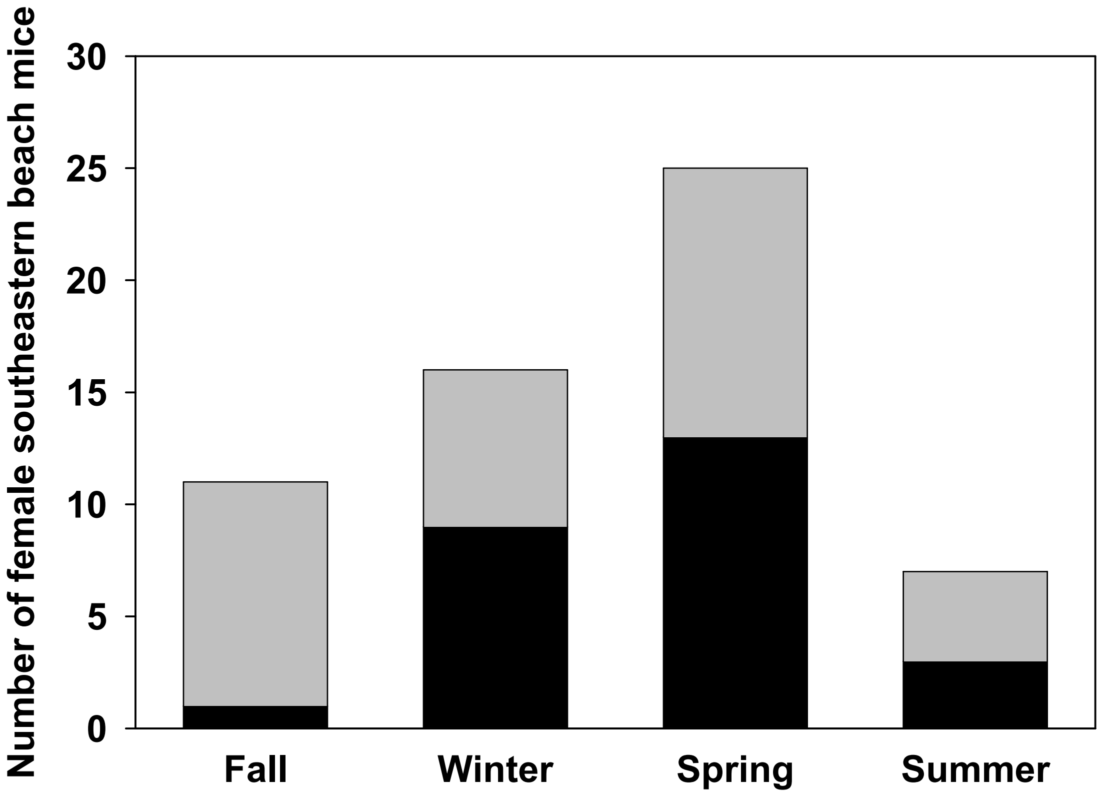


Fig. 12— Number of female *P. p. niveiventris* with developed mammaries and hair pulled away from mammaries (▩) and number showing no signs of reproduction (■) during the study at CCAFS, Florida. Reproductive condition differed among seasons, (G = 8.148, *d. f.* = 3, $P < 0.05$).

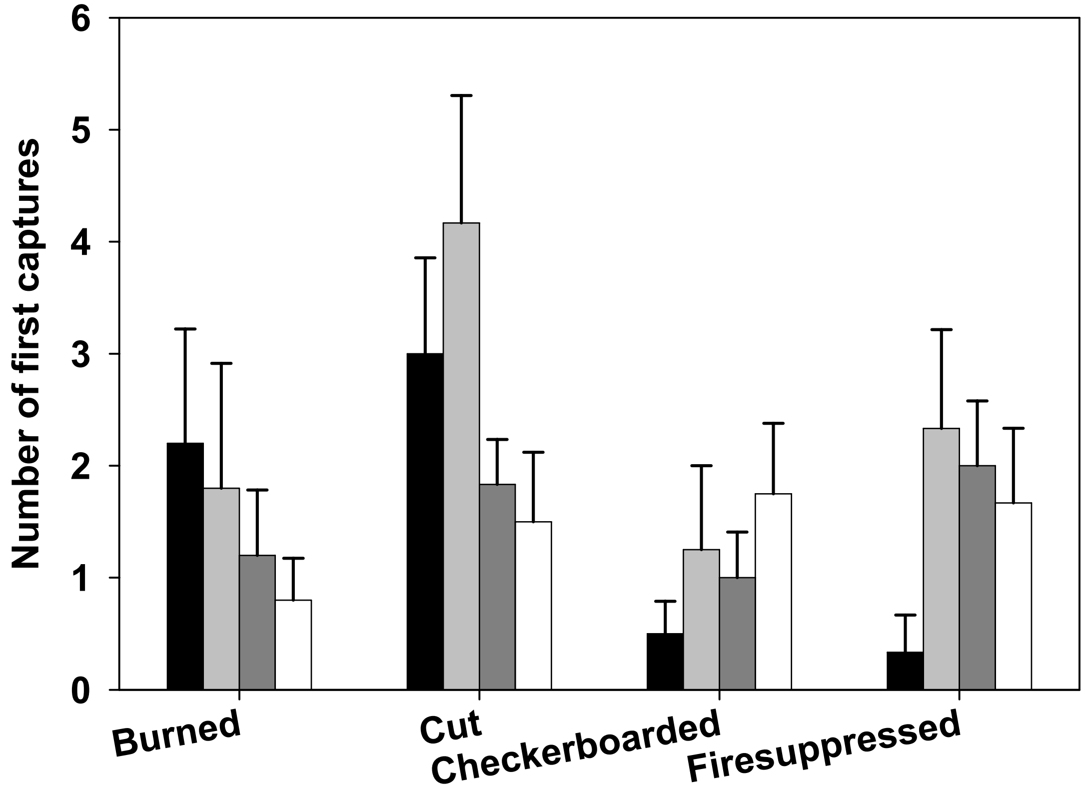


Fig. 13— Mean (± 1 SE) number of first captures *P. gossypinus* captured during (■) fall, (■) winter, (■) spring and (□) summer in land management compartments (burned = 5, cut = 6, Checkerboarded = 4 and fire suppressed = 3) at CCAFS. Mean number of first captures did not differ among seasons, (RM-ANOVA, $F_{3, 42} = 1.85$, P = 0.15) nor their treatment x season interaction (RM-ANOVA, $F_{9, 42} = 1.63$, P = 0.13).

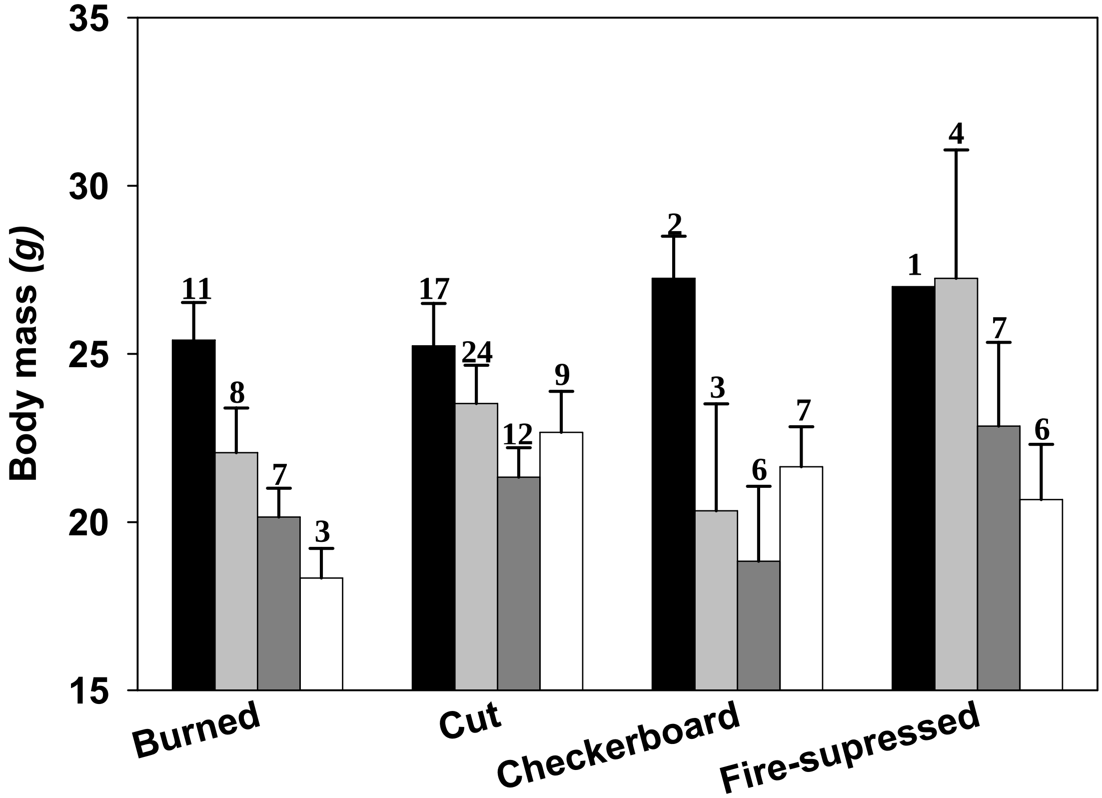


Fig. 14— Mean (±1SE) body mass of first captures *P. gossypinus* in land management compartments (burned = 5, cut = 6, check boarded = 4, and fire suppressed = 3) during (■) fall, (□) winter, (■), spring and (□) summer at CCAFS, Florida. Sample sizes are shown above error bars.

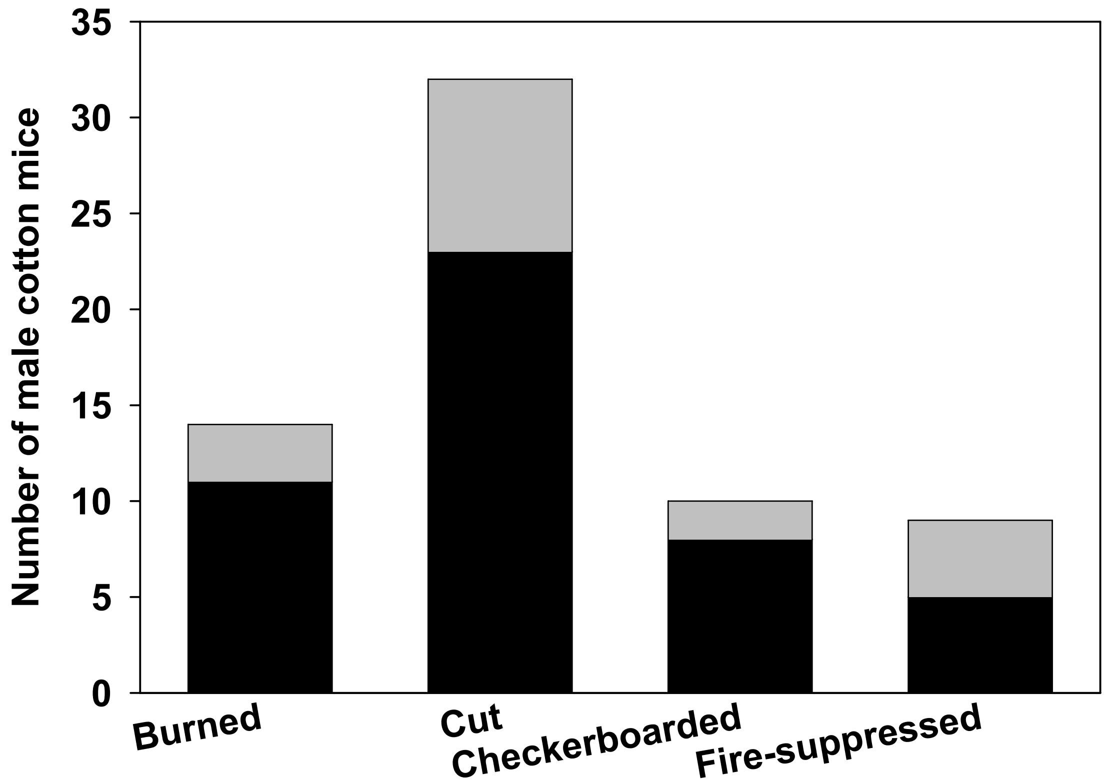


Fig.15— Number of male *P. gossypinus* with ( ) descended and ( ) non-descended testes at CCAFS, Florida, was independent of land management, (G = 1.758, d. *f*. = 3, P > 0.05).

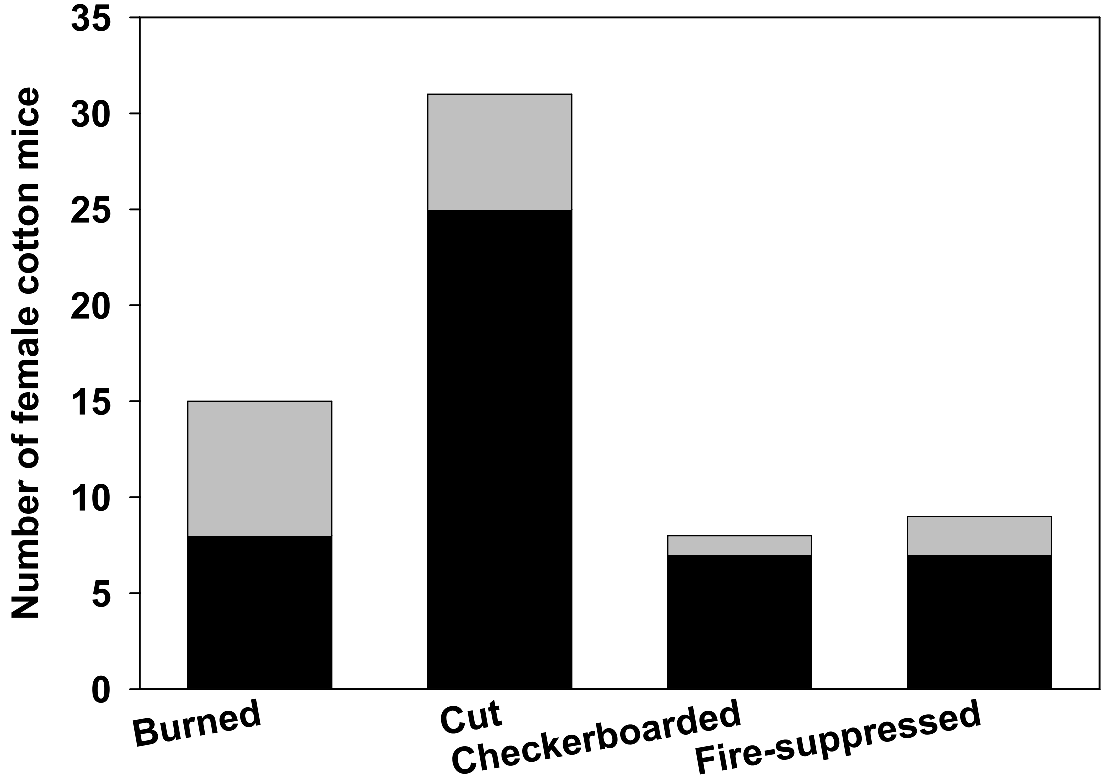


Fig.16— Female *P. gossypinus* with ( ) developed mammaries or hair pulled away from mammaries, and ( ) no sign of being in reproductive condition as a function of land management compartments at CCAFS, Florida. No association was found between reproductive condition and land management treatment, (G = 4.644, *d. f.* = 3, P> 0.05).

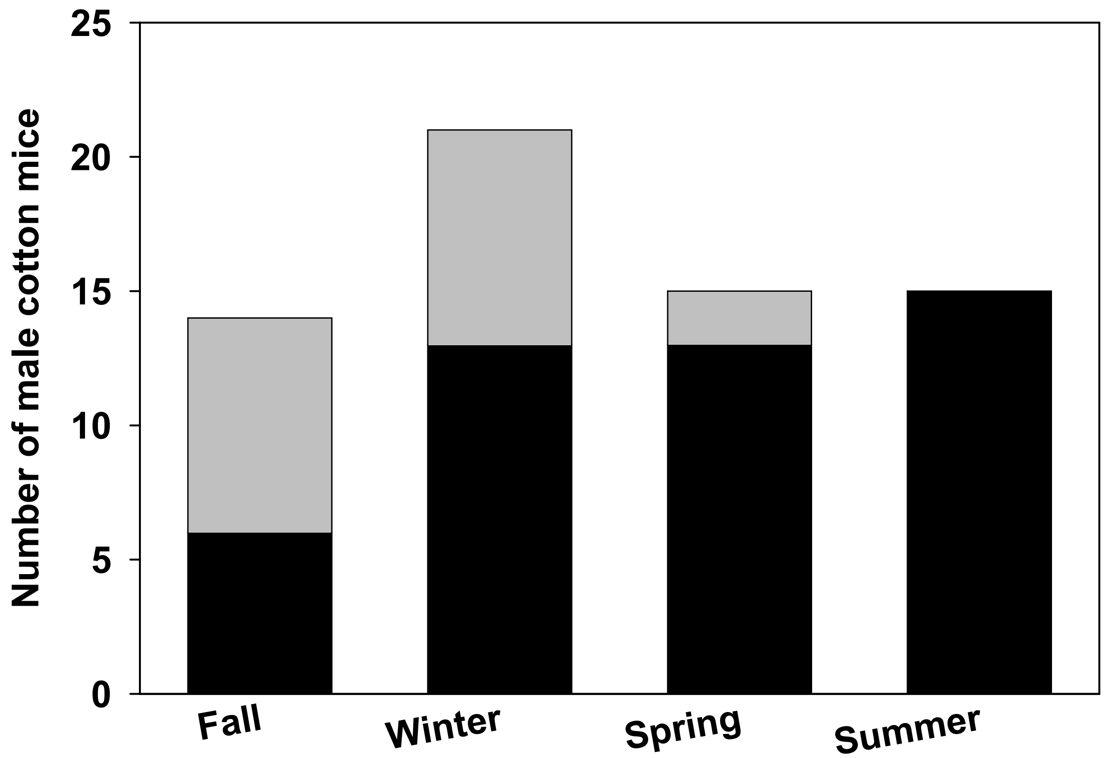


Fig. 17— Number of male *P. gossypinus* with ( ) descended and ( ) non-descended testes in 18 land management compartments at CCAFS, Florida during 2004-2005. Reproductive activity was significantly different with all males in a no-reproductive condition during summer (G = 17. 886, *d. f.* = 3, P < 0.05).

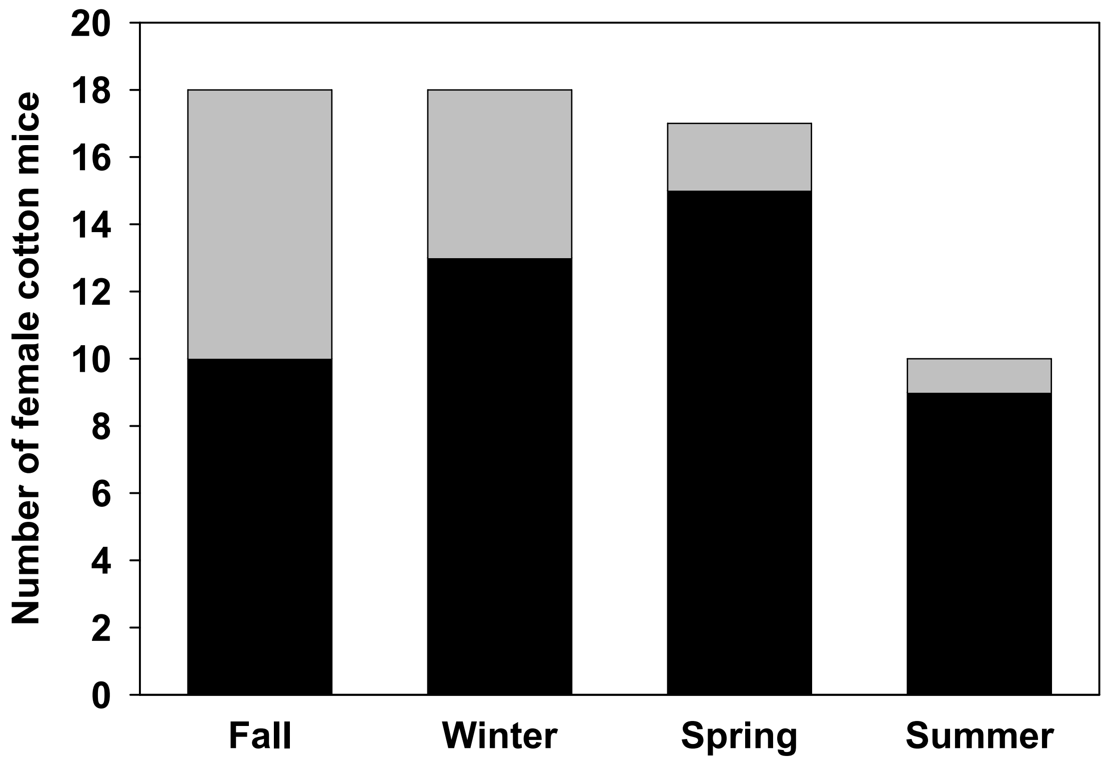


Fig. 18— Number of female *P. gossypinus* with ( ) developed mammaries or hair pulled away from mammaries, and with ( ) no signs of reproductive activity as a function of seasons at CCAFS, Florida during 2004 -2005, reproductive condition was independent (G = 6.578, *d. f.* = 3, P > 0.05).

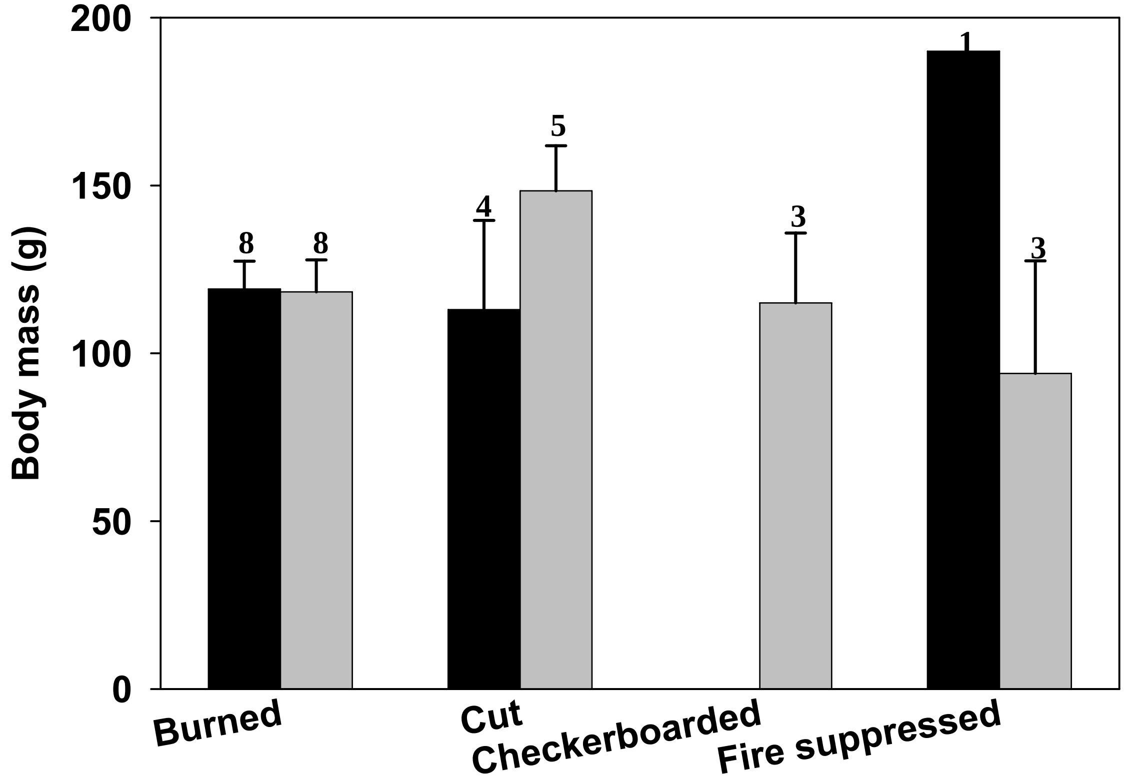


Fig. 19— Mean (± 1 SE) body mass of male (■) and female (□) cotton rats trapped in land management compartments at CCAFS, Florida. No male cotton rats were trapped in checkerboarded compartments. Sample sizes are shown above error bars.

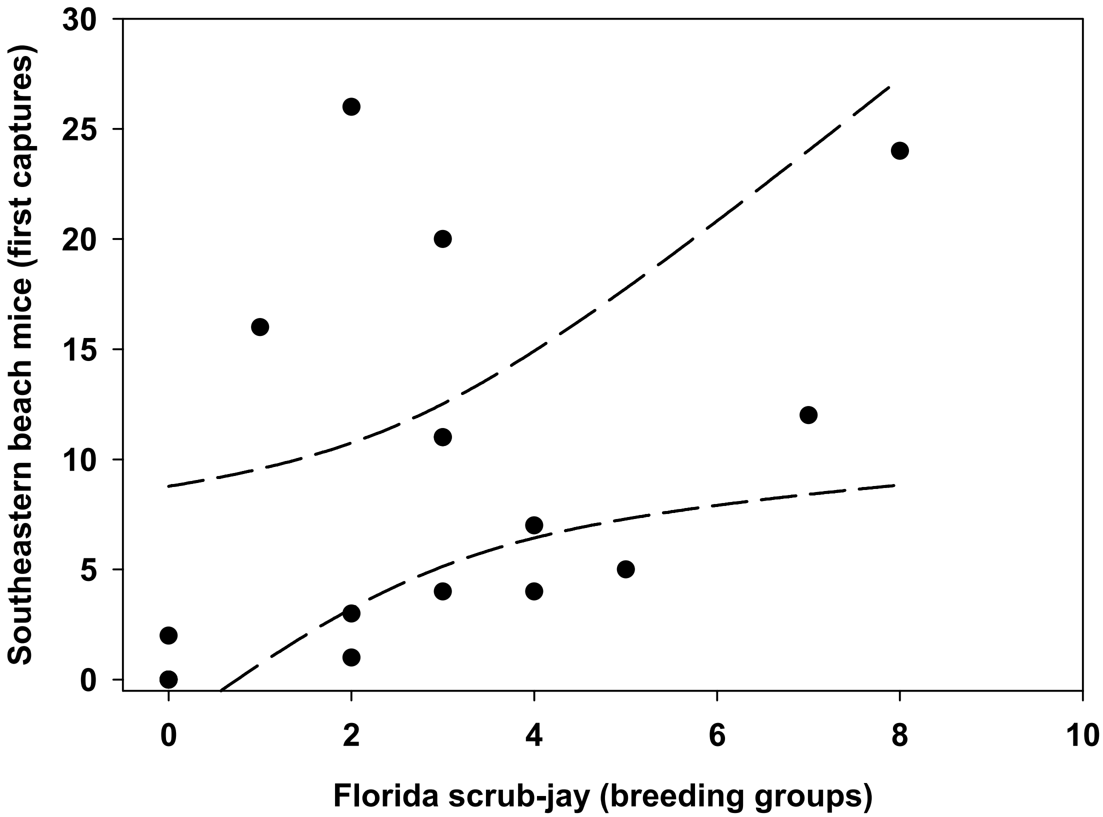


Fig. 20— Pearson correlation and 95 % confidence interval indicating the relationship between Florida scrub-jay breeding groups and first captures of southeastern beach mice in land management compartments at CCAFS, Florida. A two-tailed test found a significant relationship between breeding groups and beach mice, $r = 0.51$, $P < 0.05$. Number of compartments sampled was 18 during 2004 – 2005 field seasons.

Burned

Cut

Checkerboarded

Fire suppressed

Fig. 21— Photos of study sites show differences among land management treatments of Florida scrub at CCAFS, FL

Table 1. Mean body mass (± 1SE) of small rodents captured in land management compartments under different restoration and management techniques at CCAFS, Florida.

Species	Land management treatment							
	Burned	**N**	**Cut**	**N**	**Checker boarded**	**N**	**Fire suppressed**	**N**
Peromyscus polionotus niveiventris	15. 48 ± 0.26	83	15.34 ± 0.60	25	15.08 ± 0.42	34	12.75 ± 0.25	2
Peromyscus gossypinus	22.48 ± 0.75	29	23.44 ± 0.62	62	21.11 ± 1.11	18	23.33 ± 1.43	18
Sigmodon hispidus	118.68 ± 6.09	16	132.66 ± 14.36	9	115.00 ± 20.81	3	118.00 ± 33.73	4

Table 2. Mean body mass (±1 SE) of small rodents captured during each season in land management compartments at CCAFS, FL.

Species	**Seasons**							
	Fall	**N**	**Winter**	**N**	**Spring**	**N**	**Summer**	**N**
Peromyscus polionotus niveiventris	15.93 ± 0.41	33	14.62 ± 0.36	39	15.71 ± 0.40	52	14.67 ± 0.29	20
Peromyscus gossypinus	25.48 ± 0.79	31	23.35 ± 0.88	39	20.93 ± 0.77	32	21.38 ± 0.70	25
Sigmodon hispidus	123.50 ± 19.82	8	109.00 ± 4.00	2	117.33 ± 18.74	3	123.78 ± 7.00	19

Table 3. Abundances of Florida scrub-jay (*Aphelocoma coerulescens*) and southeastern beach mouse (*Peromyscus polionotus niveiventris*) on land management compartments during the 2004-2005 field season at Cape Canaveral Air Force Station, Florida.
[1]Florida scrub-jay data are from Stevens and Knight 2003-2004 annual report.
*Cut but unburned.

[1]Florida scrub-jay groups using compartments							Southeastern beach mouse
Compartment	**Acres (burned)**	**2004 Census**	**Breeding Season**	**Nesting**	**Successful Groups**	**Fledging**	**Number of first captures**
4	230(100)	10	8	8	0	0	24
7	38(0)	4	7	6	1	4	12
***13**	0(0)	0	0	0	0	0	0
37	19(19)	2	3	1	1	2	20
***48**	49(49)	1	3	3	3	11	4
55	0(0)	0	0	0	0	0	2
***67**	20(20)	0	2	0	0	0	3
69	61(55)	2	3	1	0	0	11
70	0(0)	0	0	0	0	0	0
77	0(0)	0	0	0	0	0	0

Table 3. Cont.

Compartment	Acres (burned)	2004 Census	Breeding Season	Nesting	Successful Groups	Fledging	Number of first captures
***79**	120(120)	0	0	0	0	0	0
81	33(30)	3	4	1	0	0	4
87	57(30)	1	2	1	1	3	26
101	30(30)	1	5	2	0	0	5
***102**	12(0)	0	4	0	0	N/A	7
***104**	16(0)	5	3	4	1	4	11
115	31(31)	0	2	0	0	0	1
118	24(18)	0	1	1	0	0	16

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Chapter 5

POPULATION VIABILITY ANALYSIS OF THE SOUTHEASTERN BEACH MOUSE

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Introduction

Population viability analysis (PVA) comprises a set of modeling techniques that utilize life history, demography, and genetics of a species along with environmental variability to project or predict the future course of population growth over many future generations (Beissinger and McCullough 2002). This type of analysis is invoked to answer questions pertaining to the life history of a species and considers those factors known or suspected to influence its population dynamics, e.g., average environmental conditions, environmental stochasticity, genetics and demographic stochasticity (Morris and Doak 20002). PVA attempts to assess the likelihood of future events based on currently available data and theory (Shaffer 1990). In applied applications, it is often used to provide insight into how resource management can change parameters influencing the probability of extinction by evaluating current practices and predicting the outcomes of future efforts such as translocations and building reserves or corridors (Boyce 1992, Morris and Doak 2002). The most appropriate model structure for a PVA depends on the availability and robustness of data and the essential features of the ecology of the organism (Boyce 1992, White 2000). The response of species to the abiotic factors and environmental variability should be understood to the extent possible. Because we lack perfect knowledge of the ecology of any species and the factors which influence the life history, PVA is inherently speculative. Nonetheless, a comprehensive and quantitative analysis of a species' risk of extinction can guide conservation biologists and land managers in making decisions on species management.

Only four attempts – one published paper, one thesis, one dissertation, and a contracted report – have been made to assess the viability and persistence of beach mice (Sankaran 1993, Frank 1996, Oli et al. 2001, and Traylor-Holzer et al. 2005). Sankaran (1993) developed a general purpose computer simulation model for studying the effects of genetic and ecological variables on the temporal and spatial structure of the Perdido Key beach mouse (*P. p. trissyllepsis*). He found that subdivided populations had shorter persistence times than panmictic populations and that the Perdido Key beach mouse is relatively unstable, exhibiting negative population growth rate (Sankaran 1993). Frank (1996) also used a simulation model called RAMAS/metapop to study the Anastasia Island beach mouse (*P. p. phasma*). His analysis suggested that the population would persist for the next 50 years if no further habitat loss occurred (1996). However, he cautioned that environmental catastrophes such as hurricanes or severe storms could raise their probability of extinction. Oli et al. (2001) discovered that Frank's prediction was, in fact, true. Incorporating a catastrophe in their model severely increased the extinction probabilities of all beach mouse populations modeled. However, even with a catastrophe, all populations will not likely persist beyond 50 years, although extinction probabilities varied between populations. They attribute these high extinction probabilities to reduction and degradation of beach mouse habitat (Oli et al. 2001). A population and habitat viability analysis of the Alabama beach mouse (*P. p. ammobates*) was reported by Traylor-Holzer et al. (2005). A risk analysis and population simulation model for the Alabama beach mouse was developed by a consensus process in a workshop populated by experts on the subspecies. VORTEX was the computer model used in the exercise. In spite of years of study and concern for the Alabama beach mouse, a major limitation in producing the model was the lack of data on densities and other features of its life history.

The factors leading to extinction, though varied, can be lumped into two categories: systematic pressures and stochastic perturbations (Schaffer 1981). These processes can also act synchronously to drive populations to extinction. Systematic pressures include those such as habitat fragmentation. Boyce (1992) states that loss and degradation of habitat is the most significant factor threatening species extinctions in the future. Beach mice continue to face loss of habitat on private and public lands as land use patterns shift with changes in public policy and priorities. Stochastic perturbations include demographic stochasticity as caused by variation in survival or fecundity rates; environmental stochasticity from competitors, predators, parasites and disease, natural catastrophes; and genetic stochasticity resulting from changes in gene frequencies due to founder effect, reduced gene flow, or inbreeding depression. Beach mice live in dynamic habitats exposed to recurring tropical storms and populations have a long history of fluctuations associated with these events. Clearly habitat loss coupled with storm events does represent an extinction threat to beach mice.

The objective of this task is to development a population viability analysis for the southeastern beach mouse on Cape Canaveral Air Force Station (CCAFS). This PVA is preliminary and may in the future be modified to incorporate new information as it becomes available.

Methods

1. Trapping

Southeastern beach mice (*Peromyscus polionotus niveiventris*) were trapped using Sherman live traps on 6 permanent grids established at Cape Canaveral Air Force Station from November 2003 to March 2006 (Figure 2 – Chapter 1). Three of the grids were placed in beach habitat while the remaining three were located in inland scrub habitat. Captured animals were ear tagged for individual identification and their mass and sex determined. Individuals were categorized into age classes as juvenile, subadult and adult based on pelage, molt lines, and mass. Reproductive status was recorded at each capture.

2. Survivorship

Survivorship (S) was estimated using program MARK (White and Burnham 1999). Individual capture history was entered into the software with the constraint that data were used from trapping events if all 6 grids were trapped in the same event, i.e., within two consecutive days; therefore, data from 17 out of 57 trapping events were excluded from the analysis. Among the variables tested (age class, gender, habitat, grid, trapping event, season and year) the best "models" to explain survivorship were based on years and seasons. The other variables resulted in poorer survivorship estimate models. Seasons were defined as winter (December, January and February), Spring (March, April and May), Summer (June, July and August) and Fall (September, October and November).

3. Fecundity

We determined the number of pregnant and pregnant/ lactating females (F_P) and the number of juveniles and subadults (Y) for each season over two years from trapping data. Fecundity (I_F) for each season for the two years was calculated by dividing number of juveniles and subadults by the number of pregnant or lactating females (eq. 1)

(1) $I_F = Y/F_P$

4. Population Viability Analysis

We simulated the projected fate of the southeastern beach mice on CCAFS using MatLab 7.1 to calculate the probability of extinction at yearly interval. Simulation consisted of 8 matrices developed using survivorship and fecundity with 2 matrices for each season. Contribution to the next season was determined for both young and adults. However, the contribution by young to young in the next season was set to zero because each season covered 3 months, and *Peromyscus polionotus* reach adulthood in approximately 30 days (Layne 1968). Thus, the probability of a subadult entering the next season as a subadult was zero. The contribution by young and adults to adults in the next season is assumed to be the survival term from one season to the next (S). The contribution of young by adults to the next season is measured by fecundity. However, because the mice can be juvenile or subadult in only one season, the fecundity measure described above (I_F) was adjusted by survival of adults to the next season (eq. 2).

2) $I_A = I_F * S^{2/3}$

The population viability analysis required two prior set population estimates: initial population size, separated into number of adults and young, and an estimate of minimum viable population size. The minimal viable population (MVP) size sets the point within the model at which a population reduced to that level will persist, but any further reduction in numbers will lead to extinction. It has long been recognized that accurate estimates of minimal viable population size are difficult to achieve (Shaffer 1981). Because estimates of MVP do not exist for any subspecies of *P. polionotus*, the initial population size was based on the number of animals captured during 2004 (444 adults and 181 young). Based on population viability analysis done on Anastasia beach mice (*P. p. phasma*), Frank (1996) estimated the carrying capacity for three populations on Anastasia Island, Florida, at 8,000 individuals. Lower range estimates for the area was 3,000 individuals (Frank 1996), but these values do not apply to the concept of MVP. Van Zant (personal communication) estimates the population of *P. p. allophrys* at Grayton Beach State Park has persisted for over 20 years while fluctuating between 50 and 200 individuals. Franklin (1980) suggested a minimal viable effective population size of 500, however this number has been questioned by others and expected to be higher than Franklin's estimations (Lande 1995). The population estimate used for this model is based on less than 9 hectares of area trapped, while Cape Canaveral includes about 3642 hectares of habitat for southeastern beach mice. For the trapped area, a MVP of 500 would underestimate the minimal viable population, as these areas are supported by migration from the surrounding areas not included in the trapping area. For the whole of Cape Canaveral, an effective population size of 500 would most likely be a significant underestimate of the minimal viable population as animals dispersed in the whole landscape would not interact. This is reflected in a study where average minimal viable population across multiple vertebrate taxa was 7316±563 (SE) (Reed et al. 2003). In our model, we chose to set the minimal population size based on the lower number of individual captures the second year of trapping (N=372). We recognized the probability of extinction rates will be overestimated in the analysis.

The model assumed no density dependent growth, and incorporated only the stochastic elements observed from differences in fecundity and survival between the seasons for the two years of data collection. The model was projected 30 years into the future and run 50 times to ensure objective results. To determine the matrix for annual change in population size the matrices for spring, summer, fall and winter were multiplied. For each season the two designated matrices had equal probability of being selected as part of the annual matrix. To estimate a pseudo-extinction probability, each run was replicated 10,000 times, if population estimates reach below the minimal viable population threshold, it was recorded as an extinction event. The frequency of extinctions was used to calculate the probability of extinction for each year.

Results

The lowest estimates of survival (0.66) were for the fall of 2004 and 2005 (Figure 1). The highest survival was for the winter of 2004 (0.82); however, the summers for both years seems to have consistently high survival (0.74 and 0.79 for 2004 and 2005, respectively; Figure. 1). Survival estimates were less variable with lower standard deviation values in 2004 relative to 2005. This may be explained in part by sample size as more animals were trapped in 2004 (625 individuals) than in 2005 (372individuals).

The fecundity estimates varied greatly between years and among seasons (Figure 2). The highest fecundity observed was 1.0 young per female in the winter of 2005. The lowest value was observed in summer 2004 as 0.23 young per female. No clear patterns emerged from the fecundity estimates apart from the fall seasons, which showed the second and third lowest values in the study (0.35 and 0.33 for 2004 and 2005, respectively; Figure 2).

Based on the parameters used in this population viability analysis, the population of southeastern beach mice is projected to increase. Our model predicts that after 30 years, the population will include approximately 10,000 individuals, from an initial population of 625 animals (Figure 3). However, each year the variance of the population estimate increases significantly, indicating that future model outputs produce more and more variable population estimates (Figure 3). It should be noted that based on 2xSD, the model will increasingly estimate population size of negative numbers and increasing extinction events.

The population starts at zero probability of extinction. However, the population viability analysis showed an increased probability in pseudo-extinction for the CCAFS population and reached a stable probability after approximately 15 years. The probability at this point was stabilized at 0.12 chance of extinction. The variance increases over time, but also stabilizes after 15 years into the simulation (Figure 4).

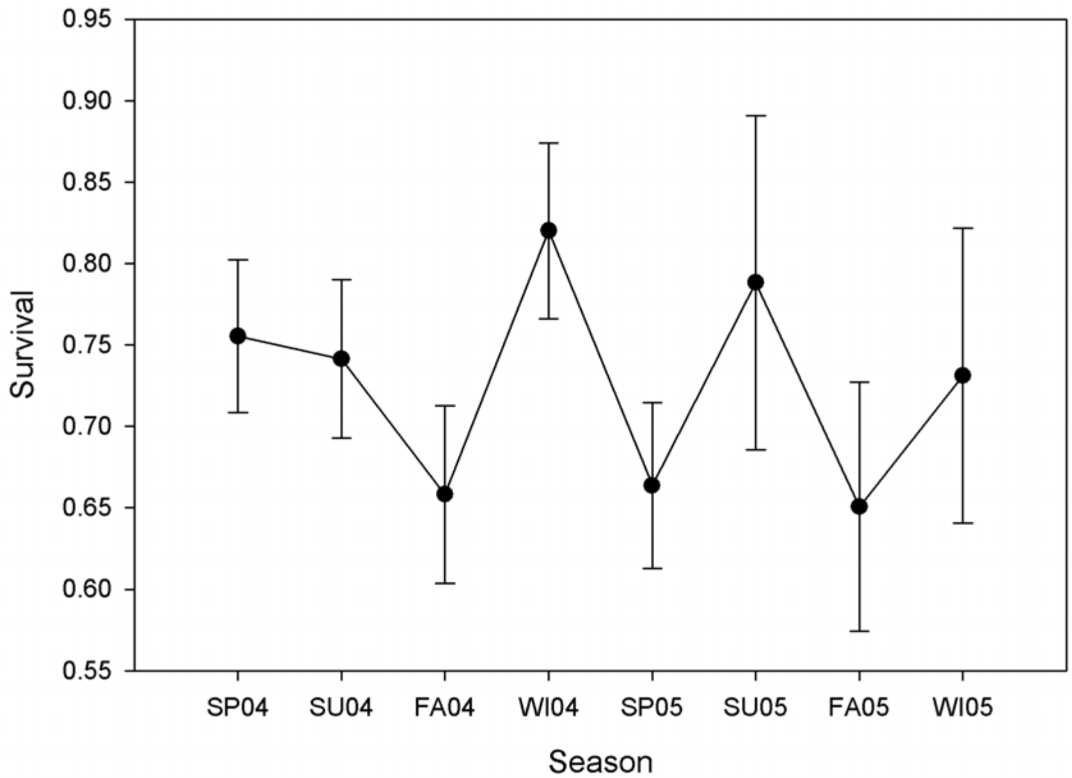

Figure 1. Survival estimates for *Peromyscus polionotus niveiventris* at CCAFS (SP=Sping, SU=Summer, FA=Fall, WI=Winter, 04=2004, 05=2005).

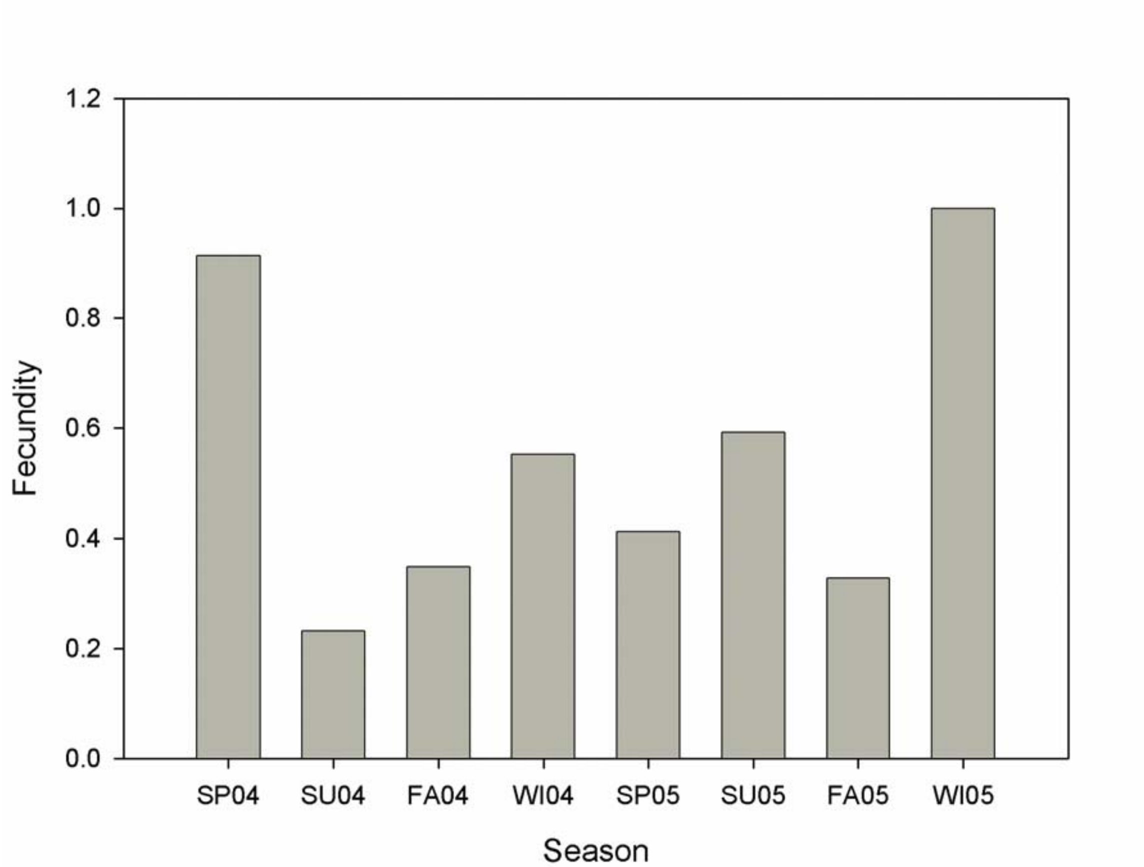

Figure. 2. Fecundity (young/female) estimates for *Peromyscus polionotus niveiventris* from trapping data over 2 years at CCAFS (SP=Spring, SU=Summer, FA=Fall, WI=Winter, 04=2004, 05=2005).

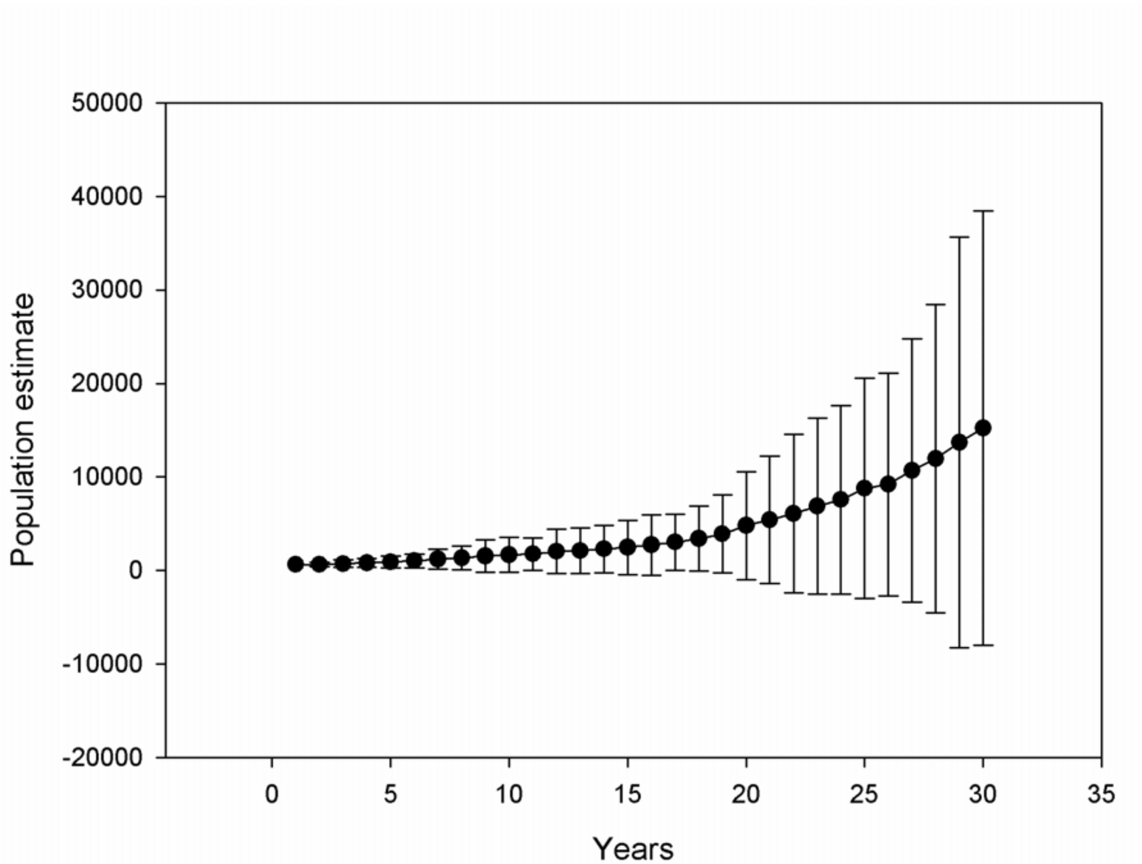

Figure 3. Projected population estimate based on population viability analysis for *Peromyscus polionotus niveiventris* at CCAFS.

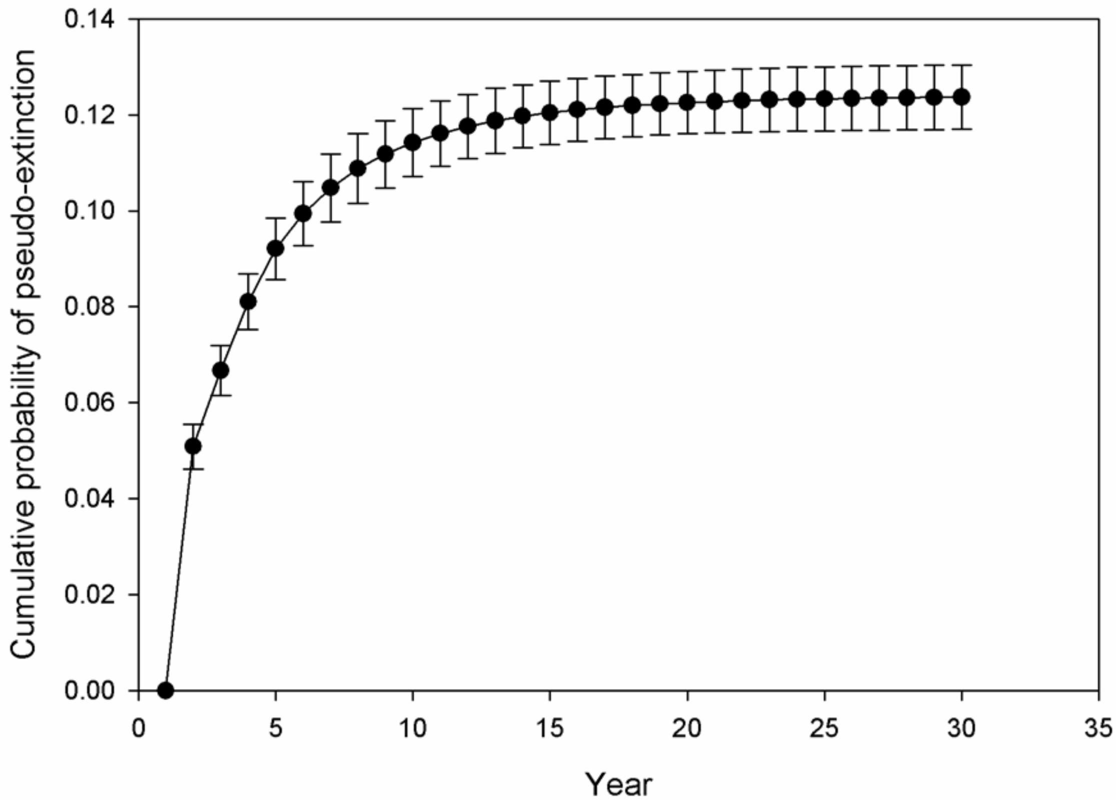

Figure 4. Cumulative probability of pseudo-extinction based on population viability analysis for *Peromyscus polionotus niveiventris* on the Cape Canaveral Air Force Station.

Discussion

Population viability analysis is a modeling approach in which natural processes are reflected using mathematical approaches. As a consequence, a PVA is only as strong or predictive of reality as the data that can be incorporated into the model (Frank 1996). Our survival estimates for *P. p. niveiventris* from program MARK were consistent with those reported for Merritt Island and Cape Canaveral nearly 30 years ago, that is, in the range of 0.70-0.81 (Extine 1980). Extine's estimates were derived from a dynamic life table analysis. Also other subspecies of *P. polionotus* have shown similar levels of survival (Rave and Holler 1992, Swilling 2000). We were not able to find a significant difference in survival between the beach and scrub habitat, however we did find that over a year there was a great deal of variation in survivorship with fall consistently a season of lower survival. This differs from the findings of Extine (1980) who found a lower survival rate in the inland scrub than in the beach habitat. Still the estimates we found are consistent with what is known of *P. p. niveiventris*. Other studies have recognized the lack of measures of fecundity based on field data (Oli et al. 2001; Traylor-Holzer et al. 2005). Approaches used to incorporate this measure have used stochastic models (Oli et al. 2005), and by estimating fecundity from data of other subspecies (Traylor-Holzer et al. 2005). Our field based estimate of fecundity showed the highest ratios of pregnant females were found during fall season, which has been found in other studies of the same population of *P. p. niveiventris* (Oddy 2000). However, fall season was also when we found the lowest ratios of young and pregnant females (Figure 2), indicating that this season shows both low survival of adults as well as low levels of fecundity.

PVA has become a widely used tool in management of endangered species (Reed et al. 2002), and is considered a robust analytical tool, as long as precautions are made and enough is known of the species and population projected (McCarthy et al. 2003). Such an analytical tool can be used in various ways, such as comparing management strategies or effect of management approaches, or assessing the condition of single or multiple populations of a species (Morris and Doak 2002; Reed et al. 2003). Based on PVA analysis and predictions, restocking of Key Largo woodrats (*Neotoma floridana smalli*) has been shown to delay the possible extinction of the remaining population at Key Largo, Florida (McCleery et al. 2005). Other applications of PVA have addressed the conservation status and future of several smaller populations for *P. p. ammobates* and *P. p. trissyllepsis* (Oli et al. 2001), whereas our study addressed the condition of the large CCAFS population of *P. p. niveiventris*.

Based on a large number of simulations, the general trends from our PVA suggest the population of *P. p. niveiventris* at CCAFS is currently persisting with a very low probability of extinction in the near future (Figure 4). The probability of extinction in our results has to be considered an overestimate where the minimal population size entered into the model was the minimal population size observed. This population would most likely persist at lower numbers, giving a probability of extinction after 30 years lower than 0.12. These values are comparable to extinction probabilities for well established populations of other subspecies of *P. polionotus* in a 30-50 year time-frame (Oli et al. 2001; Traylor-Holzer et al. 2005).

Small, isolated populations of *P. polionotus* found in circumstances where management measures have not been applied are reported to have extinction probabilities close to 1.0 (Oli et al. 2001; Traylor-Holzer et al. 2005). These populations are, however, recognized for observed reductions in population size and relatively isolated populations, giving them intuitively a poor prognosis for future persistence (Oli et al. 2001). In contrast, the population of *P. p. niveiventris* located on CCAFS exist within an areas restricted to the public. This may protect the population from over development, feral cats, fragmentation and other detrimental effects to these small rodents. In addition to the large amount of protected habitat, the extensive area of oak/palmetto scrub habitat appears to secure this population from hurricanes (Swilling et al. 1998). Based on the prognosis of our preliminary PVA, this population will most likely persist in the future, and could serve as a possible source for establishing satellite population in the historical range of *P. p. niveiventris*.

Even with high likelihood for persistence of *P. p. niveiventris* at CCAFS, there is no reason to assume the future of this subspecies to be secured. Even with robust parameter estimates, not all variables can be captured in a model. The model used for this study did not take into consideration genetic factors such as inbreeding, which has been shown to greatly affect populations of *P. polionotus* and related species (Lacy 1997, Lacy et al. 1997). Most likely *P. p. niveiventris* at CCAFS are well protected against severe hurricanes, however potential consequences of such catastrophes were not included in our model. In the case of *P. p. phasma,* multiple-year but less severe hurricanes were found to put the subspecies at risk of extinction (Frank 1996). Our PVA does not include a direct measure of the potential threat represented by natural catastrophes such as hurricanes. Another weakness of the model is the implicit assumption that the current connectivity and maintenance of habitat on the federal lands will continue into the foreseeable future. With increased utilization of the habitat, increased building and use of roads, and reduced fire maintenance, the available habitat may no longer be favorable for long term persistence. Continued protection and management of the habitat will be necessary to insure the survival of the population of *P. p. niveiventris* on Cape Canaveral Air Force Station.

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