National Park Service

National Park Service
U.S. Department of the Interior

Appendices
J-L

EVERGLADES NATIONAL PARK

2015 FIRE MANAGEMENT PLAN

List of Appendices

Appendix J
U.S. FWS Biological Opinion (BO)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
South Florida Ecological Services Office
1339 20th Street
Vero Beach, Florida 32960

June 30, 2015

Memorandum

To: Pedro Ramos, Superintendent, Everglades and Dry Tortugas National Parks

From: Donald (Bob) Progulske, Everglades Program Supervisor, South Florida Ecological Services Office

Subject: Everglades National Park Fire Management Plan; Service CPA Code: 04EF2000-2013-CPA-0083; Service Consultation Code: 04EF2000-2013-F-0294

Dear Mr. Ramos:

Enclosed is the U.S. Fish and Wildlife Service's (Service) Biological Opinion to the Everglades and Dry Tortugas National Parks of the potential effects of implementation of the Preferred Alternative for the Everglades National Park (ENP) Fire Management Plan (FMP) Environmental Assessment (EA). The ENP FMP is a programmatic document that is intended to guide fire management within ENP for the next 10 to 20 years. It includes implementation of a multi-year fuels treatment which would allow prescribed fire treatments to be planned as part of a revolving 5-year scope of work that would be reviewed and updated annually. The process would include the prioritization, selection, review, and update of fuels treatment projects. The prioritization values would include fire return interval departure, fuel loading, proximity to threatened and endangered species populations, proximity to the wildland urban interface and other park boundary values, and exotic plant species infestations.

Prescribed fires would take place in federally designated wilderness and non-wilderness areas throughout ENP. Depending on environmental conditions, the actual number of acres burned would likely be somewhat less than the number proposed, but the preferred alternative is expected to result in a substantial increase in the amount of acres burned when compared to current management. In addition, prescribed burns will be carried out in fire dependent communities where burning is currently restricted. Wildfire management remains essentially unchanged from current management practices. The FMP EA includes detailed analysis of the impacts of fire management on threatened and endangered species and critical habitat, and serves as the biological assessment for the FMP.

ENP has determined implementing the FMP "may affect, but is not likely to adversely affect" the Stock Island tree snail (*Orthalicus reses*), American crocodile (*Crocodylus acutus*) or its critical habitat, West Indian manatee (*Trichechus manatus*), wood stork (*Mycteria americana*), Everglade snail kite (*Rostrhamus sociabilis plumbeus*) critical habitat, Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*) critical habitat, Bartram's hairstreak (*Strymon acis bartrami*) critical habitat and Florida leafwing (*Anaea troglodyta floridalis*) critical habitat.

In addition, implementation of the FMP "may affect, and is likely to adversely affect" Blodgett's silverbush (*Argythamnia blodgettii* - currently a candidate species), pineland sandmat (*Chamaesyce deltoidea ssp. pinetorum*), Garber's spurge (*Chamaesyce garberi*), Florida pineland crabgrass (*Digitaria pauciflora* - currently a candidate species), Everglades bully (*Sideroxylon reclinatum ssp. austrofloridense* - currently a candidate species), Florida leafwing, Bartram's hairstreak, eastern indigo snake (*Drymarchon corais couperi*), Florida panther (*Puma concolor coryi*), Florida bonneted bat (*Eumops floridanus*), Cape Sable seaside sparrow, and Everglade snail kite.

The Service concurs with all the "No Effect" and "may affect, but is not likely to adversely affect" determinations made by ENP in regard to the applicable threatened or endangered species that are found in the action area and that the proposed plan is not likely to adversely modify critical habitat, where designated for the above species. Therefore, the enclosed Biological Opinion will only analyze effects on species listed above that ENP has made the determination of "may affect, and is likely to adversely affect." Based on the analysis in this Biological Opinion, the Service's conclusion is that implementation of the Preferred Alternative for the ENP FMP for the next 10 years as of the date of this Biological Opinion, is not likely to jeopardize the continued existence of the species listed above and is not likely to adversely modify critical habitat, where designated.

The Service understands the first priority in every fire management activity will be to ensure firefighter and public safety. The Fire Management Plan, including all species protective measures, shall be adhered to for all planned fire management actions including prescribed fire planning, preparation and implementation and monitoring activities. Unplanned wildfire response may also be conducted under the FMP except in those cases when there is a conflict with the stated priorities of protecting life, human welfare, and property. In the event actions are necessary to protect life and property, the Incident Commander and Duty Officer may determine emergency response is required and there is no practical means to adhere to the FMP to protect life and property during wildfire response. In these instances emergency consultation procedures with the Service shall be initiated as soon as practicable. During wildfire response, ENP fire management would conduct an initial fire size up, safety assessment and risk assessment. Environmental and fire behavior parameters, and fire decision support tools would be used to predict fire threats to listed species and potential conflicts with protective measures. If it is determined potential actions required to protect human life or property may be in conflict with protective measures for listed species, emergency consultation with the Service shall be initiated as soon as practicable. The terms and conditions should then be considered recommendations to minimize the effects of emergency response actions on listed species and their critical habitat until the Service is able to provide additional recommendations specific to the emergency response action and emergency consultation can be completed.

The enclosed Biological Opinion is in accordance with section 7 of the Endangered Species Act of 1973, as amended in 1998 (Act) (87 Stat. 884; 16 U.S.C. 1531 *et seq.*). The project site is located in Monroe and Miami-Dade Counties in South Florida. This Biological Opinion is based on information provided in ENP's October 2014 EA of the FMP, maps, meetings, field investigations, telephone conversations, email correspondence, and other sources of information. A complete administrative record of this consultation is on file at the Service's South Florida Ecological Services Office (SFESO), Vero Beach, Florida.

Thank you for your cooperation in the effort to protect fish and wildlife resources. If you have any questions regarding this project, please contact Bob Progulske at 772-469-4299 or Richard Fike at 772-469-4262 or by email at richard_fike@fws.gov.

Enclosure

cc: electronic only (w/enclosure)

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BIOLOGICAL OPINION
FOR THE
EVERGLADES NATIONAL PARK ENVIRONMENTAL ASSESSMENT – FIRE MANAGEMENT PLAN, OCTOBER 2014
ON EFFECTS TO THREATENED OR ENDANGERED SPECIES AND CRITICAL HABITAT

Service Consultation Code: 04EF2000-2013-F-0294

Submitted to:

Everglades National Park
National Park Service
Homestead Florida

Prepared by:

U.S. Fish and Wildlife Service
South Florida Ecological Services Office
Vero Beach, Florida

June 30, 2015

Donald R. (Bob) Progulske
Everglades Program Supervisor
South Florida Ecological Services Office

I

Table of Contents

Consultation History

On April 19, 2013, the National Park Service, Everglades and Dry Tortugas National Parks (ENP) by letter requested initiation of informal consultation with the U.S. Fish and Wildlife Service (Service) on the Everglades National Park (ENP) Fire Management Plan (FMP). Enclosed with the letter were copies of the Draft Fire Management Plan, Chapters 1 and 2 of the draft FMP Environmental Assessment (EA) and a Special Status Species section of Chapter 3 for the Service's review and comment. Together, ENP stated that these documents comprised their biological assessment, and believed they included all information needed to initiate consultation. Due to the potential for direct and indirect impacts from fire to individuals of several species, ENP considered "may affect, likely to adversely affect" determinations to be appropriate for several listed species. As such, ENP recognized that formal consultation would likely be required for this plan. However, due to the large scope of this plan and the number of species to consider, ENP requested to work with the Service through informal consultation to refine the information and determinations prior to finalizing the FMP, EA, and requesting formal consultation.

On July 11, 2013, the Service transmitted by email, a document containing the Service's initial comments on the draft ENP FMP and the sections of the draft FMP EA provided.

On February 27, 2014, ENP transmitted by email, a document that contained their responses to the Service comments and questions regarding the draft ENP FMP, and associated EA to further work toward completing consultation. ENP recognized that some sections, including the Cape Sable seaside sparrow coordination section, would likely require additional coordination to complete.

On October 27, 2014 ENP, by letter, requested initiation of formal Section 7 consultation on the ENP FMP and notified the Service on the availability of the Final EA. With the release of the final EA, ENP officially requested that formal section 7 consultation on the new FMP be completed, with the anticipated effects as described in the EA under the preferred alternative. The preferred alternative incorporated the conservation measures (mitigation) that were developed through discussions with Service staff. In addition to the consultation, ENP requested any additional comments that the Service wished to submit on the final EA.

On November 24, 2014, during the public comment period, the Service submitted comments on the final EA online at ENP's "Planning, Environment, and Public Comment" website at http://parkplanning.ENP.gov/EVER.

On February 18, 2015, ENP transmitted by email a document that contained their responses to the comments/questions the Service provided during the public comment period. They provided this response principally to aid in the consultation process for the FMP.

DESCRIPTION OF PROPOSED ACTION

Everglades National Park is proposing to update the existing fire management plan (FMP). The last FMP was approved in 1991 with an update in 1995. An updated fire management plan is needed to provide guidance for fire management actions including wildfire operations, prescribed fire and monitoring activities. Everglades National Park's proposed Fire Management

Plan is a programmatic planning and operational document intended to provide guidance and direction to meet Park goals and objectives. The updated FMP includes implementation of a multi-year fuels treatment which would allow prescribed fire treatments to be planned as part of a revolving 5-year scope of work that will be reviewed and updated annually. The process will include the prioritization, selection, review, and update of fuels treatment projects. The prioritization values will include fire return interval departure, fuel loading, proximity to threatened and endangered species populations, proximity to the wildland urban interface and other park boundary values, and exotic plant species infestations.

Everglades National Park is located in south Florida, spanning the southern tip of the Florida Peninsula and Florida Bay. The 1,509,000 acre park extends into portions of three counties: Miami-Dade, Monroe, and Collier and borders several major cities including Miami, Florida (Figure 1). Fire has the potential to impact most of the terrestrial resources within the park. Management of fire within the 659,580 terrestrial acres of ENP is the focus of the fire management plan.

The Everglades National Park Multi-Year Fuels Treatment Plan outlines a projected scope of work for the Park's fire management program. The purpose of the multi-year fuels treatment plan is to provide a projected work plan that will assist managers in planning and implementing treatments designed to reduce the risk and impacts of unwanted fire through planned ignition treatments, while restoring and maintaining fire adapted ecosystems in ENP. The multi-year fuels treatment plan outlines a projected set of prescribed burn projects for a 5-year window. Each year, one additional year of proposed projects will be added to the plan. Projects and associated acres within the multi-year fuels plan may change for various reasons including, but not limited to, unplanned fires, unfavorable weather conditions and resource management needs. ENP is divided into four Fire Management Units within the proposed FMP (Figure 2). Prescribed fire will be implemented in the manner described in the FMP EA and geographic boundaries of the burn units will generally not change, however units may be divided into smaller sub-units or partially combined with adjacent units. The multi-year fuels treatment plan proposes to burn up to 255,800 acres annually over a 5-year period within the four fire adapted terrestrial vegetation communities (sawgrass prairie, marl prairie, pine rockland, and coastal prairie marsh) across the four FMUs (Table 1).

FMUs are further divided into project units for prescribed fire treatments. Project units are specific to and within one of the four FMUs. Larger project units are considered "partial units" where only a portion of the unit is proposed for treatment at the time of burning. Projects units will be burned on the prescribed fire planning fire return interval (FRI) which is based on the fire return interval range for the community type (Table 4). Fire management and prescribed fire objectives are specific to each FMU and can be found in Table 2. Table 3 identifies management considerations when planning and implementing fire management and prescribed fire operations in the FMUs.

Vegetation types can be divided into three broad fuels categories: Grasses, shrubs, and timber. The dominant fuel type is grass which encompasses approximately 80 percent of the landscape and the remaining 20 percent consists of timber and shrub fuel types which include the pine rocklands. The standard fire behavior fuel model guide (Scott and Burgan 2005) classifies wildland fuels into fuel model categories and describes the expected fire behavior associated with the specific fuel model. Fire behavior fuel models GR 5, GR 6, GR 8, and GR 9 represent fire behavior associated with grass fuels in the Park. These fuel models demonstrate high to very high rates of spread and high flame lengths, under the influence of wind. Fire behavior fuel models TL 2, TU 3, and SH 6 demonstrate low to high rates of spread, accompanied with low to high flame lengths (Table 5).

Fire breaks are used to prevent spread of fire into non-treatment areas and protect values at risk. Weed eaters and mowers may be used during prescribed fire and unplanned ignition response operations to create temporary fire containment lines to hold fire within designated perimeters and protect values at risk. Natural and/or existing fire breaks will be used whenever possible. Fire breaks, if constructed will be limited in width and debris from construction of firebreaks will be scattered to avoid impacting sensitive species.

Everglades National Park conducts fire effects monitoring in the four fire adapted vegetation communities: sawgrass prairies; marl prairies; coastal prairie marsh; and pine rocklands. Fire effects monitoring is vegetation based, conducted to determine if prescribed fire objectives are being met and if undesired effects are occurring. Additional monitoring currently occurs to determine the effect of fire and fire treatments on exotic vegetation and butterfly host plant *Croton linearis*. Surveys and monitoring of listed species and their habitats are planned to primarily be conducted at the population level to assess overall population and trends. ENP will generally assume that species are present, and that there is potential for impacts, prior to conducting prescribed burns in lieu of specifically surveying burn units prior to ignition.

Fire Management Unit Descriptions

Fire Management Unit 1

Fire Management Unit 1 (FMU 1) is primarily the coastal portion of the park. Fire adapted acreage is estimated at 99,371 acres, out of approximately 106,964 terrestrial acres within the unit. The multi-year fuels treatment plan proposes to treat up to 11,672 acres of fire adapted vegetation within this unit annually (Table 5). The coastal prairie vegetation community is the primary fire adapted community within this FMU. In most of FMU 1, mangroves surround coastal prairies creating islands of discrete pockets of fire-dependent vegetation. FMU 1 is comprised of GR 5, GR 6, GR 8, and GR 9 fire behavior fuel models. Within FMU 1, natural processes shall be allowed to function wherever and whenever possible.

The desired fire return interval for the coastal prairie community is 2 to 10 years with a 2-year return interval for planned exotic plant treatments and a 6-year return interval assigned for all other areas.

Fire Management Unit 2

Fire Management Unit 2 (FMU 2) is the largest FMU in the park. Fire adapted acreage is estimated at 321,641 acres, out of 390,521 terrestrial acres. The multi-year fuels treatment plan proposes to treat up to 79,461 acres of fire adapted vegetation within this unit annually (Table 5). The fire adapted vegetation communities of FMU 2 consist of sawgrass *(Cladium jamaicense)* prairies and marl prairies. Associated habitats include tree islands, freshwater sloughs and emergent plant communities. FMU 2 also contains cypress and small scattered pine islands.

FMU 2 is comprised of GR 5, GR 6, GR 8, and GR 9 grass fire behavior fuel models and TL 2 (tropical hardwood hammocks) fuel model. Exotic vegetation present in the area includes Brazilian pepper (*Schinus terebinthifolius*), melaleuca (*Melaleuca quinquenervia*), and Australian pine (*Casuarina equisetifolia*).

Wet and dry hydrological patterns affect fire spread, fuel continuity and availability in FMU 2. As water levels rise, the continuity and availability of flammable fuels decrease. Thus, hydrology of this unit has a significant effect on the size, intensity and duration of fires in the Everglades. Under extremely dry conditions fires will burn across areas that would normally act as natural fuel breaks under wetter conditions. Within FMU 2, natural processes shall be allowed to function wherever and whenever possible.

The desired fire return interval for the sawgrass prairies and marl prairies is 3-12 years. A 3-year fire return interval would be maintained for areas within the wildland urban interface, and an 8-year fire return interval maintained for the remaining fire-adapted vegetation communities within FMU 2.

Fire Management Unit 3

Fire Management Unit 3 (FMU 3) includes the Park's two major pine rocklands: Long Pine Key and Pine Island. Fire adapted acreage is 44,956 acres, out of 55,131 acres. The multi-year fuels treatment plan proposes to treat fire adapted vegetation within this unit including up to 7,759 acres of pine rockland, 17,319 acres of prairie, and 3,796 acres of Hole-in-the-Donut annually (Table 5). This unit is a complex of pine rocklands, seasonally flooded prairies and tropical hardwood hammocks on the southern end of the Miami Rock Ridge. FMU 3 is comprised of GR 5 and GR 6 grass fire behavior fuel models, TU 3 and SH 6 (pine overstory, herbaceous layer, shrubs) and TL 2 (tropical hardwood hammocks).

The majority of the unit is bounded by roads, including the Main Park Road and the Old Ingraham Highway. Fire roads, consisting of a combination of original logging roads and fire lanes constructed by the park in 1956, divide the pine rocklands into distinct units known as Blocks. The Long Pine Key portion of FMU 3 includes former farmland known as Hole-in-the-Donut (HID) which is currently undergoing restoration. Prior to agricultural conversion, the HID was an extension of the pineland and prairie ecosystem. Within this FMU, natural processes shall be allowed to function wherever and whenever possible.

FMU 3 would be maintained on a three year fire return interval except as further detailed for protection of threatened and endangered species. Tropical hardwood hammocks contained within this FMU will burn only under extreme conditions.

Fire Management Unit 4

Fire Management Unit 4 (FMU 4) encompasses the East Everglades Expansion Area authorized for addition to the park in 1989. Fire adapted acreage is approximately 99,371 acres, out of 106,964 acres. The multi-year fuels treatment plan proposes to treat up to 40,421 acres of fire adapted vegetation within this unit annually (Table 5). In FMU 4 there are large continuous areas of flammable vegetation with a mix of long and short hydroperiod prairies that create conditions for fire spread. Historic and current airboat use in this area has created a large number of trails that act as fire breaks under wet conditions. Wet and dry hydrological patterns affect fire spread, fuel continuity and availability. As water levels rise the connectivity and availability of flammable fuels decrease. This dynamic has a significant effect on the size, intensity and duration of fires in the Everglades. Under extremely dry conditions, fires will burn across areas that would be natural fuel breaks under wetter conditions. Within this FMU, natural processes shall be allowed to function wherever and whenever possible.

FMU 4 would be maintained on a 3-year fire return interval except as further detailed for protection of threatened and endangered species. Tropical hardwood hammocks contained within this FMU will burn only under extreme conditions.

Action area

The action area is defined as all areas to be affected directly or indirectly by the proposed action, and not merely the immediate project area involved in the action. Fire has the potential to impact the fire adapted and fire sensitive vegetation within ENP and the proposed fire management plan addresses related fire management actions. Therefore the action area for the proposed action is the 659,580 terrestrial acres (565,339 fire adapted acres) of ENP.

STATUS OF THE SPECIES AND CRITICAL HABITAT RANGEWIDE

This section presents the biological and ecological information relevant to formulating the biological opinion. Information on species that ENP determined the proposed action may affect and is likely to adversely affect is included. Other federally listed species occur in the project area.

Plants

Blodgett's silverbush (*Argythamnia blodgettii*)

Blodgett's silverbush first became a candidate on October 25, 1999. The following discussion is summarized from the most recent species assessment (Service 2013c) and from recent research publications and monitoring reports.

Species/critical habitat description

"*A. blodgettii* is an erect, suffrutescent perennial, 1-6 decimeters (dm) tall, the stems and leaves covered with bifurcate hairs; leaves entire, oval to elliptic, sometimes slightly spatulate, 1.5-4 cm long, often colored a distinctive metallic bluish green, distinctly 3-nerved; staminate calyx 7-8 mm wide; sepals are lanceolate; petals broadly elliptic, shorter than sepals; pistillate sepals lanceolate to linear lanceolate, 5-6 mm long; capsule 4-5 mm wide (adapted from Small 1933)" (Bradley and Gann 1999). Reproduction is sexual, flowering and fruiting apparently takes place throughout the year (Bradley and Gann 1999).

Life history

On the mainland, Blodgett's silverbush grows in pine rockland and edges of rockland hammock (Bradley and Gann 1999). In the Keys, the species grows in pine rockland, rockland hammock, coastal berm and on roadsides, especially in sunny gaps or edges (Bradley and Gann 1999).

Bradley and Gann (1999) stated "*A. blodgettii* is primarily a plant of open, sunny areas in pine rockland, edges of rockland hammock, edges of coastal berms and sometimes disturbed areas in proximity to a natural area. Plants can be found growing from crevices on oolitic or Key Largo limestone or on sand. The pine rockland habitat where it occurs in Miami-Dade County and the Florida Keys requires periodic fire to maintain an open understory with a minimum amount of hardwoods." Bradley and Gann (1999) indicate this species tolerates some degree of human induced disturbance. It can often be found along disturbed edges of pine rockland, rockland hammock, and coastal berm or in completely scarified pine rockland (Bradley and Gann 1999).

Population dynamics

In the Keys, Blodgett's silverbush was known to be extant on nine islands, with three others of uncertain status (Hodges and Bradley 2006). The largest population surveyed was on Big Munson Island and was estimated to be 8,000 to 9,000 plants. The population size in the Keys was estimated to be approximately 11,000 plants (Hodges and Bradley 2006). According to data from the Institute for Regional Conservation (IRC), the estimated population of Blodgett's silverbush in Miami-Dade County was 375-13,650 (*ie.,* total of low and high estimates from log10 scale) (K. Bradley, pers. comm. 2007); however, this may be an overestimate of the actual population size because it was based on a log10 scale. It is currently known from about 20 conservation areas (Gann et al. 2014). In ENP, the current estimated population size is 1,000 to 2,000 plants (J. Sadle, pers. comm. 2015).

Status and Distribution

Historical Range/Distribution: "*A. blodgettii* historically occurred from central and southern Miami-Dade County from Brickell Hammock (latitude ca 25° 45.9') to southwestern Long Pine Key (latitude 25° 24.2'), and throughout the Florida Keys (Monroe County and Miami-Dade County) from Totten Key (latitude 25° 22.95') south to Key West (latitude 24° 32.52') (Bradley and Gann 1999). Based upon Hodges and Bradley (2006) and data from IRC (Keith Bradley IRC pers. comm. 2007), Blodgett's silverbush has been extirpated (no longer in existence) from the sites in Table 6.

Current Range/Distribution: "*A. blodgettii* is currently known from central Miami-Dade County from Coral Gables (latitude 25° 43.45') to southwestern Long Pine Key in ENP (latitude 25° 24.2'), and the Florida Keys from Windley Key (latitude 24° 57.08') southwest to Big Pine Key (latitude 24° 38.52')" (Bradley and Gann 1999). Although we do not know the total extent of the former range, approximately 12 miles (19 km) of habitat have been lost at the northern end of the range in Miami-Dade County and 43 miles (69 km) have been lost in Monroe County (Bradley and Gann 1999). More recently, Hodges and Bradley (2006) indicated that the species' verified range extends from Miami-Dade County to Boca Chica Key.

Based upon Bradley and Gann (1999), Hodges and Bradley (2006), data from IRC (K. Bradley pers comm. 2007), and data from ENP (Sadle pers. comm. 2015), Blodgett's silverbush is extant at the sites in Table 7. However, the species may be extirpated from the Charles Deering Estate, the Epmore Drive Pineland fragment, the Old Dixie Pineland, and SW 184th Street and 83 Avenue (Keith Bradley, pers. comm. 2007). Indefinite occurrences in Miami-Dade County are between

Coconut Grove and Cutler, and between Cutler and Longview Camp (K. Bradley pers. comm. 2007). The recent finding of one new occurrence in ENP (J. Sadle pers. comm. 2015) indicates that the range within the park is larger than historic records indicate.

Pineland sandmat (*Chamaesyce deltoidea* ssp. *pinetorum*)

Pineland sandmat first became a candidate on October 25, 1999. The following discussion is summarized from the most recent candidate assessment (Service 2013a) and from recent publications and monitoring reports.

Species/critical habitat description

Pineland sandmat is an ascending to erect perennial herb forming small tufts; stems are reddish; leaf blades reniform or deltoid to orbicular or ovate involucres 1 mm long, pubescent; glands green; gland appendages very narrow, even-edged; capsules 2 mm broad, pubescent; seed 1 mm long, transversely wrinkled, yellowish (Small 1933; Bradley and Gann 1999).

Although little is known about this taxon's reproductive biology and ecology, reproduction is sexual (Bradley and Gann 1999). The extensive root system of the pineland sandmat indicates that it is a long-lived plant (Wendelberger 2003). Pollinators are unknown; some congeneric species are completely reliant on insects for pollination and seed production while others are self-pollinating (Weldelberger 2003). Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979). Dispersal is unknown for pineland sandmat; however, many seed capsules of Euphorbiaceae are explosively dehiscent (Wendelberger 2003). This species is known to fruit year round (Wendelberger and Maschinski 2006).

No critical habitat has been designated for pineland sandmat.

Life history

Bradley and Gann (1999) provide the following description, "This species occurs in pine rockland pockets of clayey marl or on oolitic limestone. The soils on which it occurs outside of ENP are classified as Opalocka rock-outcrop soils (soils within the National Park have not been classified (US Department of Agriculture [USDA] 1996)). The pine rocklands where this plant occurs are at the southern end of the Miami rock ridge and are at lower elevations than most pine rockland areas to the north. This is especially true for the pine rocklands on Long Pine Key, which flood occasionally. Fire is an important element in maintaining the pine rockland habitat. Periodic fires eliminate the shrub subcanopy and remove litter from the ground." Pineland sandmat is shade intolerant and requires periodic burning to reduce competition from woody vegetation. Without fire, native hammock species and exotics invade pine rocklands changing their structure and function (Wendelberger 2003).

Pineland sandmat occurs in pine rocklands characterized by a canopy of southern slash pine, and a shrub canopy of saw palmetto *(Serenoa repens)*, wax myrtle *(Myrica cerifera)*, poisonwood (*Metopium toxiferum)*, and willow bustic *(Sideroxylon salicifolium)*, (Bradley and Gann 1999). Common herbaceous associates include: crimson bluestem *(Schizachyrium sanguineum)*, wire bluestem *(Schizachyrium gracile)*, scaleleaf aster *Symphyotrichum adnatum)*, and bastard

7

copperleaf *(Acalypha chamaedrifolia)*, (Bradley and Gann 1999). Pineland sandmat is often associated with other rare plant taxa including Blodgett's silverbush and Florida brickell-bush *(Brickellia mosieri)*, (Bradley and Gann 1999).

Population dynamics

The population size at ENP is roughly 10,000 plants (Gann 2015). Occurrences on other private lands are smaller. In assessing the overall status and trend, Bradley and Gann (1999) indicated that the population of the pineland sandmat is probably declining due to the various threats to this species. However, since that time, five additional occurrences have been found.

Status and distribution

Historical Range/Distribution: Pineland sandmat was known only from the southern portion of the Miami Rock Ridge in southern Miami-Dade County, Florida (Small 1933, Long and Lakela 1971, Wunderlin 1998) and extended south through Long Pine Key in ENP (Bradley and Gann 1999). The area outside of ENP represented nearly half of the range of this taxon (Bradley and Gann 1999).

One purported locality may have been reported inaccurately. A specimen collected by Burch (No. 232 New York Botanical Garden) in 1963 at the intersection of SW 187 Avenue and 248th Street had a label describing the station as 'Princeton' (Bradley and Gann 1999). However, this intersection is more than 5 miles (8 km) west of the area known as Princeton and 3 miles (5 km) north of the northernmost confirmed station for this taxon (Bradley and Gann 1999).

Current Range/Distribution: The current range is similar to the historic range, although most of the former habitat outside of ENP has been lost and only small remnants remain. Based upon Bradley and Gann (1999) and data from IRC (K. Bradley, pers. comm. 2007), this plant is extant at the sites in Table 8.

Garber's spurge (*Chamaesyce garberi*)

The following discussion is summarized from the final listing rule (50 CFR 29345), the South Florida MSRP (Service 1999b), the 5-year status review (Service 2007a), and from recent publications and monitoring reports.

Species/critical habitat description

Garber's spurge is a prostrate to erect herb with pubescent stems. The leaves are ovate in shape and 4-9 mm long, with entire or obscurely serrate leaf margins. The cyathia are about 1.5 mm long and borne singly at the leaf axils. The appendages are minute or completely absent. The fruit is a pubescent capsule 1.5 mm wide. The seeds are either smooth or have transverse ridges, but are not wrinkled; this is not, however, a distinctive character for this species.

Critical habitat has not been designated for Garber's spurge and it's status is currently listed as a undetermined.

Life history

Reproductive ecology in Chamaesyce has been poorly studied, but is known to be highly variable (Ehrenfeld 1976, 1979; Webster 1967). Some species are completely reliant on insects for pollination and seed production while others are self-pollinating. Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979). The seed capsules of many Euphorbiaceae are explosively dehiscent (spontaneous), ejecting seeds a short distance from the parent plant. Some seeds are dispersed by ants (Pemberton 1988).

Population dynamics

Garber's spurge is still found nearly throughout its historical range. It has been extirpated from Collier County and part of Miami-Dade County. Within its historical range, many stations where it once occurred have been lost. On mainland Florida, Garber's spurge occurs in conservation lands, including ENP. It probably occurs on less than half of the islands where it once occurred in the Florida Keys. Some populations are threatened with extirpation due to their small sizes. Examples include Cudjoe Key with 1 plant, Lower Matecumbe Key with 10-20 plants, and Crawl Key with fewer than 10 plants. Two populations are large, with probably over 1 million plants on Cape Sable and over 100,000 plants on Long Pine Key in ENP. There have been insufficient studies to determine long term population trends on any site. At many sites where Garber's spurge does occur, management is insufficient to ensure long-term persistence of the species.

Status and distribution

Garber's spurge is endemic to South Florida. It is abundant on Northwest and Middle Cape Sable. A small population was recently relocated on East Cape Sable (Sadle, unpublished data). This species is also found in Pine Block B and near Deer Hammock (Pine Block A), both within the Long Pine Key region of ENP. Garber's spurge is also found throughout the Florida Keys in small numbers. Historically, it occurred from Perrine, Miami-Dade County, west to Cape Sable, Monroe County, and to the Sand Keys west of Key West, Monroe County (Small 1933, Long and Lakela 1971). A disjunct occurrence was documented from Cape Romano, Collier County. Recent surveys failed to relocate plants on Cape Romano and the population is considered to be extirpated (Green, et al 2008).

Garber's spurge is currently known from about 17 populations, including 2 in Miami-Dade County, 1 on Cape Sable (on all three Capes), (ENP), and on 14 islands in the Florida Keys (Keys) in Monroe County (Bahia Honda Key, Big Torch Key, Boca Grande Key, Crawl Key, Key Largo, Cudjoe Key, Fat Deer Key, Grassy Key, Long Key, Long Point Key, Lower Matecumbe Key, Marquesas Keys, Sugarloaf Key, Summerland Key) (FNAI 2006). Some islands contain more than one colony.

Most (96 percent) known extant populations of Garber's spurge are on publicly owned lands and are protected from further habitat loss. Two particularly significant populations occur on privately owned coastal rock barrens, one on Long Key and another on Crawl Key. Other populations probably exist on private lands but have not been seen due to lack of access and surveys. Several populations occur on public lands that are not considered protected, for example, along the road shoulders on Grassy Key. Because of the species' tendency to grow on disturbed substrates, it is often found in places that are not considered protected for their natural resources.

All populations are threatened to a degree by exotic plant invasion. Populations on Long Pine Key are probably the least threatened by exotic plants, because of their isolation and continued management by prescribed fire. Populations in coastal habitats are threatened by invasive plants which constantly colonize via ocean dispersed seeds and can rapidly invade, especially following coastal disturbances such as tropical storms.

Fire suppression is a problem at the Deering Estate at Cutler population in Miami-Dade County. The pine rockland area with Garber's spurge has not burned since 1993. Like all pine rockland fragments in Miami-Dade County, it has been impossible to maintain a proper fire cycle at this site due to surrounding development. This situation is not likely to change in the near future.

Pine rocklands in the lower Keys, now mostly protected in the National Key Deer Refuge (NKDR), historically contained populations of Garber's spurge, although this does not seem to be the primary habitat in the Keys. It has been collected in pine rockland on Big Pine and No Name Keys, although no populations are currently known from pine rockland habitat in the Keys. This may be due to lack of a proper fire regime, compounded with an increase in Key deer (*Odocoileus virginianus clavium*) population sizes and subsequent increases in herbivory. Implementation of prescribed fire in the lower Keys, especially NKDR, has been a highly contentious issue, with much public opposition. Lack of a proper fire cycle has probably contributed to the dense hardwood and palm understory on islands with pine rockland, and a subsequent reduction in diversity and density of the herb layer, limiting habitat suitability for Garber's spurge.

Florida pineland crabgrass (*Digitaria pauciflora*)

Florida pineland crabgrass first became a candidate for listing on October 25, 1999. The following discussion is summarized from the most recent species assessment (Service 2012c) and from recent research publications and monitoring reports.

Species/critical habitat description

Florida pineland crabgrass is a rhizomatous perennial; sheath auricles ca. 1.5 mm long; sheaths hairy (becoming glabrous with age); ligule 1.5 to 2 mm long; leaf blades flexuous or twisted, spreading, 7 to 18 mm long, 1 to 2.2 mm wide, hairy on both surfaces (becoming glabrous with age); main axis of the inflorescence 10 to 80 mm long, primary branches 2 to 8, appressed or spreading from the main axis, ca. 0.3 mm wide; pedicels 2 to 3 mm long, 0.7 to 0.9 mm wide; spikelets 30 to 60 on a primary branch, lanceolate, 2.7 to 3 mm long, 0.7 to 0.9 mm wide; first glume often present; second glume the same length as the spikelet, usually 7-nerved, glabrous, acuminate to acute; lemma of lower floret 7-nerved, acuminate to acute, glabrous; upper floret the same length as the lower floret; lemma of upper floret becoming purple, acuminate to acute (adapted from Webster and Hatch 1990, Bradley and Gann 1999).

No critical habitat has been designated for Florida pineland crabgrass.

Life history

The reproductive biology and ecology has not been studied, but reproduction is sexual (Bradley and Gann 1999). In addition, plantlets produced along inflorescences from the previous season have been observed rooting into the ground. This likely represents a form of asexual reproduction and result in the large, monotypic patches that are occasionally observed (J. Sadle, unpublished observation). This species fruits in the fall (Wendelberger and Maschinski 2006). The species occurs most commonly along the ecotone between pine rockland and marl prairie habitats, but does overlap somewhat into both of these ecosystems (Bradley and Gann 1999). The soil where it formerly occurred at the Richmond Pine Rocklands has been classified as Biscayne marl, drained (USDA 1996). These habitats, particularly marl prairie, flood for one to several months every year in the wet season. Gann et al. (2006) described the major habitat types for Florida pineland crabgrass at Long Pine Key as consisting of pineland prairie ecotones and prairies. Gann et al. (2006) indicates this species is associated with low elevation pinelands and pineland/marl prairie ecotones that flood each summer.

Population dynamics

Florida pineland crabgrass is still found throughout much of its historical range. It has been extirpated from most historical locations in Miami-Dade County, outside of Everglades National Park. The extent of the population in Big Cypress National Preserve is believed to be greater than 10,000 plants (Service 2013) but a quantitative population estimate or distribution map of the occurrence is not yet available. Due to this lack of information, population trends are currently not determinable. The species has extant localized occurrences in suitable habitat spread throughout Long Pine Key. Existing data on population size in Long Pine Key is incomplete, but suggests that the population is most likely stable. Herndon (1998) reported 10 individual occurrences and suggested the total population size of Florida pineland crabgrass in Long Pine Key was likely in excess of 5,000 plants. Fellows (2002) collected counts or estimates of individual plants within 10 m of 164 GPS points, but did not provide an overall estimate of population size. In that report, reference is made to a population size of 10,000 plants, but it is not clear if this is for a single area or the entire Long Pine Key population. Gann et al. (2006) reported 13 occurrences and provided a population estimate of 1,000-10,000 plants in Long Pine Key. Recent surveys by ENP staff have resulted in the observations of additional occurrences that were not previously reported.

No studies of mortality, recruitment or other characteristics of individual occurrences are known. Gann et al. (2006) established monitoring transects intended to look at long term population trends for this species. Re-monitoring of these transects is currently underway, and data should be available by October 2015. This information may provide additional insight on long term persistence of plants at a given site.

Status and distribution

Historical Range/Distribution: The historical distribution of Florida pineland crabgrass included central and southern Miami-Dade County along the Miami Rock Ridge, from the South Miami area (latitude 25° 42.5') to Long Pine Key (latitude 25° 20.5'), a range of approximately 42 miles (67.6 km). J.K. Small and J.J. Carter (No. 916, NY) collected Florida pineland crabgrass in "pinelands near the Homestead road, between Cutler and Longview Camp, Florida, Nov 9-12, 1903" (Bradley and Gann 1999). The 1903 Eaton collections from "Jenkins to Everglades" were possibly from the same collecting trip.

Bradley and Gann (1999) stated that after a few collections in the beginning of the century, this species seemed to disappear. After a 1936 collection, it was not found again until 1973 in ENP near Osteen Hammock on Long Pine Key (Avery 1983 as cited in Bradley and Gann 1999). Since that time it has been documented many times in Long Pine Key. In 1995, a single plant was discovered in a small marl prairie on the grounds of Luis Martinez U.S. Army Reserve Center in the Richmond Pine Rocklands in Miami-Dade County; however, this plant has since disappeared (Herndon 1998; Bradley and Gann 1999). Based on data from IRC, this occurrence was last observed in 1997 and is considered extirpated due to decreased hydroperiods (K. Bradley, IRC, pers. comm. 2007; IRC 2009). This species was extirpated from its historical range by drainage and development (FNAI 2007). Prior to its discovery in Big Cypress National Preserve (BCNP) in 2003, the range of this species was thought to have contracted by approximately 29 miles (46.7 km) (Bradley and Gann 1999). Wipff (2004) noted Florida pineland crabgrass is known only from the type collection, which was collected in pinelands of Dade County, Florida. Wipff apparently did not have access to more recent collections, although the distribution map cites "reliable reports" from mainland Monroe and Collier Counties. The source of these reports is unknown. Wunderlin and Hansen (2008) report it from Miami-Dade and Monroe Counties.

Current Range/Distribution: Florida pineland crabgrass is currently known from the Long Pine Key area of ENP (Bradley and Gann 1999, Gann et al 2006) and from BCNP (Table 9) (K. Bradley pers. comm. 2005a). Citing Avery, Bradley and Gann (1999) indicated that this species occurred in an area "stretching from near the park entrance (just east of Long Pine Key), southwest to the Mahogany Hammock turnoff at the western end of Long Pine Key", an area of about 31 square miles (8,000 ha). Prior to research by Gann et al. (2006), this species was known from the following locations within Long Pine Key: Hole-in-the-Donut, and Pine Blocks A, C, D, and H. Follow up surveys of historical locations yielded two additional occurrences of this species in the Hole-in-the-Donut (Gann et al. 2006). In addition, Jimi Sadle, botanist at ENP, recently observed or found documentation (Green et al. 2008) of the species in the following additional Pine Blocks: North of A, West of A, North Pines, E, F1, G, D, East of D, I1, I2, SW2 and Boy Scout Camp. No specific occurrences are currently known from prairies east of Long Pine Key or in the Pine Island area near the park entrance. Based on these occurrences, Florida pineland crabgrass appears to have a much wider range than previously thought.

In 2003, Keith Bradley (pers. comm. 2005b) discovered this species south of Loop Road in BCNP in Monroe County. This finding is a significant discovery, since it is the first occurrence of this narrow endemic documented outside of the Miami Rock Ridge/Everglades Area (FNAI 2007). Prior to this discovery, the only extant population was on Long Pine Key (FNAI 2007). IRC and Fairchild Tropical Botanic Garden have initiated surveys of the general area around Gum Slough, south of Loop Road (K. Bradley pers. comm. 2007). Funding became available for a full survey in 2009, and a full survey began in 2011 (Bradley 2009). Bradley et al. (2013) reported on the survey status of the species in BCNP, but little additional information is available on the current status of the species in ENP. Until further studies are complete, the most accurate range-wide estimate is 1,000-10,000 individuals at Long Pine Key (Gann et al 2006) and >10,000 individuals within BCNP (K. Bradley pers. comm. 2007). Bradley et al. (2013) counted 2,365 plants in their surveys in BCNP. Gann (2015) concluded that twospike crabgrass (Florida pineland crabgrass) is widespread and apparently relatively abundant at the present time in the Long Pine Key area of ENP. There is also some potential for the species to still occur on remaining unsurveyed pine rockland fragments within Miami-Dade County.

Everglades bully (*Sideroxylon reclinatum* subsp. *austrofloridense*)

Everglades bully is a candidate for listing. The following discussion is summarized from the most recent species assessment (Service 2012a) and from recent research publications and monitoring reports.

Species description

Everglades bully is a decumbent or upright shrub, 1-2 m (3-6 ft) tall. The branches are smooth, slightly geniculate, and somewhat spiny. Leaves are thin, obovate or ovate, 2-5 cm (0.8-2 in) long, evergreen, oblanceolate, and fuzzy on their undersides. The flowers are in axillary cymes (Long and Lakela 1971). Everglades bully is distinguished from the other two subspecies of *S. reclinatum* in Florida by its leaves, which are persistently pubescent (fuzzy) on their undersides, rather than smooth or pubescent only along the midvein (Wunderlin and Hansen 2013).

Life history

Everglades bully is restricted to pinelands with tropical understory vegetation on limestone rock (pine rocklands), mostly in the Long Pine Key area of ENP, which is an area of pine rockland surrounded by wetlands. In ENP and BCNP, Everglades bully is found in the pinelands, pineland/prairie ecotones and prairies (Gann et al 2006; Bradley et al 2013). Plants are found in low elevation pinelands and pineland/marl prairie ecotones that flood each summer (Gann et al. 2006; Bradley et al. 2013). Bradley et al. (2013) conducted surveys in the Gum Slough region of Lostman's Pines and reported finding the species to have distribution within that area.

Population dynamics

In 2005, IRC reported that more than 10,000 plants were found in surveys of Long Pine Key (K. Bradley pers. comm. 2005d). The baseline abundance estimate at Long Pine Key, based on a log10 abundance estimate, is 10,000-100,000 plants (Gann et al. 2005). Gann et al. (2006) found 14 occurrences of this species recorded at 149 sample stations. Bradley et al. (2013) conducted surveys in the Gum Slough region of Lostman's Pines in BCNP and reported finding Everglades bully to have limited distribution within that area. A total of 17 plants (representing 0.2 plants/ha) were counted within three pineland plots, that were associated with sawgrass and hardwood habitats.

Fairchild Tropical Botanic Garden tagged 41 groups of plants, each group consisting of 1 to 6 individuals, for a total of approximately 73 individuals at Larry and Penny Thompson Park (Possley and McSweeney 2005). This is probably the largest population outside of Long Pine Key. Estimated population sizes for the other occurrences are noted in Table 10 (Hodges and Bradley 2006; Gann et al. 2006; K. Bradley pers. comm. 2007; J. Possley, pers. comm. 2011a, 2011b).

13

Status and distribution

The rounded global status of Everglades bully is T1, critically imperiled (NatureServe 2010). NatureServe (2010) indicates this taxon is a narrow endemic subspecies occurring in sensitive and highly fragmented pine rocklands of southern Florida. FNAI considers Everglades bully to have a global rank of G4G5T1, meaning the species as a whole is "apparently" or "demonstrably secure globally," but the subspecies is "critically imperiled globally" (FNAI 2011). Everglades bully was considered to be critically imperiled by IRC; however, based upon data collected in the first year of their study, IRC down-ranked this species to imperiled (Gann et al 2006; Gann et al. 2001-2010). Everglades bully is not listed by the State.

Historical Range/Distribution: Everglades bully was long considered to have a narrow distribution in the tropical pinelands of Miami-Dade County. Gann et al. (2002) provided a history of collections; Everglades bully was first documented at Camp Jackson near what is now the main entrance to ENP. It has been collected several times (starting in 1852) at Long Pine Key. The species has been observed in pinelands east of ENP, the Nixon-Lewis Hammock (where the pinelands have since been destroyed), privately-owned Grant Hammock, and privately owned Pine Ridge Sanctuary.

In Monroe County, this species is found only on the mainland (Hodges and Bradley 2006). Hodges and Bradley (2006) stated that if it had occurred in the Florida Keys, the most likely locations would have been pine rocklands on Key Largo, Big Pine Key, Cudjoe Key or Lower Sugarloaf Key, all of which were surveyed for this species. Hodges and Bradley indicated most of the sites on Key Largo have been developed. There have been no records of this taxon ever being collected there.

Current Range/Distribution: Everglades bully appears to have a much wider range than previously thought (Gann et al. 2006). Everglades bully is extant at 11 sites (Table 11). One population occurs locally at BCNP along the edges of Gum Slough within Lostman's Pines area (south of Loop Road), on the mainland portion of Monroe County (Bradley et al. 2013). The largest population is at Long Pine Key within ENP in Miami-Dade County (Hodges and Bradley 2006; Gann et al 2006). New occurrences within ENP are expected to be found as work continues to establish the limits of this species' habitat requirements.

One occurrence is located at Larry and Penny Thompson Park in the Richmond Pinelands adjacent to the Metrozoo in Miami-Dade County (Gann et al. 2002; Possley and McSweeny 2005). This plant also occurs at the privately owned Pine Ridge Sanctuary in Miami-Dade County and possibly a few non-protected pinelands such as Grant Hammock (Gann et al. 2002). In 2007, Bradley (pers. comm. 2007) reported small occurrences in Miami-Dade County at the following locations: Lucille Hammock, South Dade Wetlands, NFC #P-300, and NFC #P-310. More recently, Possley (J. Possley, pers. comm. 2011a) found two plants at Quail Roost Pineland, an area that was formerly very overgrown, but was manually treated for hardwood reduction in 2007 and then burned in 2009. Additionally, Possley (pers. comm. 2011b) reported populations from Navy Wells Pineland Preserve (four plants) and Sunny Palms Pinelands (two plants), both areas are Miami-Dade County conservation lands.

Invertebrates

Bartram's hairstreak butterfly (*Strymon acis bartrami*)

Species/critical habitat description

The Bartram's hairstreak butterfly, endemic to southern Florida, is a small butterfly approximately 1 inch (25 mm) in length with a forewing lengths of 0.4 to 0.5 inches (10 to 12.5 mm) (Opler and Krizek 1984; Minno and Emmel 1993). Despite its rapid flight, this hairstreak is easily observed if present at any density as it alights often, and the brilliance of its grey underside marked with bold, white post discal lines beneath both wings provides a flash of color against the foliage of its host plant, pineland croton (*Croton linearis*) (Smith et al. 1994; Salvato 1999). The Bartram's hairstreak does not exhibit sexual or seasonal dimorphism, but does show some sexual differences. The abdomen of the male is bright white, while females are grey (M. Minno, pers. comm. 2009). The Bartram's hairstreak was listed as endangered, and critical habitat was designated in August 2014. Unit BSHB1 of this critical habitat consists of 3,235 ha (7,994 ac) in Miami-Dade County. This unit is composed entirely of lands in Federal ownership located within the Lone Pine Key region of ENP. A complete discussion of the status of this species may be found at https://ecos.fws.gov/speciesProfile/profile/species profile.action?spcode=I07G.

Life history

The Bartram's hairstreak butterfly is rarely encountered more than 5 m from its host plant, the pineland croton (Schwartz 1987; Worth et al. 1996; Salvato and Salvato 2008). Females oviposit on flowering racemes of pineland croton (Worth et al. 1996; Salvato and Hennessey 2004). Eggs are laid singly on the developing flowers. Broods are laid in multiple generations, eggs are cream colored laid singly on host flower stalks, and the larvae are light olive green with numerous short hairs. Young caterpillars eat the upperside of leaves, flowers, and fruits; older caterpillars feed on leaves. There are three to four flights in Florida from February-November.

Population dynamics

The Bartram's hairstreak butterfly has been observed during every month on Big Pine Key and ENP; however, the exact number of broods appears to be sporadic from year to year (Salvato and Hennessey 2004; Salvato and Salvato 2010b). Baggett (1982) indicated the Bartram's hairstreak butterfly seemed most abundant in October-December. Salvato and Salvato (2010b) encountered the subspecies most often during March to June within ENP. Land (pers. comm. 2012) has noted the subspecies to be most abundant in the spring and summer months. One of the earliest reports of Bartram's hairstreak phenology from Big Pine Key was provided by Schwartz (1987) who encountered the subspecies only during April, November and December, despite an extensive annual survey. Subsequent research by Hennessey and Habeck (1991), Emmel et al. (1995) and Minno and Minno (2009) reported occurrences of Bartram's hairstreak on Big Pine Key throughout the year with varying peaks in seasonal abundance. Salvato (1999) recorded 92 and 36 adult Bartram's hairstreak on Big Pine Key during 1-week periods in July 1997 and January 1998, respectively, suggesting the species can occur in high numbers during any season if

15

suitable habitat and conditions are present. Since 2010 on Big Pine Key, Anderson has found them most active when temperature is consistently near 80°F, which can occur at any time of year (Anderson pers. comm. 2012).

Status and distribution

The Bartram's hairstreak butterfly is currently known to occur on Big Pine Key, in the lower Florida Keys (Monroe County), Long Pine Key within ENP (Miami-Dade County), as well as Navy Wells Pineland Preserve and the various parcels that compose the Richmond Pine Rocklands in Miami-Dade County (Salvato and Hennessey 2004). The Bartram's hairstreak is extirpated from the majority of its historic range in southern Florida. Extant populations are threatened by loss of pine rockland habitat, inconsistent fire management within pine rockland habitat, small population size, poaching, and pesticide applications.

Florida leafwing butterfly (*Anaea troglodyta floridalis*)

Species/critical habitat description

The Florida leafwing is a medium-sized butterfly approximately 2.75 to 3.00 inches (76 to 78 mm) in length with a forewing length of 1.3 to 1.5 inches (34 to 38 mm) and has an appearance characteristic of its genus (Opler and Krizek 1984; Minno and Emmel 1993). The upper-wing surface color is red to red-brown, the underside is gray to tan, with a tapered outline, cryptically looking like a dead leaf when the butterfly is at rest. The Florida leafwing butterfly exhibits sexual dimorphism, with females being slightly larger and with darker coloring along the wing margins than the males.

The Florida leafwing butterfly was listed as endangered, and critical habitat was designated in August 2014. Unit FLB1 of this critical habitat consists of 3,235 ha (7,994 ac) in Miami-Dade County. This unit is composed entirely of lands in Federal ownership located within the Lone Pine Key region of ENP. A complete discussion of the status of this species may be found at https://ecos.fws.gov/speciesProfile/profile/species profile.action?spcode=I087.

Life history

Adult Florida leafwing butterflies are rapid, wary fliers. The subspecies is extremely territorial, with both sexes flying out to pursue other butterflies (Baggett 1982; Worth et al. 1996; Salvato and Hennessey 2003; Salvato and Salvato 2010a). Minno (pers. comm. 2009) and Salvato and Salvato (2010a) note that males are generally more territorial. The Florida leafwing butterfly is multivoltine (*i.e.*, produces multiple generations per year), with an entire lifecycle of about 60 days (Hennessey and Habeck 1991) and maintains continuous broods throughout the year (Salvato 1999). Males perch on twigs about 10 feet off the ground to wait for females. Females lay eggs singly on both the upper and lower surface of the leaves of its host plant, pineland croton (*Croton linearis*), normally on developing shoots (Baggett 1982; Hennessey and Habeck 1991; Worth et al. 1996; Salvato 1999). Caterpillars eat leaves. Young caterpillars make a resting perch from a leaf vein; older caterpillars live in a rolled-up leaf shelter. Flights occur during the dry season from October-April and in the wet season from May-October. Adult food consists of rotting fruit and dung.

Population dynamics

The Florida leafwing butterfly has been observed within ENP during every month and formerly on Big Pine Key; however the exact number of broods appears to be sporadic from year to year (Baggett 1982; Opler and Krizek 1984; Minno and Emmel 1993; Salvato and Hennessey 2003; Salvato and Salvato 2010a, 2010b). Salvato and Salvato (2010a) and Land (pers. comm. 2012) encountered the subspecies throughout the year, but the majority of observations occurred from late fall to spring in ENP. By contrast, when extant on Big Pine Key, Salvato and Salvato (2010c) reported finding the subspecies abundantly throughout the year, particularly during the summer months.

Status and distribution

The Florida leafwing butterfly is currently known to occur only within the Long Pine Key area within ENP (Miami-Dade County). Recent populations on Big Pine Key, in the lower Florida Keys (Monroe County), as well as the Navy Wells Pineland Preserve and the various parcels that compose the Richmond Pine Rocklands in Miami-Dade County are no longer extant (Salvato and Salvato 2010a). The extant population within the Everglades remains threatened by inconsistent fire management of pine rockland habitat, small population size, and illegal poaching.

Reptiles

Eastern indigo snake (*Drymarchon corais couperi*)

In addition to the assessment below, a 5-year review was completed in 2008 resulting in no change to the species designation (Service 2008). The 5-year review builds upon the detailed information in the Multi-Species Recovery Plan for this species and is located at http://ecos.www.fws.gov/docs/five_year_review/doc1910.pdf.

Species/critical habitat description

The eastern indigo snake is the largest non-venomous snake in North America, obtaining lengths of up to 2.6 m (8.5 ft) (Moler 1992). Its color is uniformly lustrous-black, dorsally and ventrally, except for the red or cream-colored suffusion of the chin, throat, and sometimes the cheeks. Its scales are large and smooth (the central 3-5 scale rows are lightly keeled in adult males) in 17 scale rows at midbody. Its anal plate is undivided. In the Florida Keys, adult indigo snakes seem to have less red on their faces or throats compared to most mainland specimens (Lazell 1989). Critical habitat has not been designated for this species.

Life history

In south-central Florida, limited information on the reproductive cycle suggests that eastern indigo snake breeding extends from June to January, egg laying occurs from April to July, and hatching occurs from mid-summer to early fall (Layne and Steiner 1996). Young hatch approximately three months after egg-laying and there is no evidence of parental care. Eastern indigo snakes in captivity take 3 to 4 years to reach sexual maturity (Speake et al. 1987). Female eastern indigo snakes can store sperm and delay fertilization of eggs. There is a single record of a captive eastern indigo snake laying five eggs (at least one of which was fertile) after being isolated for more than 4 years (Carson 1945). There have been more recent reports of parthenogenetic reproduction by virginal snakes. Hence, sperm storage may not have been involved in Carson's (1945) example (Moler, pers. comm. 1998). There is no information on the eastern indigo snake lifespan in the wild, although one captive individual lived 25 years, 11 months (Shaw 1959).

Eastern indigo snakes are active and spend a great deal of time foraging and searching for mates. They are one of the few snakes that are active during the day and rest at night. The eastern indigo snake is a generalized predator and will eat any vertebrate small enough to be overpowered. They swallow their prey alive. Food items include fish, frogs, toads, snakes (venomous as well as non-venomous), lizards, turtles, turtle eggs, small alligators, birds and small mammals (Keegan 1944; Babis 1949; Kochman 1978; Steiner et al. 1983).

Population dynamics

In central and coastal Florida, eastern indigo snakes are mainly found within many of the State's high, sandy ridges. In extreme South Florida (*i.e.*, the Everglades and Florida Keys), eastern indigo snakes are found in tropical hardwood hammocks, pine rocklands, freshwater marshes, abandoned agricultural land, coastal prairie, mangrove swamps, and human-altered habitats (Steiner et al. 1983; Service 1999a). It is thought they prefer hammocks and pine forests, since most observations occur there and use of these areas is disproportionate compared to the relatively small total area of these habitats (Steiner et al. 1983). Observations over the last 50 years made by maintenance workers in citrus groves in east-central Florida indicate that eastern indigo snakes are occasionally observed on the ground in the tree rows and more frequently near the canals, roads, and wet ditches (Zeigler, pers. comm. 2006). Ceilly (2013) used radio tracking of six indigo snakes in a former citrus grove at the C-44 Reservoir and STA Project site to determine home ranges and seasonal movements. Additionally, eastern indigo snakes have been observed (including one mortality) during earthmoving and other construction-related activities in the sugarcane fields at the A-1 Reservoir Project site in the EAA (District 2008).

Eastern indigo snakes range over large areas and use various habitats throughout the year, with most activity occurring in the summer and fall (Smith 1987; Moler 1985a). Adult males have larger home ranges than adult females and juveniles; their ranges average 554 acres, decreasing to 390 acres in the summer (Moler 1985b). In contrast, a gravid female may use from 3.5 to 106 acres (Smith 1987). In Florida, home ranges for females and males range from 5 to 371 acres and 4 to 805 acres, respectively (Smith, pers. comm. 2003). At Archbold Biological Station, average home range size for females was determined to be 19 ha (46 ac) and overlapping male home ranges to be 74 ha (184 ac) (Layne and Steiner 1996). Breininger et al. (2011) determined the average home range for female indigo snakes to be 60 ha (148 ac) and overlapping male home ranges to be 179 ha (442 ac) in central Florida. Bauder and Jenkins (2013) determined the average home range for female indigo snakes to be 76 ha (188 ac) and overlapping male home ranges to be 265 ha (655 ac) in south-central Florida. Ceilly (2013) reported home ranges of 111 ha (274 ac) and 163 ha (402 ac) for two males (over 1 year) and 81 ha (33 ac) for one female (over 16 months) at the C-44 site.

Status and distribution

The eastern indigo snake was listed as threatened on January 31, 1978 (43 FR 4028), due to population declines caused by habitat loss, over-collecting for the domestic and international pet trade, and mortality caused by rattlesnake (*Crotalus adamanteus*) collectors who gas gopher tortoise burrows to collect snakes. The indigo snake (*Drymarchon corais*) ranges from the southeastern United States to northern Argentina (Conant and Collins 1998). This species has eight recognized subspecies, two of which occur in the United States: the eastern indigo snake and the Texas indigo (*D. c. erebennus*). In the United States, the eastern indigo snake historically occurred throughout Florida and in the coastal plain of Georgia and has been recorded in Alabama and Mississippi (Diemer and Speake 1983; Moler 1985b). It may have occurred in southern South Carolina, but its occurrence there cannot be confirmed. Georgia and Florida currently support the remaining endemic populations (Lawler 1977). It occurs throughout most of Florida and is only absent from the Dry Tortugas and Marquesas Keys, and regions of north Florida where cold temperatures and deeper clay soils exist (Cox and Kautz 2000).

Effective law enforcement has reduced pressure on the species from the pet trade. However, because of its relatively large home range, the eastern indigo snake is vulnerable to habitat loss, degradation, and fragmentation (Lawler 1977; Moler 1985a). The primary threat to the eastern indigo snake is habitat loss due to development and fragmentation. In the interface areas between urban and native habitats, residential housing is also a threat because it increases the likelihood of snakes being killed by property owners and domestic pets. Extensive tracts of undeveloped land are important for maintaining eastern indigo snakes. In citrus groves, eastern indigo snake mortality occurs from vehicular traffic and management techniques such as pesticide usage, lawn mowers, and heavy equipment usage (Zeigler 2006). Within the 2000 to 2005 timeframe, due to the spread of citrus canker, Zeigler (2006) reported seeing at least 12 dead eastern indigo snakes that were killed by heavy equipment operators in the act of clearing infected trees.

The most intensive study of wildlife use, especially reptiles, occurred in the Immokalee Rise area of southwest Florida (Mazzotti et al. 1993). That study area included 600,000 ha (1,482,632 acres) in southwest Florida; encompassing the region known as the Immokalee Rise which is located approximately 14 miles north and northeast of the Picayune Strand Restoration Project and includes the C-43 West Storage Reservoir project area, another Comprehensive Everglades Restoration Plan project. The study evaluated the regional effects of new citrus development on the fish and wildlife resources in southwest Florida. Citrus groves, including grove beds, canals, impacted wetlands, and reservoirs had relatively high species richness (203 species); however, the majority of species (159) were observed in agricultural reservoirs. One hundred and six species were observed in grove beds of various ages. Following a scheme developed by Duever et al. (1986), habitat importance values for 380 taxa were assigned to different land cover types in the Immokalee Rise Citrus Development Study. Citrus grove habitat utilization for the indigo snake was assigned an index of 2 (commonly used), and the species was characterized as regionally rare. The study indicated roads and ditches are the most likely places to observe eastern indigo snakes, but most sightings in natural habitat occur in pine flatwoods, hammocks, and edges of ecotones where prey is abundant. Animal burrows (especially armadillo) in canal and ditch banks likely provide refugia for the eastern indigo snake.

19

Tasks identified in the recovery plan for this species include: (1) habitat management through controlled burning, (2) testing experimental miniature radio transmitters for tracking juveniles, (3) maintenance of a captive breeding colony at Auburn University, (4) recapture of formerly released indigo snakes to confirm survival in the wild, (5) educational lectures and field trips, and (6) efforts to obtain landowner cooperation in conservation efforts (Service 1999a).

To protect and manage this species for recovery, Breininger et al. (2004) concluded that the greatest conservation benefit would be accrued by conserving snake populations in the largest upland ecosystems that connect to other large reserves while keeping edge to area ratios low. Management of these lands should be directed towards maintaining and enhancing the diversity of plant and animal assemblages within these properties. Where these goals are achieved, eastern indigo snakes will directly benefit because of improved habitat conditions. Land managers should be encouraged to utilize prescribed fire as a tool to maintain biodiversity in fire-dependent ecosystems.

Additional information on the eastern indigo snake is available in the MSRP (Service 1999b) and the 5-year review (Service 2008) located at:
http://www.fws.gov/southeast/5yearReviews/5yearreviews/easternindigofinal.pdf

Birds

Cape Sable seaside sparrow (*Ammodramus maritimus mirabilis*)

Species/critical habitat description

The Cape Sable seaside sparrow (CSSS) is one of eight extant subspecies of seaside sparrow in North America. Its distribution is limited to the short-hydroperiod wetlands, or marl prairies, located at the southern end of the greater Everglades ecosystem, on the southern tip of mainland Florida. Unlike most other subspecies of seaside sparrow, which occupy primarily brackish tidal systems (Post and Greenlaw 1994), this sparrow currently occurs primarily in the short-hydroperiod wet prairies, also referred to as marl prairies. The sparrow is generally sedentary, secretive, and non-migratory, although sparrows are known to migrate between subpopulations (Lockwood et al. 2008; Virzi et al. 2009).

Life history

Breeding and Nesting

CSSS generally begin nesting in early March (Lockwood et al. 2001), but may begin territorial behavior, courtship, and nest-building in late February (Werner and Woolfenden 1983; Lockwood et al. 1997). This timing coincides with the dry season, and most areas within the marl prairies are either dry or only shallowly inundated at the beginning of the breeding season. During the dry portion of the breeding season (March to May), sparrows build nests above the ground, but relatively low in the vegetation (6.7 to 7.1 inches) (Werner 1975; Lockwood et al. 2001). During the wet portion of the sparrow breeding season (June to August), sparrows build their nests higher in the vegetation than during dry periods, an average of 8.3 inches above the ground surface (Lockwood et al. 2001). Wet-season nests probably occur in taller vegetation than during the dry season because even at the nest height, there must be sufficient height and density of vegetation remaining above the nest to cover and conceal nests.

Pimm et al. (2002) suggest that nesting will not be initiated if water levels are at a depth greater than 4 inches during the breeding season. For many years, rising water levels resulting from the onset of summer rains were thought to end the breeding season (Werner 1975). While these statements are generally true, the sparrows may respond to changes in hydrologic conditions as long as water levels are not prohibitively high. Large rainfall events early in the wet season may cause some nest failure and sparrows generally cease breeding when water levels rise above the mean height of the nests above the ground (Lockwood et al. 1997; Basier et al. 2008; Cade and Dong 2008). However, if water levels subsequently drop, sparrows may again initiate breeding activity. The initiation of molt, which usually occurs in early September, is probably the best indicator of the true end of the breeding season.

CSSS lay three to four eggs per clutch (Werner 1978, Pimm et al. 2002) with a hatching rate ranging between 0.66 and 1.00 (Boulton et al. 2009). The sparrow nesting cycle, from nest construction to independence of young, lasts about 30 to 50 days (Werner 1975; Lockwood et al. 2001), and sparrows may renest following both successful and failed nesting attempts (Werner 1975; Post and Greenlaw 1994; Lockwood et al. 2001). Both parents rear and feed the young birds and may do so for an additional 10 to 20 days after the young fledge (Woolfenden 1956; Trost 1968). Sparrows are incapable of flight until they are about 17 days old; when approached, flightless fledglings will freeze on a perch until the threat is less than approximately 3 feet away, and then run along the ground (Werner 1975; Lockwood et al. 1997).

Because of the potential for a long breeding season in southern Florida, sparrows may regularly nest several times within a year, and may be capable of successfully fledging two to four clutches, though few sparrows probably reach this level of success (Lockwood et al. 2001). Second and third nesting attempts may occur during the early portion of the wet season, and nests later in the season usually occur over water.

Nest success rates vary among years, and range from 12 to 60 percent, depending upon time within the breeding season (Lockwood et al. 2001; Baiser et al. 2008; Boulton et al. 2009). Substantially higher nest success rates occur within the early portion of the breeding season (prior to June 1) followed by a decline in success as the breeding season progresses to a low of about 20 percent after June 1. Nest predation is the primary documented cause of nest failure (Lockwood et al. 2001; Pimm et al. 2002; Baiser et al. 2008; Boulton et al. 2009; Virzi et al. 2009), accounting for more than 75 percent of all nest failures (Lockwood et al. 1997; Baiser et al. 2008). A complete array of nest predators has not been determined, however, raccoons (*Procyon lotor*), rice rats (*Oryzomys palustris*), and snakes, including exotic pythons may be the predominant predators (Lockwood et al. 1997; Post and Greenlaw 2000; Dean and Morrison 2001). As water levels begin to rise above ground surface with the onset of the summer rains in May to June, nest predation rates also rise. Nests that are active after June 1, when water levels are above ground, are more than twice as likely to fail as nests during drier periods (Lockwood et al. 2001; Baiser et al. 2008; Cade and Dong 2008). This effect appears to be a result of both increased likelihood of nests being flooded and an increased likelihood of predation (Lockwood et al. 1997, 2001; Pimm et al. 2002).

Outside of the breeding season, sparrows generally remain sedentary in the general vicinity of their breeding territories, but expand the area that they use compared to the breeding season territory (Dean and Morrison 2001). Average non-breeding season home range size was approximately 42 acres in size, and ranged from 14.1 to 137.1 acres (Dean and Morrison 2001). Some individuals make exploratory movements away from the area of their territories, and may occasionally relocate their territories and home ranges before resuming a sedentary movement pattern (Dean and Morrison 2001).

Sparrow subpopulations require large patches of contiguous open habitat (about 4,000 acres or larger). The minimum area required to support a population has not been specifically determined, but the smallest area that has remained occupied by sparrows for an extended period is about 4,000 acres. Individuals are area-sensitive, and generally avoid the edges where other habitat types meet the marl prairies. They will only occupy small patches (less than 100 acres) of marl prairie vegetation when they occur within large, expansive areas and are not close to forested boundaries (Dean and Morrison 2001). Large expanses of deep water or wooded habitat may act as barriers to long-range movements (Dean and Morrison 2001). Once sparrows establish a breeding territory, they exhibit high site fidelity, and each individual sparrow may only occupy a small area for the majority of its life (Werner 1975). Although sparrows are generally sedentary and avoid forested areas, recent research has revealed limited movement between subpopulations east of Shark River Slough (SRS) (Lockwood et al. 2008; Virzi et al. 2009). The occurrence of sparrows over time within each of the subpopulations indicates a centrality, that is, sparrows most consistently occur and are most abundant near the center of the patch of habitat in which they occur.

Within a patch of occupied suitable habitat, sparrow breeding territories do not generally saturate the entire area. Even when sparrows occur at high densities, small areas usually remain between adjacent territories, though some territories do appear to overlap (Cassey et al. 2007). Therefore, some gaps that appear to be suitable habitat may remain unclaimed by territorial sparrows (Werner 1975). In many cases, areas that appear to be suitable for sparrow occupancy may not be suitable during certain environmental conditions and this may cause sparrow territories to appear to be widely separated from neighboring territories (Cassey et al. 2007).

CSSS are generally short-lived, with an average individual annual survival rate of 66 percent (Lockwood et al. 2001). The average lifespan is probably 2 to 3 years. Consequently, a sparrow population requires favorable breeding conditions in most years to be self-sustaining, and cannot persist under poor conditions for extended periods (Lockwood et al. 1997, 2001; Pimm et al. 2002).

Feeding Behavior

While detailed information about the diet of CSSS is not known, invertebrates comprise the majority of their diet, though sparrows may also consume seeds when they are available (Werner 1975; Post and Greenlaw 1994). Howell (1932) identified the contents of 15 sparrow stomachs and primarily found remains of insects and spiders, as well as amphipods, mollusks, and plant matter. Primary prey items that are fed to nestlings during the breeding season include grasshoppers (Orthoptera), moths and butterflies (Lepidoptera), dragonflies (Odonata), and other common large insects (Post and Greenlaw 1994; Stevenson and Anderson 1994; Lockwood et al.

1997; Pimm et al. 2002). Adult sparrows probably consume the same species during the nesting season. Sparrows may consume different proportions of different species over time and among sites, suggesting they are dietary generalists (Pimm et al. 2002). During the non-breeding season, preliminary information from evaluation of fecal collections suggests that a variety of small invertebrates, including weevils and small mollusks are regularly consumed (Dean and Morrison 2001). Evidence of seed consumption was only present in 4 percent of samples (Dean and Morrison 2001). These non-breeding season samples may not be representative of the foods most frequently consumed during that season and may only represent a portion of the items ingested.

While the sparrow appears to be a dietary generalist, an important characteristic of sparrow habitat is its ability to support a diverse array of insect fauna. In addition, these food items must be available to sparrows both during periods when there is dry ground and during extended periods of inundation. The specific foraging substrates used are unknown, but they probably vary throughout the year in response to hydrologic conditions.

Habitat and Hydrologic Requirements

Sparrows inhabiting the action area occur mostly within the short-hydroperiod freshwater marl prairies of the southern Everglades that flank the deeper sloughs. The most commonly associated vegetation species in occupied freshwater habitat is muhly grass (*Muhlenbergia filipes*) (Werner 1975; Kushlan and Bass 1983; Werner and Woolfenden 1983; Post and Greenlaw 1994; Stevenson and Anderson 1994). However, a variety of vegetation species occur within the freshwater marl prairies occupied by sparrows, including habitat where *Muhlenbergia* is absent (Ross et al. 2006). Other dominant species that occur in these prairies include sawgrass, South Florida bluestem (*Schizachyrium rhizomatum*), black-topped sedge (*Schoenus nigricans*), and beak rushes (*Rhynchospora* spp.) (Werner and Woolfenden 1983; Ross et al. 2006).

Sparrows occupy these marl prairie communities year-round, and the vegetation must support all sparrow life stages. During the dry season when the habitat is typically dry, usually coinciding with the late winter and early spring (December to May), sparrows traverse the ground surface beneath the grasses, and only occasionally perch within the vegetation. During the wet season (June to November), the ground surface is inundated, with peak water depths occasionally exceeding two feet (Nott et al. 1998). During these periods, sparrows travel within the grasses, perching low in the clumps, hopping among the bases of dense grass clumps, and walking over matted grass litter. During the wet season sparrows fly more frequently, and regularly perch low in the vegetation, but generally remain inconspicuous (Dean and Morrison 2001).

Small tree islands and individual trees and shrubs occur throughout the areas occupied by the sparrows, but at a very low density. Sparrows do not appear to require woody vegetation during any aspect of their normal behavior, and generally avoid areas where shrubs and trees are either dense or evenly distributed. However, the small tree islands and scattered shrubs and trees may serve as refugia during extreme environmental conditions, and may be used as escape cover when fleeing from potential predators (Dean and Morrison 2001). Because of their general aversion to dense trees and woody vegetation, encroachment of trees and shrubs quickly degrades potential sparrow habitat.

Hydrologic conditions have significant direct and indirect effects on sparrows. First, water depth or depth of inundation within sparrow habitat is directly related to the sparrow's ability to move, forage, nest, find shelter, and avoid predators and harsh environmental conditions. Average annual rainfall in the Everglades is approximately 56 inches per year (ENP 2005), with the majority of this falling within the summer months, which coincides with the latter half of the sparrow nesting season. This rainfall has a strong influence on the hydrologic characteristics of the marl prairies. However, throughout southern Florida, hydrologic conditions are also influenced by water management actions. The operation of a system of canals, levees, pumps, and other water management structures, can have wide-ranging impacts on the hydrologic conditions throughout much of the remaining marl prairies (Johnson et al. 1988; Van Lent and Johnson 1993; Pimm et al. 2002).

At water depths greater than 2 feet above ground surface, the majority of the vegetation in sparrow habitat is completely inundated, leaving sparrows with limited refugia. Conditions such as these may result in significant impacts to sparrow survival, and if they occur during the breeding season, these water levels cause flooding and loss of sparrow nests (Nott et al. 1998; Pimm and Bass 2002). Even more moderate water levels, in the range of six inches above ground surface, may inundate enough habitat that sparrows cannot find shelter and are restricted in their movements. These water levels, when they occur during the nesting season, result in increased rates of nest failure due to predation (Lockwood et al. 1997; Baiser et al. 2008). While topographical (elevation) variation within the remaining Everglades is relatively small, differences in elevation as little as one foot can result in different habitat characteristics.

The vegetation species composition and structure/density in the Everglades are largely influenced by the rise and fall of annual water levels or hydroperiods. Water quality has the potential to influence vegetation communities in sparrow habitat, but the literature characterized below highlights the predominant effects that hydroperiod and fire play on vegetation composition. Annual discontinuous hydroperiods that range from 60 to 270 days support the full variety of vegetation conditions that are generally suitable for sparrows (Ross et al. 2006), though the vegetation composition and structure may vary significantly. Average hydroperiods that extend much beyond 240 days per year will more closely resemble sawgrass marsh communities (Ross et al. 2006; (Nott et al. 1998), which are unlikely to support sparrows in the long term. Detailed studies relating hydroperiod characteristics to sparrow habitat have concluded that an average annual discontinuous hydroperiod range (average number of days in a year that water level or stage is above ground surface) of 90 to 210 days is optimal for the plant species important for sparrow nesting and for maintenance of sparrow habitat (Olmsted and Loope 1984; Kushlan et al. 1982; Kushlan 1990; Wetzel 2001; Ross et al. 2006).

Conversely, areas that are subjected to short hydroperiods generally have higher fire frequency than areas with longer-hydroperiods (Lockwood et al. 2003; Ross et al. 2006), and are readily invaded by woody shrubs and trees (Werner 1975; Davis et al. 2005). Both an increased incidence of fire and an increased density and occurrence of woody shrubs detract from the suitability of an area as sparrow habitat.

The local variability across the landscape within areas where sparrows occur produces a heterogeneous arrangement of different vegetation conditions that all provide habitat for sparrows during various environmental conditions. A complex relationship between hydrologic conditions, fire history, and soil depth determine the specific vegetation communities at a particular site, and variation in these characteristics may result in a complex mosaic of vegetation (Taylor 1983; Ross et al. 2006). The combination of hydroperiod and periodic fire events are critical in the maintenance of suitable mixed marl prairie communities for the sparrow (Kushlan and Bass 1983). CSSS are generally not found in communities dominated by dense sawgrass (*Cladium jamaicense*), cattail (*Typha* spp.) monocultures, long-hydroperiod wetlands with tall, dense vegetative cover, spike rush (*Eleocharis cellulosa*) marshes and sites supporting woody vegetation (Werner 1975, Kushlan and Bass 1983). Sparrows also avoid sites with permanent year-round water cover (Curnutt and Pimm 1993).

Sparrows do not regularly occupy burned areas for 2 to 3 years following fires (Pimm et al. 2002; Lockwood et al. 2005), though they can re-occupy areas after only one year post-fire under some conditions (Taylor 1983; Werner and Woolfenden 1983). This is probably because of the sparrow's dependence on some level of vegetation structural complexity that must develop to provide cover, support nests, and allow individuals to move through the habitat during wet periods. Lockwood et al. (2003), noted that fire is not uncommon within the areas occupied by sparrows, and nearly all areas where sparrows occurred at that time had been burned within the past 10 to 20 years. A combination of naturally ignited and human-ignited (both prescribed and arson/accidental ignitions) fires have resulted in different fire frequencies in different portions of the sparrow's range. Most of the vegetation species that occur within sparrow habitat are fire-adapted and respond quickly following fire (Snyder 2003). Several of the dominant grass species, including muhlenbergia, also flower primarily following fires during the growing season (Main and Barry 2002). Under normal conditions, fires do not kill the individual plants that make up the dominant species in sparrow habitat, and fires only remove the above-ground growth and leaf litter (Snyder and Schaeffer 2004). The plant species rapidly respond, sprout quickly following fire, and grow rapidly. Many of the dominant grasses may grow more than 15 inches after only a few weeks (Steward and Ornes 1975; Snyder 2003). For this reason, the species composition and even the general structural characteristics of the vegetation may be nearly indistinguishable from unburned areas only two to three years after burning (Lockwood et al. 2005).

The interaction of fire and flooding strongly influence the suitability of habitat for sparrows. In the most extreme case, vegetation that burns and is subsequently flooded within one to three weeks, either because of a natural rainfall event or human-caused flooding due to operations may not recover for up to 10 or more years (Ross, pers. comm. 2006; Sah and Ross 2014). Alternatively, if water levels overtop sprouting grasses after a fire, the grasses may die, resulting in an absence of vegetation. Recovery of vegetation from these circumstances has to result from seed germination, which requires a longer time for recovery than vegetative growth, and may result in a different plant species community (composition and structure) from the vegetation that was present prior to the fire. Under less extreme conditions, vegetation may recover more quickly following fire when water levels are near the soil surface, providing ample water for the plants to grow. In this particular case, the vegetation community (composition) does not change as a result of fire, only the vegetation structure leading to a quicker recovery of the affected vegetation.

Population dynamics

Population Size and Variability

The use of helicopters to facilitate larger spatial-scale surveys for the sparrow was first accomplished in 1974 (Werner 1975). The first comprehensive, range-wide sparrow population survey was conducted in 1981, but was not repeated until 1992. Since that time, surveys have been conducted annually including twice in 1999 and 2000 (Pimm et al. 2002). The number of survey locations has changed through time, from a high of over 850 sites in 1992 to a low of 250 sites in 1995 (Cassey et al. 2007). Over this time period, there have been substantial demographic changes in most of the six subpopulations (Table 12). The 1981 sparrow survey provided a baseline on the distribution and abundance of sparrows at that time, and the 1992 survey results were similar, though there is no information available about how the populations may have changed during the intervening 12 years. In 1981, there were an estimated 6,656 sparrows distributed across six subpopulations, with the majority (86 percent) of the sparrows occurring within subpopulations A (40 percent), B (35 percent), and E (10 percent). By comparison, the last complete CSSS population survey for all the subpopulations (2014) resulted in an estimate of 2,720 sparrows, with the majority of birds occurring within subpopulation B (69 percent) and subpopulation E (25 percent).

Subpopulation A now holds only two percent of the total population. Subpopulation A inhabits the marl prairies west of SRS in ENP and in eastern BCNP. This subpopulation supported over 40 percent of the estimated population total of 6,656 sparrows (approximately 2,688 birds) in 1981. As of 2014, subpopulation A has far fewer birds (an estimated 64 birds). Subpopulation B contained 35 percent of the total population (approximately 2,352 sparrows) that inhabited the marl prairies southeast of SRS near the center of ENP in 1981. As of the 2014 survey, subpopulation B remains one of the most abundant subpopulations, with its population remaining relatively stable containing approximately 69 percent (approximately 1,864 birds). Subpopulation E, north of subpopulation B and also east of SRS, contained over 10 percent of the total population (approximately 672 sparrows) in 1981 while in 2014 it comprised approximately 25 percent of the total population (an estimated 672 birds). Subpopulation C, located near Taylor Slough and along the eastern boundary of ENP, contained over six percent (an estimated 432 birds) of the sparrows in 1981, and in 2014, 4 percent (an estimated 112 birds). Subpopulation D, just to the southeast of subpopulation C, also held approximately six percent (an estimated 400 birds) of the sparrows in 1981 and in 2014, 1 percent (an estimated 32 birds). Subpopulation F, located between SRS and the western edge of the Atlantic coastal ridge along the eastern boundary of ENP, was the smallest subpopulation in 1981, and contained an estimated 112 sparrows or just two percent of the total population and in 2014, 0.5 percent (an estimated 16 birds).

Overall, there have been population declines recorded among all of the subpopulations, and relatively few population increases since 1981. In 1981 and 1992, the area west of SRS, where subpopulation A occurs, supported nearly half of the total CSSS population (Table 12). Subpopulation A has experienced the most dramatic sparrow population change observed, declining from more than 2,600 birds in 1992 to 432 birds in 1993 a decrease of 84 percent

(Pimm et al. 2002). This subpopulation has subsequently remained at a low level, less than 450 sparrows. The estimated population since 1993 has ranged from a high of 448 sparrows in 2000 to a low of 16 sparrows in 2004 and as of 2014 has an estimated population of 64 sparrows.

Subpopulation B has remained relatively constant over time. When first surveyed, subpopulation B contained an estimated 2,352 sparrows inhabiting the marl prairies southeast of SRS near the center of ENP. Subpopulation B remains one of the most abundant subpopulations, with the estimated size in 2014 at around 1,800 sparrows (Table 12). Estimated population size from 1981 to 2014 has ranged from a high of 3,184 sparrows in 1992 to a low of 1,792 sparrows in 2013. While these numbers span a fairly wide range, it is difficult to discern a consistent increasing or decreasing trend in population size over the 1981 to 2014 period in subpopulation B. Based on available data the last three subpopulation B estimates (2010, 2013, and 2014) have trended to the lower end of this range, but this apparent trend is complicated by the fact that no surveys were conducted in this subpopulation in four out of seven years from 2008 to 2014.

By the 1992 survey, subpopulation C, located in the vicinity of Taylor Slough and along the eastern boundary of ENP, declined to about 11 percent of its 1981 estimated size (Table 12). Since 1992, including two years with no sparrow detections, 48 sparrows were estimated in this area in 1996 and 1997, and 80 sparrows were estimated in 1998. Since 2007, the population has varied from at an estimated 32 to 176 sparrows.

Subpopulation D supported an estimated 400 sparrows in 1981, but declined to approximately 96 sparrows in 1993 (Table 12). Although no sparrows were detected in 1994, the population was estimated at 80 sparrows and 176 sparrows in 1995 and 1998, respectively. High water levels likely led to the decrease since 1999 (Slater et al. 2009) with 32 sparrows estimated in 2000. No sparrows were identified within subpopulation D from 2001 through 2003 and 2005 and 2006. Lockwood et al. (2008), concluded that the continual decline in subpopulation D, since its 1981 estimate of 400 sparrows, has possibly left this subpopulation functionally extirpated with few sparrows detected during recent range-wide surveys. Surveys from 2007 through 2011 have documented a few sparrows in this subpopulation. Recent estimates indicate 224, 16, and 32 sparrows in 2012, 2013, and 2014 respectively, although intensive ground surveys in this subpopulation give considerable reason to doubt the estimated number in these years. The main problem facing CSSS subpopulation D continues to be the low population size and highly male-biased sex ratio. It is unclear at this time why male sparrows are returning to subpopulation D while females are not, especially females that were successful breeders in the previous year (Virzi and Davis 2013; Virzi and Davis 2014). This area, like subpopulation A, has suffered from persistent high water levels that may have precluded sparrows from nesting.

Subpopulation E, like subpopulation B, has remained relatively stable since 1981 (Table 12). However, this subpopulation has fluctuated more than subpopulation B.

Estimates for subpopulation F declined from 1981 to 1992, from 112 sparrows to 32 sparrows (Table 12). No sparrows were observed in 1993 or 1995. Only 16 sparrows were estimated for each year from 1996 to 1999. However, the population increased in 2000 to an estimated 112 sparrows, but only 16 sparrows were estimated in 2004, when on-the-ground surveys did not detect evidence of successful breeding, even late in the breeding season when females and young were readily detected in the larger subpopulations (ENP 2005). There have been few sparrows detected in this subpopulation since 2006.

Subpopulations A, C, D and F are the smallest in terms of number of sparrows and area occupied, however A has a large amount of potentially suitable available habitat. Subpopulations D and F have come close to extirpation, with recent surveys detecting few or no sparrows (Boulton et al. 2009; Slater et al. 2009). During the 2006-2008 nesting seasons, intensive ground surveys were conducted in subpopulations C, D, and F, and to the present in subpopulation D, to better understand these small subpopulations (Lockwood et al. 2006; Boulton et al. 2009;Virzi et al. 2013). Data collected in these surveys included territory size, fecundity, nest success and survival rates. Results indicate that the small subpopulations exhibit: (1) suppressed breeding, (2) an excess of single males, (3) nest survival comparable to larger subpopulations, (4) low hatch rate, and 5) larger territory sizes than birds in the larger subpopulations. Boulton et al. (2009) concluded that the small subpopulations are demographically dynamic and subject to the negative effects of low densities (*e.g.*, allee effects). In addition to C and D, subpopulation A was intensively surveyed for the first time in 2009 and positive results were reported for this imperiled subpopulation (Virzi et al. 2009, Virzi et al. 2013). A promising 19 breeding pairs were detected in subpopulation A in 2009 with similar numbers in recent years, and the subpopulation exhibited similar traits to the larger subpopulations like the presence of few unmated males and comparable clutch sizes, adult return rates, and proportion of early to late nests (Virzi et al. 2009, 2013). The subpopulation was reported as extant and functional.

Overall, there has been large population declines recorded among most of the subpopulations and relatively few population increases. These population changes suggest that while declines can occur rapidly, it may take many years of favorable conditions to return to a stable population (Jenkins et al. 2003; Cassey et al. 2007; Lockwood et al. 2008). Since the significant decline of over 2,000 birds in the largest subpopulation A in 1993, that manifested the decline from an estimated overall population of approximately 6,500 birds to approximately 3,300 birds, and from which the sparrow population has not recovered to date, the overall population has varied from a low of 2,416 birds in 1994 to a high of 4,048 birds in 1997.

Population Stability

Recent information indicates that sparrow subpopulations C, D, and F may support fewer sparrows than previously estimated, and the demographics of these subpopulations may differ from the larger subpopulations (Lockwood et al. 2006). Because sparrows typically experience low nest survival, low juvenile survival, and have a relatively short lifespan, we cannot expect sparrow recovery to be rapid (Lockwood et al. 2001). The demographic attributes of sparrows preclude them from rapid recovery particularly when consistently faced with poor conditions (*i.e.*, high water levels and frequent fires) (Lockwood et al. 2008). This information affects assessment of the likelihood of the persistence of these subpopulations and the overall probability of persistence for the species.

With smaller population sizes in these subpopulations than previously assessed, the relative significance of subpopulations B and E with respect to maintaining a viable overall sparrow population is increased. Similarly, evaluations of the potential contributions of the small subpopulations to maintaining the overall sparrow population and buffering it from potential catastrophic events such as widespread fire are reduced (Lockwood et al. 2006). Pimm et al. (2002) and Walters et al. (2000) suggested three breeding subpopulations are necessary for the continued long-term survival of the sparrow. However, Slater et al. (2009) emphasize the need to recover all subpopulations, noting that with 90 to 97 percent of sparrows concentrated within two subpopulations (B and E), the species' vulnerability to stochastic events is particularly acute.

Slater et al. (2009) observed that even though the overall sparrow population has remained stable since the massive decline it experienced in the early 1990s, the population has shown minimal signs of recovery. The Sustainable Ecosystems Institute (SEI 2007a) panel also concluded that, "More important than trying to delineate populations, is recognizing that protecting the subspecies from catastrophic events will require maintaining sparrows over as wide an area as possible. This recognition actually provides a more compelling rationale for maintaining subpopulation A than the need to maintain three populations did, since subpopulation A is the only subpopulation west of SRS. It also suggests more emphasis should be placed on maintaining subpopulation D as the southeastern-most subpopulation."

Status and distribution

Range-wide Trend

The Cape Sable seaside sparrow (*A.m. mirabilis*) was listed as an endangered species on March 11, 1967, pursuant to the Endangered Species Preservation Act of 1966 (32 FR 4001). That protection was continued under the Endangered Species Conservation Act of 1969 and the Endangered Species Act of 1973, as amended in 1998 (Act) (87 Stat. 884; 16 U.S.C. 1531 *et seq*. The Cape Sable seaside sparrow was listed because of its limited distribution and threats to its habitat posed by large-scale conversion of land in South Florida to agricultural uses.

The CSSS was first discovered in the cordgrass (*Spartina* spp.) marshes on Cape Sable in 1918 and was originally thought to be limited in distribution to Cape Sable (Howell 1919). On September 2, 1935, a severe hurricane struck the Keys and southern Florida, with the hurricane's center passing within a few miles of Cape Sable (Stimson 1956). Post-hurricane observations suggest that in the vicinity of Cape Sable water levels resulting from the storm surge rose about 8 feet above normal water levels, and the sparrow was thought to have disappeared from the area due to habitat degradation as a result of the storm surge, despite occasional reports of sparrows that could not be verified (Stimson 1956). Between 1935 and the 1950s, searches on Cape Sable failed to locate sparrows (Stimson 1956). Despite the fact that sparrows were again reported on Cape Sable in 1970 (Kushlan and Bass 1983; Werner and Woolfenden 1983), the habitat in the area had been changing significantly from cordgrass marshes to mangroves and mud flats since the 1935 hurricane, and sparrows were considered to have been extirpated from this area since 1981 (Kushlan and Bass 1983).

In 1972, CSSS were discovered near Taylor Slough (Ogden 1972). Subsequent investigation revealed that a sparrow had been reported to ENP in this area in 1958, but the observation was never verified (Werner 1975; Pimm et al. 2002). Surveys conducted with the use of a helicopter by Werner in 1974 and 1975 sought to characterize the distribution and abundance of sparrows in this region. These initial surveys revealed that sparrows were widely distributed and abundant (Werner 1975). They occupied an area of about 21,745 to 31,629 acres, and the number of sparrows occurring within this area was estimated to range from 1,500 to 26,300 individuals (Werner 1975). Because of the magnitude of the area occupied and the large estimates of population size, ecologists concluded that sparrows probably occurred within this area for many years. The difficulty in accessing the areas and the vastness of the areas (Kushlan and Bass 1983), as well as the secretiveness of the sparrow, all contributed to the failure to document the sparrow's occurrence in the area previously. The sparrow populations within these areas probably fluctuated over time in response to changes in habitat suitability resulting from fires and hydrologic conditions (Taylor 1983; Kushlan and Bass 1983). These fluctuations may have also contributed to the lack of sparrow detections in these areas.

The 1981 sparrow survey provided a good baseline on the distribution and abundance of sparrows at that time, and the 1992 survey results were remarkably similar, though there is no information available about how the population may have changed over the intervening 12 years.

The overall sparrow population has declined since 1992, and there has been no evidence of significant improvements (Table 12). In addition to the decline in overall numbers, the distribution has declined. The sparrow subpopulations that have declined have also contracted toward the center of the remaining habitat patches (Cassey et al. 2007).

Cape sable seaside sparrow critical habitat

Critical habitat for the CSSS was initially designated on August 11, 1977 (42 FR 42840). The critical habitat designation was revised on November 6, 2007 (50 FR 62736) and the revised habitat included the following primary constituent elements (PCE), which are those physical and biological features essential for the conservation of the species:

1. Calcitic marl soils characteristic of the short-hydroperiod freshwater marl prairies of the southern Everglades. These soils support the unique vegetation community and probably many of the food items upon which sparrows depend. They also result from specific hydrologic conditions that are characteristic of the marl prairies. These soils are an integral component of sparrow habitat.

2. Herbaceous vegetation that includes greater than 15 percent combined cover of live and standing dead vegetation of one or more of the following species (when measured across an area of greater than 100 feet): muhly grass, Florida little bluestem, black-topped sedge, and cordgrass. These plant species are largely characteristic of areas where sparrows occur. They act as cover and substrate for foraging, nesting, and normal behavior for sparrows during a variety of environmental conditions. Many other herbaceous plant species and low-growing forbs also occur within sparrow habitat (Ross et al. 2006), and

30

some of these may have important roles in the life history of the sparrow. However, the species identified in the PCE consistently occur in areas occupied by sparrows (Sah et al. 2007).

3. Contiguous open habitat. Sparrow subpopulations require large, expansive, contiguous habitat patches with few or sparse woody shrubs or trees. This PCE provides the space for population and individual growth, and also provides the open, contiguous habitat that sparrows prefer.

4. Hydrologic regime such that the water depth, as measured from the water surface down to the soil surface, does not exceed 7.9 inches longer than 30 days during the period from March 15 to June 30 more than 2 out of every 10 years. Currently, critical habitat includes areas of land, water, and airspace in the Taylor Slough vicinity of Collier, Miami-Dade, and Monroe Counties. Much of this area is within the boundaries of ENP. The designated area encompasses about 84,865 acres and includes portions of subpopulations B through F (Figure 3).

Everglade snail kite (*Rostrhamus sociabilis plumbeus*)

Species/critical habitat description

The Everglade snail kite is one of three subspecies of snail kite, a wide-ranging New World raptor found primarily in lowland freshwater marshes in tropical and subtropical America from Florida, Cuba, and Mexico south to Argentina and Peru. The Everglade subspecies occurs in Florida and Cuba, though only the Florida population is listed. The Florida population was first listed under the Endangered Species Preservation Act in 1967, and protection was continued under the Endangered Species Conservation Act of 1969. The Everglade snail kite, and all the other species listed under the Endangered Species Conservation Act of 1969 were the first species protected under the Act of 1973, as amended, and all of these species were given the 'endangered' status.

Life history

Everglade snail kites are dietary specialists, a relatively rare foraging strategy among raptors. The Florida apple snail (*Pomacea paludosa*) is the kite's principal prey in Florida and makes up the great majority of the kites' diet (Sykes 1987a; Kitchens et al. 2002). Throughout the range of all subspecies of snail kites, pomacea snails consistently compose the primary prey of snail kites (Sykes 1987a; Beissinger 1990). Several species of non-native apple snails have become established within the kite's range in Florida and have been used to varying degrees by snail kites. Whether exotic apple snails are a threat to snail kites has not been fully discerned (SEI 2007a,b; Cattau 2010). Shells collected at nests in recent years reveal that a large proportion of snails utilized by kites are exotic (Cattau et al. 2012). Extensive use of exotic snails by kites has occurred in the Kissimmee River Valley since 2005 and more recently in Lake Okeechobee, the stormwater treatment areas (STAs), and some WCAs, likely due to the continued spread of the exotic snail (Cattau 2008; Cattau et al. 2010). A recent study demonstrated that difficulties experienced by kites handling exotic snails may have negative repercussions to juvenile energy balances and raised potential concerns about the effects of exotic snails on kite recruitment

(Darby et al. 2007). Field work for this study was conducted from 2003 through early-2007; however, due to the low numbers of kites using Lake Tohopekaliga (Toho) in 2003-2004, the bulk of the data from Toho was collected in 2005-2006. Subsequent work has revealed that the median size of exotic snails consumed by kites in Toho remained relatively stable. In addition, handling times remain higher for exotic snails than native snails. Recent observations indicate that kites are successfully foraging in hydrilla dominated habitats (Cattau et al. 2009), which appear to be utilized by smaller size exotic apple snails (Cattau et al. 2009).

While kites appear to continue to be foraging on relatively large exotic snails, there have been no data to suggest detrimental demographic effects, as hypothesized in Cattau et al. (2010). There are several reasons why this may be the case, such as changes in foraging behavior or that the energetic deficit shown in Cattau et al. (2010) may not have translated to demographic changes in survival or reproduction. Cattau, pers. comm. (2015) summarized that despite concerns raised by earlier studies of foraging behavior and energetics (e.g. Darby et al. 2007, Cattau et al. 2010), which found that exotic snails can have negative effects on kite foraging performance measures and potentially on energy balances of juvenile kites, one of the key findings from their recent work, in which they tested explicitly for exotic snail effects on kite demographic rates, was that exotic snail populations actually seem to provide a net benefit to snail kite population growth, at least in the near term. Exotic snail presence was positively associated with juvenile apparent survival (contrary to predictions made in Cattau et al. (2010), young/successful nest, and breeding rates (Cattau 2014; Cattau, pers. comm. 2015). The increased nesting effort and reproductive output in many wetlands during the last two years may be attributable, at least in part, to the presence and abundance of the exotic apple snail (Cattau 2014). These potential linkages will continue to be assessed.

The close tie between the Everglade snail kite and the Florida apple snail requires consideration of both species when developing management strategies and addressing potential impacts. Everglade snail kites and their primary prey are both wetland-dependent species and rely on wetland habitats for all aspects of their life history. The primary wetland habitat types upon which kites rely consist of freshwater marshes and the shallow-vegetated littoral zones along the edges of lakes (natural and man-made) where apple snails occur in relatively high abundance and can be found and captured by kites.

While kites are capable of foraging successfully under a variety of habitat conditions, the preferred foraging habitat is typically a combination of relatively short-stature, sparse graminoid marsh vegetation less than 6.5 feet in height. The apple snail requires emergent aquatic plants to provide substrate that allows them to reach the water surface to breathe. However, for kites to feed, the emergent vegetation must be sparse enough that they are capable of locating and capturing snails (Kitchens et al. 2002). Marshes and lake littoral zones composed of interconnected areas of open water 0.6 to 4.3 feet deep which are relatively clear and calm and patches of herbaceous emergent wetland plants or sparse continuous growth of herbaceous wetland plants generally provide the appropriate balance of emergent vegetation and open water (Sykes et al. 1995; Kitchens et al. 2002). Marsh species that commonly occur within favorable kite foraging habitat include spike rush (*Eleocharis cellulosa*), maidencane (*Panicum hemitomon*), sawgrass, bulrush (*Scirpus* spp.), and/or cattails. Shallow open-water areas may also contain sparse cover of species such as white water lily (*Nymphaea odorata*), arrowhead

(*Sagittaria lancifolia*), pickerel weed (*Pontederia lanceolata*), and floating heart (*Nymphoides aquatica*). Periphyton growth on the submerged substrate provides a food source for apple snails. Submergent aquatic plants, such as bladderworts (*Utricularia* spp.) and eelgrass (*Vallisneria* spp), may contribute to favorable conditions for apple snails while not preventing kites from detecting snails (Sykes et al. 1995).

Using field data from 1995 to 2004, Darby et al. (2006) estimated snail densities less than 0.14 individuals per square-meter are unable to support kite foraging. Darby et al. (2008) also reported that adult snails can survive dry downs lasting up to 12 weeks, although smaller snails survive at lower rates (<50 percent alive after 8 dry weeks). Snail recruitment may be truncated if dry downs occur during the peak breeding season when young snails can become stranded (Darby et al. 2008). Darby et al. (2009) recommended a range of water depths between 4 and 20 inches during the peak apple snail breeding period between April and June. Foraging habitat conditions that differ substantially from those described above will result in either reduced apple snail density or reduced ability of snail kites to locate and capture snails. Vegetation cover that is either too dense or too sparse can result in reduction in the quality of the area as foraging habitat.

The Everglade snail kite breeding season in Florida varies from year-to-year and is probably affected by rainfall and water levels (Sykes et al. 1995). Ninety-eight percent of the nesting attempts are initiated from December through July, while 89 percent are initiated from January through June (Sykes 1987c; Beissinger 1988; Snyder et al. 1989), with the peak in nest initiation occurring from February to April (Sykes 1987c). Snail kites often re-nest following failed attempts early in the season as well as after successful attempts (Beissinger 1986; Snyder et al. 1989), but the actual number of clutches per breeding season is not well documented (Sykes et al. 1995).

Pair bonds are established prior to egg-laying and are relatively short, typically lasting from nest initiation through most of the nestling stage (Beissinger 1986; Sykes et al. 1995). Male kites select nest sites and conduct most nest-building, which is probably part of courtship (Sykes 1987c; Sykes et al. 1995). Unlike most raptors, snail kites do not defend large territories and frequently nest in loose colonies or in association with wading bird nesting colonies (Sykes 1987b; Sykes et al. 1995). Kites actively defend small territories extending about 4 miles around the nest (Sykes 1987b). Copulation can occur from early stages of nest construction, through egg-laying, and during early incubation, if the clutch is not complete. Egg-laying begins soon after completion of the nest, but may be delayed a week or more (Sykes 1987c). An average 2-day interval between laying each egg results in the laying of a three-egg clutch in about 6 days (Sykes et al. 1995). The clutch size ranges from one to five eggs, with a mode of three (Sykes 1987c; Beissinger 1988; Snyder et al. 1989). Incubation may begin after the first egg is laid, but generally after the second egg with the incubation period lasting 24 to 30 days in Florida (Sykes 1987c). Incubation is shared by both sexes, but the contribution of incubation time between the male and female is variable (Beissinger 1987). Hatching success is variable from year-to-year and between areas. In nests where at least one egg hatched, hatching success averaged 2.3 chicks per nest (Sykes 1987c).

After hatching, both parents initially participate in feeding young, but there is variability in the contribution of each member of the pair (Beissinger 1987). The nestling period lasts about 23 to 34 days and fledging dates may vary by 5 days among chicks (Sykes et al. 1995). Following fledging, young are fed by one or both adults until they are 9 to 11 weeks old (Beissinger 1987).

In total, snail kites have a nesting cycle that lasts about 4 months from initiation of nest-building through independence of young (Beissinger 1986; Sykes et al. 1995).

Snail kites also have a relatively unique mating system in Florida that is described as ambisexual mate desertion, in which either the male or female may abandon nests part way through the nestling stage (Beissinger 1986, 1987). This behavior appears to occur primarily under conditions when prey is abundant, and it may be an adaptation to maximize productivity during favorable conditions. Following abandonment, the remaining parent continues to feed and attend chicks through independence (Beissinger 1986). Abandoning parents presumably form new pair bonds and initiate a new nesting attempt. Snail kites mature early compared with many other raptors and can breed successfully the first spring after they hatch, when they are about 8 to 10 months old. However, not all kites breed at this age. Bennetts et al. (1998) reported that only 3 out of 9 first-year snail kites attempted to breed, while all 23 adults that were tracked attempted to breed. Of the 23 adult kites, 15 attempted to breed once, seven attempted to breed twice, and one individual attempted to breed 3 times. Only one adult kite successfully fledged two clutches (Bennetts et al. 1998). Adult kites generally attempt to breed every year with the exception of drought years, when some kites may not attempt to nest (Sykes et al. 1995).

Nesting almost always occurs over water, which deters predation (Sykes 1987b). An important feature for snail kite nesting habitat is the proximity of suitable nesting sites to favorable foraging areas. Thus, extensive stands of contiguous woody vegetation are generally unsuitable for nesting, whereas suitable nest sites consist of single trees or shrubs or small clumps of trees and shrubs within or adjacent to an extensive area of suitable foraging habitat. Trees including willow (*Salix* spp.), bald cypress (*Taxodium distichum*), pond cypress (*Taxodium ascendens*), *Melaleuca quinquenervia*, sweetbay (*Magnolia virginiana*), swamp bay (*Persea palustris*), pond apple (*Annona glabra*), and dahoon holly (*Ilex cassine*), usually less than 32 feet tall are used for nesting. Shrubs used for nesting include wax myrtle (*Myrica cerifera*), cocoplum (*Chrysobalanus icaco*), buttonbush (*Cephalanthus occidentalis*), *Sesbania* sp, elderberry (*Sambucus simpsonii*), and Brazilian pepper (*Schinus terebinthifolius*). Nesting also can occur in herbaceous vegetation, such as sawgrass, cattail, bulrush, and reed (*Phragmites australis*) (Sykes et al. 1995). Nests are more often observed in herbaceous vegetation around Lake Kissimmee and Lake Okeechobee during periods of low water, when dry conditions beneath the willow stands (which tend to grow to the landward side of the cattails, bulrushes, and reeds) prevent snail kites from nesting in woody vegetation. Nests constructed in herbaceous vegetation on the waterward side of the lakes' littoral zones are more vulnerable to collapse due to the weight of the nests, wind, waves, and boat wakes and are more exposed to disturbance by humans (Chandler and Anderson 1974; Sykes and Chandler 1974; Sykes 1987b; Beissinger 1986, 1988; Snyder et al. 1989).

On average, adult snail kites have relatively high annual survival rates with estimated average rates ranging from 85 to 98 percent (Nichols et al. 1980; Bennetts et al. 1999; Martin et al. 2006). Adult survival is probably reduced in drought years (Takekawa and Beissinger 1989; Martin et al. 2006). However, adult survival appears to be relatively constant over time at a relatively high level (>80 percent) (Bennetts et al. 1999; Martin et al. 2006; Cattau et al. 2009). Adult longevity records indicate kites may frequently live longer than 13 years in the wild (Sykes et al. 1995).

Everglade snail kites may roost communally outside of breeding season and, occasionally, roost in groups of up to 400 or more individuals (Bennetts et al. 1994). Roosting sites are also usually located over water. On average, in Florida, 91.6 percent of roost sites are located in willows, 5.6 percent in melaleuca, and 2.8 percent in pond cypress. Roost sites are in taller vegetation among low profile marshes. Snail kites tend to roost around small openings in willow stands at a height of 5.9 to 20.0 feet in stand sizes of 0.05 to 12.35 acres. Roosting also has been observed in melaleuca or pond cypress stands with tree heights of 13 to 40 feet (Sykes 1985).

Snail kites are considered nomadic, and this behavior pattern is probably a response to changing hydrologic conditions (Sykes 1979). During breeding season, kites remain close to their nest sites until they fledge young or fail. Following fledging, adults may remain around the nest for several weeks, but once young are fully independent adults may depart the area. Outside of breeding season, snail kites regularly travel long distances within and among wetland systems in southern Florida (Bennetts and Kitchens 1997). While most movements may be in response to droughts or other unfavorable conditions, kites may also move away from wetlands when conditions appear favorable. Movements within large wetlands and movements among adjacent wetland units occurred frequently, while movements among spatially-isolated wetlands occurred less frequently (Martin et al. 2006). Fledgling kites also move frequently, but are more likely to move to immediately adjacent wetland units than adults, which may indicate a degree of familiarity with the availability of wetlands across the landscape that adult kites acquire through experience.

Snail kites are gregarious. In addition to nesting in loose colonies and roosting communally in large numbers, kites may also forage in common areas in proximity to other foraging kites.

Population dynamics

From a demographic perspective, Everglade snail kites appear to exhibit high levels of variability in some demographic parameters, while others remain relatively constant. For example, distribution of nesting appears to fluctuate dramatically based on annual variability of specific environmental factors, most notably apple snail density and availability (which in turn are affected by current and previous year water levels). Similarly, productivity appears to be highly variable and heavily influenced by environmental conditions (Sykes 1979; Beissinger 1989, 1995; Sykes et al. 1995). Duration of breeding season and amount of double or triple-brooding are also variable (Beissinger 1986). Juvenile survival also appears to be highly variable among years (Figure 4; (Beissinger 1995; Bennetts and Kitchens 1999; Martin and Kitchens 2003; Martin et al. 2006; Cattau et al. 2009).

The observed variability in juvenile survival is related to variation in environmental conditions, including those hydrologic conditions that directly affect the survival and productivity of the apple snail. Because the apple snail is the primary source of food for the snail kite, hydrologic conditions that affect the survival and productivity of the apple snail have significant effects on snail kite nest success and the survival of juvenile snail kites. In contrast, adult survival appears to be relatively constant over time at a relatively high level (>80 percent) (Bennetts et al. 1999; Martin et al. 2006; Cattau et al. 2009), with the exception of appreciable drops from 2000 through 2002, and again from 2006 through 2008 (Figure 4). During these years, adult survival decreased by 16 percent from 2000 to 2002 (Martin et al. 2006), and by approximately 35 percent from 2006 to 2008 (Cattau et al. 2009). These temporary low adult survival rates coincided with significant declines in the overall population associated with region-wide droughts during 2001 and 2007 (Figure 5). During more localized droughts, their nomadic behavior allows kites to survive and even reproduce (at lower levels) in areas less affected by the unfavorable conditions. Under favorable environmental conditions, kites have the ability to achieve high reproductive rates (Beissinger 1986), and similarly, juvenile survival rates appear to be higher under more favorable conditions.

Several authors (Nicholson 1926; Howell 1932; Bent 1937) indicated that the snail kite was numerous in central and southern Florida marshes during the early 1900s, with groups of up to 100 birds. Reports of snail kite population declines in the 1940s and 1950s suggested that as few as 6 to 100 individuals remained (Sykes 1979). When the snail kite was listed as endangered in 1967, the species was considered to be at an extremely low population level. In 1965, only 10 birds were found, 8 in WCA-2A, and 2 at Lake Okeechobee. A survey in 1967 found 21 birds in WCA-2A (Stieglitz and Thompson 1967). Relatively large fluctuations in the Everglade snail kite population size have been widely reported and generally attributed to environmental conditions (Beissinger 1986; Beissinger 1995; Martin et al. 2006; Cattau et al. 2008). It is unclear whether the reports of declines were completely from a loss in the number of individuals or a result of the kite's nomadic behavior, limited survey efforts, and the lack of biological knowledge of the species.

As it was not known at the time that snail kites are nomadic in response to unfavorable hydrologic conditions (Sykes 1979), it is possible the surveys were documenting more the absence of snail kites from their usual locations, including Lake Okeechobee and the headwaters of the St. John's marsh (Sykes 1979), and not entirely from the actual loss of individual kites. In addition, limited resources were available at that time for researchers to reach potential snail kite habitats. As such, the resulting low level of survey effort may have biased these low snail kite population estimates. Rodgers et al. (1988) have stated that it is unknown whether decreases in reported snail kite numbers in the annual count are due to mortality, dispersal (into areas not counted), decreased productivity, or a combination of these factors. However, there is little doubt that the snail kite was endangered at the time of its listing and that its range had been dramatically reduced.

Prior to 1969, the snail kite population was monitored only through sporadic and inconsistent surveys (Sykes 1979, 1984). From 1969 to 1994, an annual quasi-systematic mid-winter snail kite count was conducted by a succession of principal investigators, with counts ranging from a low of 65 kites in 1972 to a high of 996 kites in 1994 (Sykes 1979; Sykes 1983; Beissinger 1986; Bennetts et al. 1999). Bennetts et al. (1993, 1994) cautioned that the 1993 and 1994 counts were performed with the advantage of having numerous birds radio-tagged. This likely increased the total count because radio-tagged birds could easily be located and often led researchers to roosts that had not been previously surveyed. Bennetts and Kitchens (1997) identified issues with the count surveys and recommended that they should not be the basis of population estimates or used to infer demographic parameters such as survival or recruitment. Bennetts et al. (1999) analyzed these counts and the sources of variation in these counts and determined that count totals were influenced by differences in observers, survey effort, hydrologic conditions, and site effects. While significant sources of error were identified, these data could provide a crude indication of trends if all influences of detection rates had been adequately taken into account. The sources of variation in the counts should be recognized prior to using these data in subsequent interpretations, especially in attempting to determine population viability and the risk of extinction.

Refined population estimates were generated for the Everglade snail kite using a mark-recapture method beginning in 1997 (Dreitz et al. 2002). These new population estimates, which incorporate detection probability (<1.0), are higher than those resulting from the previous counts. Population size estimates generated from mark-recapture estimates for 1997 to 2000 are approximately 2 to 3 times higher than previous count-based estimates (*e.g.*, 800 to 1,000 estimated snail kites based on count-based surveys in 1993 and 1995, compared to an estimated 2,700 to 3,500 kites based on mark-recapture analyses from 1997 to 2000) (Bennetts and Kitchens 1997; Dreitz et al. 2002). Confidence intervals can also be generated for population estimates generated using the new method, which increases the validity of comparing population estimates among years.

Since 1997, population estimates and estimates of demographic parameters have been generated exclusively employing mark-recapture methods that incorporate detection probabilities. From 1997 through 1999, the snail kite population was estimated to be approximately 3,000 birds (Dreitz et al. 2002). From 1999 through 2002, the population estimates declined each year until they reached a low level of approximately 1,400 birds in 2002 and 2003, then increased slightly to about 1,700 birds in 2004 and 2005 (Martin et al. 2006). The snail kite population exhibited steep declines in both 2007 and 2008, with estimates of 1,204 birds and 685 birds, respectively, but rebounded slightly starting in 2010. The 2012 population estimate was 1,218 birds (Cattau et al. 2012), the 2013 estimate is 1,198 birds (Fletcher et al. 2014), and the 2014 estimate is 1,754 birds (Fletcher pers. comm. 2015).

The observed declines in the kite population from 1999 to 2002 (Figure 5) coincided with a regional drought that affected central and South Florida during 2000 to 2001. During this period, nest success was generally low, and demographic parameters estimated using mark-recapture methods indicated low juvenile survival rates (Martin et al. 2006). Adult survival also declined during 2001 (Figure 4; Martin et al. 2006). Despite the return to normal or wetter-than-normal hydrologic conditions from 2002 to 2006, which generally provide favorable snail kite nesting conditions, population estimates remained low, and nest success and juvenile survival rates also remained low (Martin et al. 2006). Nest success and number of young fledged increased slightly in 2007 and 2008 (Cattau et al. 2009), despite severe drought conditions in 2007. Juvenile survival significantly increased from 0.226 in 2006 to 0.558 in 2007, then decreased again to 0.381 in 2008 (Cattau et al. 2009). Conversely, adult survival decreased significantly in 2007 from 0.834 to 0.538, then rebounded to 0.826 in 2008 (Cattau et al. 2009). These irregularities are likely a result of the increased utilization of the Kissimmee Chain of Lakes (KCOL), where a majority of young fledged in 2007. Historically, water levels in KCOL have been less affected by adverse drought conditions (Bennetts and Kitchens 1997).

In 2012 and 2013, conditions in Lake Okeechobee continued to improve for kites, and in WCA-3A there was a marked increase in nesting attempts (68 nests) although only 18 of these were successful. Hypotheses for this increase range from naturally occurring favorable hydrologic and climatic conditions to an observed increase in the abundance of exotic apple snails in southern WCA-3A. Environmental conditions in the KCOL continued to allow for the highest nest success rates. While the estimated population size for 2012 along with the increased number of fledglings counted during the 2011 and 2012 breeding seasons are encouraging trends, it remains unclear whether such trends signify the beginning of a recovery phase.

Based on demographic parameters generated using mark-recapture methodology, a population viability analysis (PVA) for the Everglade snail kites was conducted in 2006. This PVA indicated that there is a high probability of quasi-extinction (identified as $\leq$ 50 female snail kites) within the next 50 years if current reproduction, survival, and drought frequency rates remain the same as those observed from 1996 to 2006 (Martin et al. 2007; Cattau et al. 2008, 2009). Quasi-extinction risk is the probability of a population falling below a critical density – an extremely undesirable population level that may be unlikely to be recoverable even with drastic management steps, such as captive breeding.

Snail kite researchers conducted a new PVA which updated the demographic parameters and incorporated effects of variable environmental (hydrologic) states. According to Cattau et al. (2012), the results from the PVA conducted in 2010 "predict a 95 percent probability of population extinction within 40 years." They further state, "These results are especially concerning, as they indicate an increased risk of extinction when compared to results from a previous PVA conducted in 2006. Recent analyses also provide indications of an aging population with problems inherent to older individuals, including increased adult mortality rates and decreased probabilities of attempting to breed, both of which have been shown to be exacerbated during times of harsh environmental conditions" (Cattau et al. 2012).

Status and distribution

In Florida, the historic range of the snail kite was larger than at present. The current distribution of the snail kite in Florida is limited to central and southern portions of the State. Six large freshwater systems are located within the current range of the snail kite: Upper St. Johns marshes, KCOL, Lake Okeechobee, Loxahatchee Slough, the Everglades, and the Big Cypress basin (Beissinger and Takekawa 1983; Sykes 1984; Rodgers et al. 1988; Bennetts and Kitchens 1992; Rumbold and Mihalik 1994; Sykes et al. 1995; Martin et al. 2005). Habitats that have supported snail kites in the Upper St. Johns drainage include the East Orlando Wilderness Park, the Blue Cypress Water Management Area, the St. Johns Reservoir, and the Cloud Lake, Strazzulla, and Indrio impoundments, with most current nesting occurring within the Blue Cypress Water Management Area, also referred to as the St. Johns Marsh (Martin et al. 2006). In the KCOL, snail kites may occur within most of the lakes and adjacent wetlands, with the majority of kite nesting occurring within Lake Kissimmee, Lake Tohopekaliga, and East Lake Tohopekaliga. In the KCOL, kites have also nested in lower numbers on Lakes Hatchineha, Istokpoga, and Jackson.

Lake Okeechobee and surrounding wetlands represent significant snail kite nesting and foraging habitats that have historically supported kites. In the Loxahatchee Slough region of Palm Beach County, snail kites may occur in the Loxahatchee National Wildlife Refuge (NWR; WCA-1) and throughout the remaining marshes in the vicinity, most frequently nesting within Grassy Waters, also known as the West Palm Beach Water Catchment Area. Kites may occur within nearly all remaining wetlands of the Everglades region, with recent nesting occurring within WCA-2B, WCA-3A, WCA-3B, and ENP (Martin et al. 2006). Within the Big Cypress basin, snail kites may occur within most of the non-forested and sparsely forested wetlands. Nesting has not been regularly documented in this area in recent years, though some nesting likely occurs.

Lake Okeechobee is of particular importance since it serves as a critical stopover point as snail kites traverse the network of wetlands within their range. A loss of suitable habitat and refugium, especially during droughts in the lake, may have significant demographic consequences (Takekawa and Beissinger 1989; Kitchens et al. 2002; Martin et al. 2006a). Once a productive breeding site, Lake Okeechobee made only minor contributions to the snail kite population in terms of reproduction from 1996 to 2006 (Cattau et al. 2008). The loss of suitable snail kite foraging and nesting areas within Lake Okeechobee was attributed to shifts in water management regimes (Bennetts and Kitchens 1997), along with habitat degradation due to hurricanes (Cattau et al. 2008). Most of the nesting in Lake Okeechobee prior to 2007 had occurred within the expansive marsh in the southwestern portion of the lake and the area southwest of the inflow of the Kissimmee River (Martin et al. 2006). However, there was no nesting within Lake Okeechobee from 2007 to 2009 and only limited nesting in 2010 within portions of the lake that are outside of the historic nesting areas.

The 2010 nesting occurred in two general areas: (1) the littoral zone from just west of where the Kissimmee River enters the lake northward to the city of Okeechobee, including Eagle Bay Marsh and (2) near Observation Island, located along the open water edge of the littoral zone in the southwest portion of the lake. However, since then, water levels in the lake have generally been lower and aquatic vegetation has improved in the lake. As a result, snail kite nesting attempts have increased. In 2011, there were 39 nest attempts, but only 16 were successful producing 26 nestlings. In 2012, there were 76 nest attempts, but only 23 were successful producing 43 nestlings. Okeechobee accounted for 25 percent of the range-wide nesting effort and produced 21 percent of the fledglings in 2012 (Cattau et al. 2012). Data have not yet been verified for 2013, but indications are that nesting attempts and success were similar to of 2012.

It is important to note there has been a large increase in the exotic apple snail population in the last few years in Lake Okeechobee. Snail kites are exploiting this population, but the long term sustainability of this is unclear. The abundance of native apple snails seems to be too low to support large numbers of nesting snail kites on Lake Okeechobee.

Water Conservation Area 3A, once an important snail kite foraging and nesting area, no longer supports high densities of snail kites. Historically, the WCAs, and WCA-3A in particular, have fledged, proportionally, the large majority of young in the region. No young were fledged in WCA-3A in 2001, 2005, 2007, 2008, or 2010. In 2012, only one successful nest, which fledged one young, was observed in WCA-3A. The decline in breeding activity and success observed in WCA-3A over recent years may reflect deteriorating habitat quality. Although the overall trend in WCA-3A has been down, recent upticks in successful nesting attempts in 2011 and 2013 may indicate a positive change in suitable habitat. In 2013, there were 68 nesting attempts predominantly in southwestern WCA-3A of which 18 were successful resulting in 27 fledged birds.

It is unclear at this time why kites have increased their usage of WCA-3A; however, it may just be the natural variation in favorable hydrologic and climatic conditions. An increase in exotic apple snail abundance in lower WCA-3A may also be playing a role in increased usage. Nesting

39

activity for the WCAs is summarized in Table 13 for the years 1994 to 2013. The shift in dependence from Lake Okeechobee and WCA-3A to the KCOL is readily apparent as reproduction within the KCOL watershed has accounted for 52, 12, 89, 72, and 61 percent of the successful nesting attempts range-wide in 2005, 2006, 2007, 2008, and 2009, respectively (Cattau et al. 2009). Lake Toho accounted for 41 percent of all successful nests and 57 percent of all fledged young that were documented on a range-wide basis from 2005-2010. In 2012, Lake Toho accounted for 25 percent and 24 percent of all successful nests and fledged young, respectively. In 2011, an unprecedented amount of breeding activity occurred on East Toho, which was utilized heavily by breeding kites again in 2012, accounting for 27 percent and 30 percent of all successful nests and fledged young, respectively.

In addition to the primary wetlands discussed above, there are numerous records of kite occurrence and nesting within isolated wetlands throughout the region. In the 1990s, Sykes et al. (1995) observed snail kites using smaller, more isolated wetlands including the Savannas State Preserve in St. Lucie County, Hancock Impoundment in Hendry County, and Lehigh Acres in Lee County. Takekawa and Beissinger (1989) identified numerous wetlands that they considered drought refugia, which may provide kite foraging habitat when conditions in the larger more traditionally occupied wetlands are unsuitable. Radio tracking of snail kites has also revealed that the network of habitats used by the species includes many smaller, widely dispersed wetlands within this overall range (Bennetts and Kitchens 1997). Snail kites may use nearly any wetland within southern Florida under some conditions and during some portions of their life history. For example, 2010 snail kite nesting surveys documented nesting in surprisingly high numbers in peripheral areas such as Harns Marsh, in Lehigh Acres, and stormwater treatment area (STA) 5. A kite nest and juveniles were also observed for the first time in the S-332D detention area in eastern ENP, also known as the Frog Pond. However, the majority of nesting continues to be concentrated within the large marsh and lake systems of the Greater Everglades, the Kissimmee basin, and the Upper St. John's marshes.

Recent population estimates are two to three times more accurate than those produced prior to 1997 owing to the improved mark-resighting method first applied in 1997 to 2000 and refined in 2002 (Dreitz 2000; Dreitz et al. 2002). While it is not possible to compare the current population size to those recorded from the 1970s through 1997 due to differences in sampling methods, several lines of evidence suggest that the current kite population has declined and may continue to decline. Two major reductions in numbers occurred following region-wide droughts in 2001 and 2007 (Dreitz et al. 2002; Martin et al. 2007; Cattau et al. 2008). The kite population dropped by more than 75 percent from an estimate of approximately 3,400 birds in 1999 to fewer than 700 in 2008 and 2009 (Figure 5; Cattau et al. 2009). In addition to negative effects of regional droughts on adult and juvenile survival, the distribution of nesting activity prior to 2011 suggests that several of the traditional nesting areas (Lake Okeechobee and WCA-3A) had suffered from a decreased forage base and the loss of suitable foraging and nesting habitat. Low productivity, both in terms of low rates of nest initiation and low success rates from those nests initiated, suggests that conditions were poor for kite nesting in those years.

More recently, conditions in Lake Okeechobee have improved and in 2011 and 2013 in WCA-3A. Relatively low juvenile survival rates in recent years also support the conclusion that conditions for kites in the recent past have been relatively unfavorable due to a variety of factors. Recent studies implicate low recruitment and a decline in the species' nearly exclusive food source, the apple snail, as factors in the pre-2011 population decline (Cattau et al. 2008). The increase in abundance and distribution of exotic apple snails since then has seemed to be one of the reasons for the recent kite population increase. The existing water management system, especially during extreme meteorological conditions, contributes to unnatural water levels and altered marsh recession rates that are hypothesized causes for the decline in snail kites and their native prey. Because apple snails are the primary food source for the snail kite, changes in hydrology that affect the survival and productivity of the apple snail and their availability to snail kites have a direct effect on the survival and productivity of the snail kite (Mooij et al. 2002).

Studies of native apple snail abundance and occurrence within traditional snail kite nesting areas also support conclusions that foraging conditions may have been poor in some of those areas. Darby et al. (2005) reported that native apple snail abundance was relatively low in areas of traditional snail kite use within Lakes Kissimmee, Tohopekaliga, and Okeechobee. Wight et al. (2013) reported finding no native adult apple snails in the northern and northwestern sections of Lake Okeechobee in 2012 (native snail egg masses were observed); however, they reported densities of exotic apples snails ranging from 0.17 to 8.5 snails/m^2. The size distribution for these exotic snails were similar to native snails that kites typically target for foraging (i.e., 75 percent were 30-50 mm in size; average size 29 ± 10 mm StdDev).

In 2002 and 2003, Darby et al. (2005) found high snail densities (e.g., > 1.0 snail per m2) at sampled sites in southern WCA-3A. In 2004, they documented an 80 percent reduction in snail densities at these same sites. This dramatic decline followed a wet spring during 2003, in which water depths remained above 1.3 to 2.0 feet during the peak snail reproductive season (April to June) and snail egg cluster production was both delayed and reduced (Darby et al. 2005). Relatively low snail densities (0.02 to 0.40 snails per m^2) continued at sampled sites into 2005 to 2007 (Darby et al. 2009). Calculated annual per capita egg production (total number of egg clusters for the year divided by snail density) at these sites ranged from 4 to 45. Darby et al. (2009) concluded that an annual per capita egg production of approximately 15 to 20 would result in a stable or increasing snail population in the following year. Conversely an annual per capita egg production ≤ 5 would result in a substantial decline in the snail population the following year (Darby et al. 2009). Comparing the data collected in the 2002 to 2004 study with the data collected in the 2005 to 2007 study revealed that snail demography is directly impacted by temporal and spatial variations in hydrologic conditions – specifically, minimum and maximum water depths during the dry (breeding) season (Darby et al. 2009).

Currently, snail densities in WCA-3A have still not recovered compared to densities found in 2002-2003 (Wight et al. 2013). In all sites sampled in WCA-3A in 2010-2012, snail densities were <0.2 snails/m^2 and in many sites no snails were found (Wight et al. 2013). Overall snail densities in WCA-3A were relatively low compared to sites sampled in 2003 in which most sites had snail densities >0.5 snails/m^2. No exotic snails were found in any sites in WCA-3A in 2002-2007; however, in 2011, exotic snails were found in several sites in southwestern WCA-3A. Native snails found in WCA-3A from 2011-2012 had an average size of 28 mm. Exotic snails had an average size of 53 mm, and in general overlapped with the native snails at sizes >30 mm. In WCA-3B, densities were similar between 2006 and 2012, and very low (<0.1 snail/m^2). No exotic snails were found in WCA-3B in 2010 or 2012 (Wight et al. 2013).

Everglade snail kite critical habitat

In total, about 841,635 acres of critical habitat (Figure 6) for the Everglade snail kite was designated in 1977 (50 CFR 17.95). Because this designation was one of the earliest under the Act, PCEs were not defined. The designation identified nine critical habitat units (HU; Table 14) that included two small reservoirs, the littoral zone of Lake Okeechobee, and areas of the Everglades marshes within the WCAs and ENP. Since this designation, the utilization of these critical HUs by snail kites as productive nesting areas has varied significantly and has also included areas that were not designated as critical habitat. Most recently, the KCOL, Lake Tohopekaliga in particular, now supports the greatest number of snail kites in Florida. This shift in productive nesting areas has been in response to regional droughts as well as habitat degradation in historic breeding locations. While the KCOL is now considered an important habitat for the snail kite, this was not the case when critical habitat was designated in 1977, and the KCOL was not included in the original designation.

High water levels and extended hydroperiods have resulted in vegetation shifts within WCA-3A, degrading snail kite habitat. The extended deep water conditions from September into January or beyond, whether as a result of meteorological conditions, regulation schedules, or a combination of both, appear to have reduced the amount of woody vegetation in the area and contributed to the transition of wet prairies to open water sloughs in WCA-3A (Zweig 2008; Zweig and Kitchens 2008). In addition to deeper water conditions, hydroperiods in WCA-3A have increased, lengthening the time between drying events and further contributing to the conversion of wet prairie.

Mammals

Florida bonneted bat (*Eumops floridalis*)

The Florida bonneted bat is a federally endangered species. A complete discussion of the status of this species, including the most recent species assessment and the final rule to list the bat as endangered, may be found at:
http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=A0JB.

Species/critical habitat description

The Florida bonneted bat is a large, free-tailed bat approximately 5.1 – 6.5 inches (130-165 mm) in length (Timm and Genoways 2004), and it is the largest bat in Florida (NatureServe 2009). The body mass of the species averages 39.7 grams (g) (1.4 ounces [oz]) with a range from 30.2 g (1.1 oz) to at least 55.4 g (2.0 oz) in pregnant females (Belwood 1981; Belwood 1992, Timm and Genoways 2004; NatureServe 2009). Timm and Genoways (2004) found that males and females are not significantly different in size, and there is no pattern of size-related geographic variation in this species. Fur is short and glossy with hairs sharply bicolored with a white base (Timm and Genoways 2004; NatureServe 2009). Color is highly variable from black to brown to brownish gray or cinnamon brown with ventral pelage paler than dorsal (Timm and Genoways 2004; NatureServe 2009). Leathery rounded ears are joined at the midline and project forward (NatureServe 2009). Relatively little is known of the ecology of the Florida bonneted bat, and long-term habitat requirements are poorly understood (Robson 1989; Robson et al. 1989;

Belwood 1992; Timm and Genoways 2004). Habitat for the Florida bonneted bat mainly consists of foraging areas and roosting sites, including artificial structures. At present, no active, natural roost sites are known, and only limited information on historical sites is available.

Critical habitat has not been designated for this species.

Life history

Relatively little is known of the ecology of the Florida bonneted bat and long-term habitat requirements are poorly understood (Robson 1989; Robson et al. 1989; Belwood 1992; Timm and Genoways 2004). Recent information on foraging habitat has been obtained largely through acoustical surveys designed to detect and record bat echolocation calls (Marks and Marks 2008a). In general, open freshwater and wetlands provide prime foraging areas for bats (Marks and Marks (2008b). Bats will forage over ponds, streams, and wetlands and drink when flying over open water (Marks and Marks 2008b). During dry seasons, bats become more dependent on remaining ponds, streams and wetlands for foraging purposes (Marks and Marks 2008b). The presence of roosting habitats is critical for day roosts, protection from predators, and the rearing of young (Marks and Marks 2008b). For most bats, the availability of suitable roosts is an important limiting factor (Humphrey 1975). South Florida bats primarily roost in trees and man made structures (Marks and Marks 2008a).

Major habitat types where this species is known to occur include dry prairie, freshwater marsh, wet prairie, and pine flatwoods (Marks and Marks 2008a). They have been known to roost in buildings, tree cavities, outcrops, and bat houses (Marks and Marks 2008a). The discovery of an adult for which the specimen tag says "found under rocks when bulldozing ground" suggests this species may roost in rocky crevices and outcrops on the ground (Timm and Genoways 2004). It is not known to what extent such roost sites are suitable. Robson (1989) indicated Florida bonneted bats are closely associated with forested areas because of their tree-roosting habits. They roost singly or in groups of up to a few dozen individuals (NatureServe 2009). The Florida bonneted bat is not migratory (Timm and Genoways 2004; NatureServe 2009). However, there may be seasonal shifts in roosting sites because Belwood (1992) reported bonneted bats were found "during the winter months in people's houses".

Florida bonneted bats feed on flying insects (e.g. Coleoptera, Diptera, Hemiptera) (Belwood 1981; Belwood 1992; NatureServe 2009). They forage in open spaces and use echolocations to detect prey at relatively long range, roughly 3 to 5 m (10 to 16 ft) (Belwood 1992). Based upon information from G.T. Hubbell, Belwood (1992) indicates that these bats leave their roosts to forage after dark, seldom occur below 10 m (33 ft) in the air, and produce loud calls audible to humans, as they fly. Precise foraging and roosting habits and requirements are not known (Belwood 1992).

Population dynamics

The Florida bonneted bat has a fairly extensive breeding season during the summer months (Timm and Genoways 2004; NatureServe 2009). Pregnant females have been found in June through September (Marks and Marks 2008a). Timm and Genoways' (2004) examination of limited data suggests that this species may be polyestrous, with a second birthing season possibly in January – February. However, the Florida bonneted bat has low fecundity, producing a litter size of one (NatureServe 2009).

There is only one record of natural predation upon this species (Timm and Genoways 2004). A skull of one specimen was found in a regurgitated owl pellet in June 2000 at the Fakahatchee Preserve (Timm and Genoways 2004; Marks and Marks 2008a).

Status and distribution

The Florida bonneted bat is recognized in Florida's Comprehensive Wildlife Conservation Strategy as one of Florida's species of greatest conservation need (FWC 2005). This species is now listed as "Federally-designated endangered" by the Florida Fish and Wildlife Conservation Commission (FWC) as the Florida bonneted bat (*Eumops floridanus*). The FNAI and NatureServe consider the global status of the Florida bonneted bat to be G1, critically imperiled (FNAI 2015). The 2015 International Union for Conservation of Nature (IUCN) Red List of Threatened Species lists *Eumops floridanus* as critically endangered because "its population size is estimated to number fewer than 250 mature individuals, with no subpopulation greater than 50 individuals, and it is experiencing a continuing decline" (Timm and Arroyo-Cabrales 2008). On November 9, 2009, the Service added the Florida bonneted bat to the candidate species list. A final rule listing the Florida bonneted bat as federally endangered was published on October 2, 2013.

The Florida bonneted bat exists only in Florida (Timm and Genoways 2004; C. Marks and G. Marks, pers. comm. 2008). This species has one of the most restricted distributions of any bat species in the New World (Belwood 1992; Timm and Genoways 2004) and its global range is estimated at < 100-250 square kilometers (km^2) (40-100 square miles [mi^2]) (NatureServe 2009). Its current range includes Charlotte, Collier, Lee, Miami-Dade, Okeechobee, and Polk Counties (Timm and Genoways 2004; NatureServe 2009; Marks and Marks 2008c). Surveys conducted in the Kissimmee River area for the FWC recorded Florida bonneted bat calls at two locations (Marks and Marks 2008b; 2008c). The findings along the Kissimmee River are significant as it is the first time the species has been found north of Lake Okeechobee except in fossil records and effectively moves the known range 80 km (50 mi) north (Marks and Marks 2008c).

Although older literature lists Fort Lauderdale as an area where the species occurred (Belwood 1992), none of the recent specimens examined in Timm and Genoways (2004) were from Broward County. However, Hipes et al. (2001) included Broward County as part of the range. Marks and Marks (2008a) did not record any Florida bonneted bat calls in the Fort Lauderdale area; surveys were conducted in Long Key Park, Miramar Pinelands, and the Plantation area. No calls were recorded on the east coast of Florida north of Coral Gables (Marks and Marks 2008a). Overall, based upon all available historic and current surveys, the species exists within a very restricted range (Timm and Genoways 2004; Marks and Marks 2008a).

Results of 2006-2008 acoustical range-wide survey indicate that the Florida bonneted bat is a rare species with limited range and low abundance (Marks and Marks 2008a). Based upon these results and an additional survey of select public lands, the species has been found at 12 locations (Marks and Marks 2008c), but the number and status of the bat at each locations is unknown. The 2006-2008 range-wide acoustical survey recorded 5016 calls; when these calls were later analyzed, it was determined that only 79 (1.6 percent) were from Florida bonneted bats (Marks and Marks 2008c). Marks and Marks (2008a) stated total population size may be less than a few hundred individuals owing to the small number of locations where calls were recorded, the low number of calls recorded at all locations, and the fact that the species forms small colonies. In his independent review of the FWC's biological status report, Ted Fleming, Emeritus Professor of biology at University of Miami, stated that the total State population numbers were "in the hundreds or low thousands" (FWC 2011). Results of the 2010-2012 survey and additional surveys by other researchers identified new occurrences within the established range (i.e., within Miami area, areas of ENP and areas of BCNP) (S. Snow pers. comm. 2011a, 2011b, 2012a-e; R. Arwood pers. comm. 2012; Marks and Marks 2012), however, not in sufficient numbers to alter previous population estimates.

Habitat loss and alteration of forested and urban areas are substantial threats to the Florida bonneted bat (Belwood 1992; NatureServe 2009). In natural areas, this species may be impacted when forests are converted to other uses or when old trees with cavities are removed (Belwood 1992; NatureServe 2009). In urban settings, this species may be impacted when buildings with suitable roosts are demolished (Robson 1989; NatureServe 2009) or when structures are modified to exclude bats. Small population size, restricted range, low fecundity, and few and isolated occurrences are considerable ongoing threats. This species is also vulnerable to prolonged extreme cold weather events. The cold spell experienced in Florida in early 2010 may have caused a decline in the Florida bonneted bat population. A colony in Lee County once included approximately 20-24 individuals in two houses (S. Trokey, pers. comm. 2008a, 2008b), but only 9 remained after the prolonged cold temperatures in early 2010 (S. Trokey, pers. comm. 2010a, 2010b).

Florida panther (*Puma concolor coryi*)

Species/critical habitat description

Panthers were once distributed across the southeastern United States and now occur in less than five percent of their historic range. The combined effects of human persecution and habitat loss led to listing of the Florida panther. It was among the first group of species listed as federally endangered under the Endangered Species Act of 1973. No critical habitat has been designated for the Florida panther. By the late 1970's the only known Florida panthers occurred in southern Florida with an estimated population of fewer than 30 individuals. In 1981 the Florida Fish and Wildlife Conservation Commission (FWC) undertook long term research to determine the status of this population in the Big Cypress region. The National Park Service began a concurrent study in Everglades National Park (ENP) in 1986. Results of both studies indicated that the remaining population suffered from geographic isolation, habitat loss, low population numbers, and extensive inbreeding resulting in loss of genetic variability. Externally, inbreeding was displayed as crooked tails and cowlicks in most cats. Of greater concern was the prevalence of rare genetically determined traits such as cryptorchidism, low sperm count/quality, atrial septal defects, and susceptibility to opportunistic infections.

Life history

Florida panthers are wide ranging habitat generalists that require large contiguous areas of habitat to meet their life history needs, and preferentially select forested upland habitats interspersed with other habitats utilized proportionate to availability. Primary prey species are white tail deer and feral swine, a diet supplemented with small to medium mammals, reptiles including alligators, and avifauna. Panthers are cryptic predators which occur at very low densities and select habitat based on prey availability and sufficient patches of dense understory vegetation which serve as critical forage, rest, and denning cover. Near impenetrable areas of dense saw palmetto, thick hammocks, and invasive Brazilian pepper stands consistently emerge as the vegetation types most frequently used by Florida panthers for denning and rearing of young.

Panthers are known to give birth year round in Florida, but the majority of panther births occur in mid-winter to early spring. For the first 2-3 months of their lives, panther kittens remain in well-concealed dens and only rarely leave dens. As they mature, kittens begin to make exploratory movements, but generally remain near den sites. ENP data on denning is sparse, but with the absence of dense saw palmetto, most known ENP dens were located primarily within dense hardwood hammocks or invasive Brazilian pepper forests located within or proximate to the pinelands.

Population dynamics

Within ENP, panthers occupy very large home ranges on the order of 450 km^2 (111,200 acres) for males and 250 km^2 (61,800 acres) for females. Dispersing juveniles have been known to wander hundreds and in some cases thousands of miles prior to establishing a permanent home range. Known individuals within ENP have overlapping primary home ranges centered in and around Long Pine Key, yet habitat use varies seasonally. Panthers in ENP can be found in nearly all terrestrial habitats, yet many years of telemetry and track data indicate that pine dominated landscapes followed by seasonally dry prairie interspersed with hammocks and cypress comprise the core habitats that support the ENP subpopulation. Panther use extends south and west into the mangrove transition zone or boundary of Shark River slough high water and; to the east and north of Long Pine Key, panthers extensively utilize areas extending to northern and eastern ENP borders and adjacent lands. Panthers are also known to occur at least seasonally in regions of ENP bordering BCNP. Sporadic reports occur in the Cape Sable region of ENP and these are most likely transitional dispersing males if and when the reports are credible, and are unlikely to be resident cats. The remote west central coast of ENP has deer and hog populations potentially sufficient to support panthers yet sightings and panther occurrence and use in this area have not been documented. Immigration and emigration are known to be rare but are poorly understood within eastern ENP and require further study. The Chekika area in particular appears to have an increasing deer and feral swine prey base sufficient to support greater use by panthers than is currently known to occur and this area may become a more significant component of home ranges in future years.

The 1994 Florida Panther Genetic Restoration and Management Plan (Service 1994) recommended genetic augmentation as the only means likely to preserve the South Florida population as genetic variability was deemed so depressed as to be the greatest immediate threat to survival. Eight female Texas puma (*Puma concolor stanleyana*) were released into the existing South Florida population in 1995, including two in ENP east of Shark River Slough. Since the introduction of the eight females, the estimated total panther population increased to 80-100 adults between 2002-2005 within approximately 2.5 million acres in South Florida (Land & Lacy, 2000; Kautz et al. 2006). Recent estimates of the total panther population range from 120-160 individuals.

Status and distribution

Florida panthers located in ENP on the east side of Shark River Slough are considered a sub-population of the broader panther population in Florida, and are isolated from the main population by Shark River Slough and rapid urban development in the greater Miami area. While panthers can cross Shark River Slough, they are unlikely to do so, and the frequency of panther movements between the ENP subpopulation and the rest of the panther population is low. Geographic isolation makes this small population particularly susceptible to extirpation due to either complete mortality of one sex (likely male) or the recurrence of genetic depression due to inbreeding. Non-invasive camera trap monitoring techniques used by ENP staff indicate that the current minimum population east of Shark River Slough consists of only 5-7 individual adult panthers, and likely only one male.

Within ENP, threats to the subpopulation include loss of genetic diversity due to inbreeding, complete mortality of one sex, disease, reduced habitat or prey availability due to changes in hydrology, and prey impacts from competing species including coyotes and large constrictors, which have arrived in ENP relatively recently. Current panther monitoring is conducted through use of camera traps, and ENP does not regularly capture panthers to assess condition or monitor detailed movements.

The Everglades ecosystem has evolved with frequent fire as a natural component of the landscape and panthers have adapted to these fires. While several studies have focused on the response of Everglades wildlife including panthers and other large carnivores/omnivores to fire, results and interpretation of these studies vary widely. Most researchers ultimately agree implementing landscape-level fire regimes which best replicate natural conditions are favored over those designed to enhance habitat for particular species.

Adult and sub-adult panthers are highly mobile and telemetry data indicate that they easily move in and around fires with no apparent ill effects, perhaps even being attracted to active fire. Several studies have shown that white tailed deer and other important prey species may benefit from fire effects, thus concluding that fire is an important component of panther ecology. Dees et al. (1999) found panthers exhibit a strong preference for pine dominated habitats for the first year post prescribed fire. This affinity declines over time until by >4 years, there is no apparent preferential selection for the area over those of longer burn interval (Dees et al 2001). Maehr et al. (1990) found that white-tailed deer, feral hogs, and other panther prey responded to prescribed fire with increased use during that same <1 year period, presumably due to increased forage quantity and quality. Both studies concluded that panthers preferential selection of these habitats post fire is in response to increased prey availability resulting from fire driven changes to vegetation composition, yet caution that overly extensive or frequent burning (intervals <4 years) may reduce cover and travel corridors for panthers and result in loss of beneficial effects.

Maehr and Larkin (2004) argued that fire return intervals as infrequent as 15-20 years would best benefit panthers and bears. This assertion was largely made based on apparent reliance on extensive patches of mature and extremely dense saw palmetto for refuge, including denning and rearing young. Fire greatly reduces the occurrence of dense, mature palmetto patches, forcing panthers to select alternative den sites. Dense saw palmetto patches are not as common in ENP as in other areas of Florida and given low population density, are not thought to limit reproduction, and panthers have used hardwood hammocks and dense Brazilian pepper in ENP for denning and cover. Excluding fire for excessively long periods and allowing dense palmetto patches to develop may encourage their use by panthers but also increase the intensity of fire when it does ultimately occur, which may increase likelihood of periodic kitten mortality, and cause changes in the suitability of habitat. Fire regimes within pine dominated habitats that result in a mosaic of recently burned, relatively open habitat, interspersed with denser unburned patches probably provide the best overall benefits for panthers in ENP.

ENVIRONMENTAL BASELINE

The environmental baseline includes the effects of past and ongoing human factors leading to the current status of the species, their habitats (including designated critical habitat), and ecosystem, within the action area. It includes the impact of other actions, which occur simultaneously with the consultation in progress, but it does not include the effects of the actions under review in this consultation.

Plants

Blodgett's silverbush

Status of the species/critical habitat within the action area

Blodgett's silverbush is currently listed as a candidate species, but is planned for consideration for listing by the Service in 2015. It occurs in Everglades National Park in three areas of higher elevation pine rocklands in FMU 3. All three occurrences of Blodgett's silverbush in ENP are located within the Long Pine Key area. The largest occurrence consists of approximately 1,000 plants and extends across the fire break road that divides the northern portion of Pine Block A from the southwestern side of Pine Block B. Portions of this occurrence were observed in 2013 and appear to be stable. A second occurrence consists of approximately 50 plants and is located entirely within the eastern side of Pine Block B. This occurrence was last observed in 2011 and is believed to be stable. A third occurrence consisting of approximately 250 plants was discovered in December 2013 by ENP staff. This occurrence is located in northern Pine Block E about 200 to 300 m southwest of the Main Park Road.

ENP periodically conducts surveys for rare plants, including Blodgett's silverbush, in appropriate habitats within ENP. Data from those surveys including geographic coordinates, estimated population size, reproductive status and associated plant species are recorded and maintained on an internal database. Future surveys may result in the detection of new occurrences of Blodgett's silverbush, but no additional locations are known at this time.

Factors affecting the species environment within the action area

The pine-rockland habitat where the Blodgett's silverbush occurs in Miami-Dade County and the Florida Keys requires periodic fires to maintain habitat with a minimum amount of hardwoods. There are approximately 22 extant occurrences, 12 in Monroe County and 10 in Miami-Dade County; many occurrences are on conservation lands. However, 4 to 5 sites are recently thought to have been extirpated. The estimated population size of Blodgett's silverbush in the Florida Keys, excluding Big Pine Key, is roughly 11,000; the estimated population in Miami-Dade

County is 375 to 13,650 plants. Blodgett's silverbush is threatened by habitat loss, which is exacerbated by habitat degradation due to fire suppression, the difficulty of applying prescribed fire to pine rocklands, and threats from exotic plants. Remaining habitats are fragmented. Threats such as road maintenance and enhancement, infrastructure, and illegal dumping threaten some occurrences. Blodgett's silverbush is vulnerable to natural disturbances, such as hurricanes, tropical storms, and storm surges. Climatic changes, including sea-level rise, are long-term threats that are expected to continue to affect pine rocklands and ultimately substantially reduce the extent of available habitat, especially in the Keys. Overall, the magnitude of threats is moderate because a number of occurrences remain with relatively high population levels, and not all of the occurrences are affected by the threats. In addition, land managers are aware of the threats from exotic plants and lack of fire, and are, to some extent, working to reduce these threats where possible.

Pineland sandmat

Status of the species/critical habitat within the action area

Within ENP, pineland sandmat occurs in higher elevation pine rocklands with open understory throughout Long Pine Key within FMU 3. Herbarium specimens, observations and field notes include records of plants in nine pine blocks, all within the Long Pine Key area. It is estimated at least 10,000 plants occur in Long Pine Key. It is unclear if this species occurs in the Pine Island area or not since surveys for pineland sandmat have not been conducted in that area. Rare plant surveys and a variety of other botanical activities have taken place in Pine Island but this species has not been recorded or collected there even though potentially suitable habitat occurs within limited areas. Systematic status surveys of the known locations have not been carried out. ENP staff frequently encounter this species and no indication of local or Long Pine Key wide changes in population status have been noted. It is believed the population status is stable, but quantitative information is needed.

ENP periodically conducts surveys for rare plants, including pineland sandmat, in appropriate habitats within ENP. Data from those surveys including geographic coordinates, estimated population size, reproductive status and associated plant species are recorded and maintained on an internal database. Comprehensive surveys of Long Pine Key for this plant would likely result in locating plants in previously undocumented locations, but no additional locations are known at this time.

Factors affecting the species environment within the action area

The Miami-Dade County pine rocklands have largely been destroyed by residential, commercial, and urban development and agriculture. Pine rocklands in the County (including patches of marl prairie) have been reduced to about 11 percent of their former extent (Kernan and Bradley 1996). Of the estimated historical extent of 74,000 ha (182,780 ac), only 8,140 ha (20,106 ac) of pine rocklands remained in 1996. Outside of ENP, only about 1 percent of the Miami Pine Rock Ridge pinelands remain and much of what is left is in small remaining blocks isolated from other natural areas (Herndon 1998). Most of the pine rocklands from the plant's northernmost occurrence south to ENP have been developed and this area contains few remaining occurrences (Bradley and Gann 1999). The area outside of ENP represents nearly half of the range of this taxon (Bradley and Gann 1999).

Pinelands were mapped for Miami-Dade County's geographic information system in 2004. The data confirm the limited extent of remaining pine rocklands outside of ENP and document severe losses of privately-owned pinelands over the past decade. Even some publicly-owned pinelands where this species occurs are vulnerable to development. The largest site outside of ENP is 140 ha (346 ac) and all other sites are less than 8 ha (20 acres) (Bradley and Gann 1999). The largest population in ENP is essentially protected from habitat loss due to development or agriculture. Hydrological changes and other natural and anthropogenic factors may still affect this species despite its protection here.

Climatic changes and sea level rise are major threats to South Florida, including this species and its habitat. Sea-level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida (U.S. Climate Change Science Program [CCSP] 2008). The overall threat level of habitat loss from sea-level rise is currently low, but it is expected to become severe in the future.

At least 277 taxa of exotic plants have invaded pine rocklands throughout South Florida (Service 1999b). Invasive exotic species, especially Brazilian pepper (*Schinus terebinthifolius*) and Burmareed (*Neyraudia reynaudiana*), threaten the pineland sandmat on public and private lands (Bradley and Gann 1999). Other invasive exotics such as Old World climbing fern (*Lygodium microphyllum*) and melaleuca (*Melaleuca quinquenervia*) are also a concern. Invasive exotic species are expected to continue to decrease the quality of the pine rocklands habitat where this taxon occurs (Bradley and Gann 1999).

Brazilian pepper is an aggressive invader that is widespread throughout pinelands FMU 3 in ENP (ENP 2005). However, this species has generally been managed on the ENP land in undisturbed sites by prescribed fire (ENP 2005) reducing the threat at this time. Cogon grass (*Imperata cylindrica*) and Burmareed have also been observed and treated in the Boy Scout Camp and along the eastern boundary at ENP (ENP 2005). ENP believes that both species could expand into the pinelands and may become problematic because of their fire adaptations (ENP 2005). In addition, Old World climbing fern is spreading toward Long Pine Key in ENP. However, at this time, the overall threat of exotics to pineland sandmat at ENP appears to be under control due to prescribed fire at ENP. It is not known if this problem will intensify or if the ENP will have the resources to continue its efforts in combating exotics within ENP in the future.

Fire suppression is a threat to pineland sandmat (Bradley and Gann 1999). Fire maintains the pine rockland community and under natural conditions, lightning fires typically occurred at 3 to 7- year intervals, or more frequently in marl prairies. With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like pineland sandmat. Fire suppression outside of ENP has reduced the size of the areas that do burn and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Thus, many pine rockland communities are becoming tropical hardwood hammocks. While application of prescribed fire is difficult in the urban pine rockland fragments in Miami-Dade County, it is somewhat easier to apply on larger public conservation lands. Fire is a necessary component of the pine rockland ecosystem, and prescribed fire is actively being used at ENP.

Invasive exotic plant species also alter the type of fire that occurs in pine rocklands. Historically, pine rocklands had an open, low understory where natural fires remained patchy with low temperature intensity, thus sparing many native plants such as the pineland sandmat. Dense exotic plant overgrowth may no longer allow the species to be conserved through prescribed burning. Dense growth can create high fire temperatures and longer burning periods that pine rockland plants cannot tolerate. Under current conditions, exotic plant control may require alternate, more labor intensive methods such as hand chopping followed by spot herbicide treatment, which is costly. Given the acreage of land, staffing, and budget constraints, this method may not be feasible in all sites.

Bradley (pers. comm. 2005c) commented that mechanical treatment (*e.g.*, hand-held power tools) is often required prior to applying prescribed fire. With too much growth of Burmareed and Brazilian pepper, it is often not possible to conduct a safe burn because it will be too hot. Native hardwoods, like exotics, regularly encroach on pinelands, and if burned can also cause a hot, destructive fire. Mechanical treatments cannot entirely replace fire because in the absence of fire, pine trees, understory shrubs, grasses, and herbs all contribute to an ever-increasing duff layer. Duff will accumulate even if hardwoods are mechanically removed. When the duff becomes thick, it covers herbs and prevents most seeds from germinating. In addition to removing duff, fires leave ashes that provides important nutrient cycling, which is lost with mechanical removal. Overall, mechanical treatments to remove native hardwoods and/or exotic plants from pine rocklands help restore the vegetation, especially when used in combination with prescribed fire.

Hydrology is a key ecosystem component that affects rare plant distributions and their viability (Gann et al. 2006). Historically, sheet flow from Shark River Slough and Taylor Slough did not reach the upland portions of Long Pine Key, but during the wet season increased surface water flow in sloughs generated a rise in groundwater across the region (Gann et al. 2006). As artificial drainage became more widespread, regional groundwater supplies declined. Historical patterns of water flow through Long Pine Key are further confounded by road construction (Gann et al. 2006). Water flow through Long Pine Key was originally concentrated in marl prairies, traversing in a north-south direction; however, construction of the main ENP road dissected Long Pine Key in an east-west direction, thereby impeding sheet flow across this area (Gann et al. 2006). Water was either impounded to the north of the main ENP road or diverted around the southern portion of Long Pine Key through Taylor Slough and Shark River Slough (Gann et al. 2006). Research Road may similarly affect the water supply of the southern portions of Long Pine Key (Gann et al. 2006).

Gann et al. (2006) and Herndon (1998) expressed concern that changes to regional water management intended to restore the Everglades could negatively affect the pinelands of Long Pine Key. Gann et al. (2006) stated that if hydrological restoration is successful, groundwater levels will presumably be raised, wet season flows will return to marl prairies and fire intensities will decrease, and growing conditions for rare pineland and hammock plants will improve. Alternatively, implementation of the Comprehensive Everglades Restoration Plan may also lead to further impoundment of water north of the main park road, possible flooding of rare plant populations, and a failure to provide relief to habitats on Long Pine Key that are compartmentalized (by the main ENP road and Research Road) and have been impacted from long-term drainage (Gann et al. 2006). Sadle (pers. comm. 2010), however, believes the threat of hydrologic changes may be overstated since this plant occurs at higher areas within ENP. At this time, it is not known whether the proposed restoration and associated hydrological modifications will have a positive or negative impact on various rare species within ENP (Gann et al. 2006).

Given the species' narrow range, pineland sandmat may be vulnerable to catastrophic events and natural disturbances, such as hurricanes. Hurricanes have impacted Miami-Dade County in the recent past (*e.g.*, Hurricane Andrew). Three hurricanes hit South Florida in 2005 (Katrina, Rita, and Wilma). According to the National Oceanographic and Atmospheric Administration, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean. The threat of future hurricanes and tropical storms is expected to continue.

In summary, pineland sandmat is vulnerable to a wide array of natural and human factors, including: small and isolated occurrences, restricted range, fire suppression, invasive exotic plants, human land use intensification (from natural areas to agricultural and urban uses), regional water management changes, road developments that alter water flow, as well as catastrophic events and natural disturbances, like hurricanes and extreme weather events.

Garber's spurge

Status of the species/critical habitat within the action area

Garber's spurge has been observed and/or collected in four areas of Everglades National Park. Within FMU 1, plants are known from beach dunes and coastal grasslands of Northwest Cape Sable, Middle Cape Sable, and East Cape Sable. Within FMU 3, plants occur in pine rockland habitats of Long Pine Key within Pine Blocks A and B. Populations in Pine Block B and Northwest Cape Sable both include large numbers of plants. Counts along transects in Pine Block B recorded 4,800 plants. While no final estimate of the total population size was calculated, the authors indicated that as many as 100,000 plants may be present. Data collected along transects on Northwest Cape Sable resulted in an estimated population size of over 630,000 plants at that site. The populations on Middle Cape Sable and Pine Block A were both reported to be quite small with 400 to 500 plants estimated at Middle Cape Sable and 600 to 700 estimated for Pine Block A (Green et al. 2007a, Green et al. 2007b). Until recently, the population on East Cape Sable was believed to be extirpated. It was last collected in 1995 and plants were not seen during surveys of the site by the Institute for Regional Conservation (Green et al 2007a). A comprehensive survey for this species was carried out between 2004 and 2008 by The Institute for Regional Conservation (Green et al. 2008). In all, 46 distinct locations were surveyed, and Garber's spurge was found on 24 of these sites. ENP staff located a small occurrence consisting of approximately 200 plants in 2013.

ENP staff periodically conduct surveys for rare plants, including Garber's spurge, in appropriate habitats within ENP. Data from those surveys including geographic coordinates, estimated population size, reproductive status and associated plant species are recorded and maintained on an internal database. All known occurrences of Garber's spurge have been observed recently, primarily when conducting other botanical work or in the case of the occurrences on East, Middle and Northwest Cape, when conducting butterfly surveys. No indication of population decline has been observed and all populations are currently believed to be stable. However, short and long term population trends are not well understood.

Factors affecting the species environment within the action area

Over time, due to habitat destruction, fire suppression, and other human modifications, Garber's spurge appeared to be increasingly rare (Service 1999b). Human induced habitat destruction and alteration are continuing threats for populations of Garber's spurge. In addition, the remaining habitat is relatively fragmented and most populations are small. Without the chance of recruitment from a nearby population, these small, disjunct populations are more susceptible to extirpation from a single disturbance, natural or man-made. Fire suppression and the invasion of exotic plants can result in over-shading of the understory, reducing the quality of the habitat. Over time this could lead to the extirpation of Garber's spurge at these sites. The ecological damage to habitats caused by exotic pest plant invasions has been well documented. For this species in South Florida the largest threats are introduced species such as Brazilian-pepper (*Schinus terebinthifolius*), Australian-pine (*Casuarina equisetifolia*), and beach naupaka (*Scaevola sericea*). Long term habitat modifications such as sea-level rise and beach erosion are also threats to Garber's spurge as they will likely reduce necessary habitat.

Florida pineland crabgrass

Status of the species/critical habitat within the action area

The current distribution of Everglades pineland crabgrass in Everglades National Park is restricted to Long Pine Key within FMU 3. The total population is estimated at 1,000 to 10,000 individuals (Service 2013a). Individuals are found in marl prairies and adjacent lower elevation pine rocklands in most of the finger glades bisecting the region. Plants reported from marl prairies near the park entrance (George N. Avery, unpublished notes) have not been seen since the 1980s. Observations of plants have also been made in prairies and associated wet pine rocklands east of the Main Park Road near Mahogany Hammock in Pine Block West of A.

ENP periodically conducts surveys for rare plants, including Florida pineland crabgrass, in appropriate habitats within ENP. Data from those surveys including geographic coordinates, estimated population size, reproductive status and associated plant species are recorded and maintained on an internal database. With the exception of plants near the park entrance, which have not been observed for many years, no indication of population declines has been observed. However, short and long term population trends are not well understood.

Factors affecting the species environment within the action area

Habitat loss continues to occur in this species' historical range and most remaining suitable habitat has been negatively altered by human activity. Pine rocklands within Miami-Dade County have largely been destroyed by residential, commercial, and urban development and agriculture. Pine rocklands in the county (including patches of marl prairie) have been reduced to about 11 percent of their former extent (Kernan and Bradley 1996). Of the estimated historical extent of 74,000 ha (182,780 ac), only 8,140 ha (20,106 ac) of pine rocklands remained in 1996. Outside of ENP, only about 1 percent of the Miami Pine Rock Ridge pinelands remain and much of what is left is in small remaining blocks isolated from other natural areas (Herndon 1998). Florida pineland crabgrass habitat at Long Pine Key in ENP (*e.g.*, pineland / prairie ecotones and prairies [Gann et al. 2006]) and BCNP are, for the most part, protected. The largest and only known populations are, therefore, essentially protected from habitat loss due to development or agriculture. Effects from hydrological changes and other natural and anthropogenic factors, however, may still affect this species.

Climatic changes and sea level rise are major threats to South Florida, including this species and its habitat. All occurrences are in low-lying areas and will be affected by climate change and rising sea level. The overall threat level of habitat loss from sea-level rise is currently low, but is expected to become severe in the future.

Fire maintains the pine rockland community. Under natural conditions, lightning fires typically occurred at 3 to 7- year intervals, or more frequently in marl prairies. With fire suppression, hardwoods eventually invade pine rocklands and shade out Florida pineland crabgrass (Bradley and Gann 1999). Fire suppression outside of ENP has reduced the size of the areas that do burn and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Thus, many pine rockland communities are becoming tropical hardwood hammocks. While application of prescribed fire is difficult in the urban pine rockland fragments in Miami-Dade County, it is somewhat easier to apply on larger public conservation lands such as ENP. Prescribed fire is actively being used at ENP and now appears to be effective in maintaining populations of Florida pineland crabgrass at Long Pine Key (J. Sadle, pers. comm. 2010). Herndon (1998) had reported a sharp decline in the number of plants in one ENP location, which he attributed to prescribed fire followed by flooding caused by tropical storm Dennis in 1981. Invasive plants have also significantly affected pine rocklands. At least 277 exotic plants have invaded pine rocklands throughout South Florida (Service 1999b). The most problematic exotic plants in pine rocklands are Brazilian pepper and Burmareed (*Neyraudia reynaudiana*) (Bradley and Gann 1999). Brazilian pepper is also a threat to marl prairies (Bradley and Gann 1999). Bradley and Gann (1999) stated the Florida pineland crabgrass in ENP is threatened by exotic plants. In their study of Long Pine Key, Gann et al. (2006) found four species of exotic nonnative plants growing in association with rare plants: shoebutton (*Ardisia elliptica*), centipede grass (*Eremochloa ophiuroides*), monk orchid (*Oeceoclades maculata*), and Brazilian pepper. Of these, only Brazilian pepper has been observed in the vicinity of Florida pineland crabgrass (J. Sadle, pers. comm. 2010). In 2008, an isolated patch of 10 Australian pines were treated in Long Pine Key, Pine Block D. Florida pineland crabgrass either resprouted or recruited to this location after the Australian pine was killed (J. Sadle, pers. comm. 2010).

Long Pine Key is susceptible to invasive exotic plants such as Burmareed and Old World climbing fern, which have spread southward into parts of ENP (Ferriter 2001, Gann *et al.* 2002, Ferriter 2003). Old World climbing fern is capable of smothering vegetation and is spreading rapidly in Florida (Ferriter 2001, Volin et al. 2004). In 2000, ENP staff discovered new, but widespread populations of the Old World climbing fern in the western coast of ENP (Ferriter 2001). The populations had not been detected in 1999 and are particularly alarming due to their remote location and seemingly rapid establishment and spread (Ferriter 2001). Similarly, Volin et al. (2004) suggested an alarming increase in establishment of this fern across South Florida, particularly in the cypress-dominated wetlands of Big Cypress Swamp. Old World climbing fern has the potential to become uncontrollable, except through biological control. In addition, the former agricultural lands of the Hole-in-the-Donut adjacent to Long Pine Key are infested by invasive plants such as Brazilian pepper and common guava (*Psidium guajava*) and are a potential source of seeds of these invasive species. ENP is restoring those former agricultural lands, but invasive exotic plants will continue to be a threat even after this restoration work is completed (J. Sadle, pers. comm. 2010).

Hydrology is a key ecosystem component that affects rare plant distributions and their viability (Gann et al. 2006). Historically, sheet flow from Shark River Slough and Taylor Slough did not reach the upland portions of Long Pine Key, but during the wet season increased surface water flow in sloughs generated a rise in groundwater across the region (Gann et al. 2006). However, as artificial drainage became more widespread, regional groundwater supplies declined. Historical patterns of water flow through Long Pine Key are further confounded by road construction (Gann et al. 2006). Water flow through Long Pine Key was originally concentrated in marl prairies, traversing in a north-south direction; however, construction of the main ENP road dissected Long Pine Key in an east-west direction, thereby impeding sheet flow across this area (Gann *et al*. 2006). Water was either impounded to the north of the main ENP road or diverted around the southern portion of Long Pine Key through Taylor Slough and Shark River Slough (Gann et al. 2006). Research Road may similarly affect the water supply of the southern portions of Long Pine Key (Gann et al. 2006).

Changes to regional water management intended to restore the Everglades could negatively affect the pinelands of Long Pine Key (Herndon 1998, Gann et al. 2002, Gann et al. 2006). Gann et al. (2006) stated if hydrological restoration is successful, groundwater levels will presumably be raised, wet season flows will return to marl prairies, fire intensities will decrease, and growing conditions for rare pineland and hammock plants will improve. Alternatively, implementation of the Comprehensive Everglades Restoration Plan may also lead to further impoundment of water north of the main park road, possible flooding of rare plant populations, and a failure to provide relief to habitats on Long Pine Key that are compartmentalized (by the main ENP road and Research Road) and have been impacted from long-term drainage (Gann et al. 2006). At this time, it is not known whether the proposed restoration and associated hydrological modifications will have a positive or negative impact on rare species within ENP, including Florida pineland crabgrass (Gann et al. 2006). However, since the ENP is only one of two locations known to support this species, it will be important to determine potential impacts and monitor the species and its habitat.

Given the species' narrow range and limited number of occurrences, Florida pineland crabgrass is vulnerable to catastrophic events and natural disturbances, such as hurricanes. Hurricanes have impacted Miami-Dade County in the past (e.g., Hurricane Andrew). Three hurricanes made landfall in South Florida in 2005 (Katrina, Rita, and Wilma). According to NOAA, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean, so this threat is expected to continue. Increased sea surface temperatures in association with climate change could increase the frequency, severity, and duration of hurricanes.

In summary, Florida pineland crabgrass is threatened by a wide array of natural and manmade factors. Fire suppression, invasive exotic plants, alterations in hydrology, and catastrophic events all pose a threat to this species. Prescribed fire and exotic species control efforts by the ENP will likely be beneficial to this pine rockland / marl prairie dependent species. The response of Florida pineland crabgrass to hydrologic changes associated with Everglades restoration will remain unknown until these projects are fully implemented. The threat from tropical weather events is expected to continue and will likely increase. Given its limited distribution and low number of known occurrences remaining, any one of these factors could have a significant impact on the continued existence of Florida pineland crabgrass. Since few occurrences remain in a restricted range, the overall magnitude of threats is considered high.

Everglades bully

Status of the species/critical habitat within the action area

In Everglades National Park, the Everglades bully is locally common in appropriate habitats throughout the Long Pine Key area within FMU 3. Plants have been recorded in marl prairie and wet pine rocklands at 11 locations. Surveys did not include habitats in the western pine blocks or the Pine Island area. It is likely additional plants would be found in these areas if surveys were conducted. The population size of this species in ENP is estimated to be between 10,000 and 100,000 plants (Gann et al 2008). Due to the widespread distribution and abundance, ENP staff does not typically record site specific information for this species when conducting rare plant surveys. Although quantitative information is lacking, qualitative observations throughout the range within ENP indicate the population is currently stable.

Factors affecting the species environment within the action area

The Miami-Dade County pine rocklands have largely been destroyed by residential, commercial, and urban development and agriculture. Pine rocklands in the county (including patches of marl prairie) have been reduced to about 11 percent of their former extent (Kernan and Bradley 1996). Of the estimated historical extent of 74,000 ha (182,780 ac), only 8,140 ha (20,106 ac) of pine rocklands remained in 1996. Outside of ENP, only about 1 percent of the Miami Pine Rock Ridge pinelands remain and much of what is left is in small remaining blocks isolated from other natural areas (Herndon 1998).

Everglades bully habitat at Long Pine Key in ENP (*e.g.,* pinelands, pineland/prairie ecotones, and prairies) are, for the most part, protected. The largest population is essentially protected from habitat loss due to development or agriculture; however effects from sea level rise, hydrological changes, and other natural and anthropogenic factors may still affect this species despite its protection on public conservation lands.

Climatic changes and sea level rise are major threats to South Florida, including this species and its habitat. The overall threat level of habitat loss from sea-level rise is currently low, but is expected to become severe in the future as climatic change and sea level rise become more of a factor over the long-term. Everglades bully are found in low elevation pinelands and pineland/marl prairie ecotones that currently flood each summer (Gann et al. 2006). These occurrences in low-lying areas will be significantly affected by rising sea level in the future.

Fire is an important feature in maintaining the pine rockland community. However, fire suppression is a significant threat to Everglades bully (Gann et al. 2002). Under natural conditions, lightning fires typically occurred at 3 to 7-year intervals or more frequently in marl prairies. With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species. The suppression of fire has reduced the size of the areas that do burn and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Thus, many pine rockland communities are becoming tropical hardwood hammocks.

Exotic species have altered the type of fire that occurs in pine rocklands. Historically, pine rocklands had an open, low understory where natural fires remained patchy, with relatively low temperatures, thus sparing many native grasses and shrubs. Dense exotic plant growth can create higher temperatures and longer burning periods. Pine rockland plants cannot tolerate these extreme conditions. As a result, the native plants may have to be conserved by removing exotics through methods other than burning. One such method, hand chopping followed by spot treatment, is labor intensive and very costly. Pinelands in Miami-Dade County outside of ENP are kept intact only by constant maintenance, including removal of exotic plants such as Burmareed, Brazilian pepper, and others, use of prescribed fires, and prevention or cleanup of dumped trash.

Long Pine Key and BCNP are susceptible to invasive exotic plants such as Burmareed and Old World climbing fern (*Lygodium microphyllum*), which has spread southward into parts of ENP (Ferriter 2001); Ferriter 2003). The former agricultural lands of the Hole-in-the-Donut adjacent to Long Pine Key are infested by exotics such as Brazilian pepper and common guava (*Psidium guajava*) and are a potential source of seeds of these exotic species. The ENP is restoring those former agricultural lands, but invasive exotic plants will continue to be a threat even after this restoration work is completed (J. Sadle, pers. comm. 2010).

Hydrology is a key ecosystem component that affects rare plant distributions and their viability (Gann et al. 2006). Historically, sheet flow from Shark River Slough and Taylor Slough did not reach the upland portions of Long Pine Key, but during the wet season, increased surface water flow in sloughs generated a rise in groundwater across the region (Gann et al. 2006). As artificial drainage became more widespread, regional groundwater supplies declined. Historical patterns of water flow through Long Pine Key are further confounded by road construction (Gann et al. 2006). Water flow through Long Pine Key was originally concentrated in marl prairies, traversing in a north-south direction; however, construction of the main ENP road dissected Long Pine Key in an east-west direction, thereby impeding sheet flow across Long Pine Key (Gann et al. 2006). Water was either impounded to the north of the main road or diverted around the southern portion of Long Pine Key through Taylor Slough and Shark River Slough (Gann et al. 2006). Research Road may similarly affect the water supply of the southern portions of Long Pine Key (Gann et al. 2006).

Gann et al. (2002) and Herndon (1998) expressed concern that changes to regional water management intended to restore the Everglades could negatively affect the pinelands of Long Pine Key. Gann et al. (2006) stated that if hydrological restoration is successful, groundwater levels will presumably be raised, wet season flows will return to marl prairies, fire intensities will decrease, and growing conditions for rare pineland and hammock plants will improve. Alternatively, implementation of Everglades restoration may also lead to further impoundment of water north of the main ENP road, possible flooding of rare plant populations, and a failure to provide relief to habitats on Long Pine Key that are compartmentalized (by the main ENP road and Research Road) and have been impacted from long-term drainage (Gann et al. 2006). At this time, it is not known whether the proposed restoration and associated hydrological modifications will have a positive or negative impact on rare species within ENP, including Everglades bully (Gann et al. 2006).

Everglades bully may be vulnerable to catastrophic events and natural disturbances, such as hurricanes. Hurricanes have impacted Miami-Dade County in the past (e.g., Hurricane Andrew). Three hurricanes made landfall in South Florida in 2005 (Katrina, Rita, and Wilma). According to the National Oceanographic and Atmospheric Administration, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean so this threat is expected to continue.

In summary, Everglades bully is vulnerable to a wide array of natural and human factors, including: few and isolated occurrences, restricted range, fire suppression, invasive exotic plants, regional water management changes, and catastrophic events and natural disturbances, like hurricanes and extreme weather events.

<u>Invertebrates</u>

Bartram's hairstreak butterfly

Status of the species/critical habitat within the action area

The Bartram's hairstreak butterfly is currently known to occur at Long Pine key within ENP as well as several of the larger pine rockland fragments outside of ENP. This species has been observed regularly in a widespread area of Long Pine Key over the past several years. In surveys conducted between 2005 and 2011, adults or larvae were recorded by ENP staff in eight individual burn blocks within FMU 3. Observations of adults or larvae have been recorded during every month of the year within ENP. The Service (2012b) indicates that population size varies due to season and other resource conditions. While the geographic range in ENP is relatively large, the number of individuals observed is typically very low. The total range-wide population size was estimated by Salvato (cited in Service 2012b) to consist of several hundred or fewer individuals. A total population estimate for the Long Pine Key portion of the current range has not been made.

Sufficient data is not available to detect short or long term trends in the Long Pine Key population. Quantitative data is needed to determine when population shifts occur and which areas still support individuals when numbers are low and distribution is localized.

Critical habitat was designated within the action area of the proposed project in August 2014. Critical habitat is currently found throughout Long Pine Key pine rockland and some adjacent marl prairie habitats.

Factors affecting the species environment within the action area

The threats to Bartram's hairstreak butterflies consist of a lack of adequate fire management, small population size, isolation due to habitat loss and fragmentation, loss of genetic diversity, nonnative species introduction, inadequate regulatory mechanisms, pesticide applications, poaching, hurricanes and storm surge, and sea level rise. Fire is necessary to maintain suitable habitat for butterflies and host plants. The species' host plant, pineland croton, resprouts rapidly after fire, exhibits significant regrowth within 6 months to 1 year. Burned areas may be recolonized by Bartram's hairstreaks as they primarily remain within 5 meters of host plants (Salvato and Salvato 2008). Regular fire also reduces understory growth and prevents the establishment and spread of exotic invasive species both of which impact pineland croton and the butterflies that it supports.

Florida leafwing butterfly

Status of the species/critical habitat within the action area

The Florida leafwing butterfly is currently known to occur only at Long Pine Key within ENP (Salvato and Hennessey 2003; Salvato, Service, pers. obs. 2008). Until recently the species was also known to occur in several pine rockland fragments outside of ENP, as well as the lower Florida Keys (Salvato and Hennessey 2003). Observations of Florida leafwing butterfly adults and/or larvae have been observed throughout Long Pine Key. These observations are generally restricted to areas of pine rockland and marl prairie which contains their only known host plant, pineland croton.

Despite the wide distribution of observations, the number of individuals observed is typically very low. Salvato (cited in Service 2012b) estimated a total population size of several hundred or fewer adult individuals in Long Pine Key. Salvato (2001) reported population densities ranging from 1.4 – 6.0 adults/ha at a single survey location within a small portion of pinelands in ENP between 1988 and 1998. More recent surveys resulted in an estimate of 1 adult/ha (Salvato and Salvato 2010a). Based on these estimates and an estimate of 1,068 ha of suitable habitat in Long Pine Key (Henessey and Habeck 1991), the Florida leafwing population in ENP could approach several thousand individuals if all suitable habitat was occupied. However, surveys of habitat with host plant populations frequently fail to result in detection of Florida leafwing adults or larvae. All suitable habitat in ENP is not utilized at any given time by Florida leafwings and a population of several hundred or fewer individuals is reasonable.

Salvato and Salvato (2010a) also suggest a decline in the Florida leafwing population at one of their study sites is occurring. A short-term decline and localization of the Florida leafwing butterfly population throughout Long Pine Key may have also occurred in late 2012 - early 2013. Salvato and Salvato (unpublished data) failed to observe any adult or immature stages at any of their long term monitoring sites in Long Pine Key for a period of approximately 1 year. Following this observation, ENP staff conducted searches for adult and immature stages at a wide range of historic locations outside of the areas with ongoing long term monitoring. Only a very limited number of immature individuals were detected and these were restricted to a small area of central Long Pine Key. Subsequently, the Florida leafwing butterfly population seems to have recovered somewhat and sightings throughout Long Pine Key are once again being made by ENP staff. While it seems certain a population wide decline in abundance and distribution occurred, the reason is not understood. Quantitative data is needed to determine when population shifts occur and which areas still support individuals when numbers are low and distribution is localized.

Critical habitat was designated within the action area of the proposed project in August 2014. Critical habitat is currently found throughout Long Pine Key pine rockland and some adjacent marl prairie habitats.

Factors affecting the species environment within the action area

The threats to Florida leafwing butterflies consist of a lack of adequate fire management, small population size, isolation due to habitat loss and fragmentation, loss of genetic diversity, nonnative species introduction, inadequate regulatory mechanisms, pesticide applications, poaching, hurricanes and storm surge, and sea level rise. Fire is necessary to maintain suitable habitat for butterflies and host plants. The species' host plant, pineland croton, resprouts rapidly after fire, exhibits significant regrowth within 6 months to 1 year. Burned areas may be recolonized by Bartram's hairstreaks as they primarily remain within 5 meters of host plants (Salvato and Salvato 2008). Regular fire also reduces understory growth and prevents the establishment and spread of exotic invasive species both of which impact pineland croton and the butterflies that it supports.

59

Reptiles

Eastern indigo snake

Status of the species/critical habitat within the action area

Little is known about the specific habits and niche of the eastern indigo snake in Everglades National Park, as most information is from incidental observations. In ENP, the species is generally found in pine and tropical hardwood forests and, to a lesser extent, in coastal habitats, and has shown no strong preference for disturbed sites. In general, it appears to prefer open, undeveloped areas (Service 1999a). Sightings and collections of road killed individuals have occurred in the past three years within Everglades National Park, but they are only rarely encountered, and there is little information about their status and distribution in ENP besides occasional anecdotal observations and roadkills. In general, the population in ENP appears to have declined in recent years. There has been no research into the apparent decline within the park, but park biologists suspect competition for the limited supply of dry burrows with the non-native introduced Burmese python (*Python molurus bivittatus*).

Factors affecting the species environment within the action area

The natural habitat of the Everglades is comprised of a mosaic of habitat types that includes the upland areas favored by indigo snakes such as pine rocklands and tropical hardwood hammock bordering the Atlantic Coastal Ridge, transitioning in lower areas to ridge and slough, sawgrass, marl prairie, and other graminoid wetlands that are interspersed with tree islands, and finally mangroves in coastal areas (Service 1999a).

Settlers to Miami-Dade County began modifying the natural hydrologic regime in the early 1920s to make the area more suitable for agriculture and urban development. The combined efforts of the State and Federal governments and private interests resulted in the construction of a network of water control structures, canals, and levees with the goal to eliminate flooding that frequently occurred in most of the area. Associated with this larger network, an expansive infrastructure of roads, berms, culverts, ditches, rock pits, building pads, etc. has further contributed to modification of the natural habitat. By 1967, an expansive engineering system known as the Central and Southern Florida (C&SF) Project had mostly taken control of the entire hydrologic system of Miami-Dade County. The C&SF Project, although not directly encompassing ENP, has had a myriad of effects on the hydrology and natural functions of the park.

The eastern indigo snake was listed because of a population decline caused by habitat loss, over-collecting for the pet trade, and mortality from gassing gopher tortoise burrows to collect rattlesnakes (Speake and Mount 1973, Speake and McGlincy 1981) (43 FR 4028). At the time of listing, the main factor in the decline of this species 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 will use most of the habitat types available in its home range, but prefers 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). Extensive tracts of wild land, such as ENP, are important as refuges for eastern indigo snakes (Diemer and Speake 1981, Moler 1985b).

Pesticides that bioaccumulate through the food chain may present a potential hazard to the snake as well. There is also concern about competition with non-native constrictors and recently introduced non-native predators such as the Argentine black and white tegu (*Salvator merianae*), a known predacious and egg scavenging lizard.

Natural and human induced wildfires, and fire management activities currently occurring as part of the ENP prescribed fire program could be impacting the eastern indigo snake if they are entrapped in burn areas, although they are capable of moving away from impacted areas and seeking refuge in fire resistant debris piles and underground refugia. Juvenile indigo snakes may potentially be more vulnerable due to their utilization of less optimal refugia due to competition. The eastern indigo snake has evolved in habitat frequently affected by fire, and most of the vegetation communities that it occupies throughout most of its current range in the U.S. are fire-adapted or fire-maintained. It is frequently observed in recently burned areas, presumably due to an increased ability for snakes to be located in areas with reduced cover for concealment. No preference for burned areas has been documented for indigo snakes. The eastern indigo snake tends to occupy burrows and holes, and may use burrows as refugia from fire. During the decades that Everglades National Park has been conducting a fire management program, a dead burned eastern indigo snake has never been observed by fire management staff.

Climate change will affect eastern indigo snake habitat in the Everglades through sea level rise. Altered weather patterns could affect water levels in wetlands and canals and, as a result, decrease prey densities. For example, more intense precipitation events could cause flooding or scouring. Increased periods of drought could reduce wetland prey habitat or refugia. It is also possible that an increase in the intensity or frequency of tropical storms may affect eastern indigo snakes by flood-related drowning (or effects related to moving out of flooded areas), loss of sheltering habitat, or direct impact with debris. These factors are difficult to quantify as the data for climate change impacts are still subjective for this area of Florida.

Birds

Cape Sable seaside sparrow

Status of the species/critical habitat within the action area

The Cape Sable seaside sparrow (CSSS) is one of eight extant subspecies of seaside sparrow in North America. Its distribution is limited to the short-hydroperiod wetlands at the bottom of the greater Everglades system, on the southern tip of mainland Florida. The great majority of these sparrows occur within ENP, and only a small number are found on the adjacent state-owned Southern Glades Wildlife and Environmental Area. It was one of the first group of species listed under the Endangered Species Act of 1973. Critical habitat was first designated for this species in 1977, and revised critical habitat designation was published in November 2007. Unlike most other subspecies of seaside sparrow, which occupy primarily brackish tidal systems (Post and Greenlaw 1994), the Cape Sable seaside sparrow currently occurs primarily in the short-hydroperiod wet prairies, also referred to as marl prairies, though it may still occupy brackish marshes in some areas.

The current critical habitat designation includes five units (Units 1–5) which correspond with sparrow subpopulations B-F, and portions of all of them include ENP lands (the majority of unit 3 lies within adjacent State land). The critical habitat designation identifies three primary constituent elements of the habitat, and these are the characteristics that are essential to the conservation of Cape Sable seaside sparrows.

Unit 1 (Subpopulation B)

Unit 1 (CSSS subpopulation B) consists of 39,029 acres of marl prairie and lies exclusively within ENP. The unit is bounded on the south by the long hydroperiod *Eleocharis*-dominated wet prairie and mangrove zone just inland of Florida Bay, on the west by the sawgrass marshes and deepwater slough communities of SRS, on the north by the pine rockland vegetation communities that occur within ENP on Long Pine Key, and on the east by the sawgrass marshes and deepwater slough vegetation communities of Taylor Slough. There is a continuous topographical gradient across the site, from the slightly higher elevated pine rocklands north of the unit down to the lower lying mangroves in the south. The area is bisected by the Main Park Road, which serves as the primary public access route from Homestead to Flamingo and Florida Bay. It is also bisected by the Old Ingraham Highway, which is the original and now abandoned and partially restored historical roadway that provides alternate access to Florida Bay. Much of the western portion of this roadway was removed and restored to grade, but the eastern portions of the road, with its associated borrow canal and woody vegetation encroachment, interrupt the contiguity of the prairies within the eastern portion of this unit. Besides the road, borrow canal, and woody vegetation, which are not critical habitat, the area consists of one large, contiguous expanse of marl prairie that contains all of the PCEs for the sparrow.

When sparrows were first recorded in the area during the 1974 to 1975 surveys, they were abundant and widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, the Service believes the sparrows have occupied this locality since at least the time of listing. These same areas have remained occupied by sparrows since their discovery over 30 years ago. Consequently, the Service considered the unit to be occupied at the time of listing. The area is the largest contiguous patch of marl prairie east of SRS. It is currently occupied, and has consistently supported the largest sparrow subpopulation since 1992 (Pimm and Bass 2002, 2005; Pimm et al. 2002, 2007).

The natural characteristics of this area make it relatively immune to risk of flooding or frequent fires (Walters et al. 2000). Its location, south of the higher-elevation pine rocklands, provides it a degree of protection from high water levels that does not occur within any other units. Within the southern portion of the greater Everglades watershed, surface water generally flows from north to south, with most water moving through SRS, and to a lesser extent through Taylor Slough. The pinelands block the southward flow of water across this area such that the primary influences on water levels are rainfall and overflow from the flanking sloughs. In addition, portions of Unit 1 occur on relatively high elevations and remain relatively dry. Consequently, this area is not easily flooded as a result of managed water releases or upstream events, and the high-water levels that may occur within other sparrow subpopulations are dampened by its relative position and topographic characteristics.

Similarly, the area is not particularly vulnerable to fires. It is not over drained as a result of local hydrologic management actions, and the fire frequency is primarily influenced by natural ignition and managed prescribed fire. The public road that traverses the area could result in an increased likelihood of ignitions, but this has not been a concern to date. In addition, the presence of both the Main Park Road and the Old Ingraham Highway within this unit provides human access greater than in any other unit and may allow better opportunities to manage both prescribed fires and wildfires such that they would pose a reduced risk to the persistence of the sparrow subpopulation.

Unit 2 (Subpopulation C)

Unit 2 consists of 8,304 acres of marl prairie habitat that lies exclusively within ENP in the vicinity of Taylor Slough, along the eastern edge of ENP. The unit consists of the prairies that flank both sides of the relatively narrow Taylor Slough. The area is bordered by the pine rocklands of Long Pine Key on the west and by isolated pine rocklands and the L-31W canal that runs along the ENP boundary to the east. It is bordered by an area of constriction in Taylor Slough that is closely flanked on both sides by forested habitats at the southern end and by the Rocky Glades, a region of thin marl soils and exposed limestone and sparse vegetation to the north. The area is bisected by the Main Park Road in the southern portion of the unit, but the remainder of the unit consists of contiguous marl prairies.

Although sparrows were not discovered in the area until 1972 (Ogden 1972), the Service considered this unit to be occupied at the time of initial listing on March 11, 1967, under the Endangered Species Preservation Act of 1967 (32 FR 4001). At the time of discovery, sparrows were found to be widely distributed and abundant in this area (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, the Service believes that sparrows have occupied this locality since at least the time of listing.

These same areas have remained occupied by sparrows since their discovery. Following its discovery, the site was the location of some of the first intensive study of the sparrow's biology and its relationship to its habitat (Werner 1975).

During the mid-1970s, sparrows were abundant at this site (Werner 1975), and surveys in 1981 estimated 432 sparrows in this area (Pimm et al. 2002). Since 1981, the sparrow subpopulation at this site has declined and estimates have ranged from 0 to 144 sparrows between 1995 and the present (Pimm et al. 2002; Pimm and Bass 2005). During intensive nest surveys in 2008, Virzi et al. (2009) documented four females and five males, nine nest attempts and reported nest survival as 22.8 percent. When sparrows were abundant in this area, the habitat was in a relatively dry condition, with average annual hydroperiods between 90 and 180 days (ENP 2005).

Beginning in 1980, a pump station (S-332), which was installed along the eastern boundary of ENP at the approximate location of the historic slough, was operated to increase hydroperiods in the area resulting in extended hydroperiods within the portions of the area downstream from the pump station (ENP 2005). Vegetation changed in this area from suitable marl prairie to unsuitable sawgrass marsh due to altered hydrology as a result of the S-332 pump station operations (ENP 2005), and sparrows ceased to occur in this area. At the same time, the northern portions of Unit 2, north of pump station S-332, continued to be over drained as a result of the pump station and adjacent canal stage operations which effectively lowered the water table in the surrounding agricultural lands immediately bordering ENP (Johnson et al. 1988; ENP 2005). In these over drained areas, frequent fires impacted the habitat and resulted in reduced sparrow numbers (Pimm et al. 2002). The most recent fire occurred in March 2007 when the Frog Pond fire swept through this area; the habitat has been recovering since then (Sah et al. 2010; Virzi et al. 2009).

This area provides a contiguous expanse of habitat that is largely separated from other nearby subpopulations in an area that is uniquely influenced by hydrologic characteristics. The Taylor Slough basin is a relatively small system, and much of the headwaters of the slough are cut off by canals, agricultural land, and development to the east of ENP. Portions of this unit near the slough have deep soil (15.7 inches) (Taylor 1983) and support resilient vegetation that responds rapidly following fire (Taylor 1983; Werner and Woolfenden 1983).

Sparrows were reported to reoccupy burned sites in this region within 1 to 2 years following fire (Werner and Woolfenden 1983). The unit contains the vegetation characteristics upon which sparrows rely, and most of the area currently experiences hydrologic conditions that are compatible with sparrows use. However, the area along the eastern boundary of ENP remains heavily influenced by water management operations (ENP 2005). Portions of the area are also over drained, resulting in the possibility of high fire frequency. The location of this unit, relative to other sparrow subpopulations, is significant in that it occurs in the center of the five sparrow subpopulations that occur east of SRS in the vicinity of Taylor Slough (subpopulations B through F). The habitat in this area most likely plays an important role in aiding dispersal among the eastern subpopulations, acting as a ''hub'' that facilitates dispersal in the region and re-colonization of local areas that are detrimentally impacted and locally extirpated.

Unit 3 (Subpopulation D)

Unit 3 consists of 10,806 acres of marl prairie vegetation in an area that lies on the eastern side of the lower portion of Taylor Slough. The majority of this area, 92 percent or 9,973 acres, is within the Southern Glades Wildlife and Environmental Area, which is jointly managed by the South Florida Water Management District (District) and FWC. The remaining 8 percent (883 acres) occurs within the boundary of ENP. The area is bordered on the south by the long hydroperiod *Eleocharis* vegetation and mangroves that flank Florida Bay, on the west by the sawgrass marshes and deepwater vegetation of Taylor Slough, on the east by long-hydroperiod *Eleocharis* vegetation and over drained areas with shrub encroachment in the vicinity of U.S. Highway 1, and on the north by agricultural lands and development in the vicinity of Homestead and Florida City.

When sparrows were discovered in this area, they were widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, the Service believes that the sparrows have occupied this locality since at least the time of listing. These same areas have remained occupied by sparrows since their discovery over 30 years ago.

This is the easternmost area where sparrows occur and is the only subpopulation that occurs on the eastern side of Taylor Slough. It is therefore unlikely to be affected by the same factors (*e.g.*, large fires or extreme hydrologic conditions) that affect the other eastern subpopulations that lie primarily between SRS and Taylor Slough. This area is separated from other sparrow subpopulations by Taylor Slough, and the area immediately north of this subpopulation consists of agriculture and urban/suburban areas around Homestead and Florida City. These discontinuities in the landscape would tend to prevent potential fires from spreading from the area which supports sparrow subpopulations B, C, E, and F into the subpopulation D area.

Similarly, hydrologic conditions in this region are different than those that affect the other subpopulations because water levels are attenuated by Taylor Slough and influenced by flood protection and water supply infrastructure in the urban and agricultural areas to the north. The 1981 comprehensive population survey estimated 400 sparrows within this region (Pimm et al. 2002). This was higher than any number of sparrows recorded in the area in recent years, and estimates have ranged from 0 to 112 sparrows between 1992 and the present (Pimm et al. 2002; Pimm and Bass 2005).

The area currently contains all PCEs, but the majority of the area is dominated by sawgrass, which indicates a wetter-than-average condition within the spectrum of conditions that support marl prairie and sparrow habitat (Ross et al. 2006). The habitat in this area is divided by several canals that are part of the C–111 basin. This canal system results in relatively altered hydrologic conditions in the region (ENP 2005) and causes extended hydroperiods during wet periods (Pimm et al. 2002).

Unit 4 (Subpopulation E)

Unit 4, subpopulation E, consists of 22,278 acres of marl prairie habitat in an area that lies along the eastern margin of SRS. This unit occurs entirely within ENP. The area is bordered to the south by the pine rocklands of Long Pine Key and by an area dominated by dwarf cypress trees. The sawgrass marshes and deepwater slough vegetation communities of SRS comprise the western and northern boundary of the area, and the Rocky Glades comprise the eastern boundary. When sparrows were discovered in this area, they were relatively widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, we believe that the sparrows have occupied this locality since at least the time of listing. These same areas have remained occupied by sparrows since their discovery over 30 years ago. We consequently consider this unit to be occupied at the time of listing. The majority of this area was included in the 1977 critical habitat designation for the sparrow (42 FR 40685 and 42 FR 47840). This area is currently occupied by sparrows and contains all of the PCEs.

Unit 4 supports one of the large, relatively stable sparrow subpopulations. It is centrally located among the areas supporting other subpopulations, and its central location probably plays an important role in aiding dispersal among subpopulations, particularly movements from the eastern subpopulations (Units 1–5) to the only subpopulation west of SRS, subpopulation A. Since 1997, this area has supported the second largest sparrow subpopulation, ranging from 576 to nearly 1,000 individuals in recent years (Pimm et al. 2002; Pimm and Bass 2005).

The centrality of this subpopulation helps to prevent it from being affected by managed hydrologic conditions because it is distant from canals, pumps, and water management structures that occur along the boundaries of ENP. The magnitude of managed water releases is generally dampened by the time their influence reaches this area. However, the proximity of this area to SRS may make the habitats and the sparrows that they support vulnerable to hydrologic effects during wet periods. The western portions of the area may become too deeply inundated to provide good habitat for sparrows under some deep water conditions. Large-scale hydrologic modifications, such as those proposed under the CERP, have the potential to influence habitat conditions in this area (*e.g.*, PCEs), and may require special management attention. Large-scale fires may detrimentally affect this area, and there are no intervening features in the region that would aid in reducing the potential impacts on this subpopulation. While the area is relatively distant from ENP boundaries and potential sources of human-caused ignition, fires that are started along the eastern ENP boundary may rapidly spread into the area. The 2001 Lopez fire was a human-caused fire that affected a portion of this unit (Lockwood et al. 2005). Risk from fire may also require management in this area to prevent impacts to this large sparrow subpopulation.

Unit 5 (Subpopulation F)

Unit 5 subpopulation F consists of 4,883 acres of marl prairie that lies along the eastern boundary of ENP, and is the northernmost of the designated critical habitat units. Unit 5 is also the smallest of the five units. It is bounded on the north and west by ENP sawgrass marshes and deepwater slough vegetation communities associated with SRS, and on the east by agricultural and residential development along the eastern boundary of ENP. Its southern boundary is defined and characterized by the sparse vegetation, shallow soils, and exposed limestone depressions and solution holes of the Rocky Glades. When sparrows were discovered in this area, they were relatively widespread (Werner 1975). Based on their limited mobility and dispersal capabilities and the presence and persistence of suitable habitat, we believe that the sparrows have occupied this locality since at least the time of initial listing. These same areas have remained occupied by sparrows since their discovery over 30 years ago. The Service consequently considered this unit to be occupied at the time of listing. The majority of this area was included in the 1977 critical habitat designation for the sparrow (42 FR 40685 and 42 FR 47840). This area is currently occupied by sparrows, and contains all of the PCEs.

The first comprehensive sparrow population survey conducted in 1981 resulted in an estimated population of 112 sparrows in this area, and most subsequent surveys have resulted in estimates lower than this, including several consecutive years when no sparrows were found (Pimm et al. 2002; Pimm and Bass 2005). However, sparrows were always found in the area in subsequent years following a zero count (Pimm et al. 2002), indicating that sparrows are consistently using the area.

This area could serve to support or recolonize subpopulations C and E (Units 2 and 4) if those areas were to become unsuitable. Loss of available habitat in this area would result in a reduction in the total spatial distribution of sparrows. Its position in the landscape results in a unique set of threats that differ from those in other subpopulations. Because of its proximity to urban and agricultural areas and its relative topographic location, this area has been consistently over drained in recent years and remains dry during the year for longer periods than other subpopulations (shortened hydroperiod). The relative dryness of the area may allow the site to remain suitable as habitat for sparrows under very wet conditions, when other subpopulations may become deeply inundated for long durations.

Due in large part to its relatively drier hydrologic condition and its proximity to developed areas, Unit 5 has been subjected to frequent human-caused fires during the past decade, resulting in periods of poor habitat quality. The PCEs within this unit may require special management consideration due to the threat from fire. In addition, the dry conditions have allowed encroachment of woody vegetation, including invasive exotic and native woody species.

Invasive exotic trees, primarily Australian pine, melaleuca, and Brazilian pepper, have become established in local areas (Werner 1975), often forming dense stands. These trees have reduced the suitability of some portions of the habitat for sparrows and have reduced the amount of contiguous open habitat. Aggressive management programs have been implemented by resource management agencies to address this issue, and control of woody vegetation will continue to be required.

Factors affecting the species environment within the action area

Hydrology

The C&SF Project is a system-wide network of canals and water-control structures. The Corps and District operate the C&SF Project to achieve a variety of local and regional objectives including flood protection, water supply, and environmental benefits. Operations of the C&SF Project affect the hydrologic conditions of nearly all the wetland systems within southern Florida to some degree, including the habitat supporting the CSSS. In general, the closer wetland habitat is located to water control infrastructure, the greater the potential effect may be. The Service's 2002 Biological Opinion prescribed the Interim Operational Plan (IOP) as a second reasonable and prudent alternative (RPA) with qualifications which included a hydrologic management regime to protect sparrow breeding by reducing water deliveries in western marl prairies that are too wet and increasing water deliveries to the eastern marl prairies that have been historically over drained prior to the expansion of ENP. Regulations (50 CFR §402.02) implementing section 7 of the ESA define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1)can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) NMFS or USFWS believe would avoid the likelihood of jeopardizing the continued existence of listed species or result in the destruction or adverse modification of critical habitat.

Under IOP, hydrologic management provided reduced flows during the breeding season to sparrow habitat located in the western marl prairies. Construction and operation of several detention areas adjacent to sparrow habitat in the eastern subpopulations increased hydroperiods in some over-drained habitats such as subpopulation C. Many other hydrologic operations throughout the C&SF system that routinely occur have resulted in changes to hydrologic conditions in and adjacent to sparrow habitat. Pre-storm and post-storm operations, testing of hydrologic management operations, and other similar activities conducted by the Corps and District have also affected hydrologic conditions within sparrow habitat, mainly through alteration of the natural timing of wetting and drying events.

Fire

Fire is a natural or human-related factor that affects marl prairies occupied by the sparrow and most sparrow habitats have burned at some point during the past 30 to 40 years. The ENP, BCNP, and FWC have all conducted prescribed burns within sparrow habitat on lands within their respective jurisdictions. Fire management on Department of Interior land (ENP and BCNP) combines fire operations, prescribed fire, and fire ecology in order to maintain fire in the natural ecosystems while adequately considering impacts on nearby human population centers as well as threatened and endangered species habitat. The Service has consulted with ENP on several fire management plans as well as participates in the annual sparrow/fire symposium held at ENP by their fire management staff. In addition, these agencies and the Florida Division of Forestry conduct wildfire suppression and management within sparrow habitat. In the short-term, fire typically renders sparrow habitat unsuitable for occupancy because it removes the vegetation that sparrows rely upon for cover and refugia especially during the breeding season. Following fire, vegetation normally begins to regenerate rapidly and reaches pre-burn density and species composition about 2 years later. Sparrows do not regularly occupy burned areas for 2 to 3 years after fire (La Puma et al. 2007). ENP has conducted prescribed fire in former sparrow habitat within the western marl prairies (subpopulation A) to facilitate habitat restoration. Within sparrow subpopulations, ENP also has conducted wildfire suppression that was intended specifically to reduce potential impacts to sparrows and sparrow habitat within subpopulation B. Prescribed burns have also been conducted along the eastern ENP boundary to reduce the likelihood of human-ignited fires spreading into sparrow habitat near subpopulations C, E, and F. Fires, prescribed, natural, and human-ignited, have occurred within and in the vicinity of subpopulation D. Because fires reduce habitat suitability for up to 3 years, prescribed fires, human-induced fires and wildfires can all have adverse short-term effects on sparrow populations, but also may be necessary in the long-term for the maintenance of habitat that outweigh the adverse short-term effects (Taylor 1983; Pimm et al. 2002; Lockwood et al. 2003, 2005; LaPuma et al. 2007).

Several fires burned within sparrow habitat during the 2008 dry season. Among these were the West Camp Fire and Mustang Corner Fire, which was the largest fire to have burned in ENP since the Ingraham Fire in 1989. Unlike previous burned areas, pre-fire vegetation data was available for these fires and Sah et al. (2010) provided a preliminary evaluation of 1 year after the fire. Post-fire hydrology in these areas was favorable for normal recovery with a gradual increase in water depth. This is in contrast to a subset of sites burned in 2005 that were flooded within 7 to 14 days of the fires, and remained significantly different from pre-burn vegetation composition even four years post fire. Continued monitoring of vegetation recovery at sites burned in 2008 can help inform sparrow habitat management. Specifically, it may allow us to better understand if fire in conjunction with water management and other techniques could be used to help restore altered sparrow habitat (Hanan et al. 2009; Sah et al. 2010).

Changes in vegetation composition can result from changes in hydrologic conditions, changes in fire frequency, and change in management actions. Many areas of sparrow habitat have experienced vegetation change since monitoring was initiated. Over drying that results from maintaining artificially low water levels within areas of sparrow habitat, such as those that occur along the eastern boundary of ENP, results in woody vegetation encroachment, which reduces the suitability of the habitat for sparrow occupancy. Extended hydroperiods and deep water depths may occur from managed water releases in combination with wet-season rainfall which can lead to vegetation changes from marl prairie species to marsh species, resulting in reduced habitat suitability.

Invasive and Exotic Species

Invasive and exotic species may also affect sparrows. Invasive plant species such as *Melaleuca* also known as punk tree or paperbark tea tree, Australian pine, Brazilian pepper, and other woody species can become established in sparrow habitat and reduce habitat suitability. While limited information is available on the effects of invasive exotic plants and animals on sparrows, species like the Burmese python have become established in sparrow habitat and may depredate sparrows. There is also concern about competition with recently introduced non-native predators such as the Argentine black and white tegu (*Salvator merianae*), a known predacious and egg scavenging lizard.

Management of invasive woody plants has been conducted by the ENP, FWC, and District in and adjacent to sparrow habitat to reduce impacts of these species on sparrow habitat suitability. Herbicide treatment of large stands of exotic trees has reduced the spread of these species and has improved sparrow habitat in some areas. These invasive plant species regenerate rapidly requiring continued maintenance controls. Efforts to remove invasive exotic animals like the Burmese python have also been initiated, but to date these efforts have largely been opportunistic.

Water Quality

The Everglades was historically an oligotrophic system, lacking nutrients such as phosphorus, but having high levels of dissolved oxygen. Major portions have become rich in nutrients that promote excessive plant growth and deplete dissolved oxygen primarily due to anthropogenic sources of phosphorus and nitrogen (cultural eutrophication). Degradation of water quality, particularly runoff of phosphorus from agricultural and urban sources, is a concern because it can cause encroachment of cattail (*Typha* sp.) and other undesirable invasive and exotic species.

Everglade snail kite

Status of the species/critical habitat within the action area

Within ENP, kite nesting has been relatively uncommon in the past two decades. In 2011, two nests were located in northeastern Shark River Slough, but both failed. This has been a typical pattern, likely due to low water levels and rapid drying in Shark River Slough that leaves nests vulnerable to predators. However, there has also been relatively low survey effort, it is difficult to survey all suitable areas within ENP, and some additional nests may occur. Regardless, ENP supports a small fraction of the snail kite nesting effort in Florida in recent years. Outside of nesting season, kites may occur and forage throughout ENP, but rarely in large numbers. In summer and fall 2012, kites were routinely observed foraging in the vicinity of Taylor Slough, as well as in other places within ENP.

Factors affecting the species environment within the action area

The persistence of the snail kite in Florida depends upon maintaining hydrologic conditions that support the specific vegetative communities that compose their habitat along with sufficient apple snail availability across their range each year. Operation of the C&SF Project and other hydrologic management actions has a significant effect on hydrologic conditions within most of the areas occupied by snail kites. The Corps, District, and St. John's River Water Management District manage water levels in snail kite habitat in accord with many different local and regional water management plans and schedules. Water management plans affect water levels in marshes and lakes upon which snail kites rely, the rates of water level recessions in lakes and marshes, and the timing of high and low water events. These factors, in turn, directly affect snail kite habitat suitability. The compartmentalization of Everglades' wetlands under the C&SF Project, and subsequent hydrologic management of each of the compartments has reduced the connectivity of wetland systems upon which kites rely. Separate and independent management regimes for the different compartments have also impacted snail kites, in some cases by allowing unfavorable conditions in adjacent wetland units at the same time.

Both short-term natural disturbances (*e.g.*, drought) and long-term habitat degradation, including impacts to their prey base, limit the snail kite's reproductive ability. WCA-3A has been identified as the most critical component of snail kite habitat in Florida, in terms of its influence on demography (Mooij et al. 2002; Martin 2007; Martin et al. 2007). A concern is the lack of reproduction within this area in recent years. Current water regulation schedules may shorten the window of time during which kites can breed, and rapid recession rates can result in nest abandonment (Cattau et al. 2008). Hydrologic conditions within WCA-3A have also resulted in reduced apple snail productivity, abundance, and density. Researchers have identified that high water during the breeding season can have significant negative impacts to apple snail egg cluster production (Darby et al. 2005; Darby et al. 2009). In addition, higher-water levels and longer hydroperiods occurring during IOP have been implicated in the conversion of wet prairies (prime kite foraging habitat) to sloughs within WCA-3A (Zweig 2008). Within WCA-3A, there are three primary factors which have the potential to adversely affect snail kites: (1) prolonged high water levels during September through January (or beyond in some years); (2) prolonged low water levels during the early spring and summer; and (3) rapid recession rates.

<u>Mammals</u>

Florida bonneted bat

Status of the species/critical habitat within the action area

Bonneted bats have been acoustically detected in Everglades National Park, albeit infrequently. Results from 81 surveys conducted on 75 nights (from October 2011 to November 2012) in ENP and surrounding areas produced relatively few call sequences indicating the presence of the Florida bonneted bat. The species was detected on three occasions along the Main Park Road from the eastern boundary to the Long Pine Key Campground. The habitat types, where detected, include pine rocklands, wet prairie, and tropical hardwoods, and are included in Fire Management Unit FMU 3. Additional locations in ENP where the bat has been detected include Darwin's Place and Watson Place along the forested northwest coast of the park, and along the northeast boundary of the park over the L-31N canal, from SW 136th Street to US 41 (FMU 1 and FMU 4 respectively). Roosting sites and confirmed foraging habitat, while anticipated, have yet to be identified in ENP. The sparse number of acoustic detections may be an indicator of the rarity of the Florida bonneted bat, but it may also underscore the difficulty of detecting a bat that may travel and forage some of the time (if not frequently) at altitudes beyond the range of detection by acoustic survey equipment. Surveys in ENP are ongoing and this possibility will be investigated.

Factors affecting the species environment within the action area

Habitat

A number of threats to the habitat of the Florida bonneted bat have been identified which have occurred in the past, are impacting the species now, and will continue to impact the species in the future. Habitat loss, fragmentation, and degradation, and associated pressures from increased human population are major threats; these threats are expected to continue, placing the species at greater risk. The species' use of conservation areas tempers some impacts, yet the threats of major losses of habitat remains. In natural or undeveloped areas, the Florida bonneted bat may be impacted when forests are converted to other uses or when old trees with cavities are removed. Routine land management activities (*e.g.*, thinning, prescribed fire) may also impact unknown roost sites. Although species occurrences on conservation lands are inherently more protected than those on private lands, habitat alteration during management practices may impact natural roosting sites because the locations of such sites are unknown. For example, removal of old or live trees with cavities during activities associated with forest management (*e.g.*, thinning, pruning), prescribed fire, exotic species treatment, or trail maintenance may inadvertently remove roost sites, if such sites are not known. Loss of an active roost or removal during critical life-history stages (*e.g.*, when females are pregnant or rearing young) can have severe ramifications, considering the species' small population size and low fecundity. In areas with buildings, suitable roost sites may also be lost when buildings are demolished or when structures are modified to exclude bats. Uncertainty regarding the species' specific habitat needs and requirements (*i.e.*, location of roost sites) arguably contributes to these threats, by increasing the likelihood of inadvertent impacts to and losses of habitat. The effects resulting from climatic change, including sea level rise and coastal squeeze, are expected to become severe in the future and result in additional habitat losses, including the loss of roost sites and foraging habitat. Although efforts are being made to conserve natural areas and, in some cases, retain cavity trees, the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future.

Disease or Predation

The effects of disease or predation are not well known. Given the Florida bonneted bat's overall vulnerability, both disease and predation could pose threats to its survival. White-nose syndrome (WNS) is an emerging infectious disease affecting insectivorous, cave-dwelling bats. It was first documented in 2006, in caves west of Albany, New York. Since its discovery, WNS has spread rapidly throughout the eastern and central United States and southeastern Canada, killing millions of bats. It is expected to continue spreading westward and southward. It has not yet been documented in Florida. WNS is caused by the cold-loving fungus, *Geomyces destructans*, a newly described fungus, and is named after the white fungal growth that often occurs on the muzzle of affected bats (Gargas et al. 2009; Lorch et al. 2011). In North America, *G. destructans* appears to infect bats only during winter hibernation. Mortality rates have been observed to vary by species and site, but have been as high as 100 percent at some hibernacula (winter bat roosts). WNS has been recorded in seven North American bat species, all of which are known to hibernate in caves and mines. WNS and *G. destructans* have not been detected in bats that typically live outside of caves, such as eastern red-bats (*Lasiurus borealis*), and the fungus is believed to need the cave environment to survive. Because the Florida bonneted bat spends its entire life cycle outside of caves and mines and in subtropical environments where no torpor or hibernation is required, it is not anticipated that it will be adversely affected by WNS. However, since the fungus is new to science and North America, it is not known how it may evolve or change in the future. Prior to the discovery of WNS, infectious diseases had rarely been documented as a large-scale cause of mortality in bat populations and had not been considered a major issue (Messenger et al. 2003 as cited in Jones et al. 2009). Jones et al. (2009) contended that because increased environmental stress can suppress the immune systems of bats and other animals, increased prevalence of diseases may be a consequence of altered environments (*i.e.,* bats may be more susceptible to disease if they are stressed by other threats). These authors contended that bats are excellent potential bioindicators because they are reservoirs of a wide range of emerging infectious diseases whose epidemiology may reflect environmental stress. Jones et al. (2009) suggested that an increased incidence of disease in bats may be an important bioindicator of habitat degradation in general. Sherwin et al. (2012) suggest that warming temperatures associated with climate change may increase the spread of disease (along with other impacts), which could cause significant mortalities to bat populations in general. At this time, it is difficult to assess whether disease is currently or likely to become a threat to the Florida bonneted bat. With anticipated climatic changes and increased environmental stress, it is possible that disease will have a greater impact on the Florida bonneted bat in the future.

Predation

In general, animals such as owls, hawks, raccoons, skunks, and snakes prey upon bats (Harvey et al. 1999). However, few animals consume bats as a regular part of their diet (Harvey et al. 1999). There is only one record of natural predation on the Florida bonneted bat (Timm and Genoways 2004). A skull of one specimen was found in a regurgitated owl pellet at the FSPSP in June 2000 (Timm and Genoways 2004; C. Marks, pers. comm. 2006; Marks and Marks 2008a; M. Owen, pers. comm. 2012a, 2012b). Although evidence of predation is lacking, the species is presumably affected by some level of predation from native wildlife (*e.g.,* hawks, owls, raccoons, rat snakes) and the large number of introduced and nonnative reptiles (*e.g.,* young Burmese pythons, boa constrictors) (Krysko et al. 2011; M. Ludlow, *in litt.* 2012; R. Timm, *in litt.* 2012). Several species of nonnative, giant constrictor snakes have become established in Florida, causing major ecological impacts (USGS 2015; 77 FR 3330). Giant constrictors are habitat generalists, can grow and reproduce rapidly, and are arboreal when young, placing birds and arboreal mammals, such as bats, at risk (USGS 2015). Given the small population of the Florida bonneted bat, it is possible that the loss to snake predation is under appreciated now or this may become more of a threat in the future (M. Ludlow, in litt. 2012; R. Timm, in litt. 2012). Some efforts to control nonnative snakes and other species are being made on some conservation lands (e.g., ENP; Harvey et al. 2013; (USGS 2015), but we do not have data on how these efforts may be impacting the Florida bonneted bat. Due to limited information, it is not possible to determine the extent to which predation may be impacting the Florida bonneted bat at this time. However, given the species' apparent small population size and overall vulnerability, it is reasonable to assume that predation is a potential threat, which may increase in the future.

Other Factors

Based on our analysis of the best available information, a wide array of natural and manmade factors affecting the continued existence of the Florida bonneted bat have been identified. Inadvertent or purposeful impacts by humans caused by intolerance or lack of awareness (*e.g.*, removal, landscaping activities, and bridge maintenance) can lead to mortality or disturbances to maternity colonies. The Florida bonneted bat's ability to adapt well to manmade structures has likely been a factor in its decline because the bat tends to inhabit structures that place it at risk from inadvertent or purposeful harm by humans. Competition for tree cavities from native and nonnative wildlife is a potential threat. The species may be exposed to a variety of chemical compounds through multiple routes of exposure, and intensive pesticide use in areas adjoining ENP may alter insect prey availability. Ecological light pollution may also be a potential threat. Small population size, restricted range, low fecundity, and few and isolated colonies are serious ongoing threats. Catastrophic and stochastic events are of significant concern. All occupied areas are at risk due to hurricanes, which can cause direct mortality, loss of roost sites, and other impacts. More frequent intense hurricanes may be anticipated due to climate change. Extreme cold weather events can also have severe impacts on the population and increase risks from other threats by extirpating colonies or further reducing colony sizes. Collectively, many of these threats have operated in the past, are impacting the species now, and will continue to impact the Florida bonneted bat in the future.

Florida panther

Status of the species/critical habitat within the action area

Florida panthers located in ENP on the east side of Shark River Slough are considered a sub-population of the broader panther population in Florida, and are isolated from the main population by Shark River Slough and rapid urban development in the greater Miami area. While panthers can cross Shark River Slough, they are unlikely to do so, and the frequency of panther movements between the ENP subpopulation and the rest of the panther population is low. Geographic isolation makes this small population particularly susceptible to extirpation due to either complete mortality of one sex (likely male) or the recurrence of genetic depression due to inbreeding. Non-invasive camera trap monitoring techniques used by ENP staff indicate that the current minimum population east of Shark River Slough consists of only 5 to7 individual adult panthers, and likely only one male.

Within ENP, panthers occupy very large home ranges on the order of 450 km^2 (111,200 acres) for males and 250 km^2 (61,800 acres) for females. Dispersing juveniles have been known to travel hundreds and in some cases thousands of miles prior to establishing a permanent home range. Known individuals within ENP have overlapping primary home ranges centered in and around Long Pine Key, yet habitat use varies seasonally. Panthers in ENP can be found in nearly all terrestrial habitats, yet many years of telemetry and track data indicate that pine dominated landscapes followed by seasonally dry prairie interspersed with hammocks and cypress comprise the core habitats that support the ENP subpopulation. Panther use extends south and west into the mangrove transition zone or boundary of Shark River Slough high water and; to the east and north of Long Pine Key, panthers extensively utilize areas extending to northern and eastern ENP borders and adjacent lands. Panthers are also known to occur at least seasonally in regions of ENP bordering BCNP. Sporadic reports occur in the Cape Sable region of ENP and these are most likely transitional dispersing males if and when the reports are credible, and are unlikely to be resident cats. The remote west central coast of ENP has deer and hog populations potentially sufficient to support panthers yet sightings and panther occurrence and use in this area have not been documented. Immigration and emigration are known to be rare but are poorly understood within eastern ENP and require further study. The Chekika area in particular appears to have an increasing deer and feral swine prey base sufficient to support greater use by panthers than is currently known to occur and this area and may become a more significant component of home ranges in future years.

Factors affecting the species environment within the action area

Today, the primary threats to the remaining panther population are habitat loss, fragmentation, and degradation. Urban sprawl, the conversion of once-diversified agricultural lands into intensified industrial farming uses, and the loss of farmland to commercial development combine to reduce the amount of suitable panther habitat adjoining ENP. Other factors include mortalities from collisions with automobiles, territorial disputes with other panthers, inbreeding, disease, and environmental toxins. All these other factors, however, are also related to habitat reduction.

Natural gene exchange between the Florida panther and three other subspecies ceased when the panther became geographically isolated, probably over a century ago (Seal et al. 1994). Isolation from *P. c. cougar*, *P. c. hippolestes*, and *P. c. stanleyana*, habitat loss, reduced population size, and inbreeding had resulted in loss of genetic variability and diminished health. Data on polymorphism and heterozygosity, when combined with multiple physiological abnormalities, suggested that the panther was experiencing inbreeding depression (Roelke et al. 1993, Barone et al. 1994). The recent history of the Florida panther documents the success of a genetic restoration program. Historically, natural gene exchange occurred between the Florida panther and other contiguous species of *Puma concolor* as individuals dispersed among populations and bred. This natural mechanism for gene exchange maintained genetic health within populations and minimized inbreeding. However, as the population declined, gene exchange between subspecies could no longer occur because the Florida panther had become isolated from neighboring subspecies such as the Texas cougar. Inbreeding accelerated, resulting in genetic depression, declining health, reduced survivability, and low numbers. If action had not taken to address the loss of natural gene exchange, it was feared that the species would soon have been extinct. In 1995 when the genetic restoration program began, the population of panthers had dwindled to only 20-30 individuals in the wild. In 1995, eight female Texas cougars were released in South Florida. Five of the eight Texas cougars produced litters and at least 20 kittens were born. By 2007, the Florida panther population had responded by tripling to about 100 animals. The genetic restoration program restored genetic variability and vitality for a healthier, more resilient population.

Like most animals, Florida panthers need food, water, shelter, and access to mates to survive. Panthers are strictly carnivores and eat only meat. About 90 percent of their diet is feral hog, white-tailed deer, raccoon, and armadillo. Occasionally they consume rabbits, rats, and birds, and occasionally even alligators. In South Florida, panthers prefer mature upland forests (hardwood hammocks and pinelands) over other habitat types. Upland forests provide dry ground for resting and denning, and prey density is higher than it is in lower habitats where flooding is more common. Much of the prime panther habitat is north of Interstate Highway 75, and panthers in that area weigh more, are healthier, and successfully raise more kittens than panthers that live primarily south of the highway and feed mostly on small prey. Panthers in ENP are smaller and fewer because much of the park consists of wetlands, while panthers need uplands in order to thrive. Although the Long Pine Key area within the park provides dry upland habitat, hogs are scarce in the park and deer are limited to dry or low water level areas. A panther has to kill and eat about 10 raccoons to equal the food value of 1 deer. To maintain their health and fitness, adult panthers need to consume the equivalent of about one deer or hog per week. Females with kittens may need twice this amount.

Prescribed fire has more to do with prey availability than it has to do with panthers. Deer and other prey animals are attracted to the new growth of grasses and forbs that occur after a fire. As the majority of a Florida panther's diet consists of deer and other animals, any management activity that improves these populations also improves the panther population. One of the goals of prescribed burning is to thin areas of dense, fast-growing shrubby vegetation which outcompete grasses and forbs for sunlight, space and soil nutrients. Increasing the amount and quality of preferred vegetation for animals subsequently benefits the panthers. Florida panthers are very capable of avoiding actively burning fires. Radio tracking studies show that panthers frequent recently burned areas and that female panthers will often have their kittens in a unit that was recently burned. A rare exception to this occurred in 2011, when four panther kittens were killed by a large wildfire in Big Cypress National Preserve that swept across their den. The 5-month-old kittens, a female and three males, had been previously marked with transponders by preserve workers.

Another possible threat that panthers are exposed to is mercury. Scientists first became aware of the potential threat of mercury to panthers in South Florida in 1989 when a female panther from ENP died. An immediate cause of death could not be determined, but later tests revealed that her liver contained high levels of mercury. That same year, the State of Florida found high levels of mercury in fish from the Everglades. Air pollution from metals mining and smelting, coal-fired utilities and industry, and solid-waste incinerators was determined to be the major source of mercury contamination. Although some of this pollution was coming from utilities and industries within Florida, some originates in other countries and continents. Summer thunderstorms scour airborne mercury out of the upper atmosphere and deposit it in the Everglades. Mercury in rainfall is transformed to methylmercury by bacteria in sediments and algal mats. Zooplankton feed on algae, fish and crayfish feed on zooplankton, raccoons feed on fish and crayfish, and panthers feed on raccoons. In the 15 months before her death, the panther with high levels of mercury in her liver fed only on small prey, primarily raccoons. As mercury moves through the food chain, it accumulates in ever-greater quantities in the tissue of each predator. The tissues of predators at the top of the food chain, such as panthers, typically contain the most mercury.

Subsequent studies found that mercury concentrations in panther tissues were lowest north of Interstate Highway 75 where adequate deer and hogs were available and highest in the Everglades and the southern part of Big Cypress National Preserve where consumption of raccoons was highest. Raccoons are thought to have been the major source of mercury in Florida panthers at that time. Since 1989, mercury concentrations in fish and birds in the Everglades have dropped by 60 to 70 percent. The drastic reductions are directly linked to the installation of technology that reduced mercury in emissions from industries in South Florida. Although mercury levels in the natural environment are a worldwide concern and mercury likely will never be completely removed from the environment, mercury reductions are expected to continue into the future.

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action on the species and/or critical habitat and interrelated and interdependent activities. Implementation of the prescribed burns and wildland fire management activities included in the proposed action will restore degraded habitat and improve habitat conditions for a variety of listed and candidate species in fire dependent plant communities throughout Everglades National Park. However, some adverse effects will occur to the covered species as described in the following sections. The project is expected to have many beneficial effects for Blodgett's silverbush, pineland sandmat, Garber's spurge, Everglades pineland crabgrass, Everglades bully, Florida leafwing butterfly, and Bartram's hairstreak butterfly by creating disturbed sites for recolonization, removing competing vegetation and introduced exotics, and favoring host plants. Habitat for the eastern indigo snake, Florida panther, Florida bonneted bat, Cape Sable seaside sparrow, and Everglade snail kite will be improved by thinning of dense patches of vegetation creating additional foraging opportunities. Florida bonneted bats may additionally be benefited by the creation of additional roosting sites (dead snags).

Factors to be considered

Increased potential of accidental mortality to individuals

In the case of listed plants, the proposed actions may include loss of individual plants due to crushing or as a result of vegetative manipulation. While fire may "top kill" or lead to mortality of some covered plant species, these species are fire adapted and have various strategies for responding to fire events, including vigorous resprouting from root stock or recolonizing from seed banks. Prescribed burning could potentially cause mortality or injury of listed species.

In the case of listed animals, accidental injury or mortality of individual members of some of the covered species may present a greater threat if prescribed burns are conducted during the nesting, brood-rearing, or denning seasons when vulnerable eggs or young are present. This is not to discount the threat that fires can present during other times of the year. Fires that burn too fast or hot may not provide individuals seeking refuge/cover, time to escape, causing mortality.

In almost all cases, recovery of habitat after a prescribed fire is rapid with improvement in habitat conditions resulting in a net conservation benefit for both plants and animals. However, a temporary reduction in habitat may occur and persist until habitat recovers following the prescribed burn. Conversely, in the absence of fire, habitat will continue to degrade and reach a point where conditions are no longer suitable for the covered species resulting in an overall loss of population numbers.

Physical disturbance (including noise)

All of the activities associated with implementation of the proposed action, either directly or indirectly, have the potential to produce some level of physical disturbance because they involve the presence of humans and/or associated equipment, vehicles, or machinery. Although effects are not quantitatively known, the literature suggests some form of physical effects from presence and associated noise will create a disturbance response to individuals of each of the covered animal species.

The net effect of physical disturbance including sustained sources of noise may be a localized reduction of survival or productivity, avoidance of otherwise suitable habitat, and/or reduction of breeding frequency. These effects are expected to rarely occur and are not expected to produce substantial changes in species distribution and abundance. However, some small level of mortality is expected due to the potential for disturbance of the affected animal and the potential for vehicle/equipment collisions, crushing and burying.

Temporary soil disturbance and vegetation removal

Temporary soil disturbance and vegetation removal are expected from the implementation of prescribed fire and wildland fire control activities. The disturbance may result in loss or temporary change in habitat conditions for the covered species. Sources of the disturbance would include use of equipment as well as practices that involve manipulation of vegetation (*e.g.,* fire break installation, mechanical treatment of vegetation, and prescribed burning). The ground disturbance may involve minor surface disturbance such as that caused by tracked or wheeled vehicles, airboats, or access on foot. Common potential adverse effects identified by the Service include short term degradation of habitat conditions and the potential for increased habitat fragmentation if the scale of the disturbance is large enough and the potential to create opportunities for colonization of the disturbed sites by invasive plants.

Temporary adverse effects on individuals can include increased levels of stress hormones, increased recesses during incubation (*i.e.,* may increase detection by predators and predation risk), or disturbance/flushing of young. If these risks are realized over a broad enough area, individual fitness is reduced and it may have population level effects.

Permanent habitat removal/loss of suitable habitat

Under certain adverse conditions, recovery and/or reestablishment of desirable vegetation communities can be severely compromised by excessive flooding depths and durations of burned areas too soon following the burn. In this scenario, flooding depths can be detrimental if they exceed vegetative regrowth height at that time.

The primary adverse effect is the permanent loss of habitat which can lead to a subsequent decline in populations of the covered species. However, any permanent loss in habitat is expected to be small in scale due to planned safeguards and will not substantially affect population trends or result in quantifiable additional habitat fragmentation effects.

In addition, ENP does not currently have resources available to determine the percent of covered plant populations that burn or remain unburned during any given fire season making it difficult to fully monitor the status and extent of all plant populations discussed in this BO. Prescribed fires are implemented to create a mosaic pattern of burned and unburned habitat and ENP believes that this approach serves as a suitable mechanism to prevent entire populations of covered plants from burning during a prescribed fire while reducing shrub encroachment and minimizing exotic plant populations to the maximum extent possible.

Increased potential for predation

Certain proposed actions may increase the potential for predation on individuals through the modification of existing habitat conditions. Some practices may temporarily reduce available cover and food sources, making the covered species more vulnerable to predation.

Species response to the proposed action

Blodgett's silverbush

Implementation of the proposed action has the potential to result in injury or mortality of individuals of Blodgett's silverbush. Although the direct impacts of fire on Blodgett's silverbush are not well understood, mortality of some individuals will likely result from the fires themselves and may also occur from activities associated with management of fire. Mortality from fire is expected to be limited as this perennial species appears to resprout following burns or other disturbance (J. Sadle, ENP, personal observation). Mortality or injury of individuals due to unintentional trampling may occur on a limited basis if fire management activities are required during fires in areas where this species is found. Installation of fire lines, if they are needed, may also result in injury or mortality. All staff involved in implementation of fire management activities in pine rockland habitat will be informed of the potential presence of this species and will be provided with identification materials prior to conducting fire management activities. Staff will also be informed of the location of known sites, if present, in a burn unit where activities will occur. Staff will be instructed to avoid impacting this species to the extent practicable when conducting work related to fire management. It is anticipated impacts from these sources would be very limited and, if they occur, would be short term in nature.

Under the proposed schedule of prescribed fires in Long Pine Key in the current multi-year fuels management plan, all of the known occurrences of Blodgett's silverbush will not be burned during any given year. In addition, prescribed fires in pine rockland habitat are expected to result in mosaic pattern of burned and unburned habitat. This approach will greatly reduce the chance of all occurrences burning in one season and will also decrease the chances that all individuals in an occurrence burn during any prescribed fire. Individuals are not known to occur along existing roads in Long Pine Key, so impacts from vehicle activity is not expected to result in injury or mortality of Blodgett's silverbush.

The proposed action is also expected to provide significant benefits to Blodgett's silverbush occurrences throughout Long Pine Key through habitat improvement and maintenance. Implementation of regular prescribed fire in pine rocklands will reduce fuel loading and ultimately result in lower intensity fires. Regularly occurring fire will also maintain an open understory that promotes plant species diversity and is needed to maintain populations of Blodgett's silverbush. Fire also reduces or prevents infestation of invasive plant species within pine rockland habitat. In addition, many fire dependent pine rockland plant species respond positively to the occurrence of fire. These responses may include increased flower fruit and seed production as well as improved germination and seedling establishment.

Pineland sandmat

Implementation of the proposed action has the potential to result in injury or mortality of individuals of pineland sandmat. Although the direct impacts of fire on this species are not well understood, mortality of some individuals will likely result from the fires themselves and may also occur from activities associated with management of fire. Mortality from fire is expected to be limited as this perennial tap-rooted species is thought to resprout following burns or other disturbance. Mortality or injury of individuals due to unintentional trampling may occur on a limited basis if fire management activities are required during fires in areas where this species is found. Installation of fire lines, if they are needed, may also result in injury or mortality. All staff involved in implementation of fire management activities in pine rockland habitat will be informed of the potential presence of this species and will be provided with identification materials prior to conducting fire management activities. Staff will also be informed of the location of known sites, if present, in a burn unit where activities will occur. Staff will be instructed to avoid impacting this species to the extent practicable when conducting work related to fire management. It is anticipated impacts from these sources would be very limited and, if they occur, would be short term in nature. Individuals are not known to occur along existing roads in Long Pine Key, therefore vehicle activity is not expected to result in injury or mortality of pineland sandmat.

Under the proposed schedule of prescribed fires in Long Pine Key in the current multi-year fuels management plan, all of the known occurrences of pineland sandmat will not be burned during any given year. In addition, prescribed fires in pine rockland habitat are expected to result in a mosaic pattern of burned and unburned habitat. This approach will greatly reduce the chance of all occurrences burning in one season and will also decrease the chances that all individuals in an occurrence burn during any prescribed fire.

The proposed action is also expected to provide significant benefits to pineland sandmat occurrences throughout Long Pine Key through habitat improvement and maintenance. Implementation of regular prescribed fire in pine rocklands will reduce fuel loading and ultimately result in lower intensity fires. Regularly occurring fire will also maintain an open understory that promotes plant species diversity and is needed to maintain populations of pineland sandmat. Fire also reduces or prevents infestation of pine rockland habitat by invasive plant species. In addition, many fire dependent pine rockland plant species, including those discussed here, respond positively to the occurrence of fire. These responses may include increased flower, fruit and seed production as well as improved germination and seedling establishment.

Garber's spurge

Implementation of the proposed action has the potential to adversely affect Garber's spurge. Although the direct impacts of fire on Garber's spurge are not well understood, Herndon (1998) observed significant mortality and recruitment following fire in pine rockland habitat. Although limited in scope, that study indicated substantial population turnover resulted from fire. It is assumed coastal populations of Garber's spurge (Cape Sable and Ten Thousand Islands), will respond to fire in the same manner as that observed for pine rockland populations. Mortality will primarily result from direct effects of fire. Mortality or injury of individuals due to unintentional trampling may occur on a limited basis if fire management activities are required during fires in areas where this species is found. Installation of fire lines, if they are needed, may result in injury or mortality to individuals. All staff involved in implementation of fire management activities in pine rockland or coastal grassland habitat will be informed of the potential presence of this species and will be provided with identification materials prior to conducting fire management activities. Staff will also be informed of the location of known sites, if present, in a burn unit where activities will occur. Staff will be instructed to avoid impacting this species to the extent practicable when conducting work related to fire management. It is anticipated impacts from these sources would be very limited and, if they occur, would be short term in nature. No vehicle access will occur in areas of Cape Sable occupied by Garber's spurge due to the remote nature of the site and lack of roads or trails.

Under the proposed schedule of prescribed fires in Long Pine Key, all of the known occurrences of Garber's spurge in that area will not be burned during any given year. In addition, prescribed fires in pine rockland habitat are expected to result in a mosaic pattern of burned and unburned habitat that will reduce fuel loading and the potential for a repeat of extensive fire in previously burned areas. This approach will greatly reduce the chance of all occurrences burning in one season and will also decrease the chances that all individuals in an occurrence burn during any individual prescribed fire. Individuals are not known to occur along existing roads in Long Pine Key, so impacts from vehicle activity is not expected to result in injury or mortality of Garber's spurge. No burns are currently planned for coastal grasslands at Cape Sable under the proposed multi-year fuels management plan. However, the response of Garber's spurge to fire that may occur either from wildfire or future planned burns in that habitat is anticipated to be the same as the response in pine rocklands, with mortality of individuals resulting from the fire followed by recruitment. Coastal populations are not subject to impacts from vehicular traffic but could be impacted by unintentional trampling or installation of fire lines, if needed, to control natural fires.

The proposed action is also expected to provide significant benefits to Garber's spurge occurrences in Long Pine Key through habitat improvement and maintenance. Implementation of regular prescribed fire in pine rocklands will reduce fuel loading and ultimately result in lower intensity fires. Regularly occurring fire will also maintain an open understory that promotes plant species diversity and is needed to maintain populations of Garber's spurge. Fire also reduces or prevents infestation of pine rockland habitat by invasive plant species. In addition, many fire dependent pine rockland plant species respond positively to the occurrence of fire. These responses may include increased flower, fruit and seed production as well as improved germination and seedling establishment. The role of fire in coastal habitats is less clear, but observations in 2004 following an unintentionally set fire at Northwest Cape Sable indicated that this plant community responds in a similar way to other open fire dependent grass dominated plant communities in ENP. At that site, Garber's spurge appears to have responded positively to fire. Based on surveys conducted three years after the fire took place, Northwest Cape Sable was determined to have the largest population of Garber's spurge in ENP (Green et al 2007b). This fire also is believed to have reduced exotic plant species cover in areas occupied by this species and reduced hardwood encroachment, further improving habitat.

Florida pineland crabgrass

Implementation of the proposed action has the potential to result in injury or mortality of individuals of Florida pineland crabgrass. Although the direct impacts of fire on this species are not well understood, mortality of some individuals will likely result from the fires themselves and may also occur from activities associated with management of fire. Mortality from fire is expected to be limited as this perennial species is thought to resprout following burns or other disturbance. Mortality or injury of individuals due to unintentional trampling may occur on a limited basis if fire management activities are required during fires in areas where this species is found. Installation of fire lines, if they are needed, may also result in injury or mortality. All staff involved in implementation of fire management activities in pine rockland and marl prairie habitat will be informed of the potential presence of this species and will be provided with identification materials prior to conducting fire management activities. Staff will also be informed of the location of known sites, if present, in a burn unit where activities will occur. Staff will be instructed to avoid impacting this species to the extent practicable when conducting work related to fire management. It is anticipated that impacts from these sources would be very limited and, if they occur, would be short term in nature. Individuals are not known to occur along existing roads in Long Pine Key, therefore vehicle activity is not expected to result in injury or mortality of Florida pineland crabgrass.

Under the proposed schedule of prescribed fires in Long Pine Key in the current multi-year fuels management plan, all of the known occurrences of Florida pineland crabgrass will not be burned during any given year. In addition, prescribed fires in pine rockland habitat and marl prairie are expected to result in a mosaic pattern of burned and unburned habitat. This approach will greatly reduce the chance of all occurrences burning in one season and will also decrease the chances that all individuals in an occurrence burn during any prescribed fire. Florida pineland crabgrass occurs in seasonally flooded habitats and fire followed by flooding could result in significant mortality within individual occurrences. However, due to the uncertain nature of weather events, it is not possible to predict when and where these impacts may occur. The widespread nature of this species in suitable habitat throughout Long Pine Key and the limited occurrence of these types of events suggest that impacts, if they occur, would not lead to population level changes.

The proposed action is also expected to provide significant benefits to Florida pineland crabgrass occurrences throughout Long Pine Key through habitat improvement and maintenance. Implementation of regular prescribed fire in pine rocklands and marl prairies will reduce fuel loading and ultimately result in lower intensity fires. Regularly occurring fire will also maintain an open understory that promotes plant species diversity and is needed to maintain populations of Florida pineland crabgrass. Fire also reduces or prevents infestation of pine rockland and marl prairie habitat by invasive plant species. In addition, many fire dependent plant species respond positively to the occurrence of fire. These responses may include increased flower, fruit and seed production as well as improved germination and seedling establishment.

Everglades bully

Implementation of the proposed action has the potential to result in injury or mortality of individuals of Everglades bully. Although the direct impacts of fire on this species are not well understood, mortality of some individuals will likely result from the fires themselves and may also occur from activities associated with management of fire. Injury or mortality from fire is expected to be limited as this perennial species resprouts following burns or other disturbance. Mortality or injury of individuals due to unintentional trampling may occur on a limited basis if fire management activities are required during fires in areas where this species is found. Installation of fire lines, if they are needed, may also result in injury or mortality. All staff involved in implementation of fire management activities in pine rockland and marl prairie habitat will be informed of the potential presence of this species and will be provided with identification materials prior to conducting fire management activities. Staff will also be informed of the location of known sites, if present, in a burn unit where activities will occur. Staff will be instructed to avoid impacting this species to the extent practicable when conducting work related to fire management. It is anticipated that impacts from these sources would be very limited and, if they occur, would be short term in nature. Individuals are not known to occur along existing roads in Long Pine Key, therefore vehicle activity is not expected to result in injury or mortality of Everglades bully.

Under the proposed schedule of prescribed fires in Long Pine Key in the current multi-year fuels management plan, all of the known occurrences of Everglades bully will not be burned during any given year. In addition, prescribed fires in pine rockland habitat and marl prairie are expected to result in a mosaic pattern of burned and unburned habitat. This approach will greatly reduce the chance of all occurrences burning in one season and will also decrease the chances that all individuals in an occurrence burn during any prescribed fire. The majority of occurrences of Everglades bully are located in seasonally flooded habitats and fire followed by flooding could result in significant mortality within individual occurrences. However, due to the uncertain nature of weather events, it is not possible to predict when and where these impacts may occur. Flooding events following fires that lead to significant changes in vegetation are also believed to be relatively infrequent. The widespread nature of this species in suitable habitat throughout Long Pine Key and the limited occurrence of these types of events suggest impacts, if they occur, would not lead to population level changes.

The proposed action is also expected to provide significant benefits to Everglades bully occurrences throughout Long Pine Key through habitat improvement and maintenance. Implementation of regular prescribed fire in pine rocklands and marl prairies will reduce fuel loading and ultimately result in lower intensity fires. Regularly occurring fire will also maintain an open understory that promotes plant species diversity and is needed to maintain populations of Everglades bully. Fire also reduces or prevents infestation of pine rockland and marl prairie habitat by invasive plant species. In addition, many fire dependent plant species respond positively to the occurrence of fire. These responses may include increased flower, fruit and seed production as well as improved germination and seedling establishment.

Bartrams' scrub-hairstreak butterfly

The direct and indirect effects of implementation of the proposed action have the potential to result in injury, mortality and disturbance to individual Bartram's hairstreak butterflies. Potential direct effects include injury, mortality and disturbance resulting from the fires and from activities associated with implementing or managing fires. Adult butterflies are sedentary and are rarely observed more than 5 meters from their host plant. As a result, only adults at the periphery of the area that burns, are likely to relocate to adjacent, unburned habitat. Immobile stages including eggs, larvae and pupae will experience mortality when occupied host plants or pupation locations are burned.

Indirect effects of the proposed action are primarily restricted to impacts to the only known host plant for this species, pineland croton. Habitat modification in the form of a temporary reduction in host plant abundance and distribution will occur following prescribed fire in burned areas with pineland croton populations. Indirect impacts to immature stages of the Bartram's hairstreak butterfly may also occur if occupied host plants are unintentionally damaged due to site access on foot or vehicle for monitoring and carrying out fire control efforts, such as preparation of fire lines. Host plant occurrence in fire roads within Long Pine Key is very limited, and impacts due to foot or vehicle traffic are expected to be minimal.

Under the proposed schedule of prescribed fires in Long Pine Key in the proposed multi-year fuels management plan, all of the known occurrences of pineland croton and Bartram's hairstreak butterflies will not be burned during any given year. In addition, prescribed fires in pine rockland habitat and marl prairie are expected to result in a mosaic pattern of burned and unburned habitat. This approach will prevent all host plant occurrences from burning in one season and will also decrease the chances that all individuals in an occurrence burn during any prescribed fire. While this will not prevent mortality of immature stages if present, it will provide refugia for adult butterflies and increase the likelihood of successful relocation and reproduction.

Several large occurrences of pineland croton are located in seasonally flooded habitats and fire followed by flooding could result in significant mortality of the host plant within individual occurrences. However, due to the uncertain nature of weather events, it is not possible to predict when and where these impacts may occur. Flooding events following fires that lead to significant changes in vegetation are believed to be relatively infrequent. The widespread nature of host plants in suitable habitat throughout Long Pine Key and the limited occurrence of these types of events suggest that impacts, if they occur, would not lead to population level changes. Finally, many pine rocklands in Long Pine Key with records of host plant and Bartram's hairstreak butterflies are not seasonally inundated, further reducing the risk of impacts to host plant populations and butterflies in the event that fire followed by flooding occurs.

Regular fire is necessary to maintain suitable habitat for butterflies and host plants through reduction of hardwood encroachment and control of non-native invasive plant species. Implementation of the proposed action may also lead to restoration of pine rockland habitat and ultimately increase the distribution of host plants in the action area.

Florida leafwing butterfly

The direct and indirect effects of implementation of the proposed action have the potential to result in injury, mortality and disturbance to individual Florida leafwing butterflies. Potential direct effects include injury, mortality and disturbance resulting from the fires and from activities associated with implementing or managing fires. Adult butterflies are likely to relocate during a fire, particularly if adjacent unburned suitable habitat exists. However, this change in behavior constitutes a disturbance resulting from the proposed action. Immobile stages including eggs, larvae and pupae will experience mortality when occupied host plants or pupation locations are burned.

Indirect effects of the proposed action are primarily restricted to impacts to the only known host plant for this species, pineland croton. Habitat modification in the form of a temporary reduction in host plant abundance and distribution will occur following prescribed fire in burned areas with pineland croton populations. Indirect impacts to immature stages of the Florida leafwing butterfly may also occur if occupied host plants are unintentionally damaged due to site access on foot or vehicle for monitoring and carrying out fire control efforts, such as preparation of fire lines. Host plant occurrence in fire roads within Long Pine Key is very limited, and impacts of this nature are expected to be minimal.

Under the proposed schedule of prescribed fires in Long Pine Key in the proposed multi-year fuels management plan, all of the known occurrences of pineland croton and Florida leafwing butterflies will not be burned during any given year. In addition, prescribed fires in pine rockland habitat and marl prairie are expected to result in a mosaic pattern of burned and unburned habitat. This approach will prevent all host plant occurrences from burning in one season and will also decrease the chances that all individuals in an occurrence burn during any prescribed fire. While this will not prevent mortality of immature stages of the butterflies, if present, it will provide refugia for adult butterflies and increase the likelihood of successful relocation and reproduction.

Several large occurrences of pineland croton are located in seasonally flooded habitats and fire followed by flooding could result in significant mortality of the host plant within individual occurrences. However, due to the uncertain nature of weather events, it is not possible to predict when and where these impacts may occur. Flooding events following fires that lead to significant changes in vegetation are believed to be relatively infrequent. The widespread nature of host plants in suitable habitat throughout Long Pine Key and the limited occurrence of these types of events suggest impacts, if they occur, would not lead to population level changes. Finally, many pine rocklands in Long Pine Key with records of host plant and Florida leafwing butterflies are not seasonally inundated, further reducing the risk of impacts to host plant populations in the event fire followed by flooding occurs.

The proposed fire management program also has the potential to benefit the Florida leafwing butterfly. Regular fire is necessary to maintain suitable habitat for butterflies and host plants through reduction of hardwood encroachment and control of non-native invasive plant species. Implementation of the proposed action may also lead to restoration of pine rockland habitat and ultimately increase the distribution of host plants in the action area.

Eastern indigo snake

The proposed action has the potential to adversely affect the eastern indigo snake adults, juveniles, nests and hatchlings within the proposed project area. Potential effects include injury, mortality, and disturbance resulting directly from fire and from activities associated with implementing the fire management program. For example, indirect impacts to the eastern indigo snake may occur if occupied sheltering areas are unintentionally damaged during site access by vehicle, preparation of fire lines, and activities carried out to control fire behavior.

Under the preferred alternative, fuel treatment burns would be implemented throughout ENP to manage fuel loads. Prescribed fire may also be used to control exotic invasive species populations. Under this alternative, fuel accumulations would be expected to be reduced in general, and less continuous. Prescribed fires would occur under environmental and fire behavior parameters designed to create a mosaic of burned and unburned vegetation within a unit. Although eastern indigo snakes move across the landscape quickly and retreat to burrows or other refugia when disturbed, some snakes may become caught in fires and these individuals may be injured or killed. If snakes are present at the fringes of habitats that don't typically burn they may move into these habitats during fires. It is expected, under the preferred alternative, that the less intense fire behavior and the presence of refugia within a burn unit will reduce the likelihood of injury or death of snakes.

Multiple ignition locations, as is expected under a prescribed fire scenario, have the potential to increase the risk of snakes becoming trapped in a prescribed fire but this risk may be ameliorated by burning under conditions expected to result in less intense fire behavior and unburned refugia. Prescribed fire for exotic plant management includes some activities that may cause mulch piles, fallen logs, and stumps that could serve as dens, but mitigation actions that remove debris piles promptly to prevent eastern indigo snakes from inhabiting those temporary piles will reduce potential for burning dens.

The preferred alternative would be expected to maintain the mosaic of habitat types that indigo snakes prefer, and also a mosaic of vegetation conditions within a vegetation type due to the expected mosaic of burned and unburned vegetation, and these qualities are expected to be favorable for eastern indigo snakes.

Fire management, suppression, and effects monitoring could all cause disturbance to eastern indigo snakes. Disturbance resulting from the presence of fire management and monitoring personnel may cause temporary changes in behavior that may affect normal breeding, feeding, and sheltering. Because mechanical ground disturbance related to fires within ENP is very limited, the likelihood of injury or death of snakes during fire management and suppression activities is very low. However, operation of vehicles during fires has the potential to injure or kill snakes.

Cape Sable seaside sparrow

Fire has been documented to affect Cape Sable seaside sparrows, both directly and indirectly. The most obvious effect is that fires have the potential to kill individuals. Sparrow eggs, nestlings, and young fledglings are susceptible to fires because they occupy the combustible marsh grasses that burn during fires, and they have limited ability to escape fires. Because the sparrows nest primarily during the dry season when naturally ignited fires are most likely to occur and to spread, eggs and young are likely to be lost to wildfires. Sparrow eggs and young may be lost during fires that occur in occupied sparrow habitat between March 1 and August 31, though fires occurring in April through June, which corresponds with the peak in sparrow nesting activity, would have the greatest impact on eggs and nestlings. In these instances, all nests, eggs, and recently fledged young that occur within a burned area would be expected to be killed. Adult and independent young Cape Sable seaside sparrows may be able to fly out of harm's way, but under some circumstances, even adults may be killed. LaPuma et al. (2007) reported that none of the 35 color-banded adult sparrows that had occupied the area burned by the Lopez fire in subpopulation E in 2001 were seen again following the fire.

Following a fire, sparrows do not nest within burned areas for a period of 2 to 3 years (LaPuma 2010, LaPuma et al. 2007), and this is likely a result of the relatively sparse density of vegetation that does not support a nest structure, and/or does not provide sufficient cover for nests. Any unburned patches within a large burned area may still be suitable for sparrow nesting, so in patchy burns, there is a greater potential for sparrows to retain the ability to nest following fires. After 2 to 3 years, suitable nesting habitat generally recovers, and sparrows resume nesting with approximately the same density and success as before fires (LaPuma et al. 2007).

Under circumstances when fires are followed by heavy rainfall that causes rapidly rising water levels to overtop the growing graminoid vegetation, nearly all vegetation can be killed. Under these circumstances, recovery of vegetation sufficient to support sparrow nesting may not occur for a decade or more. The rate of vegetation recovery may be affected by a variety of factors, including soil depth and post-fire hydrologic conditions.

Fire management and suppression activities also have the potential to affect sparrows. During nesting season, sparrow eggs, nestlings, and recently fledged young may be injured or killed by water drops, both from buckets suspended by helicopters and by air tankers. The likelihood of this occurring is low due to the relatively low probability that a nest will occur at the location where water is dropped, but it may occur.

The presence of fire management personnel, helicopter and aircraft operation, and other equipment, during suppression activities, fire effects monitoring, and related activities can also disturb sparrows, causing changes in normal behavior which may increase predation risk and interfere with normal breeding, feeding, and sheltering activity. During nesting season, activities that flush females from nests may increase the chances of nest loss.

LaPuma et al. (2007) concluded fires have little benefit to sparrow populations or to occupied suitable habitat, but subsequent studies have shown there are some beneficial effects. Fire does tend to promote the growth of C4 grasses over C3 grasses, and most of the grass species that are associated with sparrow occupancy are C4 grasses (Sah et al. 2010). In areas occupied by sparrows, this effect may have limited benefit to sparrows because the habitat is already in a suitable condition, but in areas that are suboptimal sparrow habitat, such as sawgrass dominated areas, fire may help improve suitability under some conditions. This beneficial effect has not been well-documented in the Everglades system, and may warrant further study. Fires have been shown to be very effective in reducing and controlling woody vegetation, and in some areas, this effect can improve habitat. Fire also has the beneficial effect of reducing the risk of future fires. Relatively small fires within a larger unit of sparrow habitat would reduce the likelihood of an entire habitat patch burning and would increase the likelihood of successful suppression by creating discontinuities in fuel loading. As wildland fires encounter areas of lower fuel loading, their severity and rate of spread can be reduced, allowing for more successful control and increasing likelihood that they will be extinguished by high humidity or light rainfall.

The preferred alternative allows for greater use of prescribed fire within sparrow habitat. While this could equate to increased impacts if more sparrow habitat is burned, this alternative will result in conditions that are less susceptible to catastrophic fires that would have the potential to extirpate or significantly reduce a subpopulation. Additionally, application of prescribed fire under carefully planned environmental and fire behavior parameters may result in a mosaic of burned and unburned patches that would support continued sparrow nesting while also reducing risk of catastrophic fire. As part of the implementation of the fire management strategy within Cape Sable seaside sparrow habitat the FMP will be updated and coordinated annually (as discussed in further sections). Close coordination with researchers and natural resources staff, and the intent and ability to incorporate refined guidance for managing fires in sparrow habitat, further reduces the chances that fire will have significant population-level effects on Cape Sable seaside sparrows. Lastly, the preferred alternative provides the opportunity to plan fires in conjunction with water management plans so that prescribed burns can be conducted to minimize the risk and likelihood of having the most severe effects on sparrow habitat.

Cape Sable seaside sparrow critical habitat

Fire and fire management have the potential to affect two of the four primary constituent elements of sparrow critical habitat. Fires can temporarily affect the cover of herbaceous vegetation, and reduce cover of these species below the 15 percent that is identified as a PCE. However, under most circumstances, herbaceous cover of these species will recover rapidly following fire, and will usually be reestablished within weeks to months following fire. Only under cases where recently burned habitat is flooded, resulting in mortality of herbaceous vegetation, will fire remove PCEs. The preferred alternative minimizes the likelihood of this by providing for application of fire when the risk of long-term impacts is reduced. This also reduces the likelihood that a large portion of critical habitat would be significantly degraded.

Fires have the potential to substantially improve the openness of critical habitat (PCE 3) through control of woody vegetation. The preferred alternative would provide for application of prescribed fire to accomplish these benefits, through adoption of guidance, application of science to fire management, and the close coordination with researchers and natural resources staff.

Similar to impacts to sparrows, there are cumulative impacts that result from the combination of fire impacts and hydrologic management impacts on sparrow critical habitat. Hydrologic management also has the potential to affect all of the PCEs, and some areas of critical habitat may have been degraded by hydrologic management in the past.

Everglade snail kite

Fire has the potential to directly and indirectly affect the Everglade snail kite. Kites nest within the Everglades marshes in areas that are subject to fire, and if the marshes burn when kites are nesting, eggs, nestlings, and young fledglings may be injured or killed by fires. Because kites generally nest over water, some nests in trees or shrubs that are in areas with relatively sparse emergent vegetation may not burn because of insufficient fuels around nests. However, kites often nest in dense vegetation, including within dense stands of sawgrass or cattail that would be likely to burn in fires regardless of whether there is water underneath the nests. Due to the variability in kite nesting areas and substrate, not all kite nests within a burned area would be expected to burn during fires. Surveys for snail kites nesting within ENP are not regularly conducted, and consequently, it is unlikely that all snail kite nests that occur within a particular FMU, burn unit, or area would be identified. Nests that are identified would be avoided, and suppression efforts implemented to minimize risk of nest loss to fires.

Under the preferred alternative, fuels treatment burns and exotic vegetation treatment burns would be conducted within kite habitat in FMU 2. Risk to snail kites would be mitigated through avoidance of known nests. Fuels would tend to be treated before they reached heavy accumulations. Because prescribed fires will predominate, the likelihood of fires occurring during the peak kite nesting season, when water levels are generally moderate and falling, may be more likely to occur. However, the fires that result are expected to be less severe, and may be less likely to burn kite nests.

Under the preferred alternative, fires are not expected to substantially affect the suitability of habitat for kites. Areas that burn may support better kite foraging due to improved visibility of snails, but they may also support fewer suitable nest sites. In general, these changes are not anticipated to significantly improve conditions for or limit snail kites.

Fire management, aviation, suppression, effects monitoring, and other fire-related activities could all cause disturbance to Everglade snail kites. Disturbance resulting from aviation activities and the presence of fire management and monitoring personnel may cause temporary changes in behavior that may affect normal breeding, feeding, and sheltering, and could increase risk of predation of eggs and nestlings if adults are flushed from the nest. Rotor wash from helicopters also has the potential to dislodge kite nests from substrate, causing nest failure.

Florida bonneted bat

Considering the lack of knowledge of the habitat use of the bonneted bat and its response to fire, it is difficult to predict the impacts of alternative fire management strategies. Under the preferred alternative, fuel treatment burns would be implemented throughout ENP to manage fuel loads. Prescribed fire may also be used to control exotic invasive species populations. Under this alternative, fuel accumulations would be expected to be reduced in general, and less continuous. Prescribed fires would occur under environmental and fire behavior parameters designed to create a mosaic of burned and unburned vegetation within a unit. Less intense fire behavior and the presence of unburned refugia within a burn unit is expected under the preferred alternative. This fire pattern would be expected to burn a portion of existing snags, retain a portion of the snags, and create some new snags. This pattern of snag effects would tend to lead to a consistent availability of snags over time that would support bat roosting. Few bats would be expected to perish in fires, and the preferred alternative will maintain favorable habitat in ENP by maintaining snags and natural habitat conditions that would be expected to maintain prey availability. If Florida bonneted bats are roosting in habitats not affected by fire, including hardwood hammocks or structures, impacts to those individuals would not occur under the preferred alternative.

Florida panther

Under the preferred alternative, fuel treatment burns would be implemented throughout ENP to manage fuel loads. Prescribed fire may also be used to control exotic invasive species populations. Under this alternative, fuel accumulations would be expected to be reduced in general, and less continuous. Prescribed fires would occur under environmental and fire behavior parameters designed to create a mosaic of burned and unburned vegetation within a unit. Less intense fire behavior and the presence of unburned refugia within a burn unit is expected under the preferred alternative. While adult panthers are expected to successfully avoid fires under nearly all conditions, panther kittens up to 5 to 6 months of age that occur in an area that burns are likely to be injured or killed if they occur in vegetation types that may burn. Panthers use a variety of habitat types for denning, but thick, dense vegetation is the consistent characteristic. Within ENP, these conditions are often associated with hardwood hammocks and dense Brazilian pepper, but long-unburned patches of dense sawgrass, palmetto, or other highly combustible vegetation may also be used. Considering the lack of detailed telemetry monitoring of panthers within ENP, it is unlikely that panther den locations would be known in an area subject to fire, and suppression actions would therefore likely be insufficient to protect panther dens. Because of the small number of panthers in ENP and the relatively low chances that a den will be located within burnable vegetation types, it is unlikely that a panther den will be lost in any one fire, unless it burns a large portion of the pinelands in one fire. However, the likelihood that at least one panther den will be affected by fire is substantial when considering a program of fire management conducted over large areas and over many years.

The preferred alternative would generally be expected to maintain the mosaic of habitat types that panthers use, as well as generally suitable habitat conditions. The mosaic of burned and unburned patches within an individual burn unit would provide favorable conditions for panthers by providing cover adjacent to the habitat conditions that would attract prey, and more frequent fires would tend to maintain habitat in a better condition for panther hunting. The expected lower intensity and severity of fires that are expected under the preferred alternative due to reduced fuel loads and burning under most favorable conditions will tend to prevent fires from entering hardwood hammocks and Brazilian pepper where dens may occur. Regular fuels treatment may tend to reduce the likelihood of dense combustible vegetation that panthers may select as dens. This effect could reduce availability of den sites, but would also tend to reduce likelihood of loss of kittens due to fire.

Fire management, aviation, suppression, effects monitoring, and other fire-related activities could all cause disturbance to Florida panthers. Disturbance resulting from the presence of fire management and monitoring personnel may cause temporary changes in behavior that may affect normal breeding, feeding, and sheltering, and could increase risk of predation of young kittens. Operation of vehicles during fires also has the potential to injure or kill panthers.

Other species in the action area

The ENP determined the proposed action "may affect but is not likely to adversely affect" Stock Island tree snail, wood stork, American crocodile and Florida manatee. The ENP also provided determinations of "no effect" for the following federally listed species that occur or formerly occurred within ENP: Red knot, Ivory billed woodpecker, piping plover, Kirtland's warbler, red cockaded woodpecker, roseate tern, Bachman's warbler, smalltooth sawfish, Miami blue butterfly, Cape Sable thoroughwort, Florida prairie-clover, Florida bristle fern, loggerhead seaturtle, green seaturtle, leatherback seaturtle, hawksbill seaturtle, and Kemp's ridley seaturtle.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, Tribal, 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 will require a separate consultation pursuant to section 7 of the Act.

Past projects impacting special status species include the acquisition of lands in the East Everglades addition under the Expansion Act. Acquisition of these areas has expanded the protected areas within ENP and has protected habitat for special status species, resulting in long-term beneficial impacts. Past, present, and future actions that impact special status species include all of the projects aimed at restoring habitat and delivering additional freshwater to the park. As a result of these actions, there would be additional habitat for special status species in the park. Use of wildland fire by fire management has helped maintain and improve habitat for special status species over the long term. Activities that have and continue to adversely affect special status species in the park include trampling, collecting, diminished freshwater water flows, habitat fragmentation, past agricultural practices, and sea level rise. The past, present, and reasonably foreseeable future actions described above would result in a mixture of long-term adverse and beneficial impacts on special status species. These impacts, when combined with the impacts from preferred alternative, would result in generally beneficial cumulative impacts to special status species, due to the maintenance and improvement of habitat.

Blodgett's silverbush

Blodgett's silverbush, occurs in ENP primarily in Long Pine Key occurring in patches in an area covering about 182.2 ha (450 ac) of pine rockland. Blodgett's silverbush is threatened by habitat loss, which is exacerbated by the cumulative effects of habitat degradation due to fire suppression, the difficulty of applying prescribed fire to pine rocklands, and threats from exotic plants. Hydrology has been altered within Long Pine Key at ENP by the cumulative effects of artificial drainage, which lowered groundwater, and construction of roads, which either impounded or diverted water. Regional water management intended to restore the Everglades could negatively affect the pinelands of Long Pine Key. Hydrologic restoration could improve conditions for pineland plants; however, components of Everglades restoration may also negatively affect the species.

The cumulative effects of climatic change, including sea level rise, are current and long-term threats; these factors are expected to continue to impact pine rocklands and ultimately, substantially reduce the extent of available habitat, especially in the Keys. The species is vulnerable to natural disturbances, such as hurricanes, tropical storms, and storm surges. Persistence of Blodgett's silverbush on conservation lands throughout its range will likely be largely dependent upon the implementation and success of management measures, including prescribed fire and exotic plant control. Climatic changes, including sea level rise, are major threats to South Florida, including this species and its habitat. Sea-level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida (U.S. Climate Change Science Program [CCSP] 2008). According to CCSP (2008, p. 5-31), much of low-lying, coastal South Florida will be underwater or inundated with saltwater in the coming century. IPCC (2008) concluded that climate change is likely to increase the occurrence of saltwater intrusion into coastal aquifers as sea level rises and that sea-level rise is projected to extend areas of salinization of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas. Hydrology has a strong influence on plant distribution in pine rockland and other coastal areas (IPCC 2008). Such communities typically grade from salt to brackish to freshwater species. Furthermore, Ross et al. (2009) suggest the cumulative effects of sea-level rise and pulse disturbances (*e.g.*, storm surges or fire) can cause vegetation to change sooner than projected based on sea level alone.

In summary, all known occurrences of Blodgett's silverbush are at some risk to habitat loss and modification. The overall threat level of habitat loss from sea-level rise is currently low, but expected to become severe in the future. Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect in the near term due to potential increased available habitat and reduced competition. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to Blodgett's silverbush.

Pineland sandmat

At its remaining locations, the pineland sandmat and its habitat are vulnerable to a variety of human and natural factors. The species' habitat in ENP, pine rocklands, is globally imperiled and dependent upon fire. Climatic changes, including sea level rise, are long-term and cumulative threats that will continue; these factors are expected to continue to impact pine rocklands and ultimately reduce the extent of available habitat. Pineland sandmat is threatened by the cumulative effects of habitat loss and habitat degradation due to fire suppression, the difficulty of applying prescribed fire, and exotic plants. However, the largest population of pineland sandmat occurs on lands managed by ENP where the threats of fire suppression and exotics are planned to be reduced. Hydrology has been altered within Long Pine Key at ENP by the cumulative effects of artificial drainage, which lowered groundwater, and construction of roads, which either impounded or diverted water. Regional water management intended to restore the Everglades could negatively affect the pinelands of Long Pine Key. Hydrologic restoration could improve conditions for pineland plants; however, components of Everglades restoration may also negatively affect the species. At this time, it is not known whether the proposed restoration and associated hydrological modifications will have a positive or negative effect on pineland sandmat. This narrow endemic may be vulnerable to catastrophic events and natural disturbances, such as hurricanes.

Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect in the near term due to potential increased available habitat and reduced competition. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to pineland sandmat.

Garber's spurge

Most known extant populations of Garber's spurge in ENP are found on Long Pine Key, Cape Sable and Ten Thousand Islands. All populations are threatened to a degree by the cumulative effect of exotic plant invasion. The threat of exotic plants on populations of Garber's spurge is probably least on Long Pine Key because of their isolation and continued management by prescribed fire. Populations in coastal habitats are threatened by the cumulative effects of invasive plants which constantly colonize via ocean dispersed seeds and can rapidly invade, especially following coastal disturbances such as tropical cyclones.

Hydrology has been altered within Long Pine Key at ENP by the cumulative effects of artificial drainage, which lowered groundwater, and construction of roads, which either impounded or diverted water. Regional water management intended to restore the Everglades could negatively affect the pinelands of Long Pine Key. Hydrologic restoration could improve conditions for pineland plants; however, the cumulative effects of components of Everglades restoration may also negatively affect the species. At this time, it is not known whether the proposed restoration and associated hydrological modifications will have a positive or negative effect on Garber's spurge. Similarly, the habitat on Cape Sable has been subjected to a multitude of historical hydrologic influences through episodes of drainage and restoration measures which included the construction of a series of drainage ditches and dams and their cumulative effects. The restoration measures were designed to reestablish natural conditions through installation of a series of dams constructed to slow salt water intrusion. However, many of the dams have failed and are currently proposed to be refurbished.

Sea level rise may become a significant threat influencing the long-term persistence of populations of Garber's spurge. Coastal populations occur at very low elevations, and other occurrences such as at Long Pine Key are threatened by longer-term projections of higher sea level rise. Garber's spurge may also be vulnerable to the cumulative effect of sea level rise and catastrophic events and natural disturbances, such as hurricanes.

Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect in the near term due to potential increased available habitat and reduced competition. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to Garber's spurge.

Florida pineland crabgrass

Florida pineland crabgrass is currently known from the Long Pine Key area of ENP and new occurrences are expected to be found as work continues to establish the limits of this species' habitat requirements. Florida pineland crabgrass appears to have a much wider range than previously thought (Gann et al. 2006).

Fire maintains the pine rockland community. Under natural conditions, lightning fires typically occurred at 3 to 7-year intervals, or more frequently in marl prairies. With fire suppression, the cumulative effect has been that hardwoods eventually invade pine rocklands and shade out Florida pineland crabgrass (Bradley and Gann 1999). Fire suppression can reduce the size of the areas that do burn and create habitat fragmentation, preventing fire from moving across the landscape in a natural way. Thus, many pine rockland communities are becoming tropical hardwood hammocks. Prescribed fire is actively being used at ENP and now appears to be effective in maintaining populations of Florida pineland crabgrass at this location.

Invasive plants have significantly affected pine rocklands. At least 277 exotic plants have invaded pine rocklands throughout South Florida (Service 1999). The most problematic exotic plants in pine rocklands are Brazilian pepper and Burmareed (Bradley and Gann 1999). Long

Pine Key is susceptible to invasive exotic plants such as Burmareed and Old World climbing fern, which has spread southward into parts of ENP (Ferriter 2001; Gann et al. 2002; Ferriter 2003). Old World climbing fern is capable of smothering vegetation and is spreading rapidly in Florida (Ferriter 2001; Volin et al. 2003). Old World climbing fern has the potential to become uncontrollable, except through biological control. In addition, the former agricultural lands of the Hole-in-the-Donut adjacent to Long Pine Key are infested by invasive plants such as Brazilian pepper and common guava and are a potential source of seeds of these invasive species. ENP is restoring those former agricultural lands, but invasive exotic plants will continue to pose a cumulative threat even after this restoration work is completed.

Hydrology is a key ecosystem component that affects rare plant distributions and their viability (Gann et al. 2006). Historically, sheet flow from Shark River Slough and Taylor Slough did not reach the upland portions of Long Pine Key, but during the wet season increased surface water flow in sloughs generated a rise in groundwater across the region (Gann et al. 2006). As artificial drainage became more widespread, regional groundwater supplies declined. Historical patterns of water flow through Long Pine Key are further confounded by road construction (Gann et al. 2006). Water flow through Long Pine Key was originally concentrated in marl prairies, traversing in a north-south direction; however, construction of the main ENP road dissected Long Pine Key in an east-west direction, thereby impeding sheet flow across this area (Gann et al. 2006). Water was either impounded to the north of the main ENP road or diverted around the southern portion of Long Pine Key through Taylor Slough and Shark River Slough (Gann et al. 2006). Research Road may similarly affect the water supply of the southern portions of Long Pine Key (Gann et al. 2006). Changes to regional water management intended to restore the Everglades could negatively affect the pinelands of Long Pine Key (Herndon 1998; Gann et al. 2002; Gann et al. 2006). Gann et al. (2006) stated that if hydrological restoration is successful, groundwater levels will presumably be raised, wet season flows will return to marl prairies and fire intensities will decrease, and growing conditions for rare pineland and hammock plants will improve. Alternatively, implementation of the Comprehensive Everglades Restoration Plan may also lead to further impoundment of water north of the main park road, possible flooding of rare plant populations, and a failure to provide relief to habitats on Long Pine Key that are compartmentalized by the main ENP road and Research Road and have been impacted from long-term drainage (Gann et al. 2006). At this time, it is not known whether the proposed restoration and associated hydrological modifications will have a positive or negative impact on rare species within ENP including Florida pineland crabgrass (Gann et al. 2006). However, since ENP is only one of two locations known to support this species, it will be important to determine potential cumulative impacts of past and planned projects and monitor the species and its habitat.

Given the species' narrow range and limited number of occurrences, Florida pineland crabgrass is vulnerable to the cumulative effects of catastrophic events and natural disturbances, such as hurricanes. Increased sea surface temperatures in association with climate change could increase the frequency, severity, and duration of hurricanes. The threat of hurricanes or other catastrophic events and natural disturbances is considered to be high due to the species restricted range and limited occurrences.

In summary, Florida pineland crabgrass is threatened by the cumulative effects of a wide array of natural and manmade factors. Fire suppression, invasive exotic plants, alterations in hydrology, and catastrophic events all pose a threat to this species. Prescribed fire and exotic species control efforts by the NPS will likely be beneficial to this pine rockland/marl prairie dependent species. The response of Florida pineland crabgrass to the cumulative effects of hydrologic changes associated with Everglades restoration will remain unknown until these projects are fully implemented. The threat from tropical weather events is expected to continue and will likely increase. Given its limited distribution and low number of known occurrences remaining, any one of these factors could have a significant impact on the continued existence of Florida pineland crabgrass. Since few occurrences remain in the restricted range, the overall magnitude of threats is considered high.

Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect in the near term due to potential increased available habitat and reduced competition. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to Florida pineland crabgrass .

Everglades bully

The largest population of Everglades bully (14 occurrences) is located at Long Pine Key within ENP (Gann et al. 2006). Everglades bully appears to have a much wider range than previously thought (Gann et al. 2006) and new occurrences within ENP are expected to be found as work continues to establish the limits of this species' habitat requirements.

Fire is necessary to maintain the pine rockland community. Under natural conditions, lightning fires typically occurred at three to seven year intervals, or more frequently in marl prairies. With fire suppression, the cumulative effect is that hardwoods eventually invade pine rocklands and shade out Everglades bully (Bradley and Gann 1999). Fire suppression can reduce the size of the areas that do burn and create habitat fragmentation, preventing fire from moving across the landscape in a natural way. Thus, many pine rockland communities are becoming tropical hardwood hammocks. Prescribed fire is actively being used at ENP and now appears to be effective in maintaining populations of Everglades bully at these locations.

Invasive plants have significantly affected pine rocklands. As discussed previously, at least 277 exotic plants have invaded pine rocklands throughout South Florida (Service 1999). The Hole-in-the-Donut area adjacent to Long Pine Key is also infested by invasive plants such as Brazilian pepper and common guava and is a potential source of seeds of these invasive species. NPS is restoring those former agricultural lands, but invasive exotic plants will continue to pose a cumulative threat even after this restoration work is completed.

Hydrology is a key ecosystem component that affects rare plant distributions and their viability (Gann et al. 2006). The effects of hydrology on Long Pine Key have been discussed previously. At this time, it is not known whether the proposed restoration and associated hydrological modifications will have a positive or negative impact on rare species within ENP including

Everglades bully (Gann et al. 2006). However, since the ENP is the largest extant location known to support this species, it will be important to determine potential cumulative impacts of past and planned projects and monitor the species and its habitat.

Given the species narrow range and limited number of occurrences, Everglades bully is vulnerable to the cumulative effects of catastrophic events and natural disturbances, such as hurricanes. Increased sea surface temperatures in association with climate change could increase the frequency, severity, and duration of hurricanes. The threat of hurricanes or other catastrophic events and natural disturbances is considered to be high.

In summary, Everglades bully is threatened by the cumulative effects of a wide array of natural and manmade factors. Fire suppression, invasive exotic plants, alterations in hydrology, and catastrophic events all pose a threat to this species. Prescribed fire and exotic species control efforts by the NPS will likely be beneficial to this pine rockland/marl prairie dependent species. The response of Everglades bully to the cumulative effects of hydrologic changes associated with Everglades restoration will remain unknown until these projects are fully implemented. The threat from tropical weather events is expected to continue and will likely increase. Given its limited distribution and low number of known occurrences remaining, any one of these factors could have a significant impact on the continued existence of Everglades bully. Since few occurrences remain in a restricted range, the overall magnitude of threats is considered high.

Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect in the near term due to potential increased available habitat and reduced competition. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to Everglades bully.

Bartram's hairstreak and Florida leafwing

Bartram's hairstreak

The Bartram's hairstreak has been extirpated from nearly 93 percent of its historical range; only five isolated populations remain on Big Pine Key in Monroe County, Long Pine Key in ENP, and relict pine rocklands adjacent to ENP in Miami-Dade County. All five of these populations are, in part, on protected lands. Threats of habitat loss and fragmentation from lack of fire, poaching, disease and predation, and small population size, restricted range, and influence of chemical pesticides used for mosquito control still exist for the remaining populations. Because there are only five small populations of the hairstreak, and limited law enforcement, collection has been, and continues to be, a significant threat to this butterfly. Existing regulatory mechanisms are inadequate to protect this butterfly from poaching. Because populations are isolated and the butterfly has a limited ability to recolonize historically occupied habitats that are now highly fragmented, it is vulnerable to natural and human-caused changes in its habitats. As these threats and fragmentation of habitat increases the remaining populations become less resilient and are not capable of recovering from the threats. As a result, impacts from increasing threats, singly or in combination, are likely to result in the extinction of the hairstreak.

Florida Leafwing

The Florida leafwing has been extirpated from nearly 96 percent of its historical range; the only known extant population occurs within ENP at Long Pine Key in Miami-Dade County. Threats of habitat loss and fragmentation, climatic change, poaching, parasitism and predation, small population size, restricted range, and influence of chemical pesticides used for mosquito control, still exist for the only remaining population. Because there is only one small extant population of this butterfly, and limited law enforcement, collection has and continues to be a significant threat to this butterfly. Existing regulatory mechanisms are inadequate to reduce these threats. The leafwing may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to habitats that are unsuitable for this butterfly. Because the remaining population is isolated and the butterfly has a limited ability to recolonize historically occupied habitats that are now highly fragmented, it is vulnerable to natural and human-caused changes in its habitats. As a result, impacts from increasing threats, singly or in combination, are likely to result in the extinction of the butterfly as there is no redundancy of populations.

Both Species

Habitat loss, fragmentation, and degradation, and associated pressures from increased human population are major threats; these threats are expected to continue, placing these butterflies at greater risk. Although efforts are being made to conserve natural areas and apply prescribed burns, the long-term effects of large-scale and wide-ranging habitat modification and destruction, will last into the future. Based on the best available information, vulnerability to collection and risks associated with scientific or conservation efforts are likely to continue into the future. Predation and parasitism are threats to both butterflies due to their current tenuous statuses. It is expected that poaching, wildfires, and pesticide use, will continue in the future. Therefore, it is expected that the cumulative effects of these on the Florida leafwing and Bartram's hairstreak will continue at current levels or potentially increase in the future. Effects of small population size, isolation, and loss of genetic diversity, as well as natural changes to habitat and anthropogenic factors *(e.g.,* pesticides, fire, hydrologic changes from past and planned water management projects, and processes affected by climate change) are likely significant cumulative threats. Collectively and cumulatively, these threats have impacted the butterflies in the past, are impacting these butterflies now, and will continue to impact these butterflies in the future.

The limited distributions and small population sizes of the Florida leafwing and Bartram's scrub-hairstreak make them extremely susceptible to habitat loss, degradation, and modification and other anthropogenic threats. Mechanisms leading to the decline of the Florida leafwing and Bartram's hairstreak, range from local (*e.g.,* a lack of adequate fire management, habitat fragmentation, poaching), to regional (*e.g.,* development, pesticides), to global influences (*e.g.,* climate change, sea level rise). The synergistic effects of threats (such as hurricane effects on a species with a limited distribution consisting of just a few small populations) make it difficult to predict population viability. While these stressors may act in isolation, it is more probable that many stressors are acting simultaneously (or cumulatively) on Florida leafwing and Bartram's hairstreak populations.

Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect in the near term due to potential increased available habitat and reduced competition. Therefore, the Service does not anticipate any appreciable cumulative negative effects of the ENP FMP to the Bartram's hairstreak and Florida leafwing butterfly.

Eastern indigo snake

The primary threat today to the eastern indigo snake is habitat loss and fragmentation due to development (Lawler 1977; Moler 1985a). Conversion of surrounding lands that currently support indigo snakes to residential uses that would support fewer eastern indigo snakes would be the most likely cumulative effect on the species, but only if no wetlands were impacted (*i.e.*, no Federal permit was required). Projects with wetland impacts would be evaluated through a separate consultation pursuant to section 7 of the Act. Besides loss of habitat, residential development also increases the risk of harm to eastern indigo snakes in the interface areas between urban and native habitats because it increases the likelihood of snakes being killed by property owners and domestic pets. Increased traffic associated with development may also lead to increased eastern indigo snake mortality. Given the east side of the project action area is urban and agricultural, there will be additional development pressures on the remaining lands to the west of this boundary in the future. However, jurisdictional wetlands are prominent in this area and therefore a federal permit for development and subsequent review pursuant to the Act would be required. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to the eastern indigo snake.

Cape Sable seaside sparrow

There are cumulative impacts that result from the addition of fire management to the impacts to CSSS that have occurred and will continue to occur through hydrologic restoration and water management activities. Throughout subpopulation A and portions of other subpopulations, hydrologic management has in some cases degraded habitat and reduced sparrow populations. Fires in these areas may have cumulative adverse impacts. These cumulative impacts are minimized in the preferred alternative by providing for planned fires that can explicitly minimize the potential impacts of more widespread and intense fires and the potential of cumulative hydrologic influences.

Within the action area, essentially all of the lands supporting Cape Sable seaside sparrows and their designated critical habitat are federally-owned and managed lands. Activities that may occur in the action area, but outside federally-owned lands, have the potential to affect sparrow habitat primarily through changes in hydrology or water quality. However, water management to meet flood protection requirements, water supply, and restoration are permitted by the Corps and therefore have a Federal nexus upon which section 7 consultation pursuant to the Act may be necessary. In addition, these water management efforts must meet State and Federal water quality requirements. The Service is unaware of any changes in water management that may affect sparrows or their critical habitat within the action area that would not undergo section 7 review under the Act.

The adjacent 30,000-acre Southern Glades Wildlife Management Area is managed cooperatively between the District and FWC and is located in Miami-Dade County adjacent to the C-111 Canal between ENP and U.S. Highway 1. The area was acquired to protect wildlife habitat, including the Cape Sable seaside sparrow, and as part of Everglades restoration. Activities that can and have occurred on these lands include hydrologic/habitat restoration, exotic plant and animal control, prescribed burns, public use, environmental education, and mitigation. In accordance with the Florida Statutes Chapter 373.1395, lands acquired by the District shall be managed to "ensure a balance between public access, general public recreational purposes, and restoration and protection of their natural state and condition." Generally, these actions would be consistent with the maintenance and restoration of sparrow habitat.

Therefore, the majority of potential affects to Cape Sable seaside sparrows and their habitat, including designated critical habitat, are anticipated to be related to future Federal actions that will require a separate consultation under the Act. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to Cape Sable seaside sparrows or their designated critical habitat

Everglade snail kite

There are cumulative impacts to Everglade snail kites that result from the addition of fire management to the impacts that have occurred and will continue to occur through hydrologic restoration and water management activities. Throughout ENP and the rest of the snail kite range, hydrologic management has in some cases degraded habitat and reduced kite populations. Fires in these areas may have cumulative adverse impacts. These cumulative impacts are not likely to be significant because fires are not expected to strongly affect kites or their habitat, but the effects may be additive in some cases.

Most of the wetlands within the action area for the Everglade snail kite are subject to Corps' jurisdiction and permitting under Section 404 of the Clean Water Act (CWA). In some instances, wetlands may be determined to be outside the Corps' jurisdiction. For an unknown percentage of these Federal exemptions, it is expected that the State, or county if delegated wetland permitting by the State, will claim jurisdiction and require the process of minimization of, and compensation for, wetland impacts, which should assist in minimizing impacts.

Lands surrounding or adjacent to wetlands used by the snail kite and that do not require Federal involvement are where the majority of the cumulative effects are likely to occur. These lands may be developed resulting in disturbance, habitat degradation, reduction in prey availability, isolated hydrologic changes, or permanent habitat loss. Land management activities conducted by State agencies may also have detrimental impacts to these species.

Some wetlands and the areas adjacent to them may be adversely affected by actions without Federal involvement, resulting in a decrease in habitat quality and quantity, prey availability, and productivity for snail kites. However, based on the status of the species discussed previously and the status of the species in the action area, we believe this loss and reduction is not expected to affect the recovery or survival of the snail kite. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to the Everglade snail kite or their designated critical habitat.

Florida bonneted bat

The cumulative effects of habitat loss and alteration in forested and urban areas are expected to have and continue to be substantial and imminent threats. In natural areas, this species may be impacted when forests are converted to other uses or when old trees with cavities are removed. In urban settings, this species may be impacted when buildings with suitable roosts are demolished or when structures are modified to exclude bats. Nearly half of the known occurrences are on private lands and other occurrences on public lands are at some risk to habitat loss and modification. Overall, the Florida bonneted bat is vulnerable to a wide array of cumulative natural and human factors. Distance between occupied locations, the small numbers of bats, and low fecundity may make recolonization unlikely if any site is extirpated. The small numbers within localized areas may make the species vulnerable to extinction due to genetic drift, inbreeding depression, extreme weather events (*e.g.*, hurricanes, prolonged cold temperatures), and random or chance changes to the environment. Where the Florida bonneted bat occurs in or near human dwellings or structures, it is at risk to cumulative persecution, removal or disturbance effects. Pesticide applications may be having an effect by impacting its food base or cumulative exposure, especially in coastal areas where spraying operations may be prevalent. Due to its overall vulnerability, hurricanes and extreme weather are significant threats that may become cumulatively more threatening with global warming. Intense storms can cause mortality during the storm, exposure to predation immediately following the storm, loss of roost sites, impacts to foraging areas and insect abundance, and disruption of the maternal period. Prolonged cold temperatures can lead to a reduced foraging base or make it difficult for an individual to meet its high metabolic needs.

Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect due to potential increased foraging habitat and roost sites. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to the Florida bonneted bat.

Florida panther

Habitat loss, fragmentation, and degradation, and associated human disturbance are the greatest cumulative threats to the survival and recovery of the panther. As privately-owned land is converted to agriculture, residential and commercial development, panther habitat becomes more limited and fragmented. This cumulative loss limits habitat for dispersal and possible relocation sites, as well as forces panthers into less desirable habitat. Death due to vehicle-caused mortality has been an increasing problem. This increase in mortality could be due to several factors. The panther population increased after 1995 due to the introgression of Texas cougar genes into the population. At the same time, the human population in the region has continued to grow. With an increase in human population, comes an increase in vehicle-use and an increase in construction of roads. Consequently, there were more panthers moving across more roads that were filled with more people and vehicles.

In addition, the panther population is threatened by environmental contaminants. Some individual panthers have been shown to be at risk from cumulative exposure to mercury in the food chain (Newman et al. 2004). Mercury bioaccumulates through the aquatic food chain reaching high concentrations in higher trophic level carnivores such as raccoons and alligators. Panthers preying on these species are at risk for accumulating high tissue mercury concentrations. Other environmental contaminants found in panthers include polychlorinated biphenyls (PCBs) (Arochlor 1260) and organochlorines (p, p'–DDE) (Dunbar 1995, FWC 2004).

Aggression between males is the most common cause of male mortality and an important determinant of male spatial and recruitment patterns. Intraspecific aggression, and the associated mortality, could increase as habitat decreases and interactions increase between panthers as they are forced into smaller areas. Any loss from the population of healthy panthers due to relocation or removal will increase the threats to survival of the species that is already threatened by cumulative loss of habitat, increased mortality from vehicle collisions, increased occurrence of intraspecific aggression and disease, and environmental contaminants.

Humans have historically feared large predators including panthers. Because of this fear, humans persecuted panthers almost to extinction. As humans continue to encroach on the remaining panther habitat, related development, including houses, roads, schools, and businesses, will further limit population growth of the panther, and may cause the population to decline. Additionally, negative cumulative human-panther interactions may increase as the interface between urban environments and wilderness becomes more densely populated with humans.

Planned fire management activities as part of the preferred alternative in the ENP FMP are not expected to have a cumulative negative effect given the protection measures outlined, and may have an overall positive cumulative effect due to potential increased foraging habitat. Therefore, the Service does not anticipate any appreciable negative cumulative effects of the ENP FMP to the Florida panther.

CONCLUSION

The preferred alternative would result in a wide range of impacts on special status species as previously described for individual species. In general, the preferred alternative would have beneficial impacts on special status species, due primarily to the maintenance and improvement of special status species' habitat in ENP. These beneficial impacts would be more extensive under the preferred alternative than other alternatives considered and would stem in large part from the multi-year fuels plan, which would allow ENP to conduct necessary large-scale burning in designated wilderness, which constitutes the majority of the park. ENP would continue to coordinate with the Service and state resource agencies, and would continue to minimize as much as possible impacts to individuals of special status species caused by fire management activities. However, some adverse impacts would be unavoidable. Cumulative impacts to special status species would generally be beneficial in the zone of analysis. The preferred alternative would contribute a noticeable amount to these beneficial impacts.

After reviewing the status of the Blodgett's silverbush, pineland sandmat, Garber's spurge, Florida pineland crabgrass, Everglades bully, Bartram's hairstreak, Florida leafwing, eastern indigo snake, Cape Sable seaside sparrow, Everglade snail kite, Florida bonneted bat and the Florida panther, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that, application of the reasonable and prudent measures, terms and conditions, and conservation recommendations identified in this Biological Opinion for the ENP Fire Management Plan, to support conservation actions using prescribed fire and managing wildfire in ENP is not likely to jeopardize the continued existence of any of these species. Critical habitat has been designated for the Cape Sable seaside sparrow, Everglade snail kite, Bartram's hairstreak, and Florida leafwing, however, no destruction or adverse modification of the critical habitat for these species is expected.

AMOUNT OR EXTENT OF FMP EFFECTS ON PLANTS

Blodgett's silverbush

Under the preferred alternative, prescribed fire is planned for implementation in pine rockland habitat where Blodgett's silverbush is present. The larger of the two occurrences extends across two separate pine blocks which are contained within different burn units and therefore, planned to be burned during different years under the multi-year fuels treatment plan. This will prevent the entire population of Blodgett's silverbush from burning in any given year. It will also provide an opportunity for park staff to observe the impacts of fire on individuals of this species prior to implementing a second burn. Each block is proposed to be burned at a 3-year interval under the preferred alternative. This fire return interval is within the literature derived fire return interval (Gunderson 1997, Possley et al. 2008), and is expected to lead to the long term maintenance of pine rockland habitat. It is anticipated effects on a small number of individuals of Blodgett's silverbush are likely to occur with each prescribed fire. It is also anticipated that regularly recurring fire will maintain conditions required for establishment of new individuals of this species.

Pineland sandmat

Under the preferred alternative, prescribed fire is planned for implementation in pine rockland habitat where pineland sandmat is present. Occurrences are widespread and found in a variety of higher elevation pine rockland area in Long Pine Key. As a result, only portions of the entire Long Pine Key population will burn during any given year under the multi-year fuels treatment plan. This will provide an opportunity for park staff to observe the impacts of fire on individuals of this species prior to implementing subsequent burns. Each block is proposed to be burned at a 3-year interval under the preferred alternative. This fire return interval is within the literature derived fire return interval (Gunderson 1997, Possley et al. 2008), and is expected to lead to the long term maintenance of pine rockland habitat. It is anticipated effects on a small number of individuals of pineland sandmat are likely to occur with each prescribed fire. It is also anticipated regularly recurring fire will maintain conditions required for establishment of new individuals of this species.

Garber's spurge

Under the preferred alternative, prescribed fire is planned for implementation in pine rockland habitat where Garber's spurge is present. Plants are known from two separate occurrences located in different burn units in Long Pine Key. This will prevent both occurrences from burning in any given year. It will also provide an opportunity for park staff to observe the impacts of fire on individuals of this species prior to implementing a second burn. Each block is proposed to be burned at a 3-year interval under the preferred alternative. This fire return interval is within the literature derived fire return interval (Gunderson 1997, Possley et al. 2008), and is expected to lead to the long term maintenance of pine rockland habitat. It is anticipated effects on a noteworthy number of individuals of Garber's spurge are likely to occur with each prescribed fire but the long-term benefits of fire outweigh the short-term losses. It is also anticipated that due to this species' typical response to fire disturbance, regularly recurring fire will result in the rapid establishment of new individuals of this species. The results of concurrent monitoring of fire effects and plant population(s) will be used to determine if this is the case or if management protocols should be revised.

Coastal habitats occupied by Garber's spurge are not proposed to be burned under the current multi-year fuels treatment plan. However, tropical storms appear to create disturbance effects in coastal grasslands that are similar to those caused by fire. Therefore, in the absence of prescribed fire in coastal grassland of Cape Sable, habitat maintenance should still occur. As a result, Garber's spurge populations in these communities should be maintained in both the absence or presence of fire. If prescribed fire is planned in subsequent modifications of the multi-year fuels treatment plan, implementation is expected to result in burned plants followed by rapid recruitment from seed.

Florida pineland crabgrass

Under the preferred alternative, prescribed fire is planned for implementation in pine rockland and marl prairie habitat where Florida pineland crabgrass is present. Occurrences of this species are widespread in Long Pine Key. Only portions of the Long Pine Key population will burn during any given year under multi-year fuels treatment plan providing an opportunity for park staff to observe the impacts of fire on individuals of this species prior to implementing subsequent burns. Each block is proposed to be burned at a 3-year interval under the preferred alternative. This fire return interval is within the literature derived fire return interval (Gunderson 1997, Possley et al. 2008), and is expected to lead to the long term maintenance of pine rockland and marl prairie habitats. It is anticipated effects on a small number of individuals of Florida pineland crabgrass are likely to occur with each prescribed fire. It is also anticipated that regularly recurring fire will maintain conditions required for establishment of new individuals of this species.

Everglades bully

Under the preferred alternative, prescribed fire is planned for implementation in pine rockland and marl prairie habitat where Everglades bully is present. Occurrences are widespread in Long Pine Key. As a result, only portions of the entire Long Pine Key population will burn during any given year under the multi-year fuels treatment plan. This will provide an opportunity for park staff to observe the impacts of fire on individuals of this species prior to implementing subsequent burns. Each block is proposed to be burned at a 3-year interval under the preferred alternative. This fire return interval is within the literature derived fire return interval (Gunderson 1997, Possley et al. 2008), and is expected to lead to the long term maintenance of pine rockland and marl prairie habitats. It is anticipated effects on a small number of individuals of Everglades bully are likely to occur with each prescribed fire. It is also anticipated that regularly recurring fire will maintain conditions required for establishment of new individuals of this species.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to 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 nondiscretionary, and must be undertaken by ENP so they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. ENP has a continuing duty to regulate the activity covered by this incidental take statement. If ENP (1) fails to assume and implement the Terms and Conditions or (2) fails to require the applicant to adhere to the Terms and Conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. To monitor the impact of incidental take, ENP shall report the progress of the action and its impact on the species to the Service as specified in the incidental take statement.

AMOUNT OR EXTENT OF TAKE

Florida leafwing butterfly

The Service anticipates incidental take of the Florida leafwing will be difficult to detect because of the scattered and seasonal nature of its occurrence. A current population estimate of occupied sites or assessment of current habitat conditions is not available, however these sites are believed to have received only limited fire management, in the recent past, and historical fire frequency is not known. Prescribed fires will restore and increase the distribution of pineland croton in treatments areas, perhaps also increasing the distribution of the butterfly. Due to the wide array of factors associated with limited butterfly distribution, habitat conditions, and timing of prescribed fire, butterflies or larvae may be taken during burns conducted throughout select sites within occupied habitat in ENP. Therefore, in order to minimize or avoid take, ENP fire management personnel will coordinate all burning activities with park biologists familiar with the Florida leafwing butterfly's current status and distribution. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Bartram's hairstreak butterfly

The Service anticipates incidental take of the Bartram's hairstreak will be difficult to detect because of the scattered and seasonal nature of its occurrence. A current population estimate of occupied sites or assessment of current habitat conditions is not available, however these sites are believed to have received only limited fire management, in the recent past, and historical fire frequency is not known. Butterflies, if present, may be scarce and locally distributed. Factors associated with the burn (*e.g.*, seasonality of the burn, if site is burned in entirety, nature of the fire prescription, etc.) will affect the extent of injury or mortality. The Bartram's hairstreak occurs throughout the year with variable annual peaks in abundance, so there is no "preferred" window for treatments. However, prescribed fires will restore and increase the distribution of pineland croton in treatment areas, perhaps also increasing the distribution of the butterfly. Due to the wide array of factors associated with limited butterfly distribution, habitat conditions, and timing of prescribed fire, butterflies or larvae may be taken during burns conducted throughout occupied habitat in ENP. Therefore, in order to minimize or avoid take, ENP fire management personnel will coordinate all burning activities with park biologists familiar with the Bartram's hairstreak butterfly's current status and distribution. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Eastern indigo snake

The Service anticipates incidental take of the eastern indigo snake will be difficult to detect for the following reasons: (1) wide-ranging distribution, not restricted to specialized habitats, (2) patchy distribution within suitable habitats, (3) suitable habitat may not be occupied, and (4) recent apparent decline in ENP due to competition for the limited supply of dry burrows with the non-native introduced Burmese python. ENP occupies over 1.5 million acres, of which 98 percent is either permanently or seasonally inundated by water. This leaves approximately 2 percent (30,000 acres) dry habitat in ENP that is not seasonally flooded, is potential key dry refugia habitat for burrows, and a key determinant of the maximum density of indigo snake use. However, the Service anticipates incidental take of the indigo snake associated with conducting prescribed fires and mechanical and herbicide treatment on as much as 250,000 acres per year. Juvenile indigo snakes may be more vulnerable to management actions because they are less likely to use underground refugia and often rely on above-ground vegetation for cover. Due to the lack of surveys, in conjunction with the wide-ranging activity and use of a variety of habitat types by the indigo snake, it is difficult to determine the exact number of snakes that will be taken during implementation of the ENP FMP. Bauder and Jenkins (2013) in a recent study, determined the average home range for female indigo snakes to be 94 ha (232 acres) and overlapping male home ranges to be 351 ha (868 acres) in central and southern peninsular Florida. These home range estimates are derived from studies conducted in very good habitat. There is a wide range of habitat types to be treated in the FMP, much suboptimal for indigo snakes. If indigo snakes were present at the densities seen in other studies, on all of the 250,000 acres that may be burned during a given year, then there could be up to 1,078 female and 288 male snakes present. The Service anticipates a more realistic estimation of inhabited acreage and the number of eastern indigo snakes is based on the 30,000 acres of dry habitat in ENP that is not seasonally flooded, which would result in an estimate of 129 female and 35 male indigo snakes present. However, because all of the 30,000 acres are most likely not occupied by the species, not all 30,000 acres will be burned each year, and because adult indigo snakes are able to escape and find refugia during prescribed fires and preparation work for fires, we anticipate no more than 17 snakes will be harassed and no more than 2 snakes will be injured or killed in a given year. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Cape Sable seaside sparrow

Adult CSSS will be displaced temporarily during the fire and will seek refuge in suitable habitat outside the burn unit. Prescribed fires will be planned carefully and in a mosaic fashion to minimize the possibility of take of this species. Fire treatments will be conducted on a fire return interval of 3 to 12 years in the sparrow's marl prairie habitat type. Some take would occur naturally with wildfires, and fire is necessary for maintenance of CSSS habitat. Without fire, habitat may become unsuitable to support CSSS.

The Service anticipates incidental take of CSSS will be difficult to detect because CSSS are very secretive. In addition, determining the presence or absence of all individuals, especially females, fledglings, and nests, cannot be reliably achieved, and finding a dead or impaired specimen or a disturbed or destroyed nest is unlikely. Estimates of territory size are not robust, vary notably among subpopulations, and cannot be used reliably to determine density. Without density estimates, take must be based on acreage of habitat impacted rather than number of individual birds affected. The following level of take of this species can be anticipated as a result of the proposed action because fires will destroy any CSSS nests and their contents located within the burned area during growing season fires.

The Service anticipates that CSSS may be harassed by fire management activities and the human activity associated with conducting the burns and applying herbicides and as a result of the fires themselves (smoke, noise, heat, etc.). Take may occur on up to an estimated maximum of 50,690 acres per year proposed for treatment under the planned fire return interval for CSSS habitat. However, the entire area of the habitat is not expected to be occupied by CSSS. Any wildfires occurring during the breeding season may take nests, fledglings, and post-fledged young. Therefore, there remains a possibility that fire or vehicle use associated with fire control activities could accidentally destroy nests. Nests on occupied habitat would be expected to be destroyed if dry season fires occurred, with each nest containing three to five eggs or four chicks. However this threat would be minimized by requirements to avoid burning during the sparrow breeding season and in occupied habitat, and with monitoring and coordination requirements discussed in further sections of this Biological Opinion. CSSS often re-nest after failed attempts if conditions are suitable and recently unburned habitat is available nearby. The Service further believes that, given the terms and conditions outlined in this Biological Opinion, any minor loss of nests and the productivity associated with the nests that may occur will be compensated by the improved habitat conditions and by more successful post-fire nesting in outlying years (3-4 years) because adult reproductive sparrows are not expected to be injured or killed by these management actions. Take associated with prescribed burns may also be partially compensatory rather than fully additive. In other words, CSSS mortality may occur as a result of predation or some other cause in the absence of prescribed fire. Also, measures such as timing of prescribed burns and percent of habitat patches burned in a year will be taken to reduce impacts.

All proposed fire management strategies in the ENP FMP affecting the CSSS will be based on thresholds for maximum areas burned annually. Therefore the Service has determined that incidental take of no more than a combined total of 35 percent (or 50,690 acres) of all CSSS subpopulations/critical habitat (or CSSS-A undesignated habitat), and no more than 20 percent of occupied habitat (acreage to be determined annually prior to burning) may occur with fire annually, including wildfires and prescribed fires managed to burn acres within critical habitat (or CSSS-A undesignated habitat), and/or occupied habitat. The Service recognizes not all wildfires will be able to be controlled, and wildfire has the potential to exceed these thresholds.

Additionally no more than 50 percent of any individual subpopulation critical habitat (or CSSS-A undesignated habitat) will be burned annually. Therefore the Service has determined that incidental take may occur on no more than the individual subpopulation acreage associated with this criterion; (CSSS-A 29,922 acres, CSSS-B 19,511 acres, CSSS-C 4,026 acres, CSSS-D 5,346 acres, CSSS-E 11,130 acres, and CSSS-F 2,477 acres). These thresholds were selected based on careful consideration of likely potential burn units, and the operational feasibility of achieving target treatments. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Everglade snail kite

Fire has the potential to directly and indirectly affect the Everglade snail kite. Kites nest within the Everglades marshes in areas that are subject to fire, and if the marshes burn when kites are nesting, eggs, nestlings, and young fledglings may be injured or killed by fires resulting in incidental take. Because kites generally nest over water, some nests in trees or shrubs that are in areas with relatively sparse emergent vegetation may not burn because of insufficient fuels around nests. However, kites often nest in dense vegetation, including within dense stands of sawgrass or cattail that would be likely to burn in fires regardless of whether there was water underneath the nests. Because of the variability in kite nesting areas and substrate, not all kite nests within a burned area would be expected to burn during fires. Surveys for snail kite nesting within ENP are not regularly conducted, and consequently, it is unlikely that all snail kite nests that occur within a particular FMU, burn unit, or area would be identified. Nests that are identified would be avoided, and suppression efforts implemented to minimize risk of nest loss to fires.

Under the preferred alternative, fuels treatment burns and exotic vegetation treatment burns would be conducted within kite habitat in FMU 2. Risk to snail kites would be mitigated through avoidance of known nests. Fuels would tend to be treated before they reached heavy accumulations and therefore prescribed rather than wildfires will be the predominant habitat management tool. Because prescribed fires will predominate, the likelihood of fires occurring during the peak kite nesting season, when water levels are generally moderate and falling, may be more likely to occur. However, the fires that result are expected to be less severe and less likely to burn kite nests.

Under the preferred alternative, fires are not expected to substantially affect the suitability of habitat for kites. Areas that burn may support better kite foraging due to improved visibility of snails, but they may also support fewer suitable nest sites. In general, these changes are not anticipated to significantly improve conditions for or limit snail kites.

Fire management, aviation, suppression, effects monitoring, and other fire-related activities could all cause disturbance to Everglade snail kites. Disturbance resulting from aviation activities and the presence of fire management and monitoring personnel may cause temporary changes in behavior that may affect normal breeding, feeding, and sheltering, and could increase risk of predation of eggs and nestlings if adults are flushed from the nest. Rotor wash from helicopters also has the potential to dislodge kite nests from substrate, causing nest failure. Therefore the Service has determined incidental take of one nest which may contain up to five eggs, nestlings, or young fledglings (or a combination of these) may occur within the action area annually. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Florida bonneted bat

The Service anticipates incidental take of the Florida bonneted bat will be difficult to detect for the following reasons: (1) patchy distribution within suitable habitats, (2) suitable habitat may not be occupied, (3) no known locations of natural roost sites, and (4) limited information on movements, dispersal capabilities, diet, and prey base. Roosting and foraging areas appear varied, with the species occurring in forested, suburban, and urban areas. This species roosts in trees, foliage, and other structures. It may use tree cavities, palm fronds, other vegetation, rocky crevices and outcrops on the ground, and other natural or artificial structures.

Uncertainty regarding the location of natural and artificial roost sites may contribute to the species' vulnerability. Since the location of key roost sites is not known, inadvertent impacts to and losses of roosts may be more likely to occur, placing the species at greater risk. Removal of old or live trees with cavities during activities associated with forest management (*e.g.*, thinning, pruning), prescribed fire, exotic species treatment, or trail maintenance may inadvertently remove roost sites, if such sites are not known. Loss of an active roost or removal during critical life-history stages (*e.g.*, when females are pregnant or rearing young) can have severe ramifications, considering the species' small population size and low fecundity.

Where roost sites occur in natural habitat, adults and especially young may be vulnerable to fire. Roost sites may be destroyed by fire and bats may be injured or killed during prescribed fire or fire-related activities. Harassment to Florida bonneted bats may occur during herbicide application, prescribed fires, forest management activities, human activity, and as a result of smoke, fire, heat, and noise from activities. However, it is difficult to estimate how many bats may be disturbed because little is known about their natural or artificial roost sites, nightly and seasonal movements, dispersal capabilities, and dietary requirements. Therefore, the Service anticipates that incidental take of up to two colonies of Florida bonneted bats may occur during prescribed fire and associated activities within the action area annually. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

Florida panther

Under the preferred alternative, fuel treatment burns would be implemented throughout ENP to manage fuel loads. Prescribed fire may also be used to control exotic invasive species populations. Under this alternative, fuel accumulations would be expected to be reduced in general, and less continuous. Prescribed fires would occur under environmental and fire behavior parameters designed to create a mosaic of burned and unburned vegetation within a unit. Less intense fire behavior and the presence of unburned refugia within a burn unit is expected under the preferred alternative. While adult panthers are expected to successfully avoid fires under nearly all conditions, panther kittens up to 5-6 months of age that occur in an area that burns are likely to be injured or killed if they occur in vegetation types that may burn. Panthers use a variety of habitat types for denning, but thick, dense vegetation is the consistent characteristic. Within ENP, these conditions are often associated with hardwood hammocks and dense Brazilian pepper, but long-unburned patches of dense sawgrass, palmetto, or other highly combustible vegetation may also be used. Considering the lack of detailed telemetry monitoring of panthers within ENP, it is unlikely that panther den locations would be known in an area subject to fire, and suppression actions would therefore likely be insufficient to protect panther dens. Because of the small number of panthers in ENP and the relatively low chances that a den will be located within burnable vegetation types, it is unlikely that a panther den will be lost in any one fire, unless it burns a large portion of the pinelands in one fire. However, the likelihood that at least one panther den will be affected by fire is substantial when considering a program of fire management conducted over large areas and over many years.

The preferred alternative would generally be expected to maintain the mosaic of habitat types that panthers use, as well as generally suitable habitat conditions. The mosaic of burned and unburned patches within an individual burn unit would provide favorable conditions for panthers by providing cover adjacent to the habitat conditions that would attract prey, and more frequent fires would tend to maintain habitat in a better condition for panthers to seek prey. The expected lower intensity and severity of fires that are expected under the preferred alternative due to reduced fuel loads and burning under most favorable conditions will tend to prevent fires from entering hardwood hammocks and Brazilian pepper where dens may occur. Regular fuels treatment may tend to reduce the likelihood of dense combustible vegetation that panthers may select as dens. This effect could temporarily reduce availability of den sites, but would also tend to reduce likelihood of loss of kittens due to fire because future den sites would be located in less fire-prone areas.

Fire management, aviation, suppression, effects monitoring, and other fire-related activities could all cause disturbance to Florida panthers. Disturbance resulting from the presence of fire management and monitoring personnel may cause temporary changes in behavior that may affect normal breeding, feeding, and sheltering, and could increase risk of predation of young kittens. Operation of vehicles during fires also has the potential to injure or kill panthers. Therefore the Service has determined incidental take of one den including four kittens, and one adult panther may occur within the action area annually. The incidental take is expected to be in the form of harm, harassment, and direct mortality.

EFFECT OF THE TAKE

In the accompanying Biological Opinion, the Service determined the level of anticipated incidental take, as assessed with current information, is not likely to result in jeopardy to the Bartram's hairstreak, Florida leafwing, eastern indigo snake, Cape Sable seaside sparrow, Everglade snail kite, Florida bonneted bat and the Florida panther, or destruction or adverse modification of critical habitat for the Cape Sable seaside sparrow, Everglade snail kite, Bartram's hairstreak, and Florida leafwing during implementation of the FMP.

REASONABLE AND PRUDENT MEASURES

When providing an incidental take statement, the Service is required to give Reasonable and Prudent Measures (RPMs) it considers necessary and appropriate to minimize the take, along with Terms and Conditions that must be complied with, to implement the reasonable and prudent measures. The primary objective of the Service's RPMs are to provide recommendations for minimizing adverse effects to listed species during prescribed fire and wildfire suppression activities. The Service recognizes not all wildfires will be able to be controlled and ENP must protect human life and property. Avoidance and minimization measures shall be implemented whenever practicable. This document has enumerated take for many of the affected species, as discussed above, and the Service is providing a detailed list of actions that it feels, based on the information and analyses performed as of the date of this document, will avoid, minimize, or monitor the incidental take of species by implementation of the FMP. Many of the actions have been previously coordinated with and/or proposed by ENP. Furthermore, the Service must also specify procedures to be used to handle or dispose of any individuals taken. The Service finds the following RPMs are necessary and appropriate to reduce take and to minimize the direct and indirect effects of the proposed project on the following species:

Bartram's hairstreak and Florida leafwing

1. ENP, in coordination with the Service, shall continue monitoring and evaluation of the seasonal and annual abundance and distribution of the Bartram's hairstreak and Florida leafwing butterfly populations within the Pine Rocklands Fire Management Unit (FMU 3). ENP shall make modifications to the FMP to reduce potential risk to the species if indicated and notify the Service of their conclusions.
2. Planned prescribed fires shall be conducted with the goal to maintain and improve croton host plant populations and pine rockland habitat for the Bartram's hairstreak and Florida leafwing butterfly. Burning shall be conducted to allow within unit unburned refugia and creating landscape scale mosaic patterns. Boundaries of prescribed burns shall be mapped following burns and analyzed along with butterfly host plant monitoring results to assess prescribed fire effects and make modifications if necessary for future planned fires.
3. All appropriate actions shall be taken to protect Bartram's hairstreak and Florida leafwing butterfly larvae and adults.
4. Pre- and post-fire monitoring shall be conducted to determine fire effects on host croton plant survival and recovery and to determine post-fire butterfly larval presence.
5. In conjunction with management goals using prescribed fires to enhance Bartram's hairstreak and Florida leafwing butterfly populations in ENP, seek to restore and maintain pine rockland, marl prairie, and pineland-prairie ecotone habitat, including prevention of woody plant succession where applicable and limit exotic plant invasions both within and in adjacent habitat.

Eastern indigo snake

As part of the project description, ENP has agreed to the implementation of the *Standard Protection Measures for the Eastern Indigo Snake* (Service 2013b) that are applicable to the activities under the FMP. We have considered these measures in this Biological Opinion, but believe the following reasonable and prudent measures are also necessary and appropriate to further minimize the incidental take of eastern indigo snakes:

1. Conduct prescribed fire with the goal of creating a mosaic pattern of burned and unburned habitat to provide some on-site refugia for indigo snakes and facilitate recolonization of the sites following fire. This pattern of burns should leave unburned

refugia and vegetative cover for use by adult and hatchling indigo snakes that may potentially be present. In addition to within unit refugia, create landscape scale mosaic patterns and unburned refugia by prescribed fire in adjacent Long Pine Key pine rockland management units being separated by a burn interval of at least 1 year.

2. If occupied refugia, such as stumps or burrows, are encountered, they should be marked and avoided. In the event that vehicle access to uplands for planned fire management activities is required, conduct surveys for burrows concurrently with the activities. If an occupied burrow is encountered, continue operations in a way that avoids disturbing the burrow or cease operations. Remove debris piles created from exotic plant management prescribed fire activities promptly to prevent eastern indigo snakes from inhabiting those temporary piles and thereby reduce the potential for burning dens.
3. ENP shall use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions within and adjacent to indigo snake habitat. Monitor and consider soil moisture levels in the planning and implementation of prescribed fire treatments to ensure conditions are within the prescription parameters to prevent fire spread into hammocks where indigo snakes may occur.
4. All appropriate actions shall be taken by ENP to protect eastern indigo snakes through ongoing consultation with the FWC and Service. Ignition techniques shall be used that lessen the likelihood of wildlife entrapment; ring fires should not be used. Conduct planned ignition treatments to prevent potential impacts to the indigo snake in drier mangrove habitat they may be utilizing.
5. Do not handle or move eastern indigo snakes. Instruct crews to not harm or kill snakes unless the snake is definitively identified as a Burmese python or other nonnative species. If snakes bearing a resemblance to indigo snakes are encountered, cease all operations and allow the snake to move away.
6. Record and report any sightings of eastern indigo snakes. If an eastern indigo snake is encountered during fire management operations, observations should be reported to the park wildlife biologist through the use of an observation log. If large snake skins are found that may have been shed by an eastern indigo snake, they should be collected and sent to the park wildlife biologist. ENP shall contact the Service, South Florida Ecological Service Office and the ENP Biological Resources Branch Chief if a dead eastern indigo snake is discovered.

Cape Sable seaside sparrow

1. Use operational flexibility during implementation of the ENP FMP to minimize impacts related to fire and associated activities. During the CSSS breeding season, ENP will work with the Service and other partners to identify operations that minimize detrimental effects or reduce the risk of future adverse effects to the CSSS.
2. In order to ensure the potential adverse effects of the ENP FMP do not exceed those anticipated in this Biological Opinion, the ENP must obtain information on: a) the status and distribution of CSSS in areas affected by FMP operations; b) effects of hydrology and its interrelationship with fire management operations on the CSSS and their habitat; and c) the long range effects of fire management operations on CSSS habitat, recovery intervals, effects of fuel availability and soil characteristics, and woody vegetation occurrence.

3. Plan prescribed fires in occupied and/or critical habitat (or CSSS-A undesignated habitat) to be performed during the non-breeding season (July 15 through February 28) to avoid impacts to breeding birds, nests, eggs, and fledglings. Conduct control of wildfires during the breeding season (March 1 through July 15) to the extent practicable consistent with the needs to maintain human safety. Additionally, fires threatening occupied or recently occupied habitat will be controlled to avoid impacts to breeding birds, nests, eggs, and fledglings. Recently occupied habitat is defined as the area within a radius of 1 kilometer of any documented occurrence of a Cape Sable seaside sparrow within the most recent 3 years.
4. Base all proposed fire management strategies on thresholds for maximum areas burned annually. Fires shall be planned to treat no more than a combined total of 35 percent of all CSSS subpopulations/critical habitat (or CSSS-A undesignated habitat), and no more than 20 percent of occupied habitat with fire annually, including prescribed fires and wildfires managed to burn acres within critical habitat (or CSSS-A undesignated habitat), and/or occupied habitat. It may not be possible to control all wildfires and they may have the potential to exceed these thresholds.
5. ENP shall host an annual Cape Sable seaside sparrow working group meeting at the end of each calendar year, to establish fire management strategies and collaborate with species experts. As part of this process, ENP shall continue to work with the Service to improve the Cape Sable seaside sparrow fire management strategy as the latest data on sparrow population numbers, demographics and habitat conditions dictates. ENP fire management activities that affect the Cape Sable seaside sparrow shall adhere to the most updated Cape Sable seaside sparrow fire management strategy.
6. The multi-year fuels treatment plan shall be used as the basis for proposing areas to be burned. Burn no more than 50 percent of any subpopulation critical habitat (or CSSS-A undesignated habitat), at one time based on careful consideration of likely potential burn units, and the operational feasibility of achieving target treatments. Establish the locations and the percent of critical and occupied CSSS habitat to be burned annually and the optimal frequency of return on an annual basis during the Cape Sable seaside sparrow fire management meetings with ENP, the Service, and other appropriate partners. These meetings shall be used to develop annual fire management strategies based on available information regarding population and subpopulation status, burn severity and recovery rates of vegetation in previously burned areas and data on reoccupation by CSSS of previously burned habitat. All available information should be considered during the annual meeting to determine treatment priorities for the Cape Sable seaside sparrow. It may be necessary to adjust the multi-year fuels treatment plan to ensure treatment of priority areas.
7. Evaluate prescribed fire planning units containing occupied and/or critical habitat (or CSSS-A undesignated habitat), scheduled for treatment in a given year to determine woody vegetation presence, fire history and fuel loading. Use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions in and adjacent to occupied Cape Sable seaside sparrow habitat.
8. Live, dead, or injured Cape Sable seaside sparrows will be handled appropriately including the proper notification of the FWC and Service.

Everglade snail kite

1. ENP shall continue to obtain information on snail kite demographics, habitat change and apple snail availability throughout the ENP FMP Action Area, as it relates to habitat changes from the implementation of the FMP.
2. ENP shall obtain and consider the most current snail kite nest locations from the Service, University of Florida, and South Florida Natural Resources Center, Biological Resources Branch, prior to conducting burn activities and ensure that appropriate actions are taken to protect the snail kite. Avoid activities including fire and the operation of aircraft, watercraft and other vehicles, within a 500 foot buffer around known active snail kite nests to prevent disturbance of active nests unless human health and safety would be jeopardized by doing so. Within the 500 meter foraging buffer, prescribed fire should be conducted to create a mosaic pattern of burned and unburned habitat with a goal of no more than 50 percent of the foraging buffer area burned during a given year. Planned ignition treatments would use smoke dispersal data from weather forecast and smoke modeling tools to reduce impacts from smoke to active nests.
3. Use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions within and adjacent to snail kite habitat.
4. Live, dead, or injured Everglade snail kite will be handled appropriately including the proper notification of the FWC and Service.

Florida bonneted bat

1. Information on Florida bonneted bat habitat utilization and roosting locations in ENP needs to be expanded. In an effort to improve existing information that will be used to reduce the effects of fire on this species, ENP should continue acoustic surveys for Florida bonneted bats in potential habitat use areas to the extent that resources permit, and should conduct targeted surveys and assessment if potential roost locations are identified.
2. Cavity trees, where identified, and any known or suspected roosts shall be marked and avoided or cleared around to prevent fire damage. Identification of suspected roosts shall be based on the observations of bats emerging from a tree cavity, bat vocalization heard from a tree cavity, presence of guano, observation of individuals, or recordings of echolocation calls in a focused area. If cavity trees must be removed for fire break integrity or human safety, they shall be examined for roosting bats before any action is taken.
3. Implement planned ignition treatments with the objective of creating mosaic patterned burns leaving unburned refugia and vegetative cover for use by Florida bonneted bats that may potentially be present. Provide refugia by retaining stumps, snags, large cavity trees with hollows or cavities, and woody debris during activities. Retain snags and woody debris if they do not burn to provide habitat and escape cover.
4. Conduct prescribed burns carefully in known or suspected occupied areas for bonneted bats, especially during the Florida bonneted bat breeding season (January to March; June to October). Consider avoiding these areas where prescribed fire is to be used near

known active or suspected roosts, if there are high fuel loads, to reduce the risk of losing roosts during intense fires.

5. Live, dead, or injured Florida bonneted bats will be handled appropriately including the proper notification of the FWC and Service.

Florida panther

1. Burns shall be conducted when environmental conditions prevent the spread of fire into hammocks and tree islands and create mosaic patterns of burned and unburned habitat in each burn unit. This approach should result in significant amounts of habitat in earlier successional stages, and preserve significant amounts of edge habitat and stalking cover for the Florida panther. Plan ignition treatments, where applicable, with a further goal to improve forage for white tailed deer.
2. Conduct planned ignition treatments to reduce fuel loading adjacent to hardwood hammocks to provide protection from unwanted fire spread. Monitor and consider soil moisture levels in the planning and implementation of prescribed fire treatments to ensure conditions are within the prescription parameters to prevent fire spread into tropical hardwood hammocks.
3. Use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions within and adjacent to Florida panther habitat.
4. ENP, in ongoing consultation with the South Florida Natural Resources Center, Biological Resources Branch, FWC, and the Service, shall ensure that appropriate actions are taken to protect panther den sites and juvenile panthers. This shall include ongoing review and consideration of available information on panther locations and current and former den sites. Burning pattern should be conducted to provide adequate escape corridors for Florida panthers.
5. Live, dead, or injured Florida panthers will be handled appropriately including the proper notification of the FWC and Service.

TERMS AND CONDITIONS

To minimize adverse effects to threatened and endangered species from implementation of prescribed fire and wildland fire suppression activities described in the Fire Management Plan, ENP will implement a range of avoidance and minimization measures outlined below.

Avoidance and minimization measures for all species

Conduct surveys and monitoring of listed species and their habitats at the population level to assess overall population and trends. In addition, surveys for wading bird nesting activity and snail kite nesting shall be conducted.

ENP shall notify all vehicle and equipment operators to avoid adverse impacts to all listed, proposed and candidate species. In addition, all on-site personnel will be educated to recognize covered species and where those species occur in a burn unit. If personnel encounter any listed species it will be avoided. If listed animals are encountered, project activities shall cease until the animal leaves the area.

ENP shall ensure that if a dead, injured or sick individual of any listed animal species is encountered, the South Florida Ecological Field Services Office will be contacted with information related to the animal.

ENP shall submit an annual report to the South Florida Ecological Services Office that includes: 1) a list of areas burned with dates and estimated total acreage burned by habitat; 2) identification of projects where activities were implemented where covered species are known to occur; and 3) all observed take of covered species.

ENP shall, where feasible, record the locations of any covered species and nests, dens, cover sites or tracks. ENP shall make this information available to the Service upon request.

ENP shall conduct burns in pine rocklands in small units as described in the multi-year fuels plan and shall burn with the goal of creating a mosaic pattern of burned and unburned habitat to provide some on-site refugia for imperiled species and facilitate recolonization of sites following fire.

Fire breaks, if constructed shall be limited in width to no more than 30 feet. Debris from construction of firebreaks shall be scattered in such a way as to avoid impacting butterfly host plant species or for animals, their dens, nests or cover.

Interior firebreaks within the periphery of the fire, if constructed, shall be limited to 20 feet in width. Debris from construction of firebreaks shall be scattered in such a way as to avoid impacting butterfly host plant species or for animals, their dens, nests or cover.

ENP shall construct temporary fuel breaks, if needed, using methods that have the least likelihood of creating soil disturbance.

ENP shall use prescribed fire of varying intensity and intervals to the extent practicable using an adaptive management approach in order to provide a mosaic of habitats suitable for the listed species.

ENP shall use firing patterns that provide escape routes for wildlife.

Where possible, ENP shall use fire alone to accomplish restoration goals and minimize or avoid use of mechanical or herbicide treatments.

ENP shall use objective-dependent fire effects plots, environmental sampling, fire behavior monitoring and detailed mapping protocols to evaluate mitigations and objectives as part of an adaptive management strategy and revise the FMP accordingly.

Fire supported herbicide application

ENP may use herbicide as a treatment to support prescribed fire when it enhances the application of prescribed fire and does not impact listed species.

Aerial applications of herbicide shall not be used in areas where covered species are known to occur without conducting additional consultation with the Service.

Herbicide application to invasive species may be used in conjunction with prescribed fire to improve treatment and reduction of invasive species, consistent with ENP's Invasive Plant Management EIS.

Fire supportive mechanical treatment

ENP typically does not use mechanical treatment to create safe burning conditions or more effectively introduce fire. However, if ENP determines mechanical treatment is necessary to accomplish these objectives, treatment shall be limited to perimeters or will otherwise be the least amount necessary to introduce fire.

Mechanical treatment of an entire listed plant population shall not be carried out. Treatments, if needed, will be varied by season and by year to avoid treating an entire habitat at one time. Mechanical treatment shall be limited to 50 percent of a population or habitat in a given cycle.

If employed, mechanical treatment methods shall be carried out in ways that minimize ground disturbance in habitats occupied by covered ground dwelling species.

If mowing is employed, mower height shall be as high as possible to provide some protection for listed species.

If necessary, mechanical treatments shall be carried out using methods that minimize production of fine mulch.

If necessary, mechanical treatments shall be timed to avoid sensitive periods in the life history of covered species.

If necessary, mechanical treatments shall be carried out using techniques that minimize permanent alterations to natural hydrology.

Species specific measures

ENP shall also adhere to the following species specific avoidance and minimization measures.

Invertebrates

Bartram's hairstreak and Florida leafwing butterflies

ENP shall, in coordination with the Service, implement monitoring protocols to evaluate the seasonal and annual abundance and distribution of the Florida leafwing and Bartram's hairstreak populations and croton host plant populations throughout FMU 3 and any adjoining areas into which they may expand, prior to conducting prescribed burn activities.

ENP may modify the multi-year fuels plan specifically to reduce potential risk to butterfly populations, and shall provide notification to the Service of their conclusion.

Boundaries of prescribed burns shall be mapped following burns. These maps, along with butterfly and host plant monitoring results, shall be used to assess the efficacy of prescribed fire and to modify burn plans if needed. Any modification to burn units or schedules in the multi-year fuels plan shall be coordinated with the Service prior to initiating the revised plan.

When possible, fire breaks or staging areas for prescribed fire activities shall not be placed through known occurrences of host plants for listed butterflies.

Planned ignition treatments shall be used to maintain croton host plant populations and pine rockland habitat for the Bartram's hairstreak and Florida leafwing butterfly.

Planned ignition treatments shall be implemented with the objective of creating mosaic patterned burns leaving unburned refugia for use by adult and larval Bartram's hairstreak and Florida leafwing butterflies that may potentially be present.

In addition to within unit refugia, landscape scale mosaic patterns and unburned refugia shall be created by prescribed fire in adjacent Long Pine Key pine rockland management blocks being separated by a minimum burn interval of at least one year.

Fires in all habitats within Long Pine Key that contain pineland croton will be carried out with the goal of burning a minimum of 50 percent and a maximum of 75 percent of the burnable habitat within each fire management block and retain a minimum of 25 percent and a maximum of 50 percent unburned habitat. Achieving a specific percentage of burned vs unburned is difficult to ensure, and this numerical value is considered a goal, not an objective.

Everglades Fire Management shall use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant succession, and limit exotic plant invasions within and adjacent to pine rockland habitat.

Fire and Aviation Management, in consultation with the South Florida Natural Resources Center, Biological Resources Branch, shall ensure that appropriate actions are taken to protect Bartram's hairstreak and Florida leafwing larvae and adult butterflies.

ENP Fire Management and South Florida Natural Resources Center, Biological Resources Branch, shall monitor fire effects within monitoring plots to ascertain the effects of fire on croton and post-fire butterfly larval presence. Pre- and post-fire monitoring shall be conducted on an annual basis.

Reptiles

Eastern indigo snake

If occupied refugia such as stumps or burrows are encountered, they will be marked and avoided.

In the event that vehicle access to uplands for planned fire management activities is required, surveys for burrows shall occur concurrently with the activities. If a burrow is encountered, operations shall either continue in a way that avoids disturbing the burrow or operations shall stop.

Planned ignition treatments shall be implemented with the objective of creating mosaic patterned burns, leaving unburned refugia and vegetative cover for use by adult and hatchling indigo snakes that may be present. Fires within potentially occupied indigo snake habitat will be planned with a goal to burn at least 50 percent of the potential habitat while maintaining at least 25 percent of the area unburned. Achieving a specific percentage of burned vs unburned is difficult to ensure, and this numerical value is considered a goal, not an objective. In addition to within unit refugia, landscape scale mosaic patterns and unburned refugia shall be created by prescribed fire in adjacent Long Pine Key pine rockland management units being separated by a minimum burn frequency interval of at least 1 year.

Ignition techniques shall be used that lessen the likelihood of wildlife entrapment; ring fires shall not be used.

Everglades Fire Management shall use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions within and adjacent to indigo snake habitat.

Soil moisture levels shall be monitored and considered in the planning and implementation of prescribed fire treatments to ensure conditions are within the prescription parameters to prevent fire spread into hammocks where indigo snakes may occur.

Debris piles created from prescribed fire activities shall be removed promptly to prevent eastern indigo snakes from inhabiting the temporary piles and thereby reduce the potential for burning dens.

ENP shall conduct planned ignition treatments in drier mangrove habitats utilizing the above safeguards to prevent impacts to the indigo snake that may be utilizing these areas.

Personnel shall record and report any sightings of eastern indigo snakes. If an eastern indigo snake is encountered, observations should be reported to the park wildlife biologist through the use of an observation log. Observation logs will be provided to the Service on a monthly basis.

Eastern indigo snakes, if encountered, shall not be handled or moved.

Crews shall be instructed to not harm or kill snakes unless the snake is definitively identified as a Burmese python or other nonnative species.

Where snakes bearing a resemblance to indigo snakes are encountered, all operations shall be ceased and the snake allowed to move away.

If large snake skins are found that may have been shed by an eastern indigo snake, the location should be recorded, the skin shall be collected and sent to the park wildlife biologist and the information forwarded to the Service.

Fire and Aviation Management, in consultation with the South Florida Natural Resources Center, Biological Resources Branch, shall ensure that all appropriate actions are taken to protect eastern indigo snakes.

ENP shall contact the Service, South Florida Ecological Service Office and the ENP Biological Resources Branch Chief if a dead eastern indigo snake is discovered.

Birds

Cape Sable seaside sparrow

Prescribed fires in occupied and/or critical habitat or CSSS-A undesignated habitat, (Figure 3), should be planned to be performed during the non-breeding season (July 15 through February 28) to avoid impacts to breeding birds, nests, eggs, and fledglings. However, if prescribed fires in occupied and/or critical habitat (or CSSS-A undesignated habitat) are planned to be performed during the breeding season (March 1 through July 15), it may be permitted upon coordination between the Service and ENP subject to verification by ENP that no sparrows are found within the area to be treated with the prescribed burn.

If occupied and/or critical habitat (or CSSS-A undesignated habitat) is threatened by wildfires during the breeding season (March 1 through July 15) control of fires shall be conducted to avoid impacts to breeding birds, nests, eggs, and fledglings. Wildfires that threaten occupied and/or critical habitat (or CSSS-A undesignated habitat) may be managed and allowed to burn in a manner consistent with prescribed fires following coordination between the Service and ENP, subject to a determination of the current status of the CSSS within the threatened area and the following thresholds;

1. All proposed fire management strategies shall be based on thresholds for maximum areas burned annually. No more than a combined total of 35 percent of all CSSS subpopulations/critical habitat (or CSSS-A undesignated habitat), and no more than 20 percent of occupied habitat shall be treated with fire annually, including wildfires and prescribed fires. The Service recognizes that not all wildfires will be able to be controlled, and wildfire has the potential to exceed these thresholds.
2. Additionally no more than 50 percent of any individual subpopulation critical habitat (or CSSS-A undesignated habitat), and no more than 20 percent of an individual subpopulation's occupied habitat shall be burned annually. These thresholds were selected based on careful consideration of likely potential burn units, and the operational feasibility of achieving target treatments.

Occupied habitat shall be defined as the area within a radius of 1 kilometer of any documented occurrence of a Cape Sable seaside sparrow within the most recent three years, excluding pinelands and other unsuitable vegetation communities where sparrows are not known to occur. Occupied habitat shall be identified and delineated annually prior to any fire management activities in CSSS habitat.

ENP shall host an annual Cape Sable seaside sparrow working group meeting to establish fire management strategies and collaborate with species experts. As part of this process, ENP shall continue to work with the Service to improve the Cape Sable seaside sparrow fire management strategy as the latest data on sparrow population numbers, demographics and habitat conditions dictates. ENP fire management activities that affect the Cape Sable seaside sparrow shall adhere to the most updated Cape Sable seaside sparrow fire management strategy that has been developed and approved by ENP and the Service.

The exact locations and the percent of critical and occupied CSSS habitat to be burned annually and the optimal frequency of return shall be established on an annual basis during the Cape Sable seaside sparrow fire management meetings with ENP, the Service, and other appropriate partners. These meetings shall be used to develop annual fire management strategies based on available information regarding population and subpopulation status, burn severity and recovery rates of vegetation in previously burned areas and data on reoccupation by CSSS of previously burned habitat. This information, along with the multi-year fuels treatment plan, shall be used as the basis for proposing areas to be burned. Additionally, all available information should be considered during the annual meeting to determine treatment priorities for the Cape Sable seaside sparrow. The multi-year fuels treatment plan may be adjusted to ensure treatment of priority areas.

Prescribed fire planning units containing occupied and/or critical habitat (or CSSS-A undesignated habitat), scheduled for treatment in a given year shall be evaluated to determine woody vegetation presence, fire history and fuel loading.

ENP shall use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions within and adjacent to occupied Cape Sable seaside sparrow habitat.

Fire and Aviation Management, in consultation with the South Florida Natural Resources Center, Biological Resources Branch, shall ensure that appropriate actions are taken to protect the Cape Sable seaside sparrow.

Everglade snail kite

ENP Fire Management shall obtain the most current snail kite nest locations for the burn units prior to initiating fire management. Snail kite nest location maps may be obtained from various sources including the Service, University of Florida, and South Florida Natural Resources Center, Biological Resources Branch.

ENP shall avoid activities including fire and the operation of aircraft, watercraft and other vehicles, within a 500 foot buffer around known active snail kite nests to prevent disturbance of active nests unless human health and safety would be jeopardized by doing so.

Within the 500-meter foraging buffer, prescribed fire shall be conducted to create a mosaic pattern of burned and unburned habitat with a goal of no more than 50 percent of the foraging buffer burned.

Planned ignition treatments would use smoke dispersal data from weather forecast and smoke modeling tools to reduce impacts from smoke to active nests.

Everglades Fire Management shall use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions within and adjacent to snail kite habitat.

Fire and Aviation Management, in consultation with the South Florida Natural Resources Center, Biological Resources Branch, shall ensure that all appropriate actions are taken to protect the snail kite.

Mammals

Florida bonneted bat

Cavity trees, where identified, shall be protected to the extent possible in areas where Florida bonneted bats are known to occur. If cavity trees must be removed for fire break integrity or human safety, they will be examined for roosting bats before any action is taken.

Any known or suspected roosts shall be marked and avoided or vegetation cleared around the base to prevent fire damage. Identification of suspected roosts will be based on the observations of bats emerging from a tree cavity, bat vocalization heard from a tree cavity, presence of guano, observation of individuals, or recordings of echolocation calls in a focused area.

ENP shall perform acoustic surveys for Florida bonneted bats in potential habitat use areas to the extent that resources permit, and shall conduct targeted surveys and assessment if potential roost locations are identified.

Planned ignition treatments shall be implemented with the objective of creating mosaic patterned burns leaving unburned refugia and vegetative cover for use by Florida bonneted bats that may be present.

Refugia shall be provided by retaining stumps, snags, large cavity trees with hollows or cavities, and woody debris during activities. Snags and woody debris shall be retained if they do not burn to provide habitat and escape cover.

Prescribed burns shall be conducted carefully in known or suspected occupied areas for bonneted bats, especially during the Florida bonneted bat breeding season (January to March; June to October). Where prescribed fire is to be used near known active or suspected roosts, consideration should be given to avoiding these areas if there are high fuel loads, to reduce the risk of losing roosts during intense fires.

Florida panther

ENP shall conduct planned ignition treatments to reduce fuel loading adjacent to hardwood hammocks to provide protection from unwanted fire spread.

Everglades Fire Management shall use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant encroachment, and limit exotic plant invasions within and adjacent to Florida panther habitat.

Soils moisture levels shall be monitored and considered in the planning and implementation of prescribed fire treatments to ensure conditions are within the prescription parameters to prevent fire spread into tropical hardwood hammocks.

Planned ignition treatments shall be used to improve forage for white tailed deer, an important food source for the panther.

Fire and Aviation Management, in consultation with the South Florida Natural Resources Center, Biological Resources Branch, shall ensure that appropriate actions are taken to protect panther den sites and juvenile panthers.

Burns shall be conducted when environmental conditions prevent the spread of wildfire into hammocks and tree islands and create mosaic patterns of burned and unburned habitat in each burn unit. While the planned approach will result in significant amounts of habitat in earlier successional stages, it is also expected to preserve significant amounts of edge habitat and stalking cover for the Florida panther.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities 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 further minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends:

Blodgett's silverbush, Everglades bully, Florida pineland crabgrass, Garber's spurge and Pineland sandmat

1. The multi-year FMP has been written so that the implementation of prescribed burns specifically avoids the creation of new firebreaks or staging areas through covered plant populations. However, in some instances it may be necessary to place a firebreak or staging area in the vicinity of a covered plant population. If this occurs, ENP should take all available measures to avoid placement through covered plant populations. If placement through a known covered plant population is determined to be unavoidable, a temporary firebreak or staging area should be created next to the covered plant population and plants will be allowed to seed into adjacent burned habitat. If the plant population has successfully moved into a temporary firebreak or staging area, the originally planned firebreak or staging area can then be constructed otherwise, further planning should be required to avoid impacts. It is recognized that emergency situations may arise that supersede this mitigation measure. In those instances where emergency actions are necessary, ENP should take every measure available to avoid placement of emergency firebreaks or staging areas through covered plant populations.
2. In pine rocklands, ENP should implement prescribed burns in small burn units as described in the multi-year fuels plan. These burns should be carried out with the intention of creating a mosaic burn pattern and will allow habitat to recover for a period of at least 1 year before burning adjacent unburned units. ENP will also strive for a 3 to 7 year fire rotation in those units.
3. Whenever possible, entire populations of covered plant species should not be burned at each prescribed fire site. Project units or partial units within FMU's should be designed and implemented to minimize the potential of impacting the entire population of these plant species.
4. The long term stability of covered plant populations within ENP is interpreted as a measure of the success in protecting covered plant populations where they occur. If certain populations of covered plant species are considered vulnerable by the Service and need more fine scale monitoring to determine the occurrence of plant populations either within or beyond the current extent, or the status post-fire, ENP should work in coordination with the Service to develop and implement these strategies.
5. Planned ignition treatments should be implemented to restore and maintain the pine rockland and marl prairie habitat and the pineland-prairie ecotone for these species.
6. Weather forecasts should be observed to determine appropriate timing of prescribed fire treatment implementation to avoid possible adverse fire-flood interactions.
7. Everglades Fire Management should use prescribed fire treatments to reduce the effects of unwanted fire, to maintain natural fire regimes, reduce hazardous fuel loading, prevent woody plant succession, and limit exotic plant invasions within and adjacent to pine rockland habitat.
8. Fire and Aviation Management, in consultation with the South Florida Natural Resources Center, Biological Resources Branch, South Florida Natural Resources Center, should ensure that appropriate actions are taken to protect covered plant species.
9. South Florida Natural Resources Center, Biological Resources Branch, South Florida Natural Resources Center and Fire Management staff should collaborate to monitor populations of covered plant species to determine the effects of fire on those populations.

Fire Management should use the results of this monitoring to adjust prescribed fire practices as needed to protect Blodgett's silverbush, Everglades bully, Florida pineland crabgrass, Garber's spurge and pineland sandmat populations.

REINITIATION NOTICE

As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; (3) 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 opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In this consultation incidental take is enumerated for the eastern indigo snake, Cape Sable seaside sparrow, everglade snail kite, Florida bonneted bat, and Florida panther. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

It will be essential that ENP and the Service continue to coordinate closely through the implementation and monitoring of the various phases of the ENP FMP. There will likely be instances where reinitiation of consultation may be required in addition to those mentioned above.

LITERATURE CITED

Anderson, C. 2013. Personal Communication. Email to Mark Salvato (comments on the draft Florida leafwing and Bartram's scrub-hairstreak listing package). U.S. Fish and Wildlife Service, Florida Keys National Wildlife Refuge Complex. Big Pine Key, Florida. April 1, 2013.

Arwood, R. 2012. Personal Communication. Email to Paula Halupa. Inside-Out Photography, Inc. Everglades City, Florida. March 5, 2012.

Basier, R.L., R.L. Boulton, and J.L. Lockwood. 2008. Influence of water depth on nest success of the endangered Cape Sable seaside sparrow in the Florida Everglades. Animal Conservation 11:190-197.

Babis, W.A. 1949. Notes on the food of the indigo snake. Copeia 1949 (2):147.

Baggett, H.D. 1982. Order Lepidoptera. In R. Franz (ed.), Invertebrates. In P.C. Pritchard(ed.) Rare and Endangered Biota of Florida. Vol. 6. Invertebrates, 78-81. University Press, Gainesville, Florida.

Barone, M.A., M.E. Roelke, J. Howard, J.L. Brown, A.E. Anderson, and D.E. Wildt. 1994. Reproductive characteristics of male Florida panthers: Comparative studies from Florida, Texas, Colorado, Latin America, and North American zoos. Journal of Mammalogy 75(1):150-162.

Bauder, J.M. and C.L. Jenkins. 2013. Studying the effects of non-natural landscapes on eastern indigo snake (Drymarchon couperi) ecology in central and southern peninsular Florida: A third-year progress report submitted to the U.S. Fish & Wildlife Service. Jackson, Mississippi.

Beissinger, S. R. 1986. Demography, environmental uncertainty, and the evolution of mate desertion in the Snail Kite. Ecology 67:1445-1459.

Beissinger, S. R. 1987. Anisogamy overcome: female strategies in Snail Kites. Am. Nat. 129:486-500.

Beissinger, S. R. 1988. Snail kite. Pages 148-165 *in* R. S. Palmer, eds. Handbook of North American birds, volume 4, Yale University Press, New Haven, Connecticut.

Beissinger, S.R. 1989. Everglades water levels and snail kite population viability. Presented at the Colonial Waterbird Group Meeting; Key Largo, Florida. October 27, 1989.

Beissinger, S. R. 1990. Alternative foods of a diet specialist, the Snail Kite. Auk 107:327-333.

Beissinger, S. R. 1995. Modeling extinction in periodic environments: Everglades water levels and snail kite population viability. Ecological Applications 5(3):618-31.

Belwood, J.J. 1981. Wagner's mastiff bat, *Eumops glaucinus floridanus* (Molossidae) in southwestern Florida. Journal of Mammalogy 62:411-413.

Belwood, J.J. 1992. Florida mastiff bat *Eumops glaucinus floridanus*. Pages 216-223 in S.R. Humphrey (ed.), Rare and endangered biota of Florida. Vol. I. Mammals. University Press of Florida. Gainesville, Florida.

Bennetts, R.E., P. Darby, and P. Darby. 1993. 1993 Annual Snail Kite Survey. Report to the U.S. Fish and Wildlife Service, South Florida Ecological Services, Vero Beach, Florida.

Bennetts, R. E., Collopy, M. W., and J. A. Rodgers Jr. 1994. The snail kite in the Florida Everglades: A food specialist in a changing environment. Pages 507-532, *in* Everglades: The Ecosystem and Its Restoration, S.M. Davis and J.S. Ogden (Eds.). St. Lucie Press, Delray Beach, Florida, USA.

Bennetts, R. E. and W. M. Kitchens. 1997. The demography and movements of snail kites in Florida. Technical Report Number 56. U.S. Geological Survey, Biological Resources Division, Florida Cooperative Fish and Wildlife Research Unit.

Bennetts, R. E. and W. M. Kitchens. 1999. Within-year survival patterns of snail kites in Florida. Journal of Field Ornithology 70(2):268-275.

Bennetts, R. E., K. Golden, V.J. Dreitz, and W.M. Kitchens. 1998. The proportion of snail kites attempting to breed and the number of breeding attempts per year in Florida. Florida Field Naturalist 26(3):77-108.

Bennetts, R. E., V.J. Dreitz, W.M. Kitchens, J.E. Hines, and J.D. Nichols. 1999. Annual survival of snail kites in Florida: Radio telemetry versus capture-resighting data. The Auk 116(2):435-447.

Bent, A.C. 1937. Life histories of North American birds of prey. Part 1, U.S. National Museum Bulletin, 167 pp.

Boulton, R.L., J.L. Lockwood, and M.J. Davis. 2009. Recovering small Cape Sable seaside sparrow subpopulations: breeding and dispersal of sparrows in the eastern Everglades 2008. January 2009 report to the U.S. Fish and Wildlife Service, South Florida Ecological Services, and U.S. National Park Service, Everglades National Park. Rutgers, The State University of New Jersey, School of Environmental and Biological Sciences; New Brunswick, New Jersey.

Bradley, K.A. 2005a. Personal communication. Email to Dave Martin. The Institute for Regional Conservation. Miami, Florida. April 21, 2005.

Bradley, K.A. 2005b. Personal communication. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. October 11, 2005.

Bradley, K.A. 2005c. Personal communication. Email to Dave Martin. The Institute for Regional Conservation. Miami, Florida. April 6, 2005.

Bradley, K.A. 2005d. Personal communication. Email to Dave Martin. The Institute for Regional Conservation. Miami, Florida. October 11, 2005.

Bradley, K.A. 2007. Personal communication. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. March 6, 2007.

Bradley, K.A., and G.D. Gann. 1999. Status summaries of 12 rockland plant taxa in southern Florida. The Institute for Regional Conservation. Report submitted to the U.S. Fish and Wildlife Service, Vero Beach, Florida.

Bradley, K.A., G. D. Gann, and C. van der Heiden. 2013. Status survey of Everglades bully and Florida pineland crabgrass in the Big Cypress National Preserve. The Institute for Regional Conservation. Report submitted to the U.S. Fish and Wildlife Service, March 4, 2013, Vero Beach, Florida.

Breininger, D.R., M.L. Legare, and R.B. Smith. 2004. Edge effects and population viability of eastern indigo snakes in Florida. Pgs. 299-311 *in*: H.R. Akcakaya, M. Burgman, O. Kindvall, P. Sjorgren-Gulve, J. Hatfield, and M. McCarthy, editors. Species Conservation and Management: Case Studies. Oxford University Press, New York, New York.

Breininger, D., M.R. Bolt, M.L. Legare, J.H. Drese, and E.D. Stolen. 2011. Factors influencing home-range sizes of eastern indigo snakes in central Florida. Journal of Herpetology 45(4): 484-490.

Cade, B.S. and Q. Dong. 2008. A quantile count model of water depth constraints on Cape Sable seaside sparrows. Journal of Animal Ecology 77:47-56.

Carson, H.L. 1945. Delayed fertilization in a captive indigo snake with note of feeding and shedding. Copeia 1945(4): 222-224.

Cassey, P., J.L. Lockwood, and K.H. Fenn. 2007. Using long-term occupancy information to inform the management of Cape Sable seaside sparrows in the Everglades. Biological Conservation 139:139-149.

Cattau, C.E. 2014. Behavioral, demographic, and evolutionary responses of the endangered snail kite to changing food resources in a dynamic prey landscape. PhD dissertation. University of Florida, Gainesville, Florida.

Cattau, C.E. 2015. Personal Communication. Email to Heather Tipton. U.S. Geological Survey, Biological Resources Division, Florida Cooperative Fish and Wildlife Research Unit, University of Florida; Gainesville, Florida. April 14, 2015.

Cattau, C.E., W.M. Kitchens, B.E. Reichert, A. Bowling, A. Hotaling, C. Zweig, J. Olbert, K. Pias, and J. Martin. 2008. Demographic, movement, and habitat studies of the endangered snail kite in response to operational plans in Water Conservation Area 3. 2008 annual report to the U.S. Army Corps of Engineers. U.S. Geological Survey, Biological Resources Division, Florida Cooperative Fish and Wildlife Research Unit, University of Florida; Gainesville, Florida.

Cattau, C.E., W.M. Kitchens, B.E. Reichert, J. Olbert, K. Pias, J. Martin, and C. Zweig. 2009. Snail kite demography. 2009 annual report to the U.S. Army Corps of Engineers. U.S. Geological Survey, Biological Resources Division, Florida Cooperative Fish and Wildlife Research Unit, University of Florida; Gainesville, Florida.

Cattau, C.E., J. Martin, and W.M. Kitchens. 2010. Effects of an exotic prey species on a native specialist: Example of the snail kite. Biological Conservation 143: 513-520.

Cattau, C.E., B.E. Reichert, W.M. Kitchens, R. Fletcher Jr., J. Olbert, K. Pias, E. Robertson, R Wilcox, and C. Zweig. 2012. Snail Kite demography annual report 2012 to the U.S. Army Corps of Engineers. U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, University of Florida; Gainesville, Florida.

Ceilley, D.W. and S.A. Bortone. 2000. A survey of freshwater fishes in the hydric flatwoods of flint pen strand, Lee County, Florida. Proceedings of the 27th Annual Conference on Ecosystems Restoration and Creation, 70-91. Hillsborough Community College.

CCSP. 2008. U.S. Climate Change Science Program. "Synthesis and Assessment Product 4.3 (SAP 4.3): The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity" (Peter Backlund, Anthony Janetos, and David Schimel, convening lead authors) U.S. Department of Agriculture, Washington, DC., USA, 362 pp.

Ceilly, D.W. 2013. Memorandum to the US Fish and Wildlife Service. Request for preliminary results on home range size for eastern indigo snakes at C-44 Site. Research Scientist. Florida Gulf Coast University, Fort Myers, Florida.

Chandler, R. and J.M. Anderson. 1974. Notes on Everglade kite reproduction. Am. Birds, 28:856-858.

Conant, R. and J.T Collins. 1998. A Field Guide to Reptiles and Amphibians Eastern and Central North America. Third Edition, Expanded. Houghton Mifflin Company;New York, New York.

Cox, J.A. and R.S. Kautz. 2000. Habitat conservation needs of rare and imperiled wildlife in Florida. Florida Fish and Wildlife Conservation Commission; Tallahassee, Florida.

Curnutt, J.L., and S.L. Pimm. 1993. Status and ecology of the Cape Sable seaside sparrow. Unpublished report prepared for the U.S. Fish and Wildlife Service and the National Park Service; Vero Beach, Florida.

Dahl, T.E. 1990. Wetlands losses in the United States 1780s to 1980s. U.S. Department of the Interior, Fish and Wildlife Service; Washington, D.C.

Darby, P.C., L.B. Karunaratne, and R.E. Bennetts. 2005. The influence of hydrology and associated habitat structure on spatial and temporal patterns of apple snail abundance and recruitment. Unpublished report to the U.S. Geological Survey, Gainesville, Florida.

Darby, P.C., R.E. Bennetts, and L.B. Karunaratne. 2006. Apple snail densities in habitats used by foraging snail kites. Florida Field Naturalist 34(2):37-68.

Darby, P. C., D. J. Mellow, and M.L. Watford. 2007. Food handling difficulties for snail kites capturing non-native apple snails. Florida Field Naturalist 35(3): 79-85.

Darby, P. C., D. J. Mellow, and P. L. Valentine-Darby. 2009. Interactions between apple snails, habitat structure and hydrology, and availability of snails to foraging snail kites. Final report to the U.S. Fish and Wildlife Service. University of West Florida, Pensacola, Florida.

Davis, S.M., E.E. Gaiser, W.F. Loftus, and A.E. Huffman. 2005. Southern marl prairies conceptual ecological model. Wetlands 25(4):821-831.

Dean, T.F. and J.L. Morrison. 2001. Non-breeding season ecology of the Cape Sable seaside sparrow. Final report to the U.S. Fish and Wildlife Service; Vero Beach, Florida.

Dees, C.S., J.D. Clark, and F.T. Van Manen. 2001. Florida panther habitat use in response to prescribed fire. Journal of Wildlife Management 65:141-147.

Diemer, J.E. and D.W. Speake. 1981. The status of the eastern indigo snake in Georgia. Pp. 52-61 in R.R. Odom, J.W. Guthrie, eds. Proceedings of Nongame and Endangered Wildlife Symposium, August 13-14, 1981, Athens, Georgia.

Diemer, J.E. and D.W. Speake. 1983. The distribution of the eastern indigo snake, *Drymarchon corais couperi*, in Georgia. Journal of Herpetology 17(3):256-264.

District (South Florida Water Management District). 2008. Letter to Steve Mortellaro of the U.S. Fish and Wildlife Service. EAA A1 Reservoir annual indigo snake sighting summary. West Palm Beach, Florida. June 19, 2008.

Dreitz, V. J. 2000. The influence of environmental variation on the snail kite population in Florida. Final PhD Dissertation. University of Miami, Coral Gables, Florida.

Dreitz, V. J., J.D. Nichols, J.E. Hines, R.E. Bennetts, W.M. Kitchens, and D.L. DeAngelis. 2002. The use of resighting data to estimate the rate of population growth of the snail kite in Florida. Journal of Applied Statistics 29(1-4):609-623.

Duever, M.J., J.E. Carlson, J.F. Meeder, L.C. Duever, L.H. Gunderson, L.A. Riopelle, T.R. Alexander, R.L. Myers, and D.P. Spangler. 1986. The Big Cypress National Preserve. National Audubon Society, New York.

Dunbar, M.R. 1995. Florida panther biomedical investigations. Annual performance report. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida.

Emmel, T.C. R.A. Worth and K. Schwarz. 1995. The relationships between host plant and habitat for the distribution of three potentially endangered South Florida butterfly species. Report to the National Biological Survey.

Everglades National Park. 2005. An assessment of the interim operational plan. Unpublished report to congress, May 2005. South Florida Natural Resources Center, Biological Resources Branch, Everglades National Park; Homestead, Florida.

Ehrenfeld, J. 1976. Reproductive biology of three species of *Euphorbia* subgenus *Chamaesyce* (Euphorbiaceae). American Journal of Botany 63(4):406-413.

Ehrenfeld, J. 1979. Pollination of three species of *Euphorbia* subgenus *Chamaesyce* (Euphorbiaceae), with special reference to bees. American Midland Naturalist 101:87-98.

Fellows, M.Q.N., J.E. Possley, C.P. Lane, and G.G. Noe. Microhabitat characteristics of *Digitaria pauciflora* Hitchc., a rare and imperiled grass of Everglades National Park. *In:* Conservation of South Florida endangered and threatened flora. Final report to the Endangered Plant Advisory Council, Florida Department of Agriculture and Consumer Services, Contract #006466, December 2002. Fairchild Tropical Garden. Coral Gables, Florida.

Ferriter, A., ed. 2001. Lygodium Management Plan for Florida. Florida Exotic Pest Plant Council's Lygodium Task Force. West Palm Beach, Florida.

Ferriter, A.P. 2003. *Lygodium microphyllum* in the Everglades: A Report from Florida's Lygodium Task Force. Poster presentation. Invasive Plants in Natural and Managed Systems: Linking Science and Management. 7th International Conference on the Ecology and Management of Alien Plant Invasions. November 5, 2003.

Ferrer, J.R., G. Perera, and M. Yong. 1990. Life tables of *Pomacea paludosa* (Say) in natural conditions. Florida Scientist 53 (supplement): 15.

Fletcher, R.J. 2015. Personal Communication. Email to Heather Tipton. University of Florida, Gainesville, Florida. April 16, 2015.

Fletcher, R., C. Cattau, R. Wilcox, C. Zweig, B. Jeffery, E. Robertson, B. Reichert, and W. Kitchens. 2014. Snail kite demography annual progress report 2013. Interim Report. Unpublished report to the U.S. Geological Survey, Gainesville, Florida.

Florida Natural Areas Inventory (FNAI). 2006. Florida Natural Areas Inventory, (*Chamaesyce garberi*, Garber's spurge). Florida State University, Tallahassee, Florida.

Florida Natural Areas Inventory (FNAI). 2007. Florida Natural Areas Inventory, (*Digitaria pauciflora*, Florida pineland crabgrass). Florida State University, Tallahassee, Florida.

Florida Natural Areas Inventory (FNAI). 2015. Florida Natural Areas Inventory, Element Tracking Summary (*Eumops floridanus*, Florida Bonneted Bat). Florida State University, Tallahassee, Florida.

FWC (Florida Fish and Wildlife Conservation Commission). 2004. Land, E.D., M. Cunningham, M. Lotz, and D. Shindle. Florida panther genetic restoration and management. Annual report, Florida Panther Research Number 93112503002; Tallahassee, Florida.

FWC (Florida Fish and Wildlife Conservation Commission). 2011. Florida Bonneted Bat Biological Status Review Report. March 31, 2011. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Gann, G.D. 2015. Vascular plant species of management concern in Everglades National Park. Final report submitted to Everglades National Park. The Institute for Regional Conservation, Delray Beach, Florida.

Gann, G.D., K.A. Bradley, and S.W. Woodmansee. 2002. Rare plants of South Florida: their history, conservation, and restoration. The Institute for Regional Conservation; Miami, Florida. 1056 pages.

Gann, G.D., K.A. Bradley, and S.W. Woodmansee. 2001-2010. The floristic inventory of South Florida database online. The Institute for Regional Conservation, Miami, Florida. http://regionalconservation.org/ircs/database/plants/PlantPage.asp?TXCODE=Sidereclaust [Accessed: April 30, 2010]

Gann, G. D., E. V. Grahl, S. W. Woodmansee, and K. A. Bradley. 2005. Rare Plant Monitoring and Restoration on Long Pine Key, Everglades National Park Year End Report, YEAR 2. Cooperative Agreement #H5284-03-0044. Submitted by The Institute for Regional Conservation, Miami, Florida to Everglades National Park, Homestead, Florida.

Gann, G.D., K.N. Hines, E.V. Grahl, and S.W. Woodmansee. 2006. Rare plant monitoring and restoration on Long Pine Key, Everglades National Park. Year End Report, YEAR 3, Cooperative Agreement #H5284-03-0044. Submitted by The Institute for Regional Conservation, Miami, Florida to Everglades National Park, Homestead, Florida.

Gann, G.D., K.A. Bradley and S.W. Woodmansee. 2014a. The Floristic Inventory of South Florida Database Online. 2001-2014. The Institute for Regional Conservation, Delray Beach, Florida.

Gargas, A., M. Trest, M. Christensen, T. J. Volk, and D. Blehert. 2009. *Geomyces destructans* sp. nov., associated with Bat White-Nose Syndrome. Mycotaxon. 108:147-154.

Green, S.E., K.A. Bradley, and S.W. Woodmansee. 2007a. Status survey of the Federally threatened *Chamaesyce garberi* in South Florida. Quarterly Report 2, Grant Agreement # 401816G055. Submitted by The Institute for Regional Conservation, Miami, Florida to U.S. Fish and Wildlife Service, Vero Beach, Florida.

Green, S.E., K.A. Bradley, and S.W. Woodmansee. 2007b. Status survey of the Federally threatened *Chamaesyce garberi* in South Florida. Quarterly Report 3, Grant Agreement # 401816G055. Submitted by The Institute for Regional Conservation, Miami, Florida to U.S. Fish and Wildlife Service, Vero Beach, Florida.

Green, S.E., K.A. Bradley, and S.W. Woodmansee. 2008. Status survey of the Federally threatened *Chamaesyce garberi* in South Florida. Final Report Grant Agreement # 401816G055. Submitted by The Institute for Regional Conservation, Miami, Florida to U.S. Fish and Wildlife Service, Vero Beach, Florida.

Gunderson, L. H. 1997. Vegetation of the Everglades: Determinants of Community Composition. Pages 323-340 *in* S.M. Davis and J.C. Ogden, editors. Everglades, The Ecosystem and Its Restoration. CRC Press; Boca Raton, Florida.

Hanan, E., M. Ross, J. Sah, P.L. Ruiz, S. Stoffella, N. Timilsina, D. Jones, J. Espinar, and R. King. 2009. Woody plant invasion into the freshwater marl prairie habitat of the Cape Sable seaside sparrow. Final report to the U.S. Fish and Wildlife Service; Vero Beach, Florida. Florida International University, South Environmental Research Center; Miami, Florida.

Harvey, M.J., J.S. Altenbach, and T.L. Best. 1999. Bats of the United States. Arkansas Game and Fish Commission and U.S. Fish and Wildlife Service. Asheville, North Carolina.

Harvey, R.G., M.L. Brien, M.S. Cherkiss, M. Dorcas, M. Rochford, R.W. Snow, and F. Mazzotti. 2013. Burmese Pythons in South Florida: Scientific Support for Invasive Species Management. Institute of Food and Agricultural Services, University of Florida, Gainesville, Florida.

Herndon, A. 1998. Life history studies of some plants endemic to pine rockland in Everglades National Park. Final Report to National Park Service, Everglades National Park, Homestead, Florida. 142 pages.

Hennessey, M.K. and D.H. Habeck. 1991. Effects of mosquito adulticides on populations of non-target terrestrial arthropods in the Florida Keys. Final Report and Research Results submitted to U.S Fish and Wildlife Service. University of Florida Cooperative Wildlife Research Unit, Gainesville, Florida. 75 pages.

Hodges, S.R., and K.A. Bradley. 2006. Distribution and population size of five candidate plant taxa in the Florida Keys: *Argythamnia blodgettii*, *Chamaecrista lineata* var. *keyensis*, *Indigofera mucronata* var. *keyensis*, *Linum arenicola*, and *Sideroxylon reclinatum* subsp. *austrofloridense*. The Institute for Regional Conservation. Final Report Contract Number 401815G011, submitted to U.S. Fish and Wildlife Service, Vero Beach, Florida.

Howell, A.H. 1919. Description of a new seaside sparrow from Florida. The Auk 36(1):86-87.

Howell, A.H. 1932. Florida bird life. Coward McCann; New York, New York.

Humphrey, S.R. 1975. Nursery roosts and community diversity of Nearctic bats. Journal of Mammalogy 56(2):321-346.

Intergovernmental Panel on Climate Change (IPCC). 2008. Climate Change and Water [B.C. Bates, Z.W. Kundzewicz, S. Wu, and J.P. Palutikof, Editors]. Technical Paper of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change Secretariat, Geneva, Switzerland.

Johnson, R.A., J.I. Wagner, D.J. Grigsby, and V.A. Stern. 1988. Hydrologic effects of the 1984 through 1986 L-31N canal drawdown on the northern Taylor Slough basin of Everglades National Park. South Florida Research Center Report-88/01. Everglades National Park; Homestead, Florida.

Jones, G., D.S. Jacobs, T.H. Kunz, M.R. Willig, and P.A. Racey. 2009. Carpe noctem: the importance of bats as bioindicators. Endangered Species Research 8: 93-115.

Kautz, R., R. Kawula, T. Hoctor, J. Comiskey, D. Jansen, D. Jennings, J. Kasbohm, F. Mazzotti, R. McBride, L. Richardson, and K. Root. 2006. How much is enough? Landscape-scale conservation for the Florida panther. Biological Conservation 130:118-133.

Keegan, H.L. 1944. Indigo snakes feeding upon poisonous snakes. Copeia 1944 (1):59.

Kernan, C., and K. Bradley. 1996. Conservation survey of *Linum arenicola* in Dade County, Florida. Fairchild Tropical Garden. Report to the U.S. Fish and Wildlife Service, Vero Beach, Florida.

Kitchens, W.M., R.E. Bennetts, and D.L. DeAngelis. 2002. Linkages between the snail kite population and wetland dynamics in a highly fragmented South Florida hydroscape. Pages 183-201 *in* J.W Porter and K.G. Porter, editors. The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook. CRC Press, Boca Raton, Florida.

Kochman, H.I. 1978. Eastern indigo snake, *Drymarchon corais couperi*. Pages 68-69 *in* R.W. McDiarmid, ed. Rare and endangered biota of Florida. University Presses of Florida; Gainesville, Florida.

Krysko, K.L., J.B. Burgess, M.R. Rochford, C.R. Gillette, D. Cueva, K.M. Enge, L.A. Somma, J.L. Stabile, D.C. Smith, J.A. Wasilewski, G.N. Kieckhefer III, M.C. Granatosky, and S.V. Nielsen. 2011. "Verified Non-Indigenous Amphibians and Reptiles in Florida from 1863 through 2010: Outlining the Invasion Process and Identifying Invasion Pathways and Stages," *Zootaxa*, Vol. 3028, 2011, pp. 1–64.

Kuntz, G.C. 1977. Endangered species: Florida Indigo. Florida Naturalist: 15-19.

Kushlan, J.A. 1990. Freshwater marshes. Pages 324- 363 *in* R. L. Myers and J. J. Ewel. Ecosystems of Florida. University of Central Florida Press; Orlando, Florida.

Kushlan, J.A., O.L. Bass, Jr., L.L. Loope, W.B. Robertson Jr., P.C. Rosendahl and D.L. Taylor. 1982. Cape Sable seaside sparrow management plan. South Florida Research Center Report M-660. U.S. Department of the Interior, Everglades National Park; Homestead, Florida.

Kushlan, K.A. and O.L. Bass, Jr. 1983. Habitat use and the distribution of the Cape Sable seaside sparrow. Pages 139-146 *in* T.L. Quay, J.B. Funderburg, Jr., D.S. Lee, F. Potter, and C.S. Robbins, Eds. The seaside sparrow, its biology and management. North Carolina Biological Survey, Raleigh; North Carolina.

Land, A. 2012. Personal Communication. Email to Mark Salvato. Everglades National Park Fire Effects. Everglades National Park. Homestead, Florida. August 9, 2012.

Land, E.D. and R.C. Lacy. 2000. Introgression level achieved through Florida panther genetic restoration. Endangered Species Update 17:99-103.

La Puma, D.A., J.L. Lockwood, and M.J. Davis. 2007. Endangered species management requires a new look at the benefit of fire: the Cape Sable seaside sparrow in the Everglades ecosystem. Biological Conservation 136:398-407.

LaPuma, D.A. 2010. Come hell or high water: Conservation of the federally endangered CSSS in the dynamic Florida Everglades. PhD dissertation, Rutgers University, New Brunswick, New Jersey.

Layne, J.N. and T.M. Steiner. 1996. Eastern indigo snake (*Drymarchon corais couperi*): summary of research conducted on Archbold Biological Station. Report prepared under Order 43910-6-0134 to the U.S. Fish and Wildlife Service; Jackson, Mississippi.

Lawler, H.E. 1977. The status of Drymarchon corais couperi (Holbrook), the eastern indigo snake, in the southeastern USA. Herpetological Review 8(3): 76-79.

Lazell, Jr. J.D., Jr. 1989. Wildlife of the Florida Keys: a natural history. Island Press; Washington, D.C.

Lockwood, J.L., K.H. Fenn, J.L. Curnutt, D. Rosenthal, K.L. Balent, and A.L. Mayer. 1997. Life history of the endangered Cape Sable seaside-sparrow. Wilson Bulletin 109(4): 720-731.

Lockwood, J.L., K.H. Fenn, J.M. Caudill, D. Okines, O.L. Bass, Jr., J.R. Duncan, and S.L. Pimm. 2001. The implications of Cape Sable seaside sparrow demography for Everglades restoration. Animal Conservation 4:275-281.

Lockwood, J.L., M.S. Ross, and J.P. Sah. 2003. Smoke on the water: the interplay of fire and water flow on Everglades restoration. Frontiers in Ecology 1(9):462-468.

Lockwood, J.L., D.A. La Puma, and M.J. Davis. 2005. The response of the Cape Sable seaside sparrow to fire. 2005 annual report, Critical Ecosystem Studies Initiative, Everglades National Park; Homestead, Florida.

Lockwood, J.L., R.L. Boulton, B. Baiser, M.J. Davis, and D.A. LaPuma. 2008. Detailed study of Cape Sable seaside sparrow nest success and causes of nest failure. 2008 annual report to the U.S. Fish and Wildlife Service, Vero Beach, Florida.

Loftus, W.F. and A.M. Eklund. 1994. Long-term dynamics of an Everglades small-fish assemblage. Pages 461-484 *in* S.M. Davis and J.C. Ogden (eds.), Everglades: the ecosystem and its restoration. St. Lucie Press, Delray Beach, Florida.

Long, R.W., and O. Lakela. 1971. A flora of tropical Florida. University of Miami Press, Coral Gables, Florida.

Lorch, J.M., A.M. Minnis, C.U. Meteyer, J.A. Redell, J.P. White, H.M. Kaarakka, L.K. Muller, D.L. Lindner, M.L. Verant, V. Shearn-Bochsler, and D.S. Blehert. 2011. The fungus *Trichophyton redellii sp. nov.* causes skin infections that resemble white-nose syndrome of hibernating bats. Journal of Wildlife Diseases 51(1): 36-47.

Maehr, D.S., R. C. Belden, E. D. Land, and L. Wilkins. 1990. Food habits of panthers in southwest Florida. Journal of Wildlife Management 54: 420-423.

Maehr, D.S., and J.L. Larkin. 2004. Do prescribed fires in South Florida reduce habitat quality for native carnivores? Natural Areas Journal 24:188-197.

Main, M.B. and M.J. Barry. 2002. Influence of season of fire on flowering of wet prairie grasses in South Florida, USA. Wetlands 22(2):430-434.

Marks, C. 2006. Personal Communication. Email to Paula Halupa. Florida Bat Conservancy. Bay Pines, Florida. July 26, 2006.

Marks, G.E. and C.S. Marks. 2008a. Status of the Florida bonneted bat (*Eumops floridanus*). Final report. Submitted by the Florida Bat Conservancy under grant agreement number 401815G192. Florida Bat Conservancy. Bay Pines, Florida.

Marks, G.E. and C.S. Marks. 2008b. Status of the Florida bonneted bat (*Eumops floridanus*). Supplemental report. Submitted by the Florida Bat Conservancy under grant agreement number 401815G192. Florida Bat Conservancy. Bay Pines, Florida.

Marks, G.E. and C.S. Marks. 2008c. Bat conservation and land management Kissimmee River WMA. Florida Bat Conservancy. Bay Pines, Florida.

Marks, C. and G. Marks. 2008. Personal Communication. Email to Paula Halupa. Florida Bat Conservancy. Bay Pines, Florida. May 27, 2008.

Martin, J. 2007. Population Ecology and Conservation of the Snail Kite. Dissertation, University of Florida, Gainesville, Florida, USA.

Martin, J., W. M. Kitchens, C. Cattau, A. Bowling, M. Conners, D. Huser, and E. Powers. 2006. Snail kite demography annual report 2005. U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, Florida.

Martin, J., J.D. Nichols, W.M. Kitchens, and J.E. Hines. 2006a. Multiscale patterns of movement in fragmented landscapes and consequences on demography of the snail kite in Florida. Journal of Animal Ecology 75: 527-539.

Martin, J., W. and W. M. Kitchens. 2003. Snail kite demography annual report 2003. U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, Florida.

Martin, J., W. Kitchens, C. Cattau, A. Bowling, S. Stocco, E. Powers, C. Zweig, A. Hotaling, Z. Welch, H. Waddle, and A. Paredes. 2007. Snail kite demography annual progress report 2006. U.S. Geological Survey, Florida Cooperative Fish and Wildlife Research Unit, University of Florida, Gainesville, Florida.

Mazzotti, F. J., L.A. Brandt, L.G. Pearlstine, W.M. Kitchens, T.A. Obreza, F.C. Depkin, N.E. Morris, and C.E. Arnold. 1993. An Evaluation of the Regional Effects of New Citrus Development on the Ecological Integrity of Wildlife Resources in Southwest Florida. Institute of Food and Agricultural Services, University of Florida, Gainesville, Florida.

Mazzotti, F.J., M.S. Cherkiss, G.S. Cook, and E. McKercher. 2002. Status and conservation of the American crocodile in Florida: Recovering and endangered species while restoring an endangered ecosystem. Draft Final Report to Everglades National Park, 51 pp.

Messenger, S. L., J.S. Smith, L.A. Orciari, P.A. Yager, and C.E. Rupprecht. 2003. Emerging pattern of rabies deaths and increased viral infectivity. Emerg Infect Dis 9, 151–154.

Minno, M. 2009. Personal Communication. Email to Paula Halupa. Eco-Cognizant, Inc. Gainesville, Florida. February 16, 2009.

Minno, M.C., and T.C. Emmel. 1993. Butterflies of the Florida Keys. Scientific Publishers, Inc., Gainesville, Florida.

Minno, M., and M. Minno. 2009. A plan to conserve rare butterflies in the Florida Keys. Submitted to: Edsel M. Fussel, Director, Florida Keys Mosquito Control District. Eco-Cognizant, Inc. Gainesville, Florida.

Moler, P.E. 1985a. Distribution of the eastern indigo snake, Drymarchon corais couperi, in Florida. Herpetological Review 16(2): 37-38.

Moler, P.E. 1985b. Home range and seasonal activity of the eastern indigo snake, Drymarchon corais couperi, in northern Florida. Final Performance Report, Study E-1-06, III-A-5. Florida Game and Freshwater Fish Commission; Tallahassee, Florida.

Moler, P.E. 1992. Eastern indigo snake. Pages 181-186 *in* P.E. Moler, ed. Rare and endangered biota of Florida, volume III, Amphibians and Reptiles. University Press of Florida; Gainesville, Florida.

Moler, P.E. 1998. Personal communication. Biologist. Comments dated January 9, 2006, to the U.S. Fish and Wildlife Service on the technical/agency draft Multi-Species Recovery Plan for South Florida. Florida Fish and Wildlife Conservation Commission; Tallahassee, Florida.

Mooij, W.M., R.E. Bennetts, W.M. Kitchens, and D.L. DeAngelis. 2002. Exploring the effect of drought extent and interval on the Florida snail kite: interplay between spatial and temporal scales. Ecological Modelling 149: 25-39.

NatureServe. 2009. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer. (Accessed: July 27, 2009).

Newman, J., E. Zillioux, E. Rich, L. Liang, and C. Newman. 2004. Historical and other patterns of monomethyl and inorganic mercury in Florida panther (Puma concolor coryi). Archives of Environmental Contaminants and Toxicology 48:75-80.

Nichols, J. D., G. L. Hensler, and P. W. Sykes. 1980. Demography of the Everglade kite: Implications for population management. Ecological Monitoring 9(1980):215-232.

Nicholson, D. J. 1926. Nesting habits of the Everglades kite in Florida. Auk 43:2-67.

Nott, M.P., O.L. Bass, Jr., D.M. Fleming, S.E. Killeffer, N. Fraley, L. Manne, J.L. Curnutt, T.M. Brooks, R. Powell, and S.L. Pimm. 1998. Water levels, rapid vegetational changes, and the endangered Cape Sable seaside sparrow. Animal Conservation 1: 23-32.

Ogden, J.C. 1972. Florida region. American Birds 26:852.

Olmstead, I.C. and L.L. Loope. 1984. Plant communities of Everglades National Park. Pages 167-184 *in* Gleason, P.J., Ed. Environments of South Florida: past and present II. Miami Geological Society; Coral Gables, Florida.

Opler, P.A., and G.O. Krizek. 1984. Butterflies east of the Great Plains. The John Hopkins University Press, Baltimore, Maryland.

Owen, M. 2012a. Personal Communication. Email to Paula Halupa. Florida Department of Environmental Protection, Fakahatchee Strand Preserve State Park. Copeland, Florida. July 31, 2012.

Owen, M. 2012b. Personal Communication. Telephone conversation with Paula Halupa. Florida Department of Environmental Protection, Fakahatchee Strand Preserve State Park. Copeland, Florida. August 1, 2012.

Pemberton, R.W. 1988. Myrmecochory in the introduced range weed, leafy spurge (*Euphorbia esula* L.). American Midland Naturalist 119(2):431-435.

Pimm, S.L. and O.L. Bass, Jr. 2002. Range-wide risks to large populations: the Cape Sable seaside sparrow as a case history. Pages 406-424 *in* Beissinger, S.R., and D.L. McCullough, Eds. Population viability analysis. The University of Chicago Press; Chicago, Illinois.

Pimm, S.L. and O.S. Bass, Jr. 2005. 2005 annual report on the Cape Sable seaside sparrow. U.S. Fish and Wildlife Service, South Florida Ecological Services Office; Vero Beach, Florida.

Pimm, S.L., J.L. Lockwood, C.N. Jenkins, J.L. Curnutt, M.P. Nott, R.D. Powell, and O.L. Bass, Jr. 2002. Sparrow in the grass: a report on the first 10 years of research on the Cape Sable seaside sparrow. Everglades National Park, Homestead, Florida.

Pimm, S., C. Jenkins, and S. Bass. 2007. 2006 annual report on the Cape Sable seaside sparrow. U.S. Fish and Wildlife Service; South Florida Ecological Services Office; Vero Beach, Florida.

Possley, J. 2011a. Personal Communication. Email to Paula Halupa. Fairchild Tropical Botanic Garden. Coral Gables, Florida. April 26, 2011.

Possley, J. 2011b. Personal Communication. Email to Paula Halupa. Fairchild Tropical Botanic Garden. Coral Gables, Florida. December 2, 2011.

Possley, J., and E. McSweeney. 2005. Critically imperiled *Sideroxylon reclinatum* spp. *austrofloridense* in Larry and Penny Thompson Park – 2003.

Possley, J., S.W. Woodmansee, and J. Maschinski. 2008. Patterns of plant composition in fragments of globally imperiled pine rockland forest: Effects of soil type, recent fire frequency, and fragment size. Natural Areas Journal 28:370-394.

Post, W. and J.S. Greenlaw. 1994. Seaside sparrow *in* A. Poole and F. Gill, Eds. The birds of North America, No. 127. The Academy of Natural Sciences and The American Ornithologists' Union; Philadelphia, Pennsylvania and Washington, D.C.

Post, W., and J. S. Greenlaw. 2000. The present and future of the Cape Sable seaside sparrow. Florida Field Naturalist 28:93-160.

Robson, M. 1989. Status survey of the Florida mastiff bat. Final performance report. Florida Game and Fresh Water Fish Commission. Nongame Wildlife Section. Tallahassee, Florida.

Robson, M.S., F.J. Mazzotti, and T. Parrott. 1989. Recent evidence of the mastiff bat in southern Florida. Florida Field Naturalist 17(4):81-82.

Rodgers, J. A., Jr., S. T. Schwikert, and A. S. Wenner. 1988. Status of the snail kite in Florida: 1981-1985. American Birds 42:30-35.

Roelke, M.E., J.S. Martenson, and S.J. O.Brien. 1993. The consequences of demographic reduction and genetic depletion in the endangered Florida panther. Current Biology 3: 340-350.

Ross, M.S. 2006. Personal communication. Research professor. Personal communication with the U.S. Fish and Wildlife Service dated January 19, 2006. Florida International University; Miami, Florida.

Ross, M.S., J.P. Sah, P.L. Ruiz, D.T. Jones, H. Cooley, R. Travieso, J.R. Snyder, and D. Hagyari. 2006. Effect of hydrologic restoration on habitat of the Cape Sable seaside sparrow. Annual report of 2004-2005. Florida International University, Southeast Environmental Research Center; Miami, Florida, and U.S. Geological Survey, Center for Water and Restoration Studies; Ochopee, Florida

Ross, M.S., J.J. OBrien, R.G. Ford, K. Zhang, and A. Morkill. 2009. Disturbance and the rising tide: the challenge of biodiversity management on low-island ecosystems. Frontiers in Ecology and the Environment 7(9): 471478.

Rumbold, D. G., and M. B. Mihalik. 1994. Snail kite use of a drought-related habitat and communal roost in West Palm Beach, Florida: 1987-1991. Florida Field Naturalist 22: 29-38.

Sadle, J. 2010. Personal Communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. January 28, 2010.

Sadle, J. 2015. Personal communication. Email correspondence to David Bender, February 13, 2015. National Park Service, Everglades National Park, Homestead, Florida.

Sah, J.P. and M.S. Ross. 2014. Cape Sable seaside sparrow Sub-pop D Habitat: Vegetation Dynamics - An Overview. Presentation to the South Florida Water Management District, October 22, 2014. West Palm Beach, Florida.

Sah, J.P., M.S. Ross, P.L. Ruiz, D.T. Jones, R. Travieso, S. Stofella, N. Timilsina, and H. Cooley. 2007. Effect of hydrologic restoration on habitat of the Cape Sable seaside sparrow - Annual report of 2005-2006. Southeast Environmental Research Center, Florida International University; Miami, Florida.

Sah, J.P., M.S. Ross, J.R. Snyder, P.L. Ruiz, S. Stoffella, N. Colbert, E. Hanan, L. Lopez, and M. Camp. 2010. Cape Sable seaside sparrow habitat – vegetation monitoring. Fiscal Year 2009 final report to the U.S. Army Corps of Engineers; Jacksonville, Florida. Florida International University, Southeast Environmental Research Center; Miami, Florida, and U.S. Geological Survey, Big Cypress National Preserve, Florida Integrated Science Center; Ochopee, Florida.

Salvato, M.H. 1999. Factors influencing the declining populations of three butterfly species in South Florida and the lower Florida Keys. M.S. Thesis. University of Florida, Gainesville, Florida.

Salvato, M. 2001. Butterfly conservation and host plant fluctuations: the relationship between *Strymon acis bartrami* and *Anaea troglodyta floridalis* on *Croton linearis* in Florida (Lepidoptera: Lycaenidae and Nymphalidae). Holarctic Lepidoptera 8(2) 53-57.

Salvato, M.H. and M.K. Hennessey. 2003. Notes on the historic range and natural history of *Anaea troglodyta floridalis* (Nymphalidae). Journal of the Lepidopterists Society. 57(3) 243-249.

Salvato, M.H., and M.K. Hennessey. 2004. Notes on the status and fire-related ecology of *Strymon acis bartrami*. Journal of the Lepidopterists' Society 58(4):223-227.

Salvato, M.H., and H.L. Salvato. 2008. Notes on the feeding ecology of Strymon acis bartrami and Anaea troglodyta floridalis. Florida Scientist. 71: 323-329.

Salvato, M.H., and H.L. Salvato. 2010a. Notes on the status and ecology of *Anaea troglodyta floridalis* in Everglades National Park. Journal of the Lepidopterists' Society. 64: 91-97.

Salvato, M.H., and H.L. Salvato. 2010b. Notes on the status and ecology of *Strymon acis bartrami* in Everglades National Park. Journal of the Lepidopterists' Society. 64: 154-160.

Salvato, M.H., and H.L. Salvato. 2010c. Notes on the status of *Anaea troglodyta floridalis* on Big Pine Key. News of the Lepidopterists' Society. 52: 139-140.

Schwartz, A. 1987. The butterflies of the Lower Florida Keys. Milwaukee Public Museum, Contributions in Biology and Geology 73:1-34.

Scott, J. H and R.E. Burgan. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Seal, U.S., and workshop participants. 1994. A plan for genetic restoration and management of the Florida panther (*Felis concolor coryi*). Report to the Florida Game and Fresh Water Fish Commission, by the Conservation Breeding Specialist Group, Species Survival Commission, IUCN; Apple Valley, Minnesota.

Shaw, C.E. 1959. Longevity of snakes in the United States as of January 1, 1959. Copeia 1959(4): 336-337.

Sherwin, H.A., W.I. Montgomery and M.G. Lundy. 2012. The Impact and Implications of climate change for bats. Mammal Review 43(3) 171-182.

Slater, G.L., R.L. Boulton, C.N. Jenkins, J.L. Lockwood, and S.L. Pimm. 2009. Emergency management action plan for the endangered Cape Sable seaside sparrow. Report to the U. S. Fish and Wildlife Service. Ecostudies Institute; Mount Vernon, Washington.

Small, J. K. 1933. Manual of the southeastern flora. The University of North Carolina Press, Chapel Hill, North Carolina. 1499 p.

Smith, C.R. 1987. Ecology of juvenile and gravid eastern indigo snakes in north Florida. M.S. thesis, Auburn University; Auburn, Alabama.

Smith, D.S., L.D. Miller, and J.Y. Miller. 1994. The butterflies of the West Indies and South Florida. Oxford University Press, New York.

Smith, R. 2003. Personal communication. Biologist. Presentation to the U.S. Fish and Wildlife Service on February 24, 2003. Dynamac Corporation; Kennedy Space Center, Florida.

Snow, S. 2011a. Personal communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. December 13, 2011.

Snow, S. 2011b. Personal communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. December 30, 2011.

Snow, S. 2012a. Personal communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. April 25, 2012.

Snow, S. 2012b. Personal communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. January 3, 2012.

Snow, S. 2012c. Personal communication. Email (with recorded calls) to Paula Halupa. Everglades National Park. Homestead, Florida. March 30, 2012.

Snow, S. 2012d. Personal communication. Email (with map) to Paula Halupa. Everglades National Park. Homestead, Florida. March 30, 2012.

Snow, S. 2012e. Personal communication. Email (with data) to Paula Halupa. Everglades National Park. Homestead, Florida. April 12, 2012.

Snyder, J.R. 2003. Clipping as a substitute for fire to study seasonal fire effects on muhly grass (*Muhlenbergia capillaris* var. *filipes*). U.S. Geological Survey, Center for Water and Restoration Studies; Ochopee, Florida.

Snyder, J.R. and C. Schaeffer. 2004. Response of muhly grass to different seasons of prescribed fire in southern Florida. U.S. Geological Survey Florida Integrated Science Center, Water and Restoration Studies; Ochopee, Florida.

Snyder, N. F. R., S.R. Beissinger, and R. Chandler. 1989. Reproduction and demography of the Florida Everglade (Snail) Kite. Condor 91:300-316.

South Florida Water Management District. 2008. Letter to Steve Mortellaro of the U.S. Fish and Wildlife Service. EAA A1 Reservoir annual indigo snake sighting summary. West Palm Beach, Florida. June 19, 2008.

South Florida Water Management District. 2010. Final conceptual habitat improvement plan for the Cape Sable seaside sparrow – subpopulation D and environs. Prepared by Miami-Dade County Department of Environmental Resources Management (DERM), U.S. Fish and Wildlife Service, and the South Florida Water Management District. October 15, 2010.

Speake, D.W., D. McGlincy, and C. Smith. 1987. Captive breeding and experimental reintroduction of the eastern indigo snake. Pages 84-90 *in* R.R. Odom, K.A. Riddleberger, and J.C. Ozier eds. Proceedings of the 3rd Southeastern Nongame and Endangered wildlife symposium, Georgia Department of Natural Resources, Game and Fish Division.

Steiner, T.M., O.L. Bass, Jr., and J.A. Kushlan. 1983. Status of the eastern indigo snake in Southern Florida National Parks and vicinity. South Florida Research Center Report SFRC-83-01, Everglades National Park; Homestead, Florida.

Stevenson, H.M. and B.H. Anderson. 1994. The birdlife of Florida. University Press of Florida; Gainesville, Florida.

Steward, K.K. and W.H. Ornes. 1975. The autecology of sawgrass in the Florida Everglades. Ecology 56:162-171.

Stimson, L.A. 1956. The Cape Sable seaside sparrow: its former and present distribution.

Sustainable Ecosystems Institute (SEI). 2007a. Everglades multi-species avian ecology and restoration review - final report. Portland, Oregon.

Sustainable Ecosystems Institute (SEI). 2007b. Everglades multi-species avian ecology and restoration review - summary of findings and recommendations. Portland, Oregon.

Sykes, P. W., Jr. 1979. Status of the Everglade Kite in Florida.1968-1978. Wilson Bulletin 91:495-511.

Sykes, Jr., P.W. 1983. Snail kite use of the freshwater marshes of South Florida. Florida Field Naturalist 11:73-88.

Sykes, Jr., P.W. 1985. Evening roosts of the snail kite in Florida. Wilson Bulletin 97:57-70.

Sykes, Jr., P.W. 1987a. The feeding habits of the snail kite in Florida, USA. Colonial Waterbirds 10:84-92.

Sykes, Jr., P.W. 1987b. Snail Kite nesting ecology in Florida. Florida Field Naturalist. 15:57-84.

Sykes, Jr., P.W. 1987c. Some aspects of the breeding biology of the snail kite in Florida. Journal of Field Ornithology. 58:171-189.

Sykes, Jr., P.W. and R. Chandler. 1974. Use of artificial nest structures by Everglade kites. Wilson Bulletin 86:282-284.

Sykes, P.W., Jr., J.A. Rodgers, Jr., and R.E. Bennetts. 1995. Snail kite (*Rostrhamus sociabilis*) *in* A. Poole and F. Gill, eds. The birds of North America. Number 171, The Academy of Natural Sciences, Philadelphia, and the American Ornithologists Union, Washington, D.C.

Takekawa, J.E. and S.R. Beissinger. 1989. Cyclic drought, dispersal, and the conservation of the snail kite in Florida: Lessons in critical habitat. Conservation Biology 3(3):302-311.

Taylor, D.L. 1983. Fire management and the Cape Sable seaside sparrow. Pages 147-152 *in* T.L. Quay, J.B. Funderburg, Jr., D.S. Lee, F. Potter, and C.S. Robbins, Eds. The seaside sparrow, its biology and management; Occasional Paper of the North Carolina Biological Survey. Raleigh, North Carolina.

Timm, R.M. and H.H. Genoways. 2004. The Florida bonneted bat, *Eumops floridanus* (Chiroptera: Molossidae): distribution, morphometrics, systematics, and ecology. Journal of Mammalogy 85(5):852-865.

Timm, R.M. and J. Arroyo-Cabrales. 2008. *Eumops floridanus*. In: IUCN 2010. IUCN Red list of Threatened Species. Version 2010.1. www.iucnredlist.org Downloaded on 23 March 2010.

Trokey, S. 2008a. Personal Communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. October 18, 2008.

Trokey, S. 2008b. Personal Communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. February 5, 2008.

Trokey, S. 2010a. Personal Communication. Telephone conversation with Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. March 15, 2010.

Trokey, S. 2010b. Personal Communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. March 16, 2010.

Trost, C.H. 1968. *Ammospiza nigrescens* (Ridgway) Dusky seaside sparrow *in* O.L. Austin, Jr., Ed. Life histories of North American cardinals, grosbeaks, buntings, towhees, finches, sparrows, and allies. Order Passeriformes: Family Fringillidae, Part two: Genera Pipilio through Spizella. U.S. National Museum Bulletin 237: 849-589. Smithsonian Institution; Washington, D.C.

U.S. Department of Agriculture, Soil Conservation Service (USDA-SCS). 1989. Soil survey of Dade County Area, Florida. 117 pages.

U.S. Fish and Wildlife Service. 1994 Final Environmental Assessment Genetic Restoration of the Florida Panther. U.S. Fish and Wildlife Service, Gainsville, Florida.

U.S. Fish and Wildlife Service. 1999a. Eastern indigo snake (*Drymarchon corais couperi*) species profile in Multi-species recovery plan for South Florida. U.S. Fish and Wildlife Service, Atlanta, Georgia. 16 pages.

U.S. Fish and Wildlife Service. 1999b. South Florida multi-species recovery plan. Fish and Wildlife Service; Atlanta, Georgia.

U.S. Fish and Wildlife Service. 2007a. Garber's spurge (*Chamaesyce garberi*) 5-year review: summary and evaluation. U.S. Fish and Wildlife Service, Southeast Region, South Florida Ecological Services Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service. 2008. Eastern indigo snake (*Drymarchon couperi*) 5-year review: summary and evaluation. U.S. Fish and Wildlife Service, Southeast Region, Mississippi Ecological Services Field Office; Jackson, Mississippi.

U.S. Fish and Wildlife Service. 2012a. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Sideroxylon reclinatum spp. austrofloridense*, Everglades Bully candidate assessment. South Florida Ecological Services Field Office. Vero Beach, Florida.

U.S. Fish and Wildlife Service. 2012b. Bartram's hairstreak butterfly (*Strymon acis bartrami*) candidate species assessment dated current as of 6/15/2010. U.S. Fish and Wildlife Service, South Florida Ecological Field Services Office, Vero Beach, Florida. 33 pages.

U.S. Fish and Wildlife Service. 2013a. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Chamaesyce deltoidea pinetorum*, Pineland sandmat candidate assessment. South Florida Ecological Services Field Office. Vero Beach, Florida.

U.S. Fish and Wildlife Service. 2013b. Standard protection measures for the eastern indigo snake. South Florida Ecological Services Office; Vero Beach, Florida.

U.S. Fish and Wildlife Service. 2013c. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form. *Argythamnia blodgettii*, Blodgett's silverbush candidate assessment. South Florida Ecological Services Field Office. Vero Beach, Florida.

U.S.Geological Survey (USGS). 2015. Giant Constrictor Snakes in Florida: A Sizable Research Challenge. Fort Collins Science Center. http://www.fort.usgs.gov/FL Constrictors/. March 18, 2015.

Van Lent, T. and R. Johnson. 1993. Towards the restoration of Taylor Slough. Report to South Florida Natural Resources Center, Biological Resources Branch, Everglades National Park; Homestead, Florida.

Virzi, T., J.L. Lockwood, R.L. Boulton, and M.J. Davis. 2009. Recovering small Cape Sable seaside sparrow subpopulations: breeding and dispersal of sparrows in the Everglades. October 2009 report to the U.S. Fish and Wildlife Service, South Florida Ecological Services, and U.S. National Park Service, Everglades National Park. Rutgers, The State University of New Jersey, School of Environmental and Biological Sciences; New Brunswick, New Jersey.

Virzi, T. and M. Davis. 2013. Recovering small Cape Sable Seaside Sparrow (*Ammodramus maritimus mirabilis*) subpopulations: breeding and dispersal of sparrows in the Everglades. Final report to Everglades National Park. Rutgers University, New Brunswick, NJ.

Virzi, T. and M. Davis. 2014. 2014 Research Summary: Cape Sable seaside sparrow Breeding and Habitat Changes in Subpopulation D. Presentation to the South Florida Water Management District , October 22, 2014. West Palm Beach, Florida.

Virzi, T., M. T. Davis, and A. Anholt. 2013. Biweekly Cape Sable seaside sparrow field summaries, 2013 field season.

Volin, J. C., M. S. Lott, J. D. Muss, and D. Owen. 2004. "Predicting Rapid Invasion of the Florida Everglades by Old World Climbing Fern (*Lygodium microphyllum*)." Diversity and Distributions 10(5-6):439-446.

Walters, J.R., S.R. Beissinger, J.W. Fitzpatrick, R. Greenberg, J.D. Nichols, H.R. Pulliam, and D.W. Winkler. 2000. The American Ornithologists Union conservation committee review of the biology, status, and management of Cape Sable seaside sparrows: Final report. Auk 117(4):1093-1115.

Webster, R.L. 1967. Genera of *Euphorbiaceae*. Journal of the Arnold Arboretum. 48.

Wendelberger, K.S. 2003. Conservation Action Plan – *Chamaesyce deltoidea* spp. *pinetorum*. Conservation of South Florida Endangered and threatened Flora (ETFLORA) Project. Research Department, Fairchild Tropical Garden, Miami, Florida.

Wendelberger, K.S., and J. Maschinski. 2006. Portion of work on National Park Service Task Order No. 03-02 Under Cooperative Agreement H262303W060 Progress Report November 2006. Center for Plant Conservation and Fairchild Tropical Garden, Miami, Florida.

Werner, H.W. 1975. The biology of the Cape Sable seaside sparrow. Report to the U.S. Fish and Wildlife Service, Frank M. Chapman Memorial Fund, the International Council for Bird Preservation, and the U.S. National Park Service. Everglades National Park; Homestead, Florida.

Werner, H.W. 1978. Cape Sable seaside sparrow. Pages 19-20 *in* H.W. Kale, II, ed., Rare and endangered biota of Florida, Vol. 2, Birds. Univ. Presses of Florida.

Werner, H.W., and G.E. Woolfenden. 1983. The Cape Sable seaside sparrow: its habitat, habits, and history. Pages 55-75 *in* T.L. Quay, J.B. Funderburg, Jr., D.S. Lee, F. Potter, and C.S. Robbins, Eds. The seaside sparrow, its biology and management. Occasional Paper of the North Carolina Biological Survey. North Carolina Biological Survey; Raleigh, North Carolina.

Wetzel, P.R. 2001. Plant community parameter estimates and documentation for the across trophic level system simulation (ATLSS). Data report prepared for the ATLSS project team. The Institute for Environmental Modeling, University of Tennessee; Knoxville, Tennessee.

Wight, B.R., P.C. Darby, and M.P. Therrien. 2013. Monitoring apple snail demographics to support information needs for recovery of Everglades fauna. Final Report to the US Fish and Wildlife Service. Department of Biology, University of West Florida, Pensacola, Florida. July 3, 2013.

Wipff. J. K. 2004. Digitaria, in Flora of North America, grass manual online. http://herbarium.usu.edu/grassmanual/. Accessed June 6, 2004.

Woolfenden, G.E. 1956. Comparative breeding behavior of *Ammospiza caudacuta* and *A. maritima*. University of Kansas Publications, Museum of Natural History 10(2): 45-75.

Worth, R.A., K.A. Schwarz, and T.C. Emmel. 1996. Notes on the biology of *Strymon acis bartrami* and *Anaea troglodyta floridalis* in South Florida. Holarctic Lepidoptera 3(2): 62-65.

Wunderlin, R.P. 1998. Guide to the vascular plants of Florida. *Lupinus*, pages 363, 364. University Presses of Florida; Gainesville, Florida. 806 pages.

Wunderlin, R.P., and B.F. Hansen. 2008. Atlas of Florida Vascular Plants (http://www.plantatlas.usf.edu/). [S.M. Landry and K.N. Campbell (application development), Florida Center for Community Design and Research.] Institute for Systematic Botany, University of South Florida, Tampa, Florida. [Accessed March 16. 2010].

Wunderlin, R.P., and B.F. Hansen. 2013. Atlas of Florida Vascular Plants, Florida Pineland Crabgrass. Institute for Systematic Botany. http://www.florida.plantatlas.usf.edu/Plant.aspx?id=1108

Zeigler, M. 2006. Personal communication. Citrus grove operations manager. Meeting with the U.S. Fish and Wildlife Service on August 1, 2006. Agricultural Resource Management; Vero Beach, Florida.

Zweig, C. L. 2008. Vegetation ecology of an impounded wetland: information for landscape-level restoration. PhD dissertation. University of Florida; Gainesville, Florida.

Zweig, C.L. and W.M. Kitchens. 2008. Effects of landscape gradients on wetland vegetation communities: information for large-scale restoration. Wetlands 28(4): 1086-1096.

Table 1: The multi-year fuels treatment plan proposed annual burn acreage over a 5 year period within the fire adapted vegetation across the four Fire Management Units (FMUs).

Coastal Prairies	Year 1	Year 2	Year 3	Year 4	Year 5
FMU 1	42737	42737	42737	42737	42737
	73989	13433	73989	13433	73989
		12608		12608	
		47948		47948	
FMU 1 Total acres	116726	116726	116726	116726	116726
River of Grass	Year 1	Year 2	Year 3	Year 4	Year 5
FMU 2	19909	30418	30418	30418	30418
	608	35026	21039	49043	35026
	9898	14017	28004		14017
	49043				
FMU 2 Total acres	79458	79461	79461	79461	79461
EE	Year 1	Year 2	Year 3	Year 4	Year 5
FMU 4	11660	2721	20933	11660	2721
	9673	35531	17319	9673	35531
	10004		2169	10004	
FMU 4 Total acres	31337	38252	40421	31337	38252
Pinelands grass	Year 1	Year 2	Year 3	Year 4	Year 5
FMU 3	1710	17319	7328	1710	0
	3147			3147	
FMU 3 pineland grass Total acres	4857	17319	7328	4857	0
HID	Year 1	Year 2	Year 3	Year 4	Year 5
FMU 3	894	0	1710	894	1001
			2086		
FMU 3 HID Total acres	894	0	3796	894	1001
Pine rocklands	Year 1	Year 2	Year 3	Year 4	Year 5
FMU 3	967	1250	549	967	1250
	791	1073	1391	791	1073
	1562	299	325	1562	299
	424	910	4283	424	910
	916	224	1052	916	224
	867	20	47	867	20
	162	11	33	162	11
	193	40	11	193	40
	113	12	7	113	12
	82	103	61	82	103
		8			8
		29			29
		63			63
					205
FMU 3 Pine Rocklands Total acres	6077	4042	7759	6077	4247
Total Acres All FMUs	Year 1	Year 2	Year 3	Year 4	Year 5
	239349	**255800**	**255491**	**239352**	**239687**

146

Table 2: Fire Management Objectives for each Fire Management Unit.

Fire Management Objectives	FMU 1: Coastal Prairies	FMU 2: River of Grass	FMU 3: Pinelands	FMU 4: East Everglades
Planned ignition treatments would be used to help manage the spread of Old World Climbing fern (Lygodium microphyllum) and inhibit the encroachment of Brazilian pepper (Schinus terebinthifolius)	X			
Planned ignition treatments would be used in conjunction with chemical and mechanical treatments to manage exotic vegetation populations identified by the Exotic Vegetation Management Program.	X	X	X	X
Fires would be managed using the full range of management strategies to protect, restore, or maintain resources in the park.	X	X	X	X
Planned ignition treatments would be used to reduce hazardous fuels to protect park values.	X	X	X	X
Planned ignition treatments would be used to create mosaic patterns to break up the fuel continuity and maintain habitat diversity, and provide species refugia.	X	X	X	X
Planned ignition treatments would be used to reduce fuel loading adjacent to hardwood hammock, tree islands, and cultural resource sites to provide protection from unwanted fire spread.		X	X	X
Unplanned ignitions would be managed in order to achieve resource benefits limiting suppression actions whenever possible.	X	X	X	X
Unplanned ignitions would be evaluated using a decision support process that examines the full range of management responses under the following conditions; strategies and tactics would consider firefighter and public safety first, fire cause, current and predicted weather, current and potential fire behavior and effects, values to be protected, sensitive tree island and hammocks, archeological and/or cultural resources, proximity to wildland urban interface areas and park infrastructure, untreated stands of melaleuca (Melaleuca quinquenervia), and Australian pine (Casuarina equisetifolia), resource availability, and cost effectiveness.	X	X	X	X
It would be ensured that all fire management activities comply with the annual Cape Sable Seaside Sparrow fire management strategy.		X	X	X
Planned ignition treatments would be used to restore natural fire processes in areas in the Hole-in-the-Donut identified by resource management			X	
Use science based fire management to maintain and enhance the wilderness character of the Marjory Stoneman Douglas Wilderness	X	X	X	X

147

Table 3: Fire Management Considerations for each Fire Management Unit.

Management Consideration or Constraint	FMU 1: Coastal Prairies	FMU 2: River of Grass	FMU 3: Pinelands	FMU 4: East Everglades
The FMU is in a Class I airshed but smoke impacts to the overall airshed are negligible.	X	X	X	X
Fire operations in designated wilderness would be managed in accordance with the minimum tool analysis presented in appendix E of the fire management plan.	X	X	X	X
The spread of exotic species would be limited through conducting fire operations in support of the exotic plant management program.	X	X	X	X
In the event that research identifies the need, prescribed fire could be used to achieve future resource management objectives.	X	X	X	X
Recommendations from resource specialists would be considered during planning and implementation of fire management activities.	X	X	X	X
Threatened and endangered species, rare habitats, species of special concern, park infrastructure, and archeological and cultural resources would require protection.	X	X	X	X
In addition to the prescribed fire notification process for the park and cooperators, advanced notification of planned fire operations would be provided at visitor access, points, permitting stations, visitor centers, and/or entrance stations (based on fire locations).	X	X	X	X
Prior to planned ignitions, reconnaissance would verify that area is clear of visitors.	X	X	X	X
A burn authorization would be obtained from the Florida Division of Forestry for each prescribed fire.	X	X	X	X
Any fires that span the Big Cypress National Preserve boundary would receive the appropriate level of management approval from both Big Cypress National Preserve and Everglades National Park.	X	X		
Park and private infrastructure and transportation corridors represent an additional management consideration	X	X	X	X
When safe, fire management strategies would require actions to exclude fire from untreated stands of Melaleuca and Australian pine.		X		X
A significant safety concern involves hazardous materials illegally disposed in this FMU.				X

Table 4: Fire Adapted Vegetation Fire Return Intervals (FRI) and Prescribed Fire Treatment Interval.

Vegetation Type	FMU	Fire Return Interval (FRI) range	WUI / Non-WUI / Exotic management	Prescribed Fire Planning Treatment FRI
Pine Rockland	FMU 3	3-7 years	WUI	3 year
			Non-WUI	3 year
Saw Grass Prairie	FMU 2	3-12 years	WUI	3 year
			Non-WUI	8 year
Saw Grass Prairie	FMU 3	3-12 years	WUI	3 year
			Non-WUI	8 year
Saw Grass Prairie	FMU 4	3-12 years	WUI	3 year
			Non-WUI	8 year
Muhly Prairie	FMU 2	3-12 years	WUI	3 year
			Non-WUI	8 year
Muhly Prairie	FMU 3	3-12 years	WUI	3 year
			Non-WUI	3 year
Muhly Prairie	FMU 4	3-12 years	WUI	3 year
			Non-WUI	8 year
Coastal Prairie	FMU 1	2-10 years	Non-WUI	6 year
			Exotic	2 year

Table 5: Vegetation Fuel Types.

Fuel Type	Description	Vegetation	FMU
GR5	The primary carrier of fuel model GR5 is humid-climate grass, which is characterized by short and long hydroperiod prairies in the Coastal Prairies, River of Grass, and East Everglades FMU's. These fuel models average 1-2 foot tall grasses, with an average depth of 1-2 feet.	Marl Prairie, Coastal Prairie	1,2,3,4
GR6	The primary carrier of fuel model GR6 is continuous humid-climate grass, which is characterized by black needlerush (*Juncus roemerianus*), and short hydroperiod prairies, found in the Coastal Prairies and River of Grass FMU's. These fuel models average 1-2 foot tall grasses, with an average depth of 1-2 feet.	Marl Prairie, Coastal Prairie	1,2,3,4
GR8	The primary carrier of fuel model GR8 is continuous, very coarse, humid-climate grass, which consists of long hydroperiod prairies found mostly in the River of Grass and East Everglades FMU's. These grass models consist of a heavier, more continuous grass ranging from 3-8 feet tall. Spread rates and flame lengths are usually extreme.	Sawgrass, Coastal Prairie	1,2,3,4
GR 9	The primary carrier of fuel model GR9 is dense, tall, humid-climate grass, consisting of cordgrass prairies and long hydroperiod prairies found throughout the park. These grass models consist of a heavier, more continuous grass ranging from 3-8 feet tall. Spread rates and flame lengths are usually extreme.	Sawgrass, Coastal Prairie	1,2,3,4
TU3	The primary carrier of fire in fuel model TU3 is moderate forest litter with grass and shrub components. This fuel type is commonly found in the Pine Rocklands that are within the lower range of the fire return interval, usually less than 3 years or areas that consist of a less dense understory, characterized with light to moderate fuel loads. Spread rates are high, with low to medium flame lengths.	Pine Rocklands	3
SH6	The primary carrier of fire in fuel model SH6 is woody shrubs and shrub litter. This fuel type consists of dense shrubs and fire behavior is much more intense with spread rates high combined with high flame lengths. The shrubs may act as ladder fuels resulting in passive torching into the overstory of South Florida slash pine (*Pinus elliottii var. densa)*.	Pine Rocklands	3
TL2	The primary carrier of fire in fuel model TL2 is hardwood litter and is represented by hardwood hammocks and tree islands. These areas are not targeted for fuel treatments; however unplanned ignitions may occur and ignite these areas. Hardwood hammocks and tree islands experience infrequent fire. Hammock and tree island fires are creeping, smoldering, low intensity, high severity ground fires.	Hammocks/ Tree Islands	2,3,4

150

Table 6: Extirpated Occurrences of Blodgett's silverbush.

Site	Owner	County	Last Observed	Cause
Brickell Hammock	Unknown	Miami-Dade	1937	Developed
Caribbean Park	Miami-Dade County	Miami-Dade	1998	Developed
Coconut Grove	Unknown	Miami-Dade	1901	Developed
Coral Gables Area	Unknown	Miami-Dade	1967	Developed
Fuchs Hammock	Miami-Dade County	Miami-Dade	1991	Developed, fire suppression
Key West	Unknown	Monroe	1965	Developed
Key West Cemetery	Public	Monroe	1965	Unknown
Miller and 72 Ave	Unknown	Miami-Dade	1975	Developed
North Key Largo	Various	Monroe	1977	Unknown
Orchid Jungle	Miami-Dade County	Miami-Dade	1930	Unknown (development, fire suppression, exotic pest plants likely)
Palms Woodlawn Cemetery	Private	Miami-Dade	1992	Developed
S. of Miami River	Unknown	Miami-Dade	1913	Developed
Stock Island	Private	Monroe	1981	Developed
Totten Key (Biscayne National Park)	National Park Service	Miami-Dade	1904	Unknown
Vaca Key	Unknown	Monroe	1909	Developed
NFC #317	Private	Miami-Dade	unknown	Developed

Table 7: Extant occurrences of Blodgett's silverbush.

Site	Owner	County	Population Size	Threats
Big Munson Island	The Boy Scouts of America	Monroe	1,001-10,000	exotic plants, possible development in future (non-imminent)
Big Pine Key, Cactus Hammock and Long Beach coastal berm	National Key Deer Refuge	Monroe	1,000 – 10,000 (approximately 2,000)	fire suppression, storm surge, exotic plants, trail maintenance
Big Pine Key, Koehn's subdivision	National Key Deer Refuge (in part)	Monroe	101 – 1,000 (approximately 200)	fire suppression, exotic plants, road maintenance, illegal dumping, paving, infrastructure projects, herbicide spraying
Big Pine Key, Watson's Hammock	National Key Deer Refuge	Monroe	2	fire suppression, hot fires, other natural disturbance events, exotic plants
Blue Heron Hammocks, Vaca Key	Florida Fish and Wildlife Conservation Commission	Monroe	11-100	road maintenance, exotic plants, infrastructure, herbicide spraying
Boot Key	private	Monroe	11-100	development
Camp Owaissa Bauer	Miami-Dade County	Miami-Dade	101-1,000	fire suppression, exotic plants
Castellow Hammock	Miami-Dade County	Miami-Dade	11-100	fire suppression, exotic plants
Charles Deering Estate**	Miami-Dade County	Miami-Dade	11-100	fire suppression, exotic plants, fence line maintenance
Country Ridge Estates	private	Miami-Dade	11-100	exotic plants
Epmore Drive Pineland Fragment**	private	Miami-Dade	2-10	development, exotic plants
ENP, Deer Hammock Area (pine block A) and adjacent pine block B	National Park Service	Miami-Dade	1,000	Brazilian pepper
Fuchs Hammock Addition	Miami-Dade County	Miami-Dade	2-10	
Gifford Arboretum Pineland	private	Miami-Dade	2-10	development, exotic plants
Key Largo, Dove Creek Hammocks	Florida Fish and Wildlife Conservation Commission	Monroe	11 - 100	road construction, mowing, exotic plants
Key West Naval Air Station, Boca Chica Key	Department of Defense	Monroe	1,001 – 10,000 (approximately 1,200)	lead tree (*Leucaena leucocephala*), maintenance activities, development, dumping of toxic substances, opening of new roads
Larry and Penny Thompson Park and adjacent properties	Miami-Dade County	Miami-Dade	1,001-10,000	development, fire suppression, exotic plants
Lignumvitae Key Botanical State Park, Lignum Vitae Key	Department of Environmental Protection	Monroe	11-100	maintenance activities, exotic plants
Lignumvitae Key Botanical State Park, Klopp Tract, Matecumbe Key	Department of Environmental Protection	Monroe	11-100	general disturbance, weedy and exotic plants
Ned Glenn Nature Preserve	Miami-Dade County	Miami-Dade	11-100	fire suppression, exotic plants
Old Dixie Pineland (= Keg South Pineland)**	private	Miami-Dade	11-100	development, fire suppression, exotic plants
Owaissa Bauer Addition	Miami-Dade County	Miami-Dade	100-1,000	fire suppression, exotic plants
Pine Ridge Sanctuary	private preserve	Miami-Dade	2-10	exotic plants
Snake Creek Hammock, Plantation Key	Florida Fish and Wildlife Conservation Commission	Monroe	101-1,000	exotic plants, maintenance activities
S.W. 184 St. and 83 Ave.**	private	Miami-Dade	11-100	development, fire suppression, exotic plants
Windley Key Fossil Reef State Geological Site	Florida	Monroe	11-100	maintenance activities, exotic plants

152

Table 8: Extant Occurrences of Pineland sandmat.

Extant Occurrences

Site	Owner	County	Population Size	Threats	Habitat
Everglades National Park	National Park Service	Miami-Dade	10,000-100,000	Hydrologic changes, exotic pest plants, fire suppression	Pine rockland
Florida City Pineland	Miami-Dade County	Miami-Dade	100-1,000	Exotic pest plants, fire suppression	Pine rockland
Navy Wells	Miami-Dade County	Miami-Dade	1,000-10,000	Exotic pest plants, fire suppression	Pine rockland
Navy Wells #2	Private	Miami-Dade	1,000-10,000	Exotic pest plants, development, fire suppression	Pine rockland
Palm Drive Pineland	Miami-Dade County	Miami-Dade	10-100	Exotic pest plants, fire suppression	Pine rockland
Pine Ridge Sanctuary	Private Preserve	Miami-Dade	10-100	Exotic pest plants, fire suppression	Pine rockland
Rock Pit #39	Miami-Dade County	Miami-Dade	100-1,000	Exotic pest plants, fire suppression	Pine rockland
Seminole Wayside Park	Miami-Dade County	Miami-Dade	100-1,000	Exotic pest plants, fire suppression	Pine rockland

Status Undetermined (not seen by authors)

Site	Owner	County	Last Observation	Habitat
Kings Hwy. 0.5 miles west of 162 Ave.	Private	Miami-Dade	1979	Pine rockland
SW 296 St. & 207 Ave.	Private	Miami-Dade	1985	Pine rockland
SW 300 St. & 197 Ave.	Private	Miami-Dade	1980	Pine rockland
SW 302 St. & 197 Ave.	Private	Miami-Dade	1982	Pine rockland
SW 334 St. & 194 Ave.	Private	Miami-Dade	1985	Pine rockland
SW 340 St. & 183 Ave.	Private	Miami-Dade	1980	Pine rockland
SW 340 St. & 216 Ave.	Private	Miami-Dade	1980	Pine rockland

Indefinite Occurrences

Site	County	Last Observation	Habitat
Between Cutler and Longview Camp	Miami-Dade	1903	Pine rockland
Between Cutler and Longview Camp	Miami-Dade	1904	Pine rockland
Between Homestead and Camp Jackson	Miami-Dade	1904	Pine rockland
Between Long Prairie and Camp Longview	Miami-Dade	1906	Pine rockland
Camp Jackson to Camp Longview	Miami-Dade	1911	Pine rockland
Homestead to Big Hammock Prairie	Miami-Dade	1911	Pine rockland
Pinelands about Nixon-Lewis Hammock	Miami-Dade	1915	Pine rockland
Pinelands about Ross Hamock	Miami-Dade	1915	Pine rockland
Pinelands about Sykes Hammock	Miami-Dade	1915	Pine rockland
Pinelands near Camp Longview	Miami-Dade	1904	Pine rockland
Pinelands near Long Prairie	Miami-Dade	1904	Pine rockland
Pinelands near Nelson Hammock	Miami-Dade	1915	Pine rockland

Possibly Erroneous

Site	County	Last Observation
Sw 248 St. & 187 Ave.	Miami-Dade	1983

Table 9: Extant Occurrences and Population Estimates of Florida pineland crabgrass.

Extant Occurrences

Site	Owner	County	Population Size	Threats	Habitat
Everglades National Park	National Park Service	Miami-Dade	1,000-10,000	Fire suppression, exotic pest plants, hydrologic changes	Uncommon in marl prairies and pine rockland

Extirpated Occurrences

Site	Owner	County	Last Observation	Cause	Habitat
Luis Martinex Army Reserve Station	U.S. Army Reserve	Miami-Dade	1997	Decreased hydroperiod	Marl prairie

Indefinite Occurrences

Site	County	Last Observation	Habitat
Between Cutler and Longview Camp	Miami-Dade	1903	Pine rockland
Jenkins Homestead	Miami-Dade	Unknown	Unknown
South Miami	Miami-Dade	1939	Pine rockland

153

Table 10: Everglades bully Estimated Population Size.

Site	Owner	County	Estimated abundance	Threats (site specific only)
Long Pine Key, ENP	NPS	Miami-Dade	10K – 100K	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Big Cypress National Preserve	NPS	Monroe	Unknown	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Larry and Penny Thompson Park	Miami-Dade County	Miami-Dade	Approx 73	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Navy Wells Pineland Preserve	Miami-Dade County	Miami-Dade	4	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Sunny Palms Pineland	Miami-Dade County	Miami-Dade	2	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Pine Ridge Sanctuary	private	Miami-Dade	Unknown	Sea level rise, development, fire suppression, exotic plants
Lucille Hammock	Miami-Dade County	Miami-Dade	11 - 100	Sea level rise, exotic plants, fire suppression
South Dade Wetlands	Partially acquired by Miami-Dade County	Miami-Dade	Unknown	Sea level rise, exotic plants, fire suppression
NFC #P-300	private	Miami-Dade	2 - 10	Sea level rise, development, fire suppression, exotic plants
NFC #P-310	private	Miami-Dade	11 - 100	Sea level rise, development, fire suppression, exotic plants
Quail Roost Pineland	Miami-Dade EEL Preserve	Miami-Dade	2	Sea level rise, fire suppression, exotic plants

Table 11: Everglades bully Extant Occurrences.

Site	Owner	County	Estimated abundance	Threats (site specific only)
Long Pine Key, ENP	NPS	Miami-Dade	10K – 100K	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Big Cypress National Preserve	NPS	Monroe	Unknown	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Larry and Penny Thompson Park	Miami-Dade County	Miami-Dade	Approx 73	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Navy Wells Pineland Preserve	Miami-Dade County	Miami-Dade	4	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Sunny Palms Pineland	Miami-Dade County	Miami-Dade	2	Sea level rise, exotic plants, fire suppression, hydrologic alterations
Pine Ridge Sanctuary	private	Miami-Dade	Unknown	Sea level rise, development, fire suppression, exotic plants
Lucille Hammock	Miami-Dade County	Miami-Dade	11 - 100	Sea level rise, exotic plants, fire suppression
South Dade Wetlands	Partially acquired by Miami-Dade County	Miami-Dade	Unknown	Sea level rise, exotic plants, fire suppression
NFC #P-300	private	Miami-Dade	2 - 10	Sea level rise, development, fire suppression, exotic plants
NFC #P-310	private	Miami-Dade	11 - 100	Sea level rise, development, fire suppression, exotic plants
Quail Roost Pineland	Miami-Dade EEL Preserve	Miami-Dade	2	Sea level rise, fire suppression, exotic plants

Table 12. Cape Sable seaside sparrow Counts (BC) and Population Estimates (EST) by Year as Recorded in the ENP Range-wide Survey.

Population	A		B		C		D		E		F		Total	
Year	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**	**BC**	**Est**
1981	168	2,688	147	2,352	27	432	25	400	42	672	7	112	416	6,656
1992	163	2,608	199	3,184	3	48	7	112	37	592	2	32	411	6,576
1993	27	432	154	2,464	0	0	6	96	20	320	0	0	207	3,312
1994	5	80	139	2,224	NS	NS	NS	NS	7	112	NS	NS	151	2,416
1995	15	240	133	2,128	0	0	0	0	22	352	0	0	170	2,720
1996	24	384	118	1,888	3	48	5	80	13	208	1	16	164	2,624
1997	17	272	177	2,832	3	48	3	48	52	832	1	16	253	4,048
1998	12	192	113	1,808	5	80	3	48	57	912	1	16	191	3,056
1999a	25	400	128	2,048	9	144	11	176	48	768	1	16	222	3,552
1999b	12	192	171	2,736	4	64	NS	NS	60	960	0	0	247	3,952
2000a	28	448	114	1,824	7	112	4	64	65	1,040	0	0	218	3,488
2000b	25	400	153	2,448	4	64	1	16	44	704	7	112	234	3,744
2001	8	128	133	2,128	6	96	2	32	53	848	2	32	204	3,264
2002	6	96	119	1,904	7	112	0	0	36	576	1	16	169	2,704
2003	8	128	148	2,368	6	96	0	0	37	592	2	32	201	3,216
2004	1	16	174	2,784	8	128	0	0	40	640	1	16	224	3,584
2005	5	80	142	2,272	5	80	3	48	36	576	2	32	193	3,088
2006	7	112	130	2,080	10	160	0	0	44	704	2	32	193	3,088
2007	4	64	157	2,512	3	48	0	0	35	560	0	0	199	3,184
2008	7	112	NS	NS	3	48	1	16	23	368	0	0	34	3,056*
2009	6	96	NS	NS	3	48	2	32	27	432	0	0	38	3,120*
2010	8	128	119	1904	2	32	4	64	57	912	1	16	191	3,056
2011	11	176	NS	NS	11	176	1	16	37	592	2	32	62	2,896*
2012	21	336	NS	NS	6	96	14	224	46	736	4	64	91	3,360*
2013	18	288	112	1,792	8	128	1	16	45	720	1	16	185	2,960
2014	4	64	114	1864	7	112	2	32	42	672	1	16	170	2720

NS = Not Surveyed
* Includes Subpopulation B most recently conducted survey data for years not surveyed.

Table 13. Number of Active and Successful Snail Kite Nests, Calculated Nest Success, Number of Young Fledged, and General Location (South [S], Central [C], and North-central [NC]) of Nesting Within WCA- 3A from 1994 to 2013. Active Nests are Those With at Least One Egg Laid; Successful Nests are Those Having at Least One Young Fledged.

Year	Active Nests	Successful Nests	Nest Success	Number of Young Successfully Fledged	General Location of Nesting within WCA-3A
1994	41	19	0.46*	24	No location data
1995	66	21	0.32*	38	No location data
1996	79	35	0.44	63	S
1997	247	140	0.57	303	C-S
1998	221	84	0.38	176	NC-C-S
1999	70	14	0.20	19	C-S
2000	112	33	0.29*	56	NC-C-S
2001	0	0	NA	0	--
2002	60	21	0.35	35	S
2003	82	27	0.32*	34	C-S
2004	49	19	0.39*	29	C-S
2005	12	0	0.00	0	S
2006	61	13	0.22	13	C-S
2007	3	0	0.00	0	S
2008	0	0	NA	0	--
2009	11	1	0.09	2	C-S
2010	15	0	0.00	0	C-S
2011	23	11	0.48	11	W
2012	7	1	0.15	1	W
2013**	68	18	0.26	27	W-S

*Survey data during 1994, 1995, 2000, 2003, and 2004 include many nests with undetermined fate, some of which may have been successful. Thus, calculated estimates of nest success for these years are minimums that would increase if any nests of undetermined fate were actually successful.

**Unverified data

Table 14. Everglade Snail Kite Critical HUs and Acreage.

Critical Habitat Unit Description	Acres
St. Johns Reservoir, Indian River County	2,075
Cloud Lake and Strazzula Reservoirs, St. Lucie County	816
Western Lake Okeechobee, Glades and Hendry Counties	85,829
Loxahatchee NWR, Palm Beach County	140,108
WCA-2A, Palm Beach and Broward Counties	106,253
WCA-2B, Broward County	28,573
WCA-3A. Broward and Miami-Dade Counties	319,078
ENP, Miami-Dade County	158,903
Total	841,635

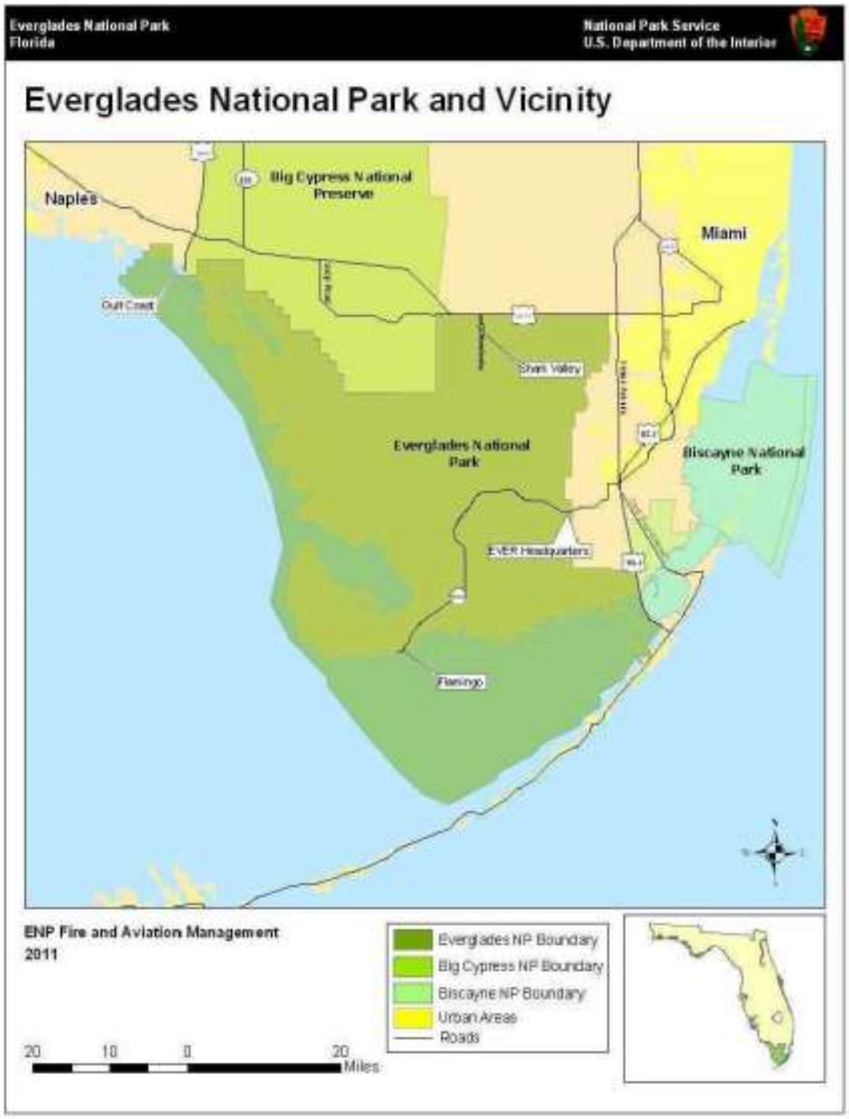

Figure 1: Everglades National Park Map.

158

Figure 2: Everglades National Park Fire Management Units.

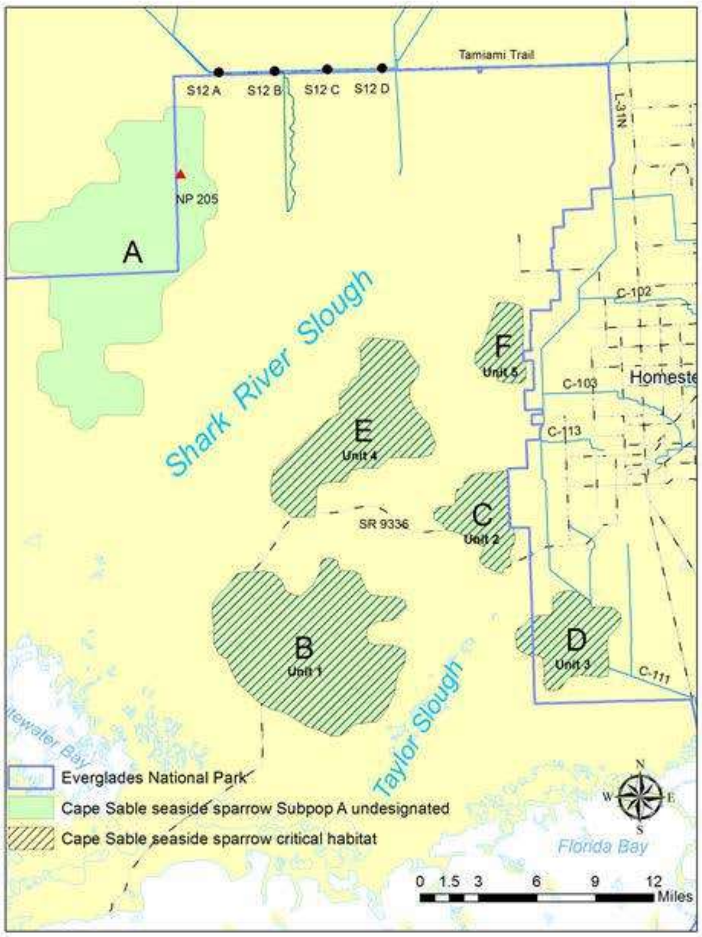

Figure 3: Cape Sable Seaside Sparrow Designated Critical Habitat Map.

160

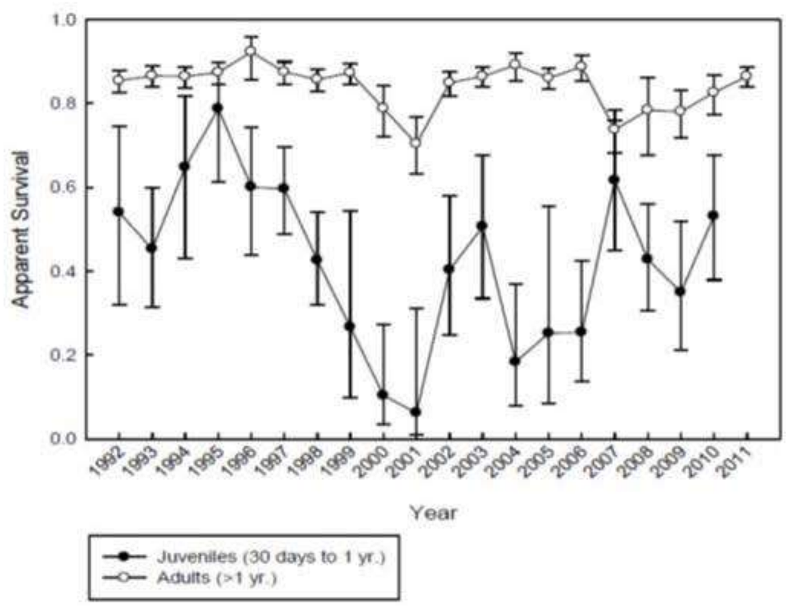

Figure 4. Model Averaged Estimates of Adult (white circles) and Juvenile (black circles) Snail Kite Survival from 1992 to 2011 (Cattau et al. 2012). Error Bars Correspond to 95 percent Confidence Intervals.

161

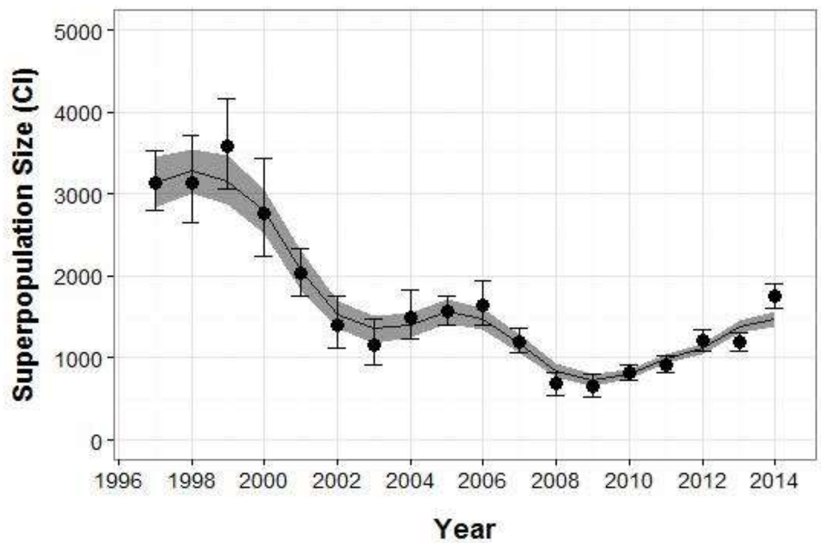

Figure 5. Estimated Snail Kite Population Size from 1997 to 2014 (Cattau et al. 2012; Fletcher et al. 2014; Fletcher pers. comm. 2015) Using the Super-population Approach.

162

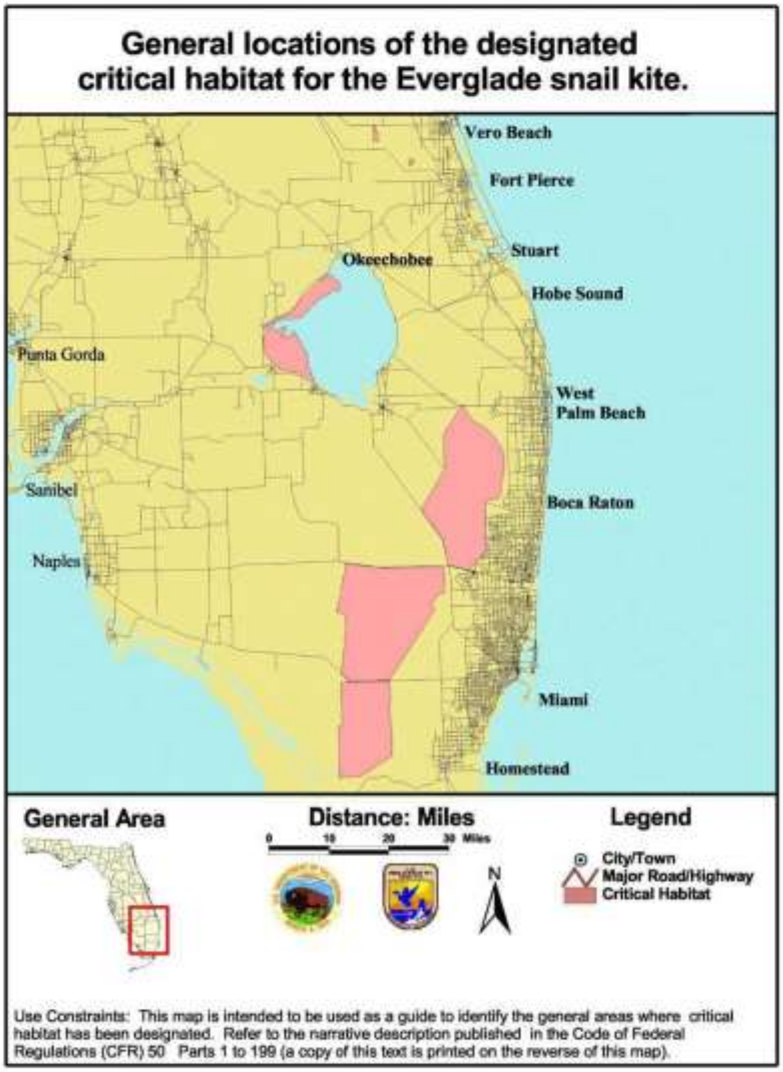

Figure 6. Everglade Snail Kite Designated Critical Habitat.

163

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Appendix K
Pre-Attack Plan

Everglades National Park
Fire & Aviation Management
Pre-Attack Plan

Introduction
The Pre-Attack Plan is used to familiarize incoming resources with the fire organization at Everglades National Park (NP). It provides information that will assist Fire Managers, Duty Officers, Incident Commanders (IC), and Incident Management Teams (IMT) to identify critical information required to make sound decisions, support Wildland Fire Decision Support System (WFDSS), and create Incident Action Plans (IAP) during incidents. The Pre-Attack Plan is primarily focused on identifying:

- Management structure of the program
- Key contacts within the Park
- Suppression protocols (initial attack, extended, and large fires)
- Physical location of key geographical values, hazards, and features
- Geospatial data and location
- Logistical information

I. COMMAND

SAFETY

INTERAGENCY AGREEMENT/ANNUAL OPERATING PLAN

WILDLAND FIRE DECISION SUPPORT SYSTEM (WFDSS)

JOB HAZARD ANALYSIS (JHA)

CLOSURE PROCEDURES

MEDICAL EVACUATION

STRUCTURAL PROTECTION NEEDS

PUBLIC INFORMATION

NATURAL AND CULTURAL RESOURCE ADVISORS

PLANNING

INTERAGENCY OPERATIONS

Incident Action Plans (IAP)

Special Values at Risk

Management Constraints & Mitigations

Archeological and Cultural

Endangered Species, Species of Special Concern, and Critical Habitat

Minimum Tool Analysis

Minimum Impact Suppression Tactics (MIST)

Visitor Use Areas

Land Ownership Status (include inholdings)

Maps

Figure 1. Land Status

Figure 2. Park Infrastructure

Figure 3. Vegetation

Figure 4. Fuels

Figure 5. Wilderness

Figure 6. Aerial Hazards

Figure 7. Mutual Response Zone

Figure 8. Fire Management Units

Figures 9-12. Sensitive Species/Values at Risk by Fire Management Unit

Figure 13. Fire History

Figure 14. Water Sources

Figure 15. Wildland Urban Interface –Tamiami Ranger Station

Figure 16. Wildland Urban Interface –Shark Valley

Figure 17. Wildland Urban Interface –Hwy 41 Inholdings

Figure 18. Wildland Urban Interface -Chekika/East Everglades

Figure 19. Wildland Urban Interface -Headquarters

Figure 20. Wildland Urban Interface -Pine Island

Figure 21. Wildland Urban Interface- Royal Palm/Hidden Lake

Figure 22. Wildland Urban Interface –Long Pine Key Campground

Figure 23. Wildland Urban Interface –Daniel Beard & Robertson buildings

Figure 24. Wildland Urban Interface -Missile Base

Figure 25. Wildland Urban Interface -Flamingo housing & Maintenance

Figure 26. Wildland Urban Interface -Flamingo Concessions & VC Ranger Station

Figure 27. Wildland Urban Interface -Flamingo Campground

OPERATIONS

HELIBASE/HELISPOT & AIRPORT LOCATIONS

STATION LOCATIONS/RESOURCES

FLIGHT ROUTES/RESTRICTIONS/HAZARDS

WATER SOURCES

Human/Natural barriers

Staging Areas

Wildland Urban Interface (WUI)

LOGISTICS

Communication – Mobilization Guide

1. **Phone lists**
2. **Radio Frequencies**
3. **Key Contacts**

Medical Facilities

Locks/Combinations for gates

Fire Cache Inventory

Incident Command Post (ICP)

Services and Supply

COMMAND

Safety

The health and safety of firefighters, employees, and the public is the number one priority of the Everglades NP Fire and Aviation Program. Operational guidance directs all fire management activities to be conducted to enhance and provide resource benefits and mitigate risk from unwanted wildland fire. Hazards within the Everglades NP include poisonwood, pinnacle rock, heat, high humidity, thunderstorms, snags, venomous snakes, alligators, hazardous materials, vehicle operations, and aviation operations. All actions will conform to safety policies defined in, but not limited to: *Interagency Standards for Fire and Fire Aviation Operations* guide (Red Book), *NPS Director's Order 18*, and the Standards for Operations and Safety chapter in the *NPS Reference Manual 18*.

- Apply Lookouts, Communications, Escape Routes, and Safety Zones (LCES) to all planned actions.
- Review and apply the "18 Watch-Out Situations" and "10 Standard Fire Orders".
- Be particularly cautious of the following:
    - Burning snags
    - Burning or partially burned live and dead trees
    - Unburned fuel between you and the fire
- Clearly designate Escape Routes and Safety Zones

Interagency Agreement/Annual Operating Plan

The National Park Service, US Fish and Wildlife Service (USFWS), and Florida Forest Service (previously Florida Division of Forestry) have a state-wide Cooperative Agreement specific to the management of wildland fire. The Florida Forest Service also maintains state-wide agreements with structural fire suppression organizations. Under the umbrella of these agreements, annual operating plans are established at the local level. Such an annual operating plan coordinates wildland fire management between Everglades NP, the Everglades District of the Florida Forest Service, and Miami-Dade Fire Rescue. The annual operating plan establishes a Mutual Response Zone (MRZ) along the eastern boundary of the park that enables all agencies involved to take initial attack actions (Figure 7). The annual operating plan also establishes procedures for agencies to provide assistance anywhere in Miami-Dade County outside of the MRZ. The cooperative agreement can be found on the server at the Robertson Building: M:\Fire Management Plan 2010\Appendices.

WILDLAND FIRE DECISION SUPPORT SYSTEM (WFDSS)

Wildland fire, resulting from unplanned ignitions, will be evaluated to determine the appropriate response based on criteria designed to meet the Park's management goals and objectives. Decision support processes and analysis that help determine and document decisions regarding the management of individual ignitions will follow current national direction. Currently, WFDSS will be used to aid in the management decisions for fires that exceed initial attack. Wildland fires will be managed for Park and resource benefits or suppressed to protect values at risk. Specific management options are listed in the Fire Management Plan (FMP).

JOB HAZARD ANALYSIS (JHA)

Employee and public safety is the first priority in every fire management activity. Employees are responsible for knowing, understanding, and practicing safe work and fire management practices. Everglades NP fire personnel review and update all JHA's on an annual basis. The individual JHA's can be found on the server at the Robertson Building: M:\SAFETY\JSA-JHA\JHA\2011

CLOSURE PROCEDURES

The decision to close off any portion of the park or to restrict activities will be made by the Park Superintendent and implemented by the Chief Ranger.

MEDICAL EVACUATION

The Everglades NP Emergency Medical Field Evacuation Plan (EMFEP) establishes procedures and required documentation during a field medical emergency evacuation. The EMFEP is to be used for National Park Service personnel while working in the National Park. This plan is not intended to be used for private citizens injured on National Park Lands. Search and Rescue of private citizens injured on National Park Lands is the responsibility of Miami-Dade Fire Rescue. This plan includes procedures and responsibilities of Everglades NP personnel when dealing with an Emergency Medical Field Evacuation, a listing of Medical Facilities and EMS organizations (which may be used during a Medivac situation), and a Medical Incident Patient Log that can be used to assist with the evacuation of injured Park Service personnel.

STRUCTURAL PROTECTION NEEDS

Three Wildland Urban Interface (WUI)Communities at Risk in and adjacent to the park include the Miccosukee Reserved Area, 8 ½ Square Mile Area, and Pine Island and Park Headquarters. These areas are at risk from wildfires burning in natural fuels intermixed with homes. Other park infrastructure potentially at risk from wildfire is located in Long Pine Key, Flamingo, East Everglades, and Shark Valley. WUI assessments have been completed for structures within the Park boundary and inholdings. A complete list of structures and their locations is located on the server at the Robertson Building: M:\WUI

Public Information

Through press releases issued by the Park's Public Affairs Officer, Everglades NP will make an effort to fully inform the public of the risks associated with wildfires and the roles and cooperative efforts of the Park in fighting wildfires and protecting life and property.

Natural and Cultural Resource Advisors

Everglades Fire and Aviation Management consults with the Chief of Natural Resource Branch and the Chief of Cultural Resource Branch to assure the appropriate actions are taken to protect natural and cultural resource sites within the Park.

PLANNING

Interagency Operations

As stated above, the NPS, USFWS, and FSF have a state-wide Cooperative Agreement specific to the management of wildland fire. An annual cooperator meeting is held each year to review the Cooperative Agreement, review each unit's Pre-Attack Plans, FMP's, and to discuss updates.

Incident Action Plans (IAP)

An IAP is prepared by the IC for each incident on a daily basis throughout the response. This plan must be prepared prior to the operational shift and distributed during briefing. It provides incident objectives, resource requirements, work assignments, tactics, communication plans, and safety protocols for the Park. The IAP must be approved and signed by the IC and the Fire Management Officer or designee.

Special Values at Risk

Wildland fire resulting from unplanned ignitions will be evaluated to determine the appropriate response based on the criteria designed to meet the park management goals and objectives. One objective of the Everglades NP fire program is to protect values at risk. As stated in the FMP, wildland fires threatening values at risk will be suppressed as long as it can be done safely. The following is a list of values within and surrounding the Park's boundary:

- Cape Sable seaside sparrow habitat
- Urban interface/ communities at risk
- Sensitive tree islands and hammocks
- Transportation corridors
- Park Infrastructure
- Archeological and cultural sites
- Untreated stands of Melaleuca (*Melaleuca quinquenervia)* and Australian Pine (*Casuarina equisetifolia)*
- Rookeries and significant nesting and denning sites
- Park boundary

Maps for these values are located on the shared drive at M:\GIS\Fire\Products\Pre-Attack_Plan

MANAGEMENT CONSTRAINTS & MITIGATIONS

Archeological and Cultural

Everglades NP manages hundreds of archeological sites, historic structures, ethnographic resources and cultural landscapes. Comprehensive cultural resource inventories have not been completed for the park, but surveys of high probability areas have revealed sites in five broad categories: archeological sites, historic sites, cultural landscapes, ethnographic resources, and museum collections. Strategies and tactics will consider firefighter and public safety first. These resources will be identified, protected, and preserved to the greatest extent possible. The following mitigations will assist fire managers in achieving this objective:

- The park Cultural Resource Branch will provide Fire and Aviation Management with the most current data of cultural and archeological sites.
- In consultation with the Cultural Resources Branch, Fire and Aviation Management will assure that appropriate actions are taken to protect cultural resource sites.
- Cultural resource protection and mitigations will be a consideration in every fire management action.
- The use of MIST will be employed at all times to minimize ground disturbance to any known or unknown cultural resource sites.
- Prior to the use of ground disturbing equipment or techniques in planned ignition operations, the Cultural Resource Branch will be consulted and consultation will occur with the State Historic Preservation Office (SHPO) and affiliated Tribes when necessary.
- Planned ignition treatments will be used to reduce fuels adjacent to cultural sites to provide protection from unwanted fire spread.
- During periods of high fire risk, fire management will implement prepositioning of suppression resources.
- Soils moisture levels will be monitored and considered in the planning and implementation of planned ignition treatments to ensure conditions are within the prescription parameters to prevent fire spread into high probability cultural sites including tree islands and hammocks.
- Fire management will request resource advisor or technical specialist assistance as required for planning and implementing fire management activities in or near cultural resource sites.
- Consultation with the Miccosukee and Seminole Tribes will occur to ensure that Tribal cultural values are protected.
- Fire effects and cultural resource staff will survey selected low probability areas after selected planned ignition treatments to confirm the probability model or document sites and fire effects on them.
- Fire Management will work with the Cultural Resource Branch to obtain and use the best available science to plan, review, and adjust fire management practices as needed to mitigate impacts to cultural resources.

Endangered Species, Species of Special Concern, and Critical Habitat

Everglades NP provides sanctuary for more than 20 federally listed and 270 state-listed rare, threatened, and endangered species. In addition there are a number of species of special concern, including reintroduced and rare species. Species of special concern and associated habitats will be protected and preserved to the degree practicable. The following mitigations will assist fire managers in achieving this objective:

- Planned ignition treatments will be used to reduce fuel loading adjacent to hardwood hammocks, tree islands and other fire sensitive habitats to provide wildlife protection from unwanted fire spread.
- Soils moisture levels will be monitored and considered in the planning and implementation of planned ignition treatments to ensure conditions are within the prescription parameters to prevent fire spread into tree islands and hammocks.
- Planned ignition treatments will be implemented to restore and maintain the pine rockland and wetland prairie ecosystems to benefit wildlife and plant species associated with these habitats.
- Fire effects monitoring in the pine rockland and prairie ecosystems will continue to inform fire managers and support adaptive management in fire operations.
- South Florida Natural Resources Council (SFNRC) will provide Fire and Aviation Management the

most current information and data regarding species of special concern.

- Fire Management will work with the SFNRC and the USFWS to obtain and use the best available science to plan, review, and adjust fire management practices as needed to help maintain or expand the population size or numbers of populations of species of special concern.

Minimum Tool Analysis

The Minimum Tool Analysis comprehensively addresses prohibited activities and restrictions associated with wilderness and potential wilderness. Fire retardant, class A foam, and specialized equipment, such as rolligons, will be used only when an operation cannot be safely completed and/or impacts to values cannot be mitigated. Permission will be granted by the Park Superintendant. A copy of the minimum tool analysis is located in the FMP.

Minimum Impact Suppression Tactics

Minimum Impact Suppression Tactics (MIST) are used to minimize the amount of force necessary to effectively achieve fire management objectives. It applies a greater sensitivity to the impacts of suppression tactics and their long term effects when determining how to manage the fire with the appropriate response and tactics that result in minimum cost and minimum resource damage. The goal of MIST is to halt or delay fire spread in order to maintain the fire within predetermined parameters while producing the least possible impact on the resource being protected. These parameters are considered during the initial attack incident commander's size-up of the situation. It is important to consider probable rehabilitation need as a part of selecting the appropriate suppression response. Tactics that reduce the need for rehab are preferred whenever feasible. General Considerations for Everglades NP are as follows:

- The water tanks of air tankers will be rinsed prior to use in the Park to eliminate residual substances being transferred through the water being dropped.
- During fire management operations: funnels and spouts will be used when dispensing fuel and/or oil, spill containment berms will be used during portable pump operations, and containers will be filled to the appropriate level to prevent overflow and spills.
- Class A foam (surfactant) will only be used to protect life and property. Everglades fire management engines will be flushed to eliminate residual foam in pump equipment used in Park fire operations.
- Specialized equipment will be used only when an operation cannot be safely completed and/or impacts to values cannot be mitigated without the use of this equipment.
- Fire retardant will be used only when an operation cannot be safely completed and/or impacts to values cannot be mitigated without the use of retardant. Additional approval from the Superintendent will be required prior to the use of retardant.
- Types II and III helicopters are allowed to land in unimproved sites but no improved heli-spots can be created (Type I helicopters cannot land). Any helicopter can be used for water drops within airspace over MSD Wilderness. Types II and III helicopters can also be used for delivering people and equipment for aerial reconnaissance and aerial ignition operations.
- Motorized vehicles (such as trucks, fire engines, and passenger vehicles) are restricted to established roads and essential wilderness roads unless an operation cannot be safely completed and/or impacts to values cannot be mitigated. Widland fire management operations will conform to the Minimum Tool Analysis unless the onsite fire manager deems it is necessary to utilize additional resources in fire response.
- ATV's/UTV's are authorized on roads and off-road in direct support of wildand fire management operations. Widland fire management operations will conform to the Minimum Tool Analysis unless the onsite fire manager deems it is necessary to utilize additional resources in fire response.
- Mechanized equipment such as weedeaters, pumps, chainsaws, pushmowers, and mechanized battery operated hand tools such as drills are allowed in support of wildland fire operations. Widland fire management operations will conform to the Minimum Tool Analysis unless the onsite fire manager deems it is necessary to utilize additional resources in fire response.

The complete MIST document for Everglades NP is located in the FMP.

Visitor Use Areas

The primary high visitor use areas that are potentially impacted by fire include Royal Palm, Ernest Coe Visitor Center, Long Pine Key Campground, Flamingo, Shark Valley, Mahogany Hammock, Pahayokee Overlook, and Chekika. Everglades NP also has an extensive backcountry area accessible by boaters. Fires in the wilderness pose potential risk to these park visitors (Figure 2).

Land Ownership Status

Everglades NP is located in the southern tip of Florida west of the greater Miami area. The park is divided into four fire management units: Coastal Prairies (FMU 1); River of Grass (FMU 2); Pine Rocklands (FMU 3); and East Everglades (FMU 4). Each FMU has specific fire management objectives, management constraints, and values and are listed in the FMP.

Approximately 90% of the Park contains the Marjory Stoneman Douglas Wilderness. The Wilderness Act provisions apply to all fire management activities undertaken on wilderness lands. Wilderness character will be protected and preserved and all fire management operations will comply with Wilderness legislation. Mitigations to assist fire managers in achieving this objective are listed in the FMP.

The Boyscout Camp is the only inholding within the Everglades NP boundary. It is located in Fire Management Unit 3 in the pine rocklands and consists of approximately 200 acres including multiple campsites and shelters which are primarily utilized from January through June.

Maps

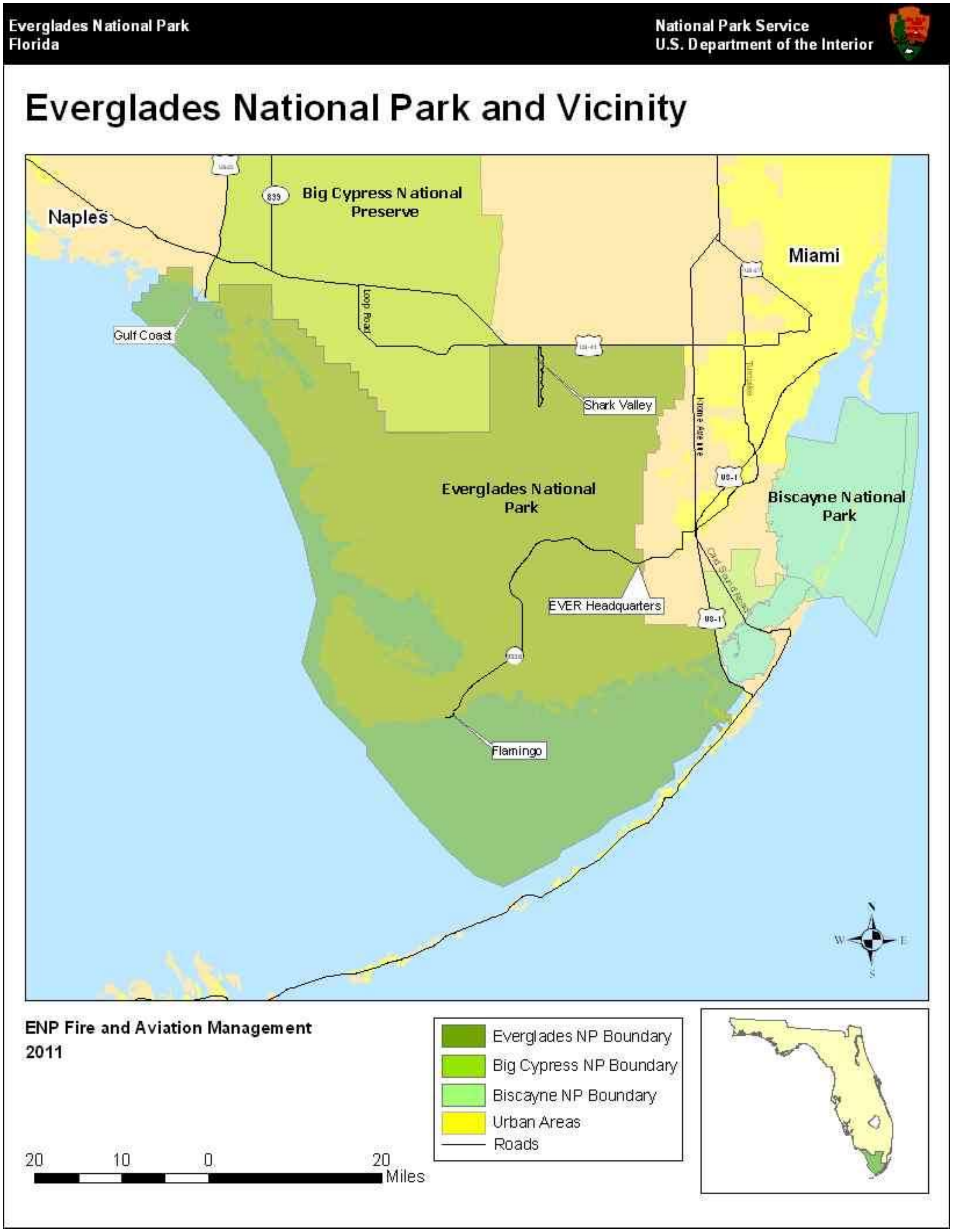


Figure 1. Land Status Map

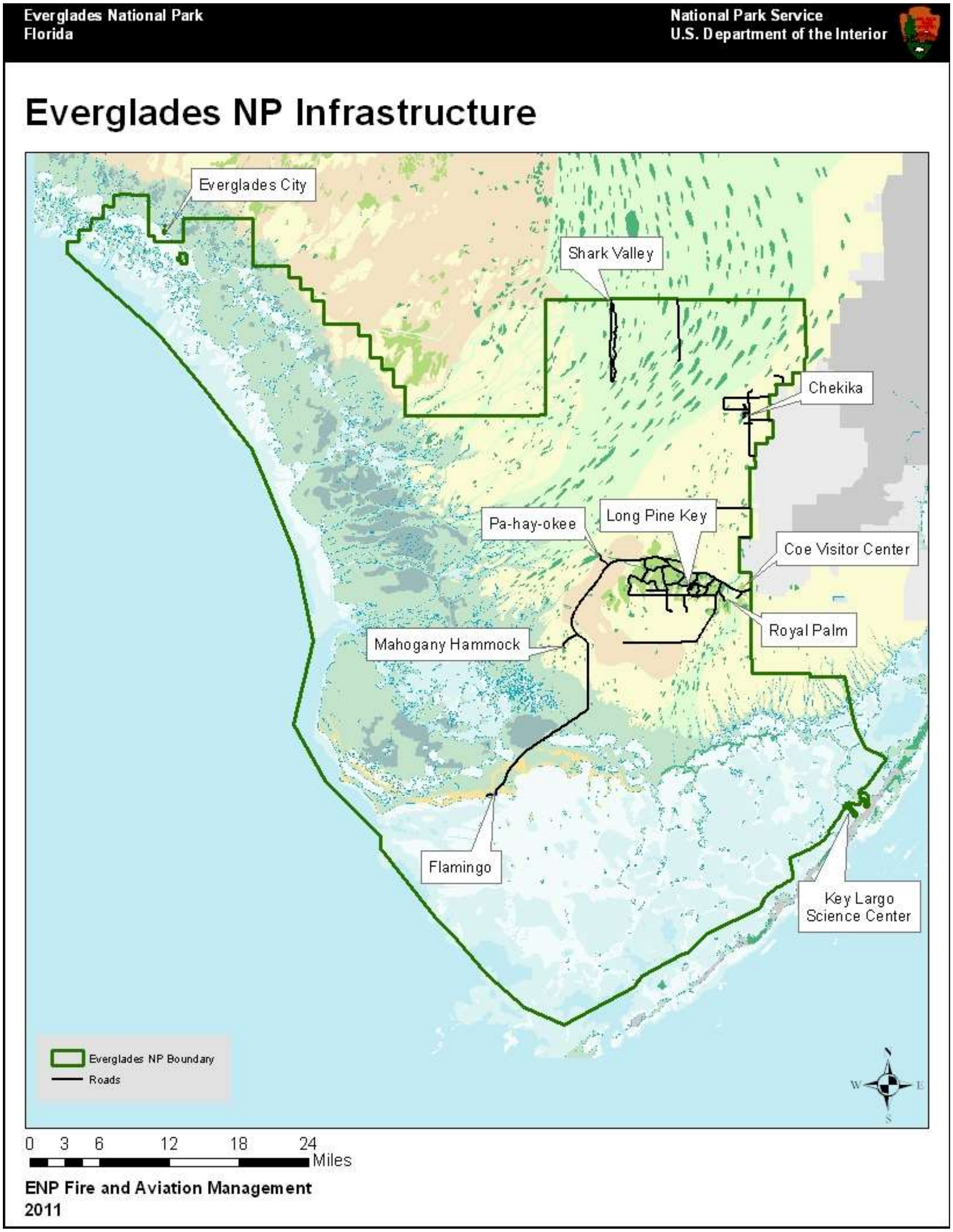


Figure 2. Park Infrastructure

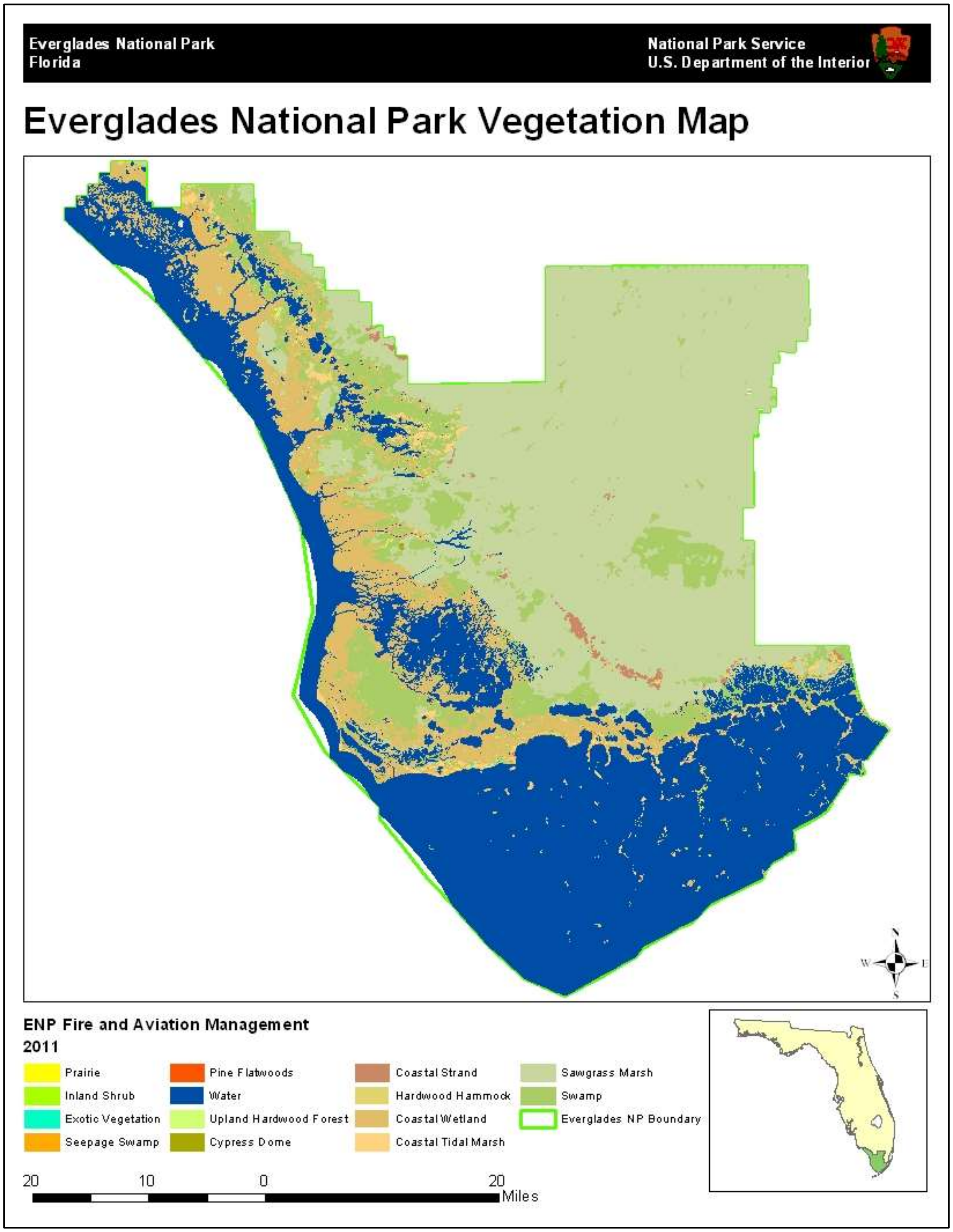


Figure 3. Vegetation

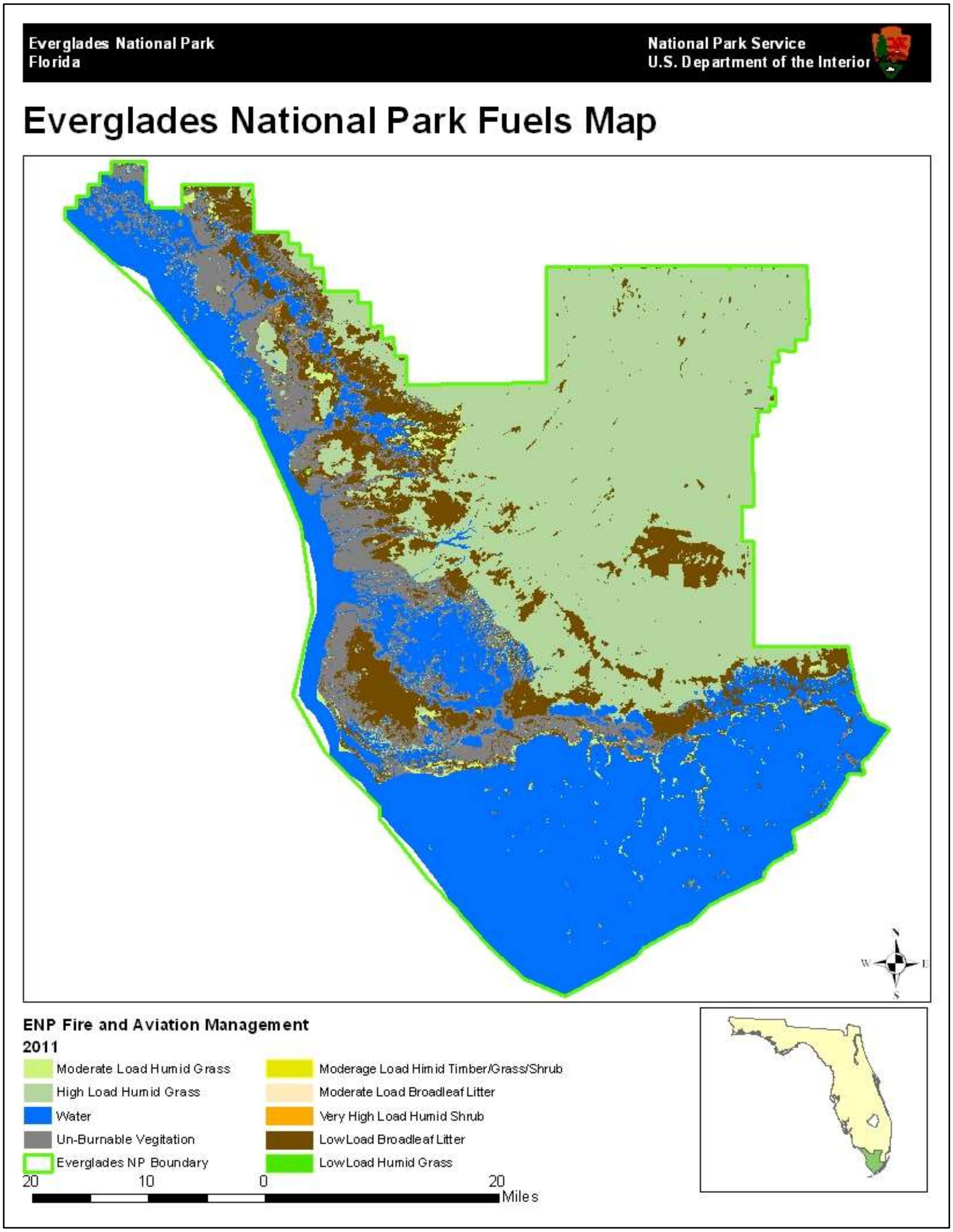


Figure 4. Fuels Map

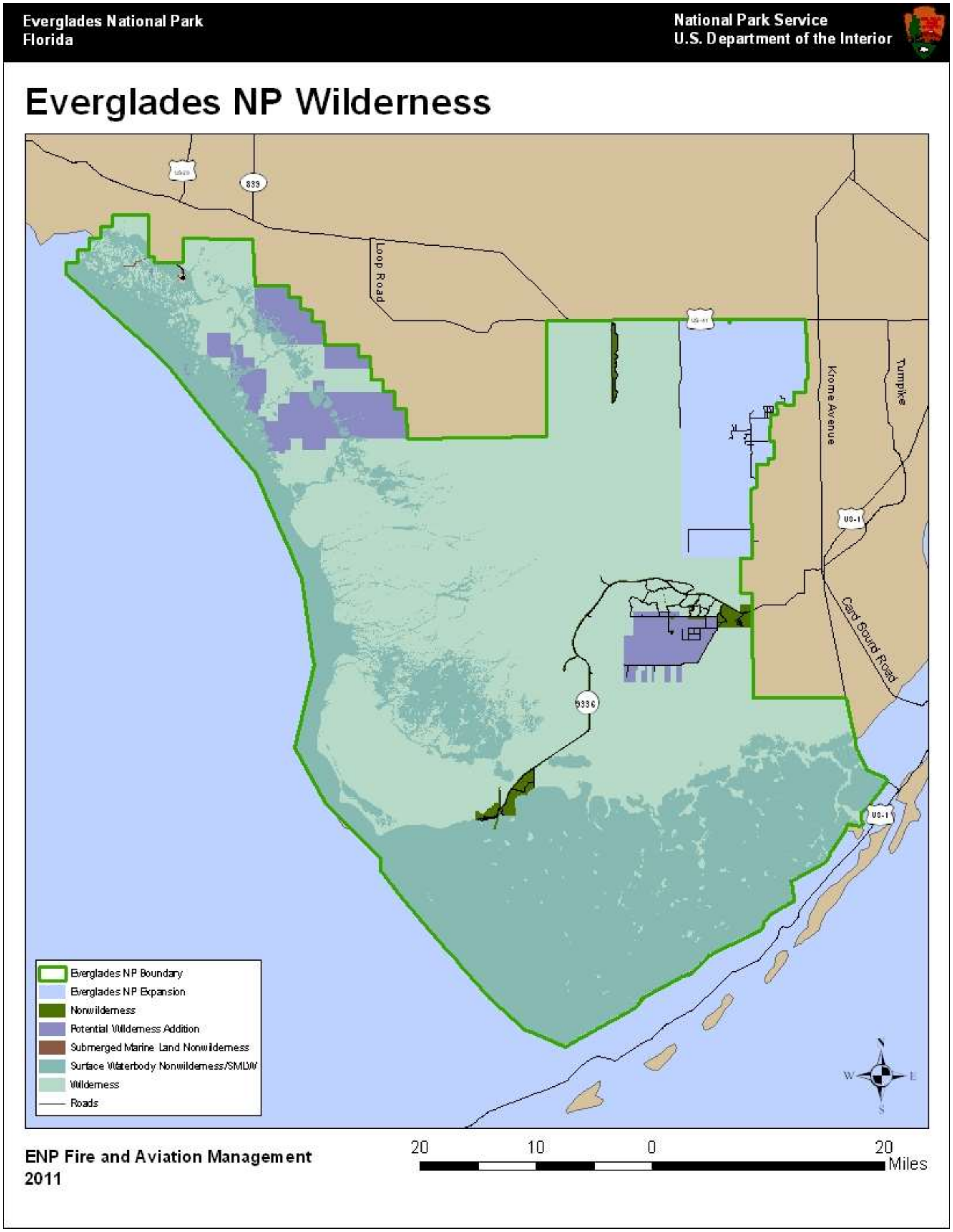


Figure 5. Wilderness

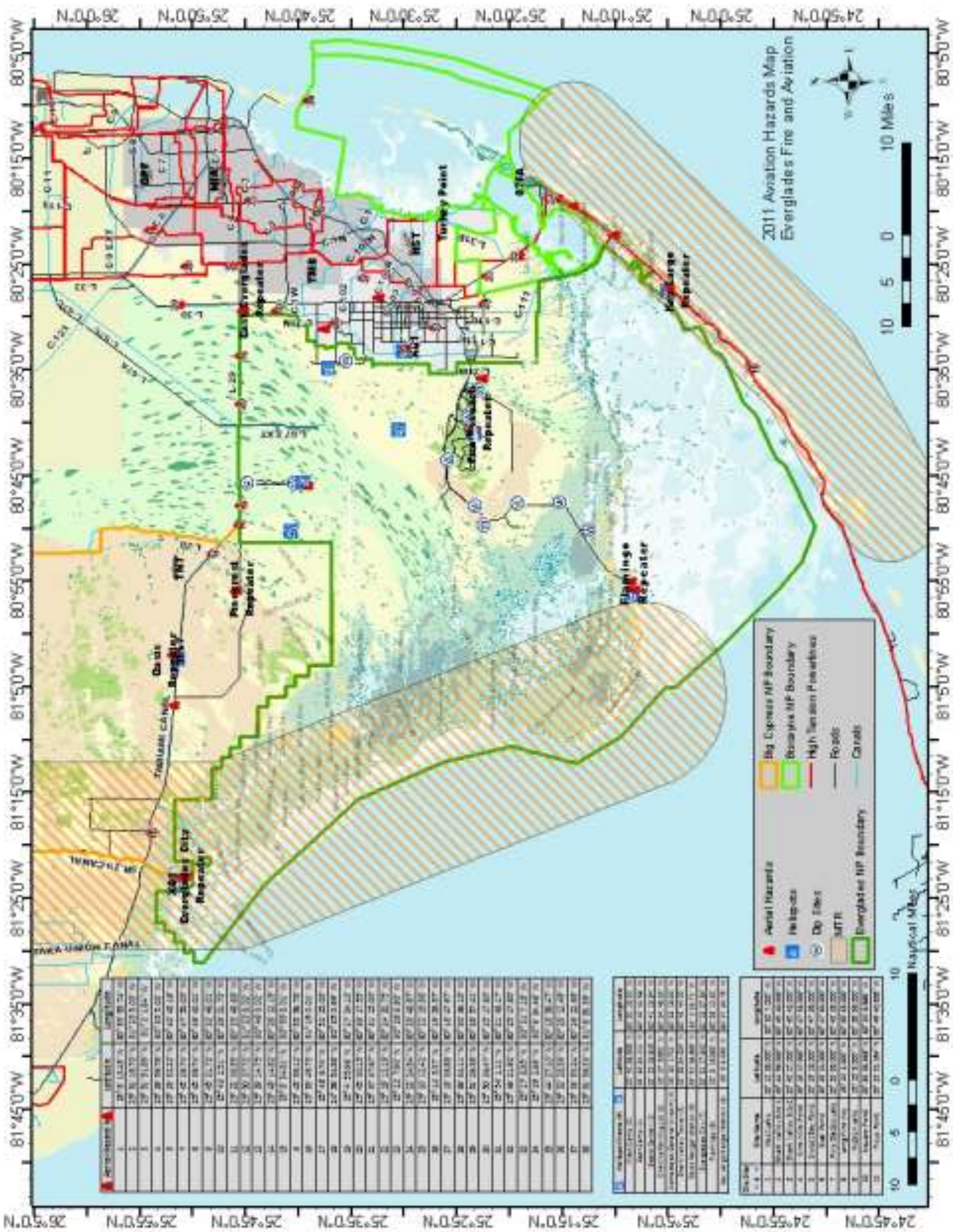


Figure 6. Aerial Hazards

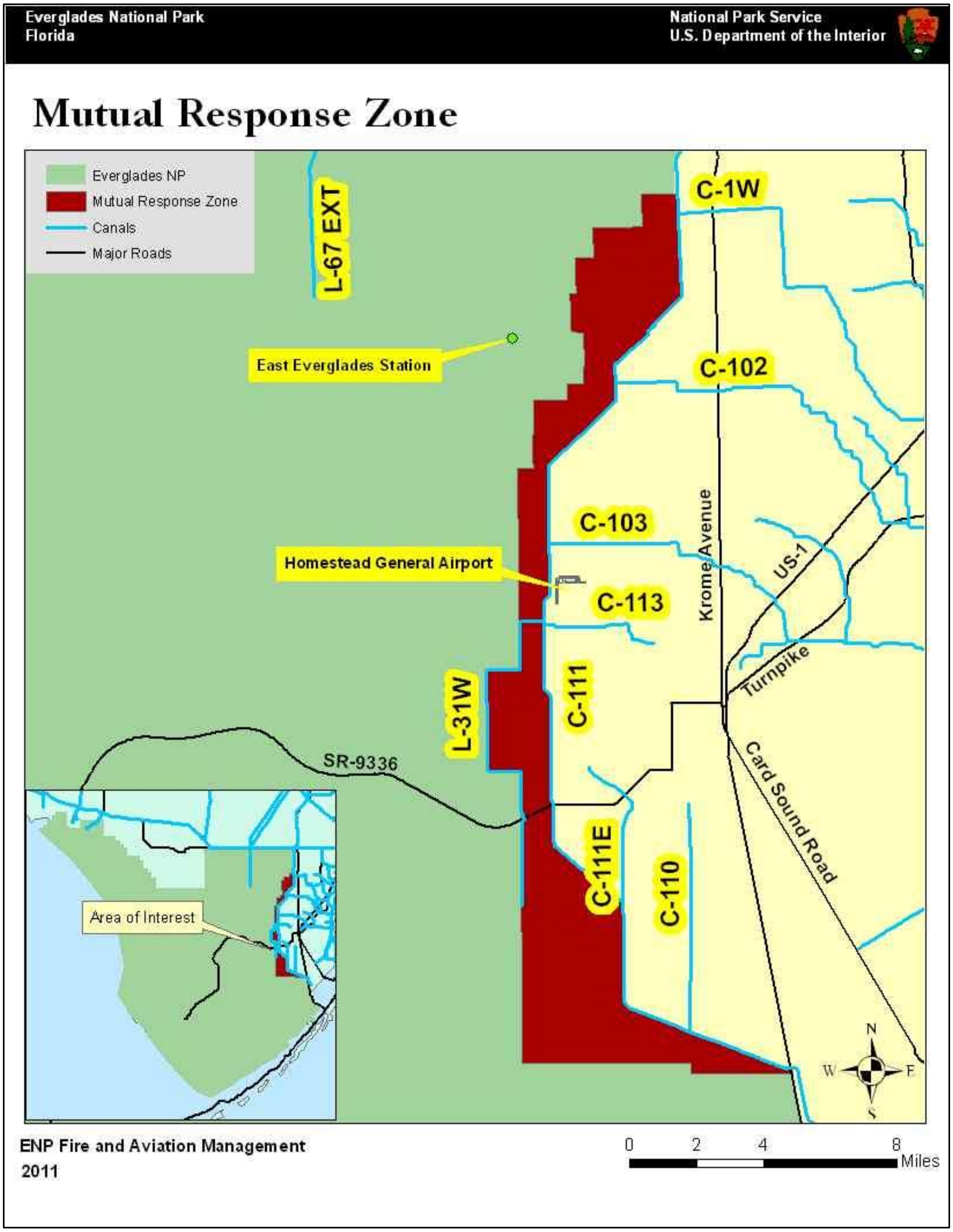


Figure 7. Mutual Response Zone

Figure 8. Fire Management Units (FMU's)

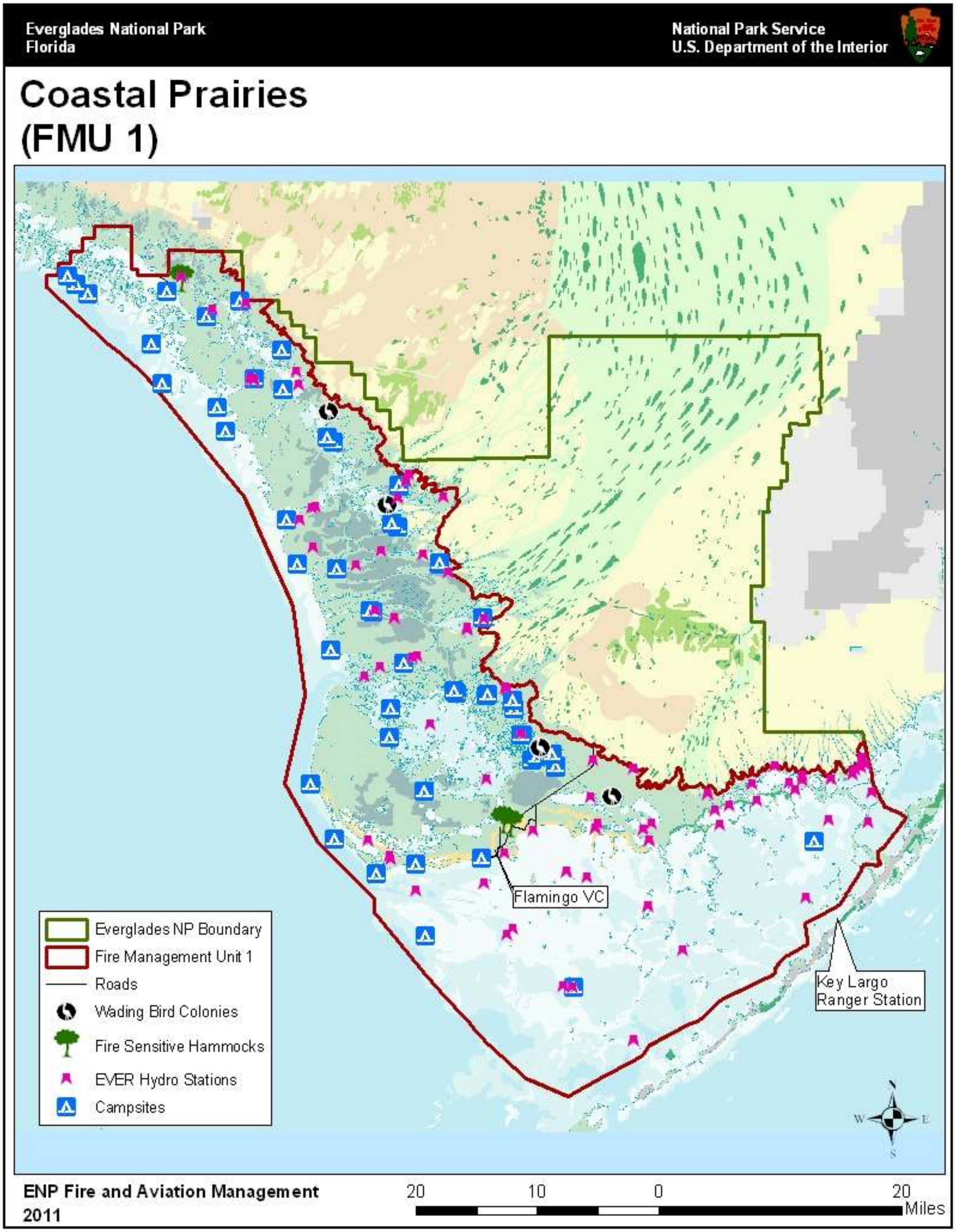


Figure 9. Sensitive Species/Values at Risk FMU 1

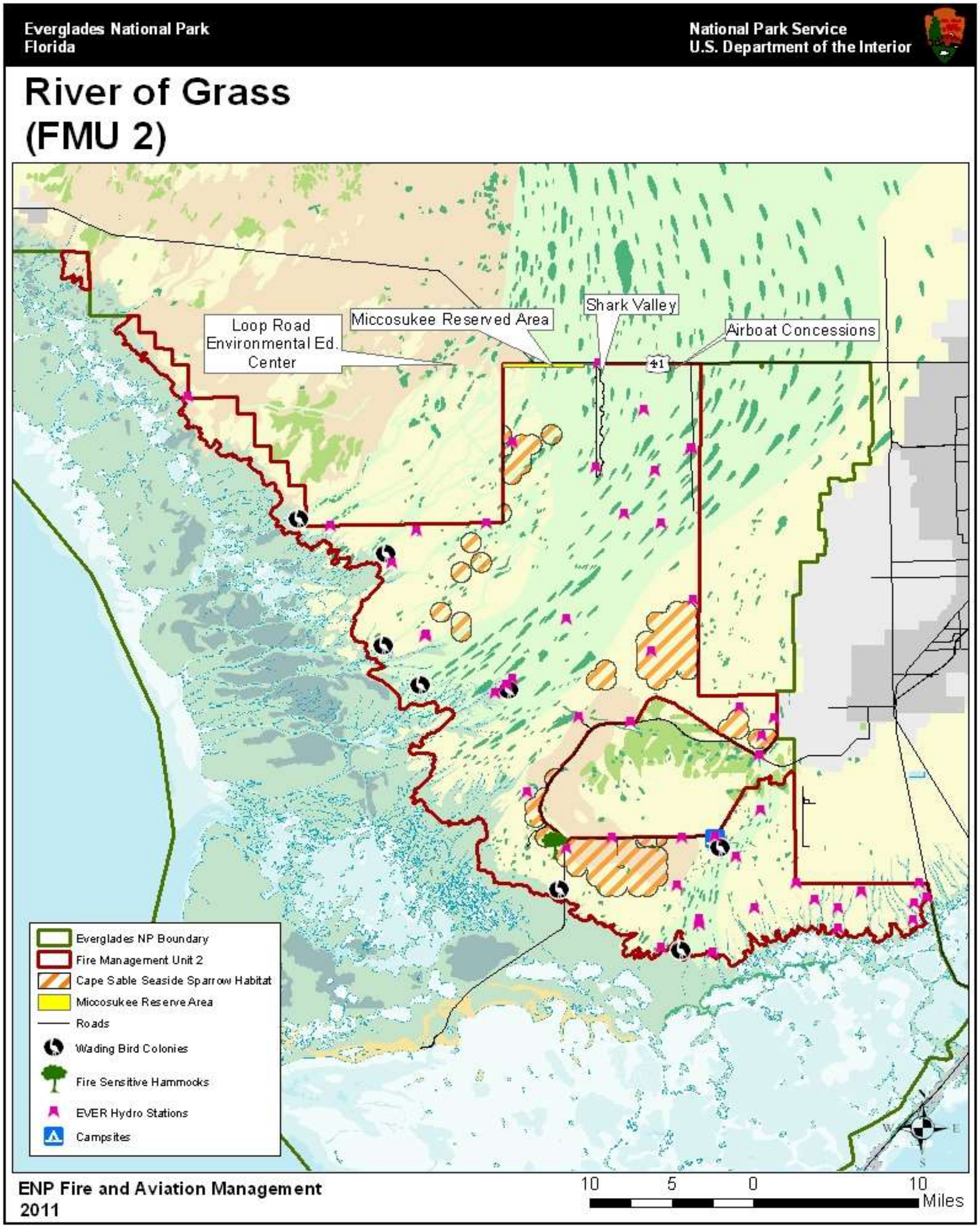


Figure 10. Sensitive Species/Values at Risk FMU 2

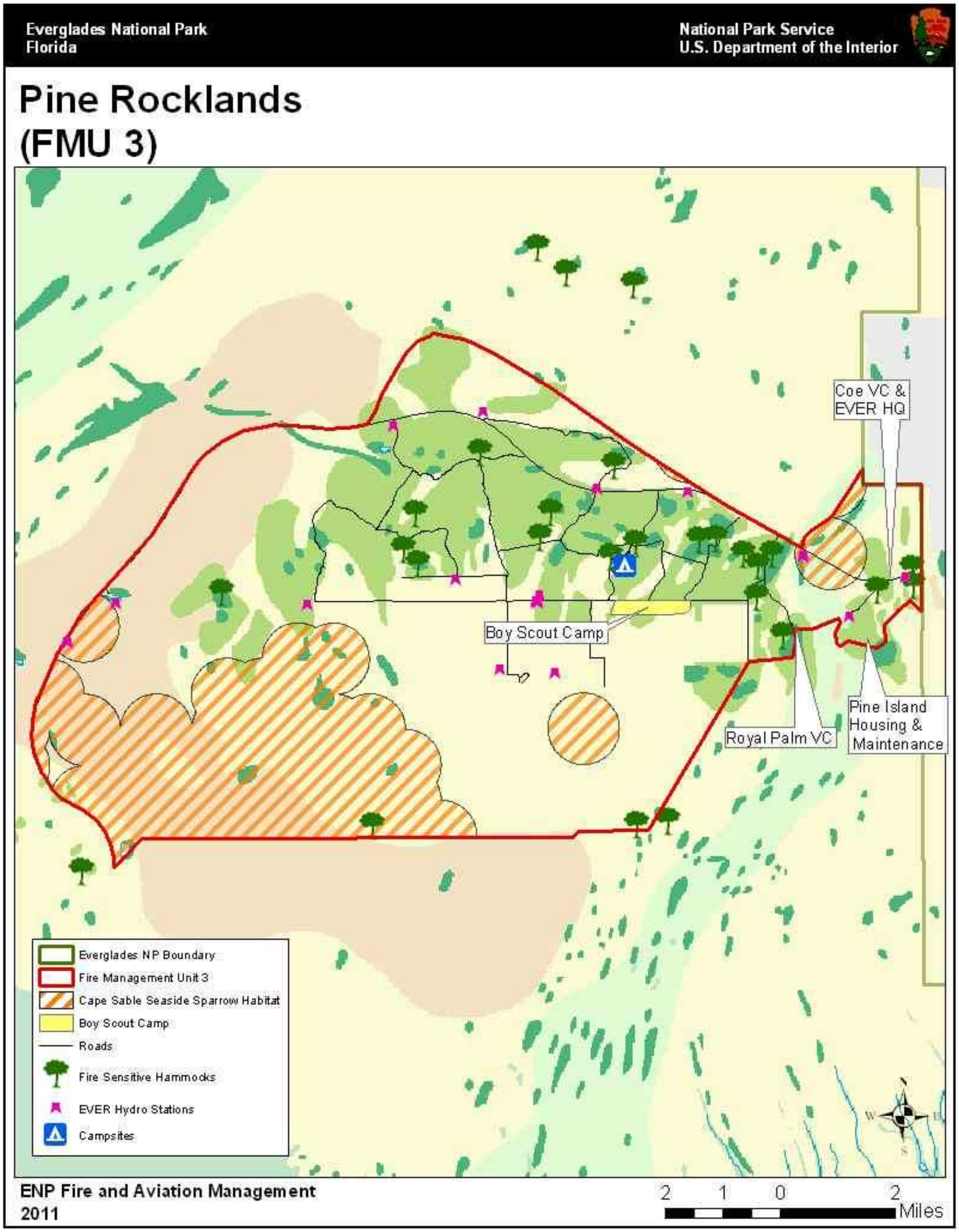


Figure 11. Sensitive Species/Values at Risk FMU 3

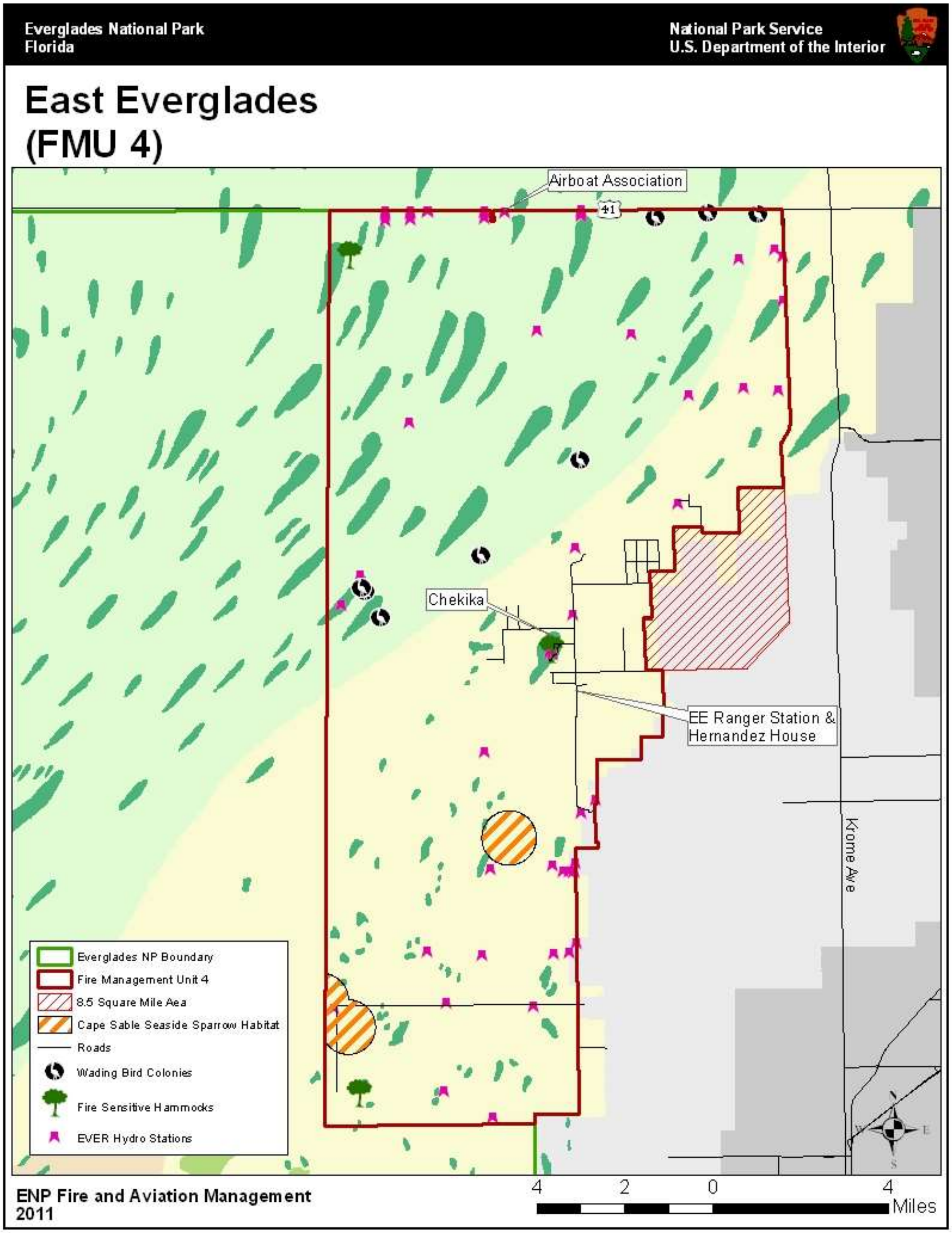


Figure 12. Sensitive Species/Values at Risk FMU 4

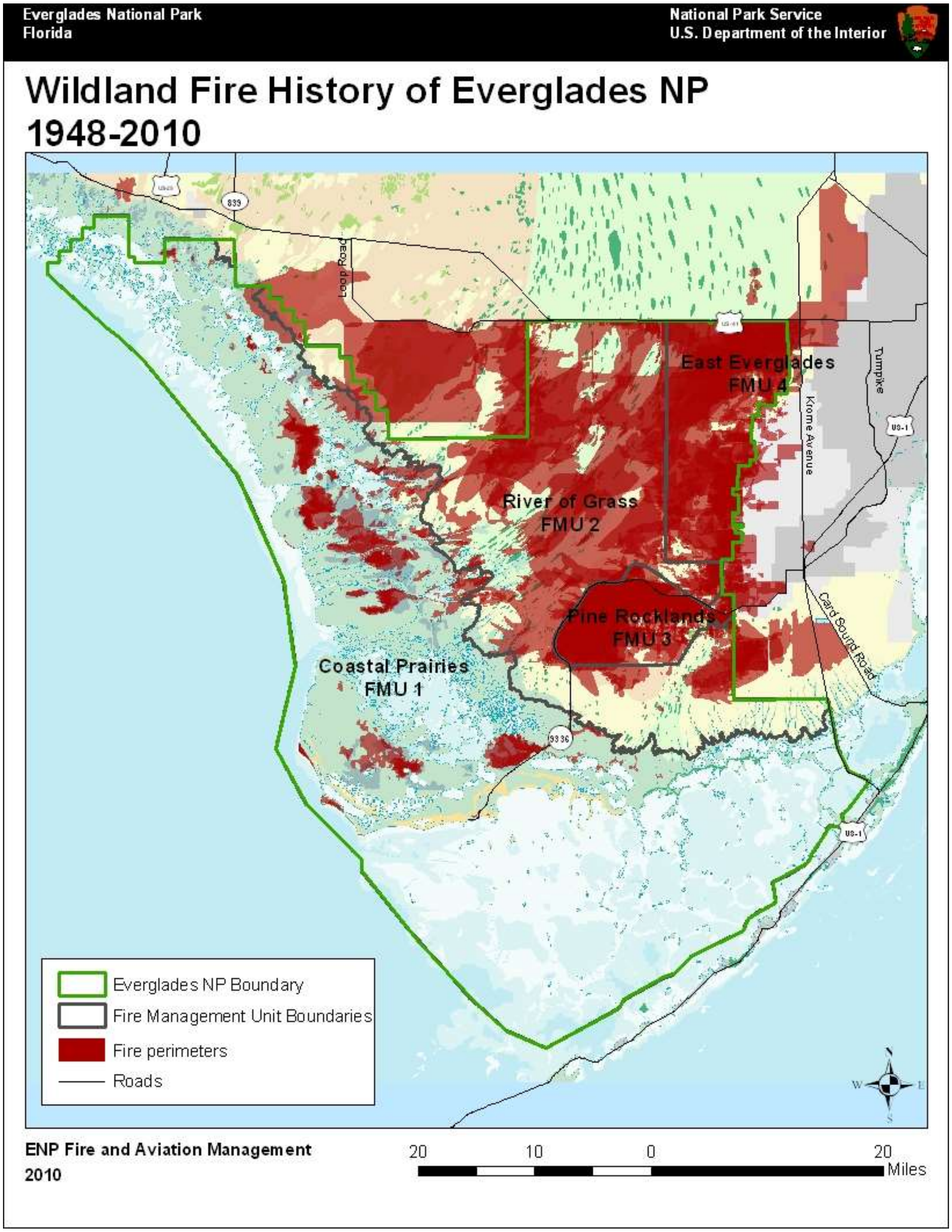


Figure 13. Fire History

OPERATIONS

HELIBASE/HELISPOT & AIRPORT LOCATIONS

Airports/Helibases/Helispots:		
	DDM	Decimal Degrees
Beard Center Helibase:	N 25 23' 16" x W 80 41' 00"	N 25 23.265' x W 80 41.00'
Big Cypress HQ Helispot	N 25 53' 59" x W 81 19' 15"	N 25 53.99' x W 81 19.25'
Chekika Helispot	N 25 36' 45" x W 80 35' 03"	N 25 36.748' x W 80 35.049'
Everglades City Airport	N 25 50' 58" x W 81 23' 22"	N 25 50.965' x W 80 23.367'
Flamingo Helispot	N 25 08' 40" x W 80 55' 29"	N 25 08.651' x W 80 55.477'
Homestead General Airport	N 25 30' 05" x W 80 33' 05"	N 25 30.079' x W 80 33.085'
Miccosukee Tribal Helispot	N 25 45' 36" x W 80 47' 53"	N 25 45.598' x W 80 47.883'
Oasis Helibase and landing strip	N 25 51' 46" x W 81 02' 02"	N 25 51.764' x W 81 02.033'
Key Largo Helispot	N 25 05' 09" x W 80 27' 09"	N 25 05.148' x W 80 27.15'
Deep Lake Helispot	N 25 02' 33" x W 81 20' 37"	N 25 02.55' x W 81 20.624'

STATION LOCATIONS/RESOURCES

Everglades Fire Operations Program consists of four modules; two modules at the East Everglades Station, one module at the Robertson Building (Fire Cache), and one module at the airport. The following resources are located at each station:

- 2 Type 6 Engines located at the East Everglades Station
- 1 Kubota located at East Everglades Station
- 1 Type 6 & 1 Type 3 Engine located at the Fire Cache
- 2 Kubota's (UTV's) with 50 gallon tanks located at the Fire Cache
- 1 Type 3 helicopter located at Homestead General Airport

FLIGHT ROUTES/RESTRICTIONS/HAZARDS

There are four military training routes (IR34, IR53, IR55, & IR56) located outside the western and southeastern portions of the boundary. These routes must be deconflicted daily through the Airspace Managers office (23WG Det 1) at MacDill Airforce Base located in Tampa, Florida. The Aviation Hazard map contains airports, helicopter dip sites, communication towers, and flight restricted areas within and surrounding the Park. Also, covering a significant area of the eastern-central portion of the Park, Alert Area A-291 D is a Special Use Airspace for a high volume of fixed and rotary wing pilot flight training. Flights heading east towards Biscayne National Park need to be aware of restricted airspace around Turkey Point

Nuclear Generating Station and Homestead Air Force Base (HST). See Figure 6. Aerial Hazards map.

WATER SOURCES

Within and surrounding the Park, there are several water sources available incidents including canals, manmade lakes, wells, and pressurized hydrants. Hydrants are located at Pine Island, Headquarters, and Shark Valley. Wells are located throughout the Park and a well pump is located at Iori/Fire Cache (Figure 14). During wood stork nesting season, bucket operations are prohibited at Paurotis Pond.

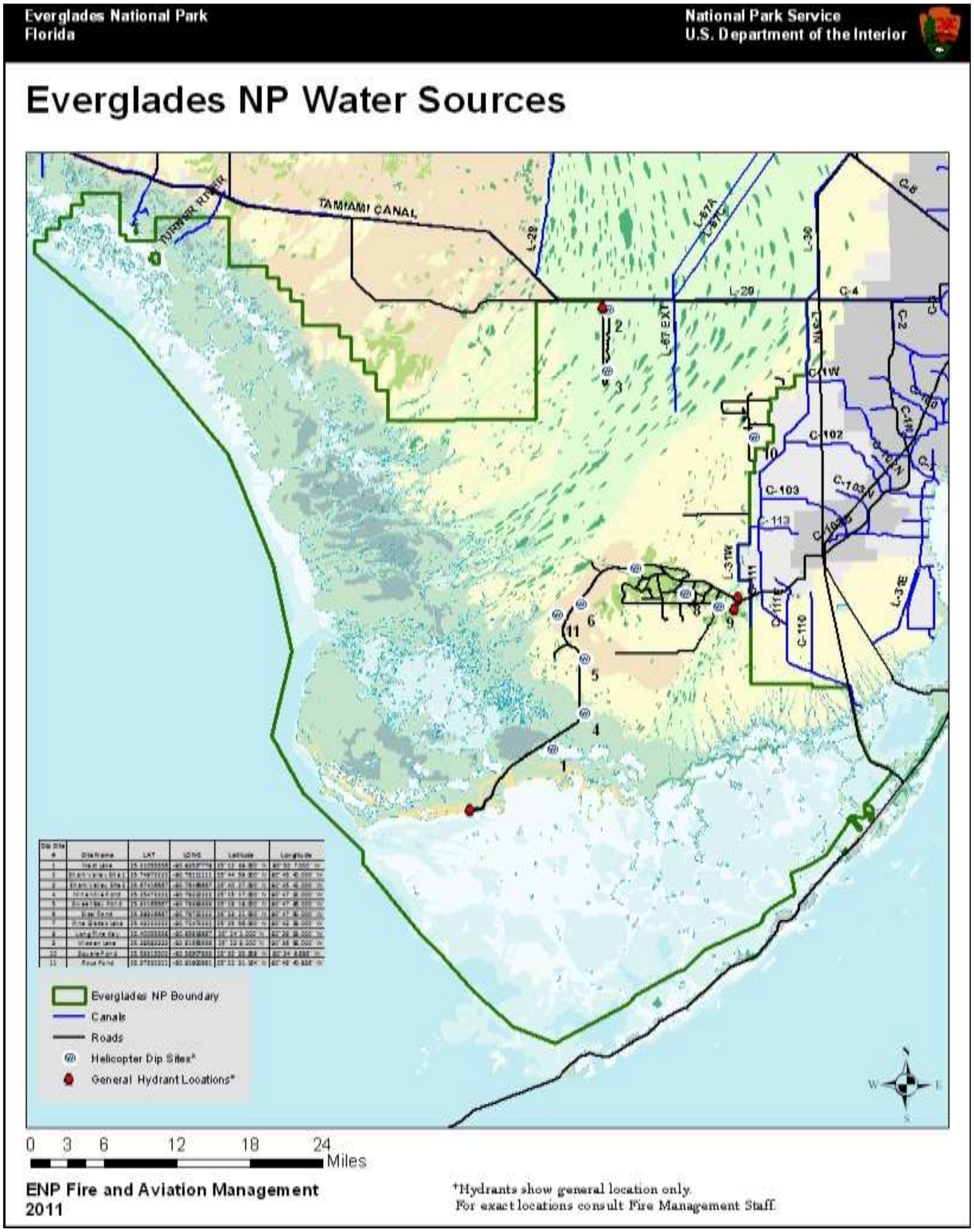


Figure 14. Water Sources

Human/Natural barriers

Everglades NP contains several human and natural barriers:

- Water bodies (rivers, creeks, canals)
- Shark Valley Slough (water levels at NP44 >1.00)
- Airboat trails
- Brazilian pepper stands
- Mangroves
- Hammocks (soil moisture levels >82%)

Roads

Hard surfaced roads in the park include:

- Main Park Road (SR 9336)
- Royal Palm Road
- Research Road
- Pine Island Road
- Long Pine Key Campground Road
- Various Scenic Spur Roads off Main Park Road
- Shark Valley Loop
- SW 168th Street
- SW 237th Avenue
- Old Ingraham Highway

Unpaved Roads include:

- Context Road
- U-Road
- The system of fire roads in the Pine Rocklands.
- SW 136th Street

Staging Areas

- Beard Center
- Robertson Building
- Chekika
- Homestead General Airport

Wildland Urban Interface

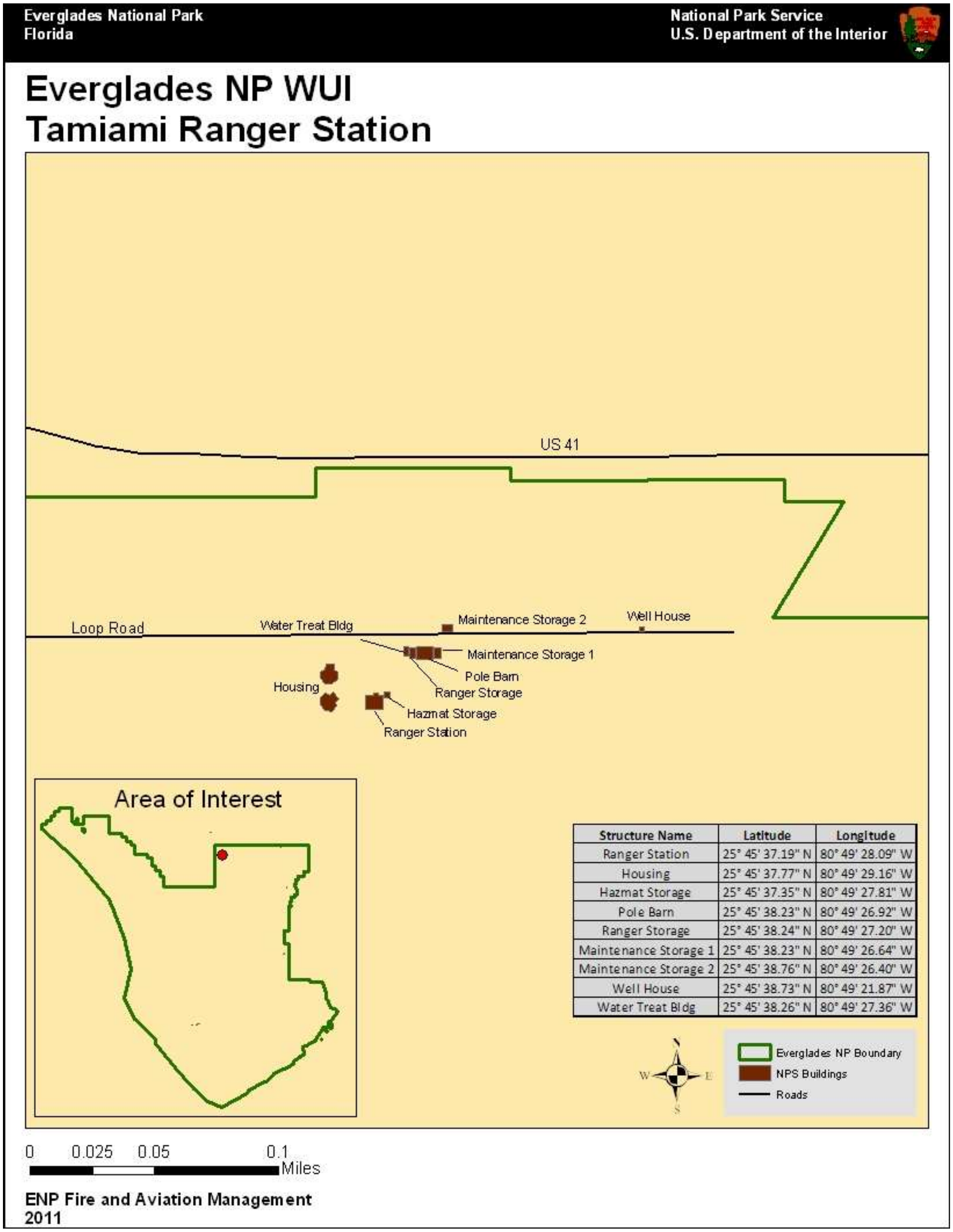
As mentioned in the structural protection needs section, Everglades NP has three WUI communities at risk: Miccosukee Reserved Area, 8 ½ Square mile area, and the Pine Island and Park headquarters areas. Other park infrastructure potentially at risk from wildfire is located in Long Pine Key, Flamingo, East Everglades, and Shark Valley.

Everglades NP contains a number of WUI structures within the park and several surrounding communities. Residential houses are located within the park in Pine Island, Chekika, and Flamingo. Residential communities, including the Miccosukee Indian Reserved Area which is a nationally designated WUI community at risk, concessioners and businesses (airboat tours, nurseries, Shark Valley, Flamingo store and tours), and the Everglades correctional institute are located within or adjacent to the Park boundary. In addition to residential communities, several visitor and education facilities and offices are located throughout the Park. A WUI assessment has been completed for the Park and can be located on the server at the Robertson building: M:/WUI.

A number of monitoring/research stations, access boardwalks, and campsites are scattered throughout the park (located in prairies, mangroves, and other habitats). These stations record valuable data for Everglades restoration and contain expensive high tech sensitive equipment.

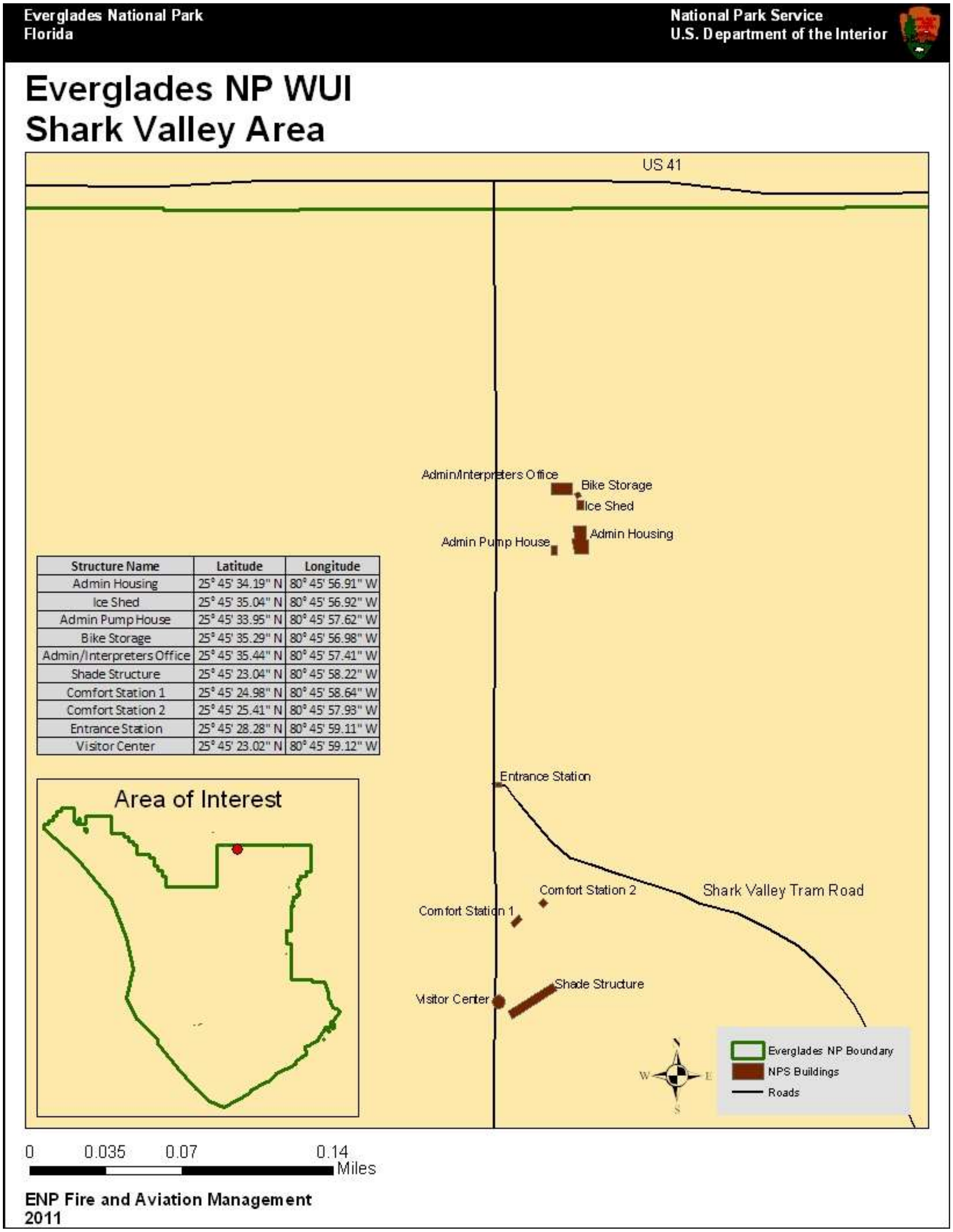
In the East Everglades FMU, there are 2 in-holdings that contain radio towers:
Eastern Tower site: Contact Steve James 954-279-8803
Salem Radio Towers, WHIM 1080 AM
Western tower site: Contact Ruben Garcia 305-986-4929
FCC # 305-521-5100
Facility #30837

Transportation corridors within and adjacent to the Park include park roads, US Hwy 41, US Highway 1, and Krome Avenue. Public health can be impaired by long-lasting and dense amounts of smoke. Local economies can experience severe financial loss when a wildland fire causes road and area closures, as well recreational losses.



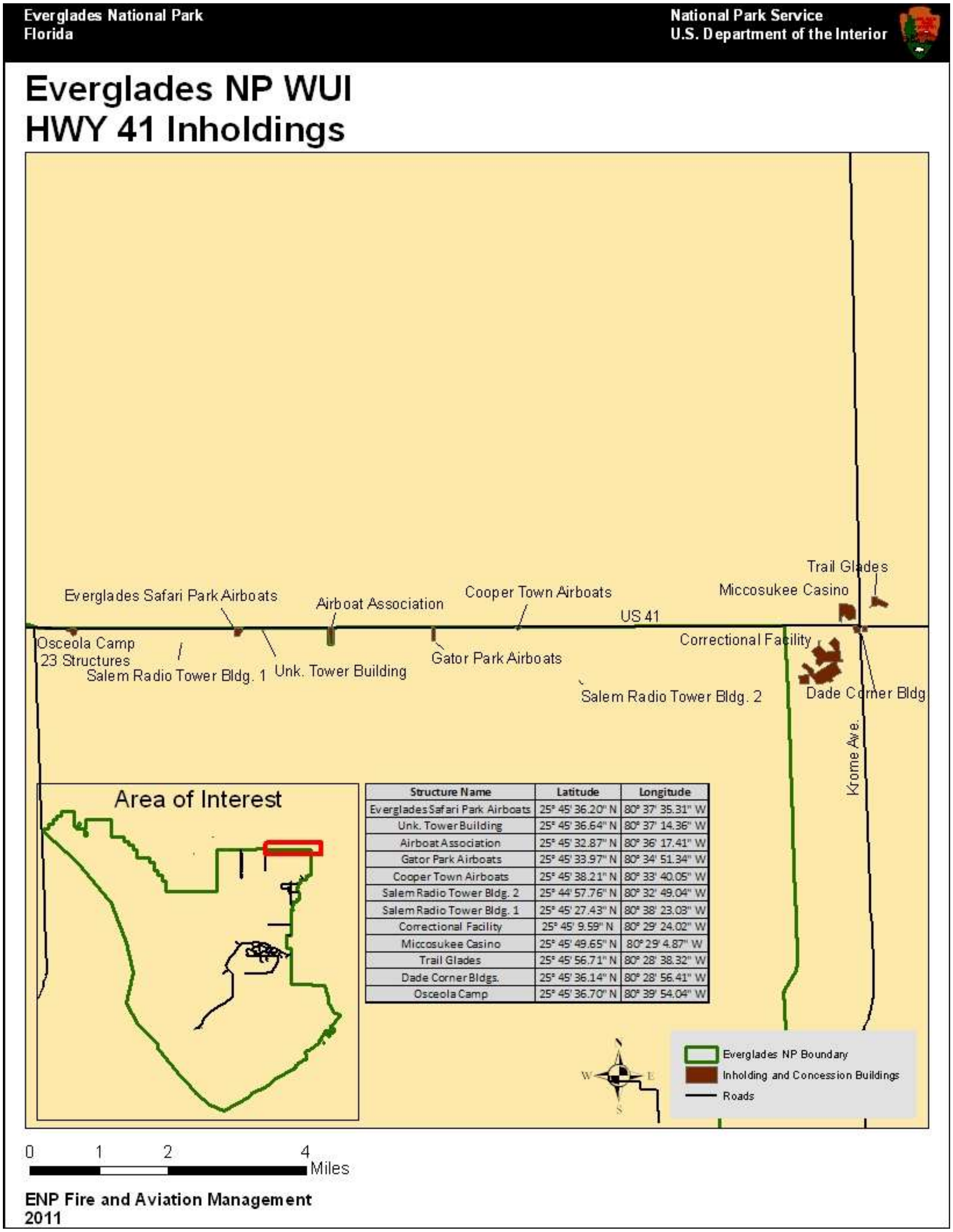
Structure Name	Latitude	Longitude
Ranger Station	25° 45' 37.19" N	80° 49' 28.09" W
Housing	25° 45' 37.77" N	80° 49' 29.16" W
Hazmat Storage	25° 45' 37.35" N	80° 49' 27.81" W
Pole Barn	25° 45' 38.23" N	80° 49' 26.92" W
Ranger Storage	25° 45' 38.24" N	80° 49' 27.20" W
Maintenance Storage 1	25° 45' 38.23" N	80° 49' 26.64" W
Maintenance Storage 2	25° 45' 38.76" N	80° 49' 26.40" W
Well House	25° 45' 38.73" N	80° 49' 21.87" W
Water Treat Bldg	25° 45' 38.26" N	80° 49' 27.36" W

Figure 15. Wildland Urban Interface –Tamiami Ranger Station



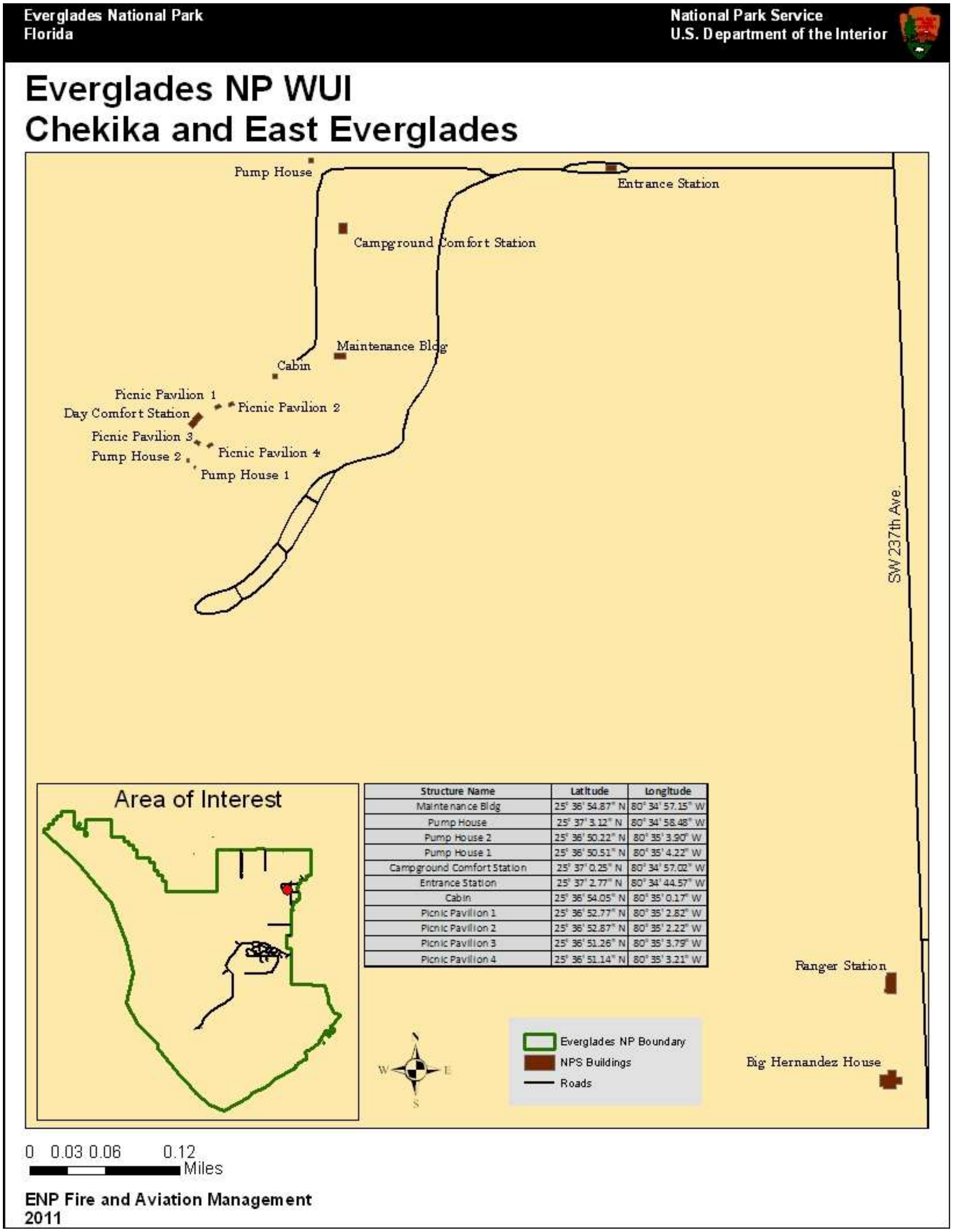
Structure Name	Latitude	Longitude
Admin Housing	25° 45' 34.19" N	80° 45' 56.91" W
Ice Shed	25° 45' 35.04" N	80° 45' 56.92" W
Admin Pump House	25° 45' 33.95" N	80° 45' 57.62" W
Bike Storage	25° 45' 35.29" N	80° 45' 56.98" W
Admin/Interpreters Office	25° 45' 35.44" N	80° 45' 57.41" W
Shade Structure	25° 45' 23.04" N	80° 45' 58.22" W
Comfort Station 1	25° 45' 24.98" N	80° 45' 58.64" W
Comfort Station 2	25° 45' 25.41" N	80° 45' 57.93" W
Entrance Station	25° 45' 28.28" N	80° 45' 59.11" W
Visitor Center	25° 45' 23.02" N	80° 45' 59.12" W

Figure 16. Wildland Urban Interface –Shark Valley



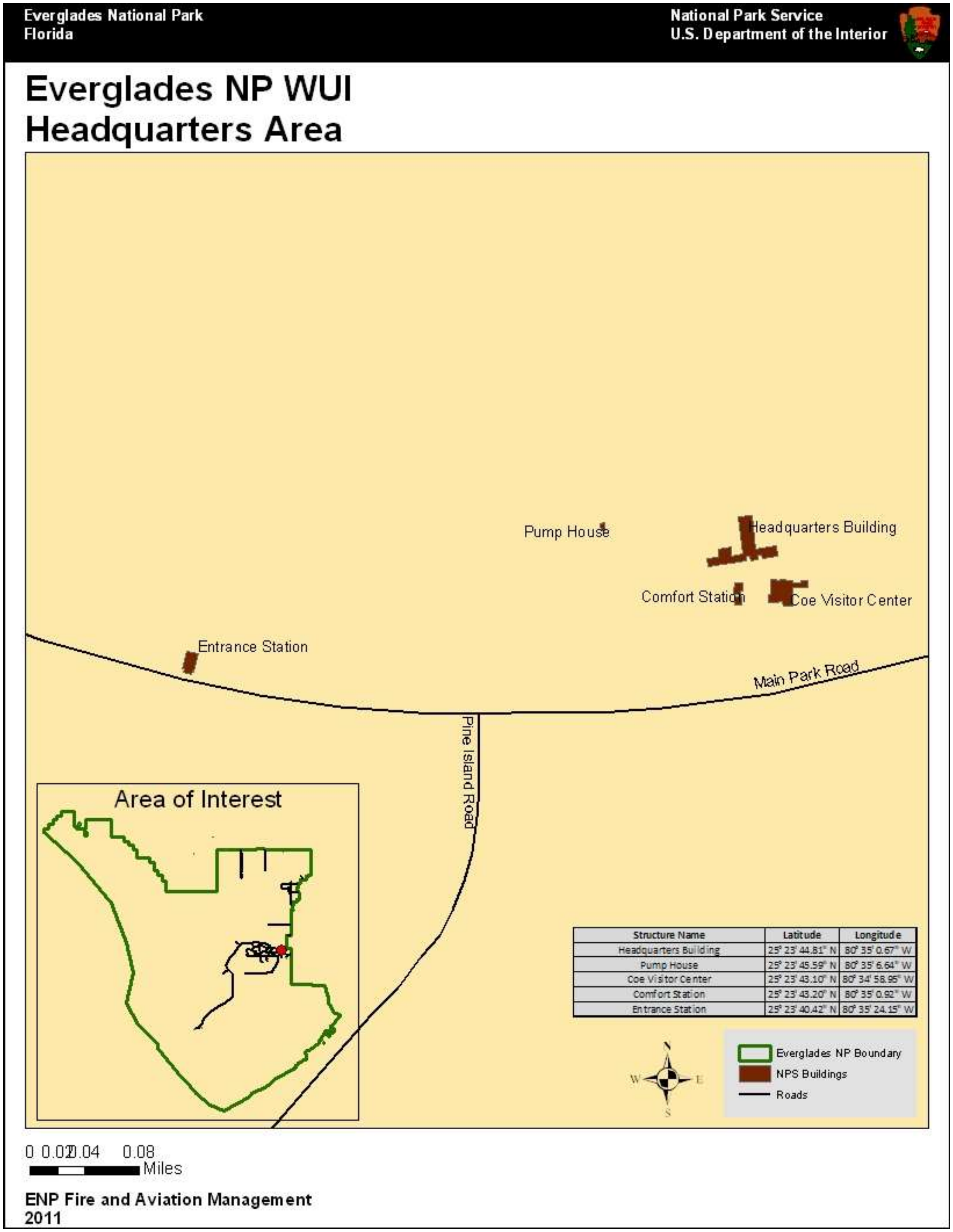
Structure Name	Latitude	Longitude
Everglades Safari Park Airboats	25° 45' 36.20" N	80° 37' 35.31" W
Unk. Tower Building	25° 45' 36.64" N	80° 37' 14.36" W
Airboat Association	25° 45' 32.87" N	80° 36' 17.41" W
Gator Park Airboats	25° 45' 33.97" N	80° 34' 51.34" W
Cooper Town Airboats	25° 45' 38.21" N	80° 33' 40.05" W
Salem Radio Tower Bldg. 2	25° 44' 57.76" N	80° 32' 49.04" W
Salem Radio Tower Bldg. 1	25° 45' 27.43" N	80° 38' 23.03" W
Correctional Facility	25° 45' 9.59" N	80° 29' 24.02" W
Miccosukee Casino	25° 45' 49.65" N	80° 29' 4.87" W
Trail Glades	25° 45' 56.71" N	80° 28' 38.32" W
Dade Corner Bldgs.	25° 45' 36.14" N	80° 28' 56.41" W
Osceola Camp	25° 45' 36.70" N	80° 39' 54.04" W

Figure 17. Wildland Urban Interface –Hwy 41 Inholdings



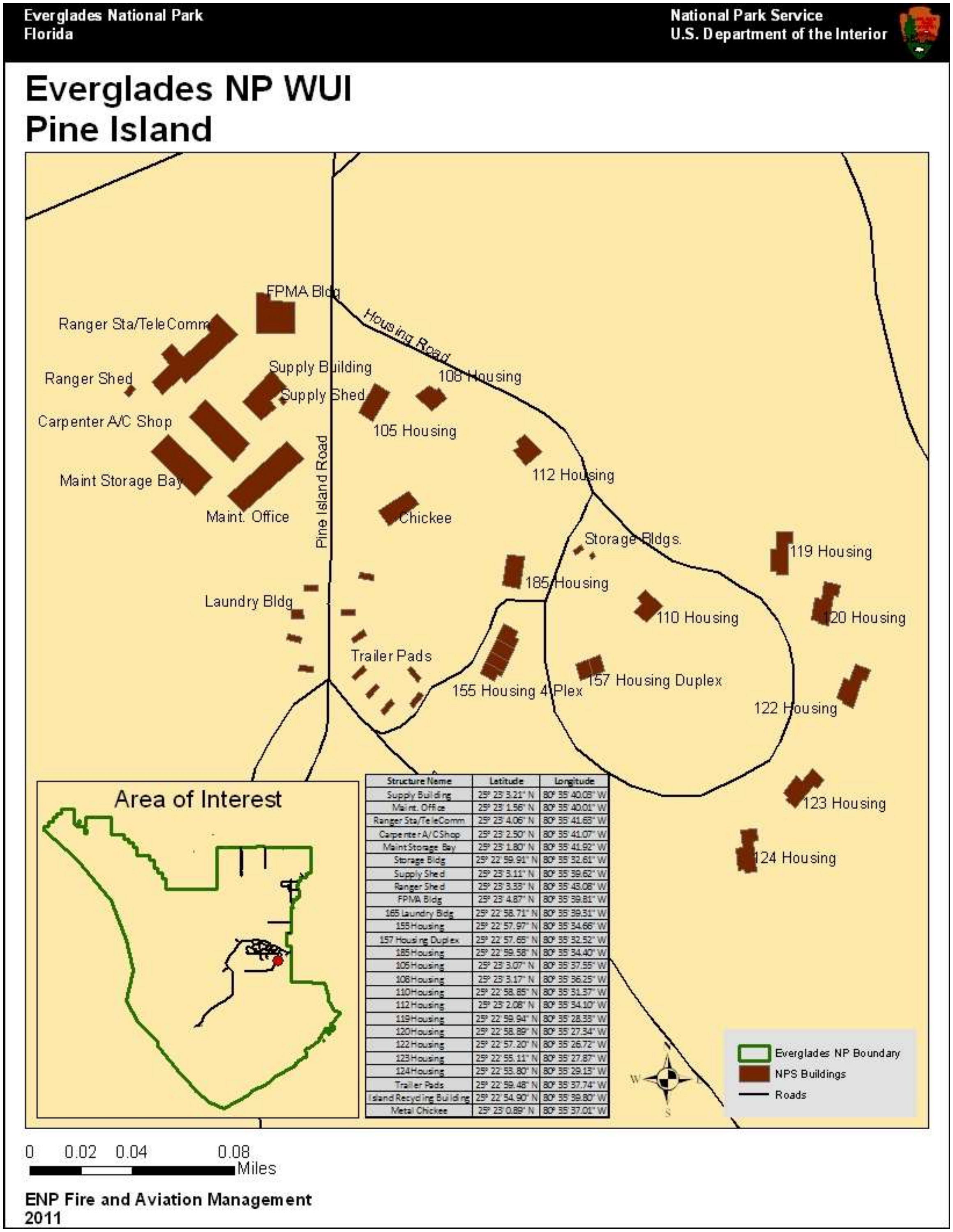
Structure Name	Latitude	Longitude
Maintenance Bldg	25° 36' 54.87" N	80° 34' 57.15" W
Pump House	25° 37' 3.12" N	80° 34' 58.48" W
Pump House 2	25° 36' 50.22" N	80° 35' 3.90" W
Pump House 1	25° 36' 50.51" N	80° 35' 4.22" W
Campground Comfort Station	25° 37' 0.25" N	80° 34' 57.02" W
Entrance Station	25° 37' 2.77" N	80° 34' 44.57" W
Cabin	25° 36' 54.05" N	80° 35' 0.17" W
Picnic Pavilion 1	25° 36' 52.77" N	80° 35' 2.82" W
Picnic Pavilion 2	25° 36' 52.87" N	80° 35' 2.22" W
Picnic Pavilion 3	25° 36' 51.26" N	80° 35' 3.79" W
Picnic Pavilion 4	25° 36' 51.14" N	80° 35' 3.21" W

Figure 18. Wildland Urban Interface -Chekika/East Everglades



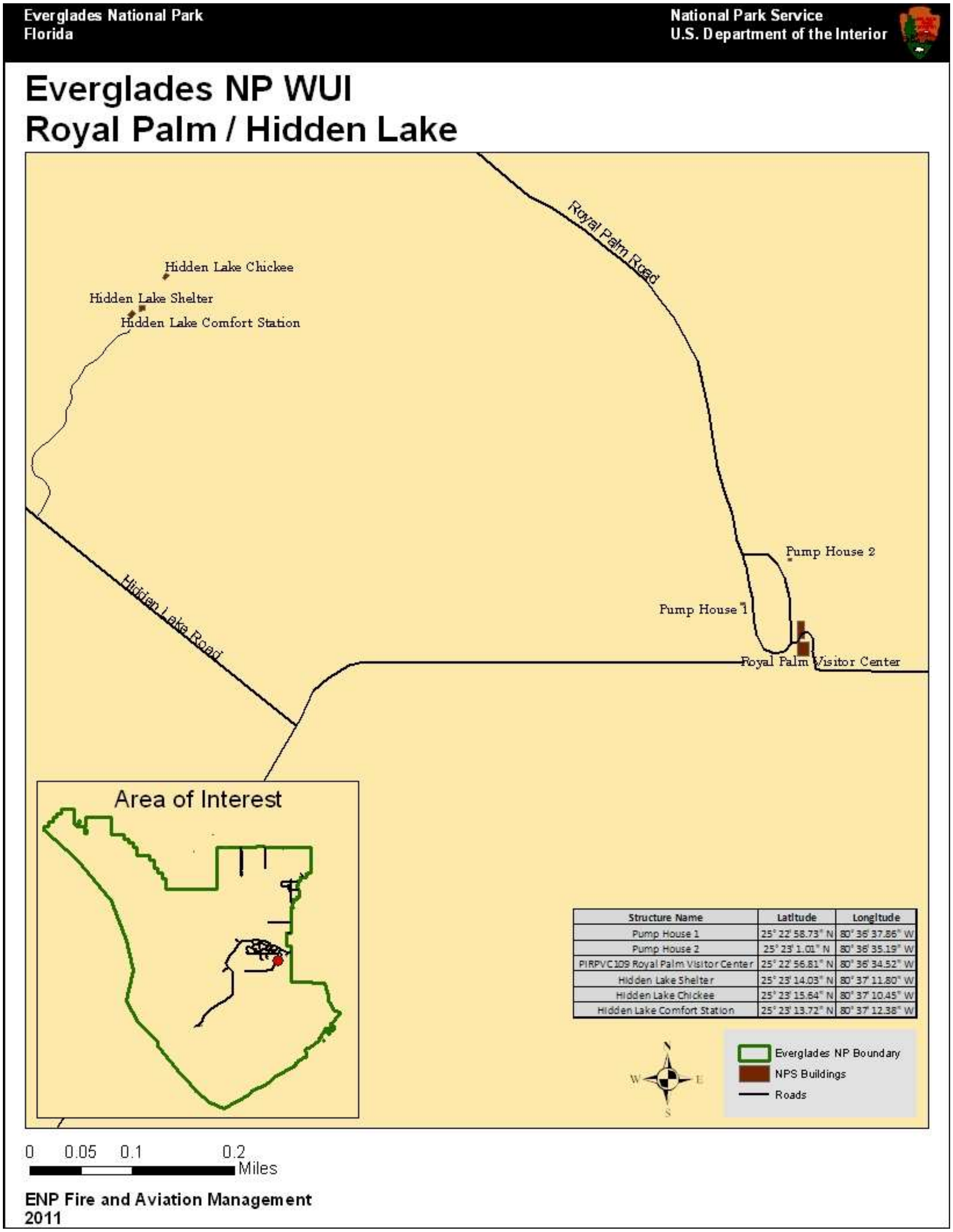
Structure Name	Latitude	Longitude
Headquarters Building	25° 23' 44.81" N	80° 35' 0.67" W
Pump House	25° 23' 45.59" N	80° 35' 6.64" W
Coe Visitor Center	25° 23' 43.10" N	80° 34' 58.95" W
Comfort Station	25° 23' 43.20" N	80° 35' 0.92" W
Entrance Station	25° 23' 40.42" N	80° 35' 24.15" W

Figure 19. Wildland Urban Interface –Headquarters



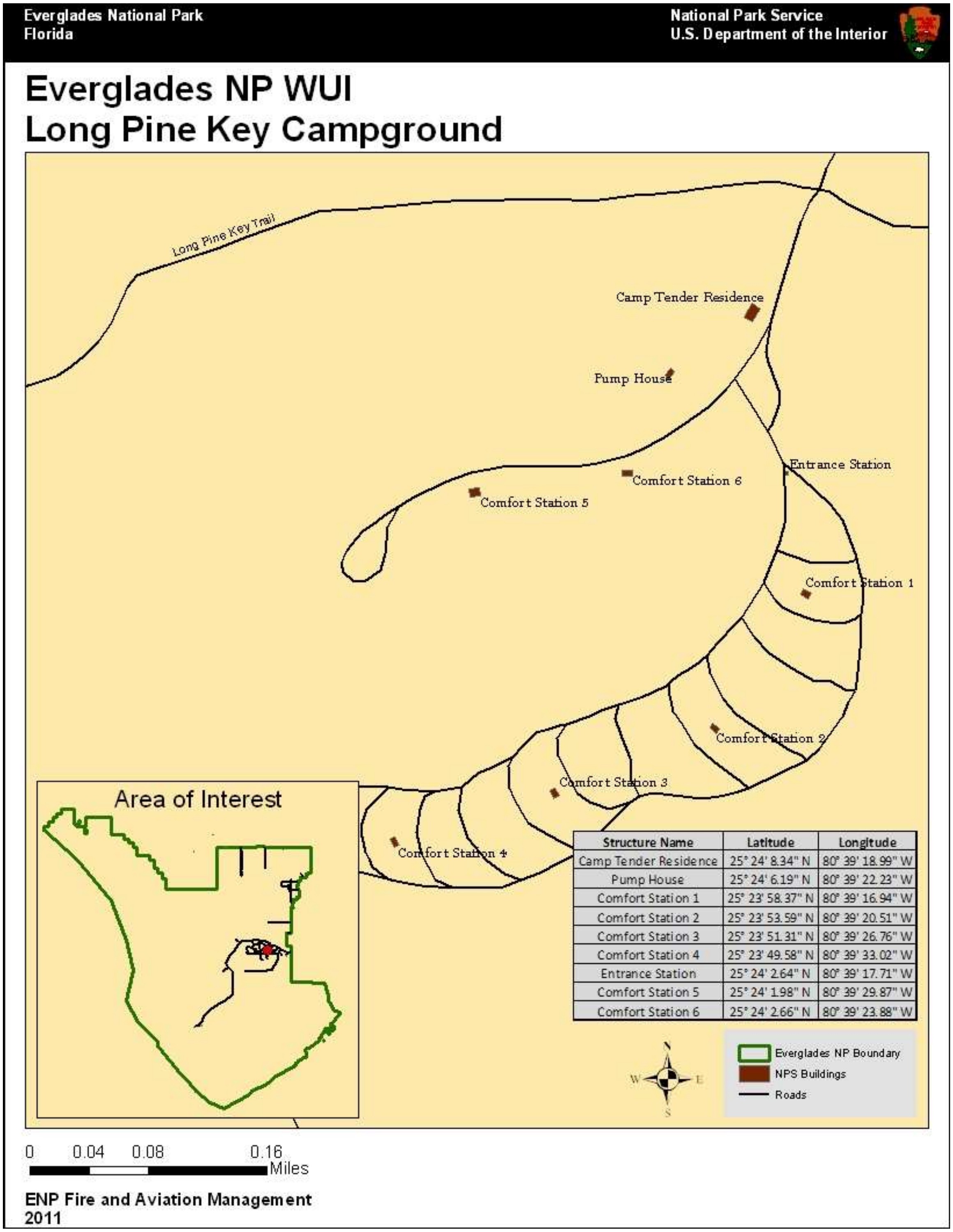
Structure Name	Latitude	Longitude
Supply Building	25° 23' 3.21" N	80° 35' 40.08" W
Maint. Office	25° 23' 1.56" N	80° 35' 40.01" W
Ranger Sta/TeleComm	25° 23' 4.06" N	80° 35' 41.63" W
Carpenter A/C Shop	25° 23' 2.50" N	80° 35' 41.07" W
Maint Storage Bay	25° 23' 1.80" N	80° 35' 41.92" W
Storage Bldg	25° 22' 59.91" N	80° 35' 32.61" W
Supply Shed	25° 23' 3.11" N	80° 35' 39.62" W
Ranger Shed	25° 23' 3.33" N	80° 35' 43.08" W
FPMA Bldg	25° 23' 4.87" N	80° 35' 39.81" W
165 Laundry Bldg	25° 22' 58.71" N	80° 35' 39.31" W
155 Housing	25° 22' 57.97" N	80° 35' 34.66" W
157 Housing Duplex	25° 22' 57.65" N	80° 35' 32.52" W
185 Housing	25° 22' 59.58" N	80° 35' 34.40" W
105 Housing	25° 23' 3.07" N	80° 35' 37.55" W
108 Housing	25° 23' 3.17" N	80° 35' 36.25" W
110 Housing	25° 22' 58.85" N	80° 35' 31.37" W
112 Housing	25° 23' 2.08" N	80° 35' 34.10" W
119 Housing	25° 22' 59.94" N	80° 35' 28.33" W
120 Housing	25° 22' 58.89" N	80° 35' 27.34" W
122 Housing	25° 22' 57.20" N	80° 35' 26.72" W
123 Housing	25° 22' 55.11" N	80° 35' 27.87" W
124 Housing	25° 22' 53.80" N	80° 35' 29.13" W
Trailer Pads	25° 22' 59.48" N	80° 35' 37.74" W
Island Recycling Building	25° 22' 54.90" N	80° 35' 39.80" W
Metal Chickee	25° 23' 0.89" N	80° 35' 37.01" W

Figure 20. Wildland Urban Interface -Pine Island



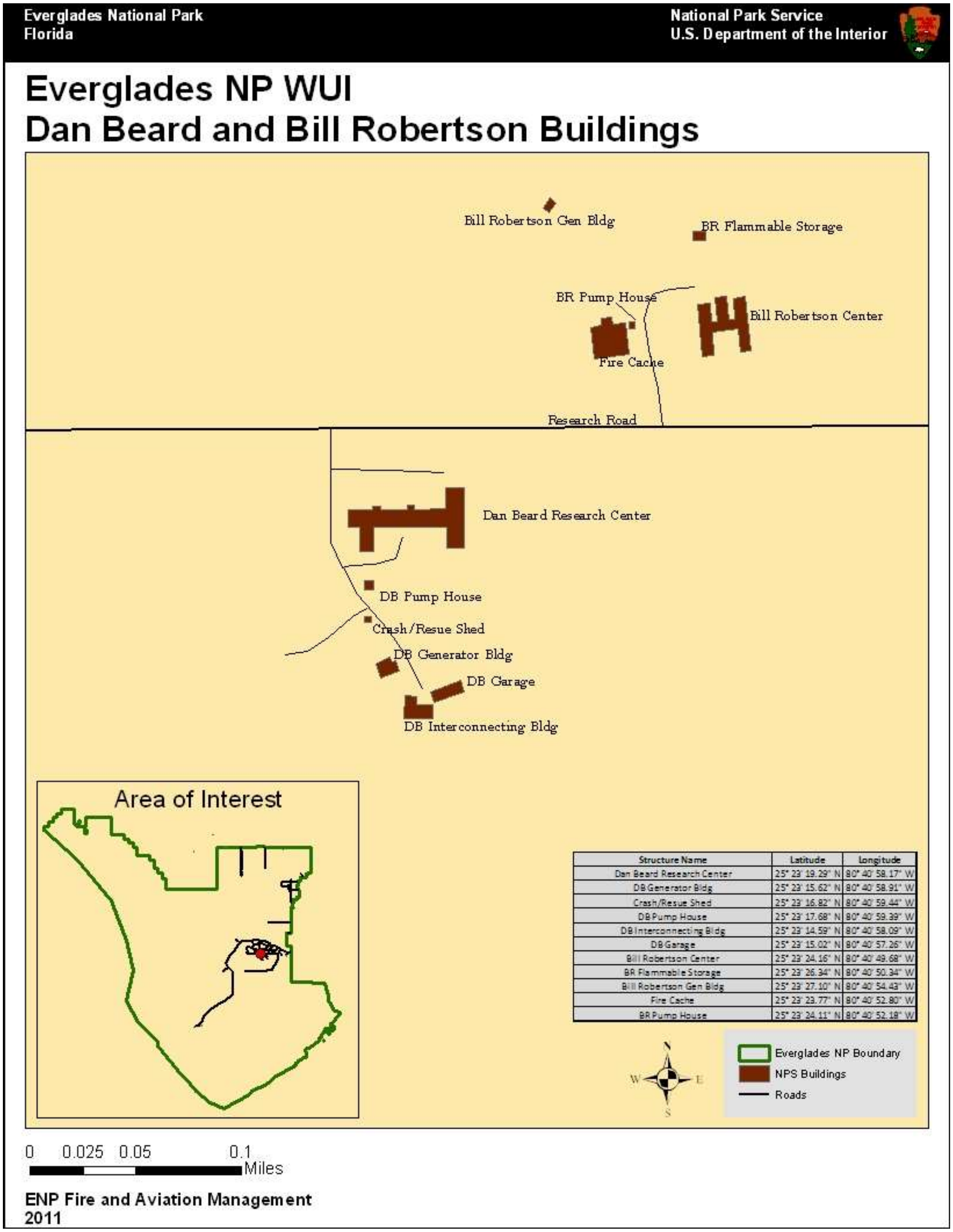
Structure Name	Latitude	Longitude
Pump House 1	25° 22' 58.73" N	80° 36' 37.86" W
Pump House 2	25° 23' 1.01" N	80° 36' 35.19" W
PIRPVC109 Royal Palm Visitor Center	25° 22' 56.81" N	80° 36' 34.52" W
Hidden Lake Shelter	25° 23' 14.03" N	80° 37' 11.80" W
Hidden Lake Chickee	25° 23' 15.64" N	80° 37' 10.45" W
Hidden Lake Comfort Station	25° 23' 13.72" N	80° 37' 12.38" W

Figure 21. Wildland Urban Interface- Royal Palm/Hidden Lake



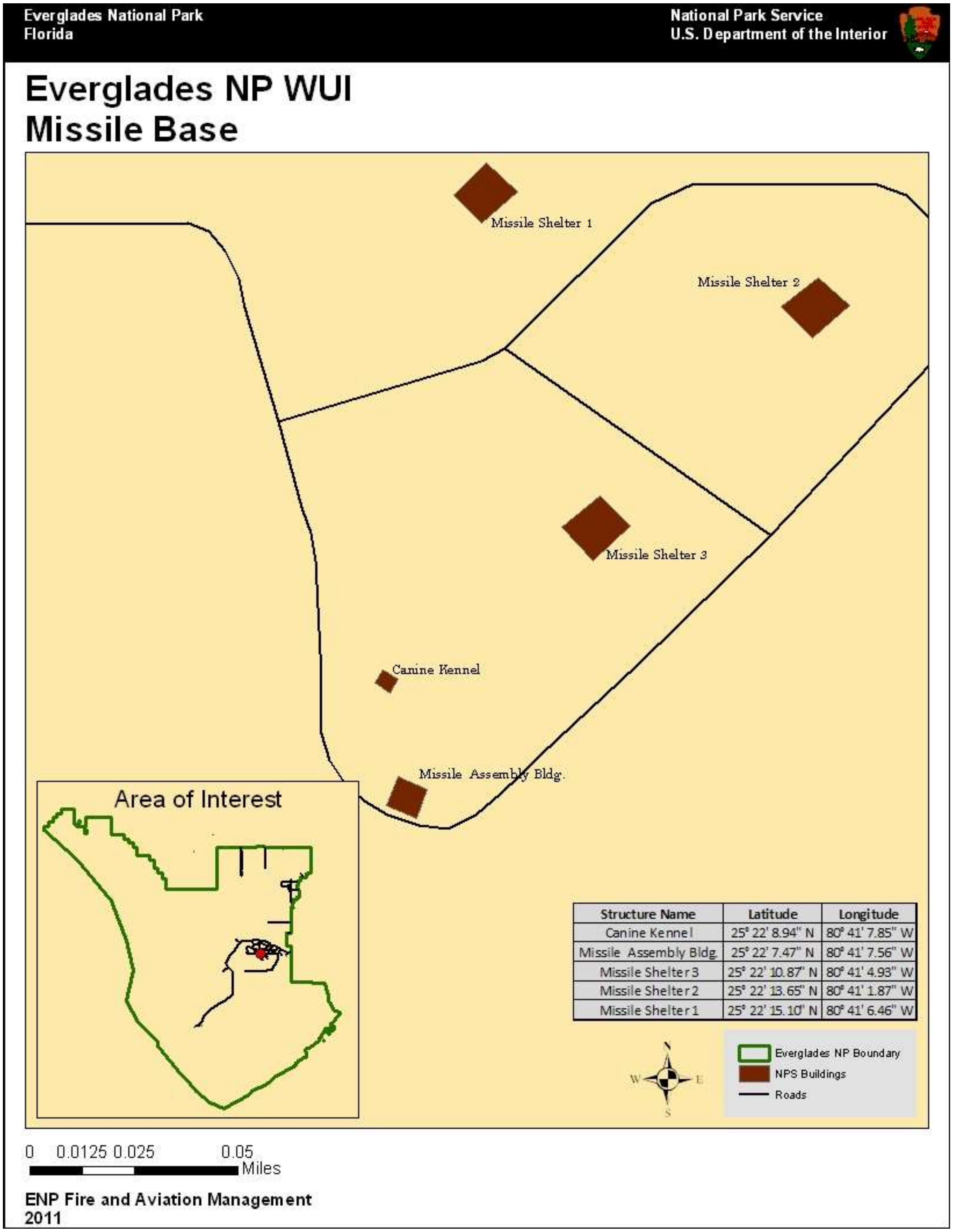
Structure Name	Latitude	Longitude
Camp Tender Residence	25° 24' 8.34" N	80° 39' 18.99" W
Pump House	25° 24' 6.19" N	80° 39' 22.23" W
Comfort Station 1	25° 23' 58.37" N	80° 39' 16.94" W
Comfort Station 2	25° 23' 53.59" N	80° 39' 20.51" W
Comfort Station 3	25° 23' 51.31" N	80° 39' 26.76" W
Comfort Station 4	25° 23' 49.58" N	80° 39' 33.02" W
Entrance Station	25° 24' 2.64" N	80° 39' 17.71" W
Comfort Station 5	25° 24' 1.98" N	80° 39' 29.87" W
Comfort Station 6	25° 24' 2.66" N	80° 39' 23.88" W

Figure 22. Wildland Urban Interface –Long Pine Key Campground



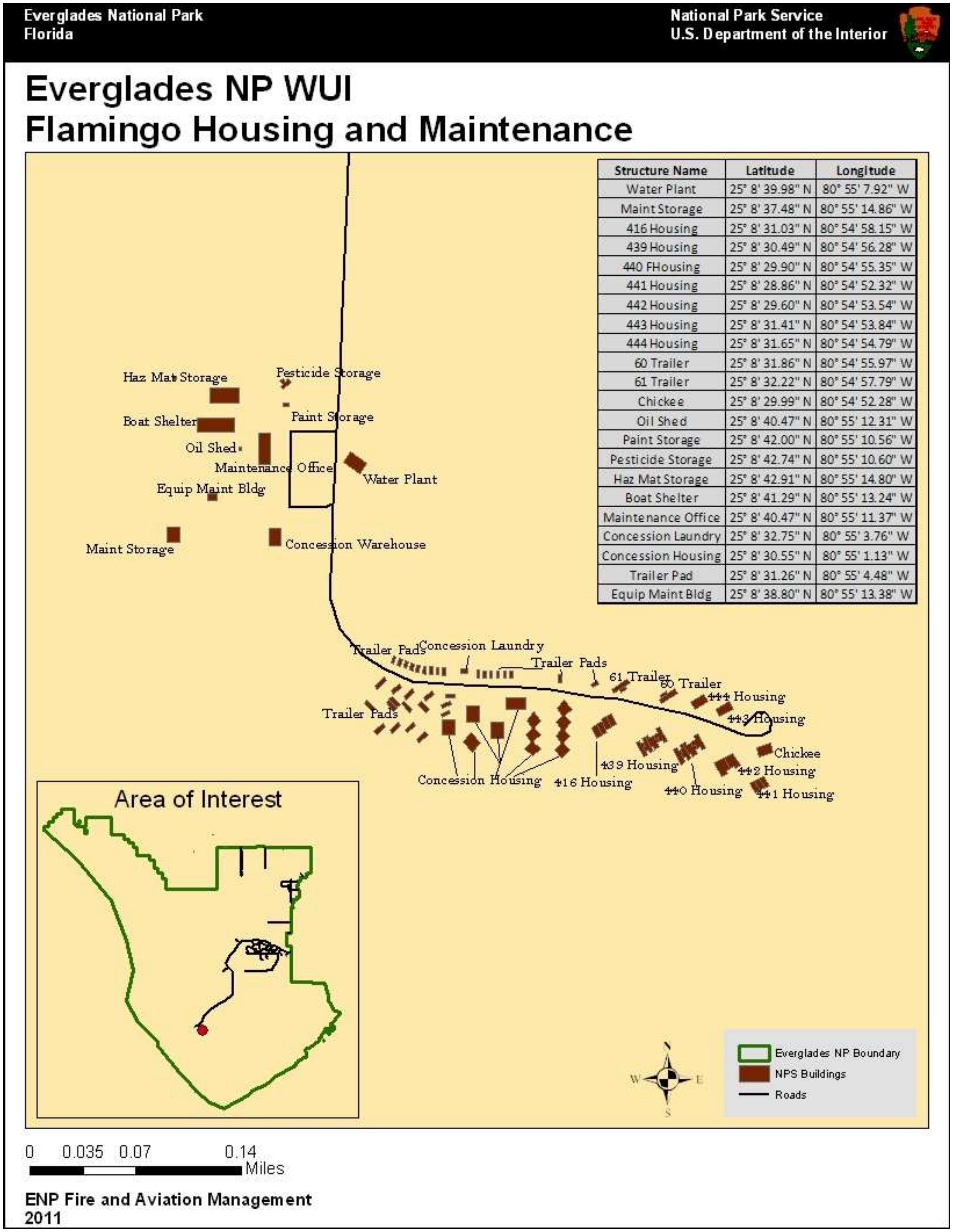
Structure Name	Latitude	Longitude
Dan Beard Research Center	25° 23' 19.29" N	80° 40' 58.17" W
DB Generator Bldg	25° 23' 15.62" N	80° 40' 58.91" W
Crash/Resue Shed	25° 23' 16.82" N	80° 40' 59.44" W
DB Pump House	25° 23' 17.68" N	80° 40' 59.39" W
DB Interconnecting Bldg	25° 23' 14.59" N	80° 40' 58.09" W
DB Garage	25° 23' 15.02" N	80° 40' 57.26" W
Bill Robertson Center	25° 23' 24.16" N	80° 40' 49.68" W
BR Flammable Storage	25° 23' 26.34" N	80° 40' 50.34" W
Bill Robertson Gen Bldg	25° 23' 27.10" N	80° 40' 54.43" W
Fire Cache	25° 23' 23.77" N	80° 40' 52.80" W
BR Pump House	25° 23' 24.11" N	80° 40' 52.18" W

Figure 23. Wildland Urban Interface –Daniel Beard & Robertson buildings



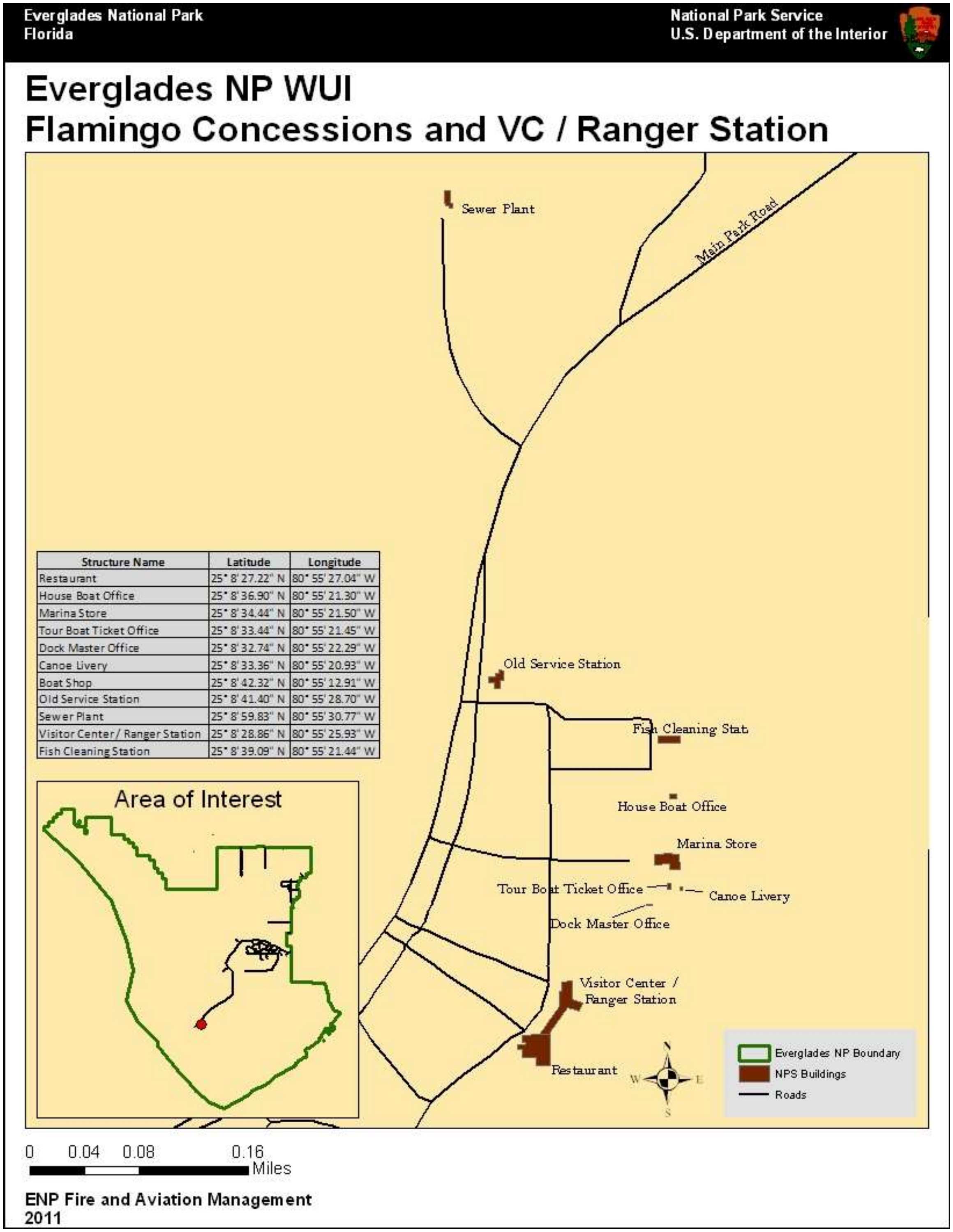
Structure Name	Latitude	Longitude
Canine Kennel	25° 22' 8.94" N	80° 41' 7.85" W
Missile Assembly Bldg.	25° 22' 7.47" N	80° 41' 7.56" W
Missile Shelter 3	25° 22' 10.87" N	80° 41' 4.93" W
Missile Shelter 2	25° 22' 13.65" N	80° 41' 1.87" W
Missile Shelter 1	25° 22' 15.10" N	80° 41' 6.46" W

Figure 24. Wildland Urban Interface -Missile Base



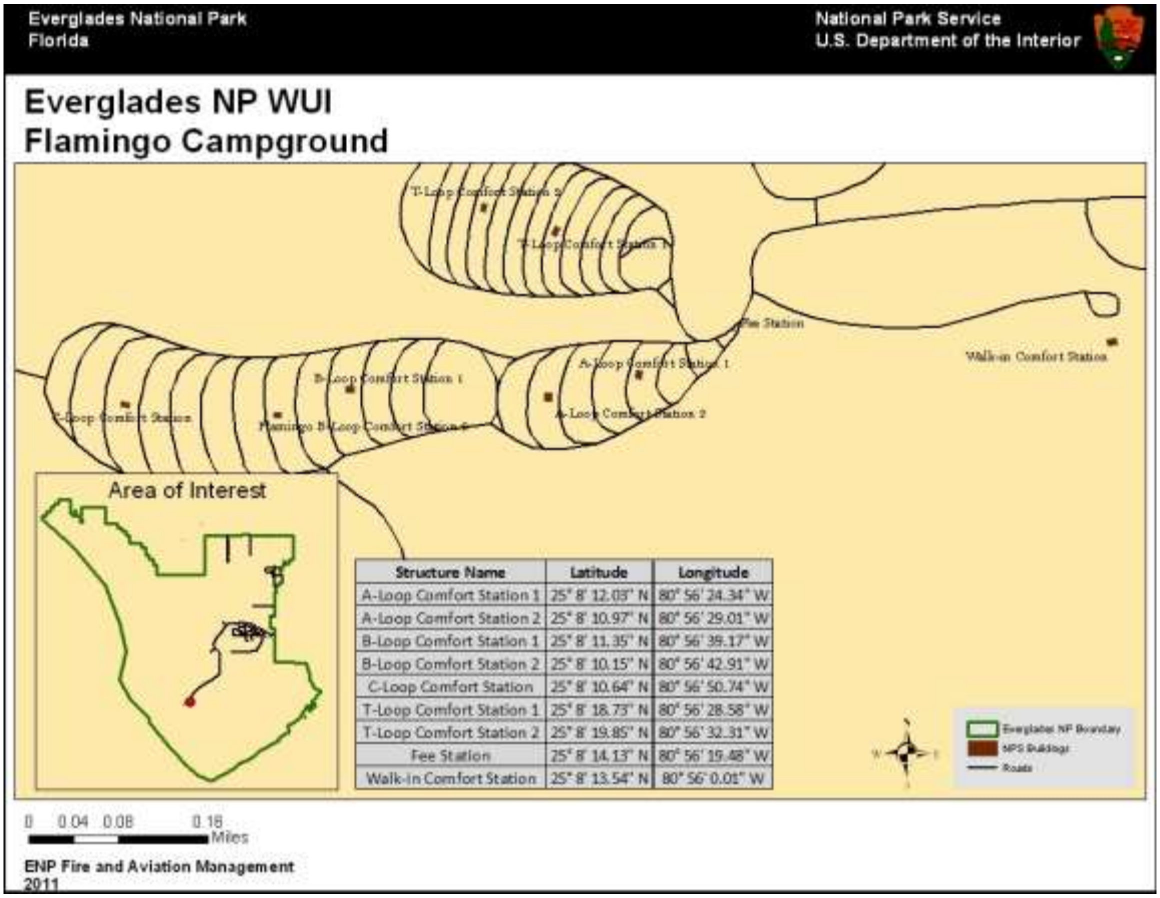
Structure Name	Latitude	Longitude
Water Plant	25° 8' 39.98" N	80° 55' 7.92" W
Maint Storage	25° 8' 37.48" N	80° 55' 14.86" W
416 Housing	25° 8' 31.03" N	80° 54' 58.15" W
439 Housing	25° 8' 30.49" N	80° 54' 56.28" W
440 FHousing	25° 8' 29.90" N	80° 54' 55.35" W
441 Housing	25° 8' 28.86" N	80° 54' 52.32" W
442 Housing	25° 8' 29.60" N	80° 54' 53.54" W
443 Housing	25° 8' 31.41" N	80° 54' 53.84" W
444 Housing	25° 8' 31.65" N	80° 54' 54.79" W
60 Trailer	25° 8' 31.86" N	80° 54' 55.97" W
61 Trailer	25° 8' 32.22" N	80° 54' 57.79" W
Chickee	25° 8' 29.99" N	80° 54' 52.28" W
Oil Shed	25° 8' 40.47" N	80° 55' 12.31" W
Paint Storage	25° 8' 42.00" N	80° 55' 10.56" W
Pesticide Storage	25° 8' 42.74" N	80° 55' 10.60" W
Haz Mat Storage	25° 8' 42.91" N	80° 55' 14.80" W
Boat Shelter	25° 8' 41.29" N	80° 55' 13.24" W
Maintenance Office	25° 8' 40.47" N	80° 55' 11.37" W
Concession Laundry	25° 8' 32.75" N	80° 55' 3.76" W
Concession Housing	25° 8' 30.55" N	80° 55' 1.13" W
Trailer Pad	25° 8' 31.26" N	80° 55' 4.48" W
Equip Maint Bldg	25° 8' 38.80" N	80° 55' 13.38" W

Figure 25. Wildland Urban Interface -Flamingo housing & Maintenance



Structure Name	Latitude	Longitude
Restaurant	25° 8' 27.22" N	80° 55' 27.04" W
House Boat Office	25° 8' 36.90" N	80° 55' 21.30" W
Marina Store	25° 8' 34.44" N	80° 55' 21.50" W
Tour Boat Ticket Office	25° 8' 33.44" N	80° 55' 21.45" W
Dock Master Office	25° 8' 32.74" N	80° 55' 22.29" W
Canoe Livery	25° 8' 33.36" N	80° 55' 20.93" W
Boat Shop	25° 8' 42.32" N	80° 55' 12.91" W
Old Service Station	25° 8' 41.40" N	80° 55' 28.70" W
Sewer Plant	25° 8' 59.83" N	80° 55' 30.77" W
Visitor Center / Ranger Station	25° 8' 28.86" N	80° 55' 25.93" W
Fish Cleaning Station	25° 8' 39.09" N	80° 55' 21.44" W

Figure 26. Wildland Urban Interface -Flamingo Concessions & VC Ranger Station



Structure Name	Latitude	Longitude
A-Loop Comfort Station 1	25° 8' 12.03" N	80° 56' 24.34" W
A-Loop Comfort Station 2	25° 8' 10.97" N	80° 56' 29.01" W
B-Loop Comfort Station 1	25° 8' 11.35" N	80° 56' 39.17" W
B-Loop Comfort Station 2	25° 8' 10.15" N	80° 56' 42.91" W
C-Loop Comfort Station	25° 8' 10.64" N	80° 56' 50.74" W
T-Loop Comfort Station 1	25° 8' 18.73" N	80° 56' 28.58" W
T-Loop Comfort Station 2	25° 8' 19.85" N	80° 56' 32.31" W
Fee Station	25° 8' 14.13" N	80° 56' 19.48" W
Walk-In Comfort Station	25° 8' 13.54" N	80° 56' 0.01" W

Figure 27. Wildland Urban Interface -Flamingo Campground

LOGISTICS

COMMUNICATION – MOBILIZATION GUIDE

A current Mobilization Guide for the Park can be found in the Dispatch office at the Robertson building and/or on the server: M:\2011 Mob Guide. This guide is reviewed and update annually.

1. **Phone lists**

Everglades Fire & Aviation Phone List

		PHONE	FAX
FIRE DISPATCH		305-242-7850	305-242-7855
AIRCRAFT DISPATCH		305-242-7868	305-242-7859
Main Park Dispatch/24Hr Emergency		305-242-7740	305-242-7729
East Everglades Fire Station		305-251-7064	305-251-0614
Fire Line @ H House		305-232-4421	or 305-251-0179
Helibase @ Homestead General Airport		305-246-9111	305-246-9197
Duty Officer after hours		305-242-7054	
East Everglades Rangers		305-251-6594	305-251-0614
Everglades Employee Hotline		305-242-7719	
NAME	EXT.	HOME	CELL #
Adams, Jennifer	7851	505-554-5486 ©	(305)338-6069
Anderson, Rick	7853	407-402-8564	305-546-9358
Barron, Mike - Pilot		954-385-5436	954-554-6705
Budzinski, Katie	305-251-7064		423-608-2519
Camblin, Clayton	7868		954-629-8771
Carnall, Gary	305-246-9112		305-242-1316
del Valle, Henry	305-246-9114	305-596-5445	786-352-7170
Densel, Darrell	305-251-7064	305-247-1004	305-898-0532
DesLiu, Ryan	7042		916-606-3874
Edwards, Pat	7857		208-863-2831
Foist, Bonnie	7739	305-245-9665	305-498-4297
Gill, Andrew	305-246-9111		435-668-2392
Graham, Bill	7041		863-448-2063
Holland, Colleen	7029		786-999-5511
Holland, Tristan	7053		786-999-5516
Hoopes, Erika	305-251-7064		253-820-3325
Hunkler, Lucas	305-251-7064		786-972-9860
Land, Aerin	7052		859-338-0644
Lane, Tracie	7056	305-775-9942	305-546-9352
Lindquist, Chris	7870		305-781-8706
Mahy, Alex	7870		305-510-4543
Markson, Sam	7870		210-378-6848
Martinez, Sergio	305-246-9111		687-490-5729
Newland, Steve	305-246-9111	305-247-4356	305-282-2514
Ott, Matt	7054	305-242-2063	305-972-1683
Rodriguez, Kenny	305-246-9111		786-738-3510
Stebner, John	305-251-7064	954-436-6368	305-395-0510
Trincado, Robert	305-251-5740	305-245-4239	305-972-4986
Tupai, Maya	7055	305-247-7712	480-518-2712
Weer, Jack	7057	305-393-5360	305-484-8058
Woody, Tim	305-251-5740	305-242-0876	305-972-4909

	PHONE	FAX
Big Cypress NP / FOC	239-695-9280	239-695-9284
FMO John Nobles	EXT. 104	239-777-9656©
AFMO		
Deep Lake	239-695-1052	239-695-1056
Oasis	239-695-1220	239-695-3493
Fire Dispatch Kevin Logiudice	239-695-1228	239-695-3493
Oasis Hanger	239-695-0278	
Prescribed Fire	EXT. 101	
HMGB Mike O'Leary x1266	239-695-1220	239-450-2481©
Biscayne NP	305-230-1144	
Scott Johnson	EXT. 3069	305-283-1951©
Seminole Agency - BIA	863-983-7029	863-983-7637
FMO Jeff Alter	863-860-0006	941-253-7049©
DOF- Everglades District	954-475-4120	954-475-4126
DOF Homestead Work Center	305-257-0875	
Gary Lewis (DOF)	954-347-8059©	
Florida Fish & Wildlife C.C.(FWC)	888-404-3922	
FL Panther Refuge- Work Center	239-657-7637	
FMO Cas Palmer	239-657-5476	239-253-6465
Fletcher Flying Service SEAT	863-675-3302	863-675-3725
Owner Steve Fletcher	239-860-2028	
Speed Aviation - Fixed Wing	305-451-5968	239-596-5249
Homestead General Airport	305-247-4883	
Tamiami Airport	305-256-7628	
FAA	305-716-1500	
Homestead Air Reserve	305-224-7023/7516 (comm tow)	
Miami- direct pilot contact	305-716-1648 or 1650	
EMERGENCY CONTACTS		
Florida Highway Patrol	305-470-2510	
LE # (not public)	305-718-6100	
Miami-Dade Fire Dept	305-596-8575	305-596-8448
Miami-Dade Fire/Police Dispatch	305-595-1201	
Miscellaneous		
National Weather Service	305-229-4523	
South Florida Water Management	305-377-7274	
Sato Travel & Gov Trip Assistance	866-486-6135	877-834-3459
Sato Emergency Travel Assistance	877-273-6040	877-834-3459
FICC	850-523-8600	850-523-8621
Boy Scout Camp #0084 Jim	786-473-0700	

2. **Radio Frequencies**

FIRE NORTH (Group 1)									
#	Name	RX	MODE	RX CG	RX NAC	TX	MODE	TX CG	TX NAC
1	EVERSIM	172.525	D		659	172.525	D		659
2	RESEARCH	172.525	D		1365	171.625	D		1365
3	PINCREST	172.525	D		1365	171.625	D		1462
4	EVERCITY	172.525	D		1365	171.625	D		1567
5	EVER FLT	169.725	D		1514	163.3875	D		1413
6	EASTEVER	172.525	D		1365	171.625	D		1622
7	FIRESIM	171.775	D		659	171.775	D		659
8	FIREREP	171.775	D		1567	172.775	D		1567
9	FIRE EE	171.775	D		1567	172.775	D		1273
10	RED	154.265	A			154.265	A		
11	WHITE	154.28	A			154.28	A		
12	BLUE	154.295	A			154.295	A		
13	AIRGUARD	168.625	A			168.625	A		

14	NAT FLT	168.65	A			168.65	A		
15	WEATHER	162.55	A						

FIRE SOUTH (Group 2)									
#	**Name**	**RX**	**MODE**	**RX CG**	**RX NAC**	**TX**	**MODE**	**TX CG**	**TX NAC**
1	EVERSIM	172.525	D		659	172.525	D		659
2	RESEARCH	172.525	D		1365	171.625	D		1365
3	FLAMINGO	172.525	D		1365	171.625	D		1273
4	KEYLARGO	172.525	D		1365	171.625	D		1188
5	EVER FLT	169.725	D		1514	163.3875	D		1413
6	EASTEVER	172.525	D		1365	171.625	D		1622
7	FIRESIM	171.775	D		659	171.775	D		659
8	FIREREP	171.775	D		1567	172.775	D		1567
9	FIRE EE	171.775	D		1567	172.775	D		1273
10	RED	154.265	A			154.265	A		
11	WHITE	154.28	A			154.28	A		
12	BLUE	154.295	A			154.295	A		
13	AIRGUARD	168.625	A			168.625	A		
14	NAT FLT	168.65	A			168.65	A		
15	WEATHER	162.55	A						

3. Key Contacts

Cooperator	Function
Big Cypress National Preserve	Adjacent Landowner Fire Assistance
Miami-Dade Fire Rescue	Fire Assistance
Florida Division of Forestry	Fire Assistance
Florida Interagency Coordination Center	Resource Mobilization/Situation Reporting
Florida Panther NWR	Fire Assistance

MEDICAL FACILITIES

Name	Address	Travel Time		Phone	Helipad		Trauma Center	Burn Level
		Air	Ground		Yes	No		

Homestead Hospital	975 Baptist Way, Homestead, FL N 25.25’50” W80.25’53”	10 min	60 min	786-243-8000	X			NO
Jackson Memorial	1611 NW 12th Avenue, Miami, FL N25.47’31” W80.12’44”	45 min	2.5 hours	305-585-1111	X		1	YES
Baptist Hospital	8900 North Kendal Drive, Miami, FL N25.40’01” W80.19’59”	20 min	1.5 hours	786-596-1960	X			NO

LOCKS/COMBINATIONS FOR GATES

Locks requiring a key:
Gates within the Park – resource management key
Gates along canals and levees outside the Park – chub key located on the key rings of all fire vehicles
Robertson Building – EA4, DBP1, & DBP2
Fire Cache/Iori Building – RM3
East Everglades – PP2

Locks requiring a combination:
Gates within the Park that are accessible with a combination lock can be obtained in the dispatch office.
Gates are located:
Boyscout Camp
Chekika
Gate at the main kiosk
Aerojet
Frog City

FIRE CACHE INVENTORY

Everglades NP has two caches: one located at the Robertson Building and one located at Homestead General. The fire cache is managed by the Captain of Engine 301. The airport cache is managed by the Aviation Manager. The Cache inventory is stored on the server at the Robertson Building: M:\Fire Cache\Current Cache Inventory

INCIDENT COMMAND POST (ICP)

Everglades NP does not have facilities in the Park that would be adequate locations for an ICP and/or a base camp. The nearest locations for these facilities are private buildings in Homestead or Florida City.

SERVICES AND SUPPLY

Business	Address	Phone	Contact	Service/Supply	Paid By
Holiday Inn Express	32500 S. Dixie Hwy. Florida City, FL 33034	305-347-3414	Rakesh Patel Manager	ICP and Rooms for Firefighters	Purchase Card - LS
The Floridian Hotel	990 N. Homestead Blvd., Homestead, FL 33030	305-247-7020	Diana	Rooms for Firefighters	Purchase Card - LS

Ramada Inn	124 E. Palm Drive, Florida City, FL 33034	304-247-8833		Rooms for Firefighters	Purchase Card - LS
Best Western	411 S. Krome Ave.	305-245-5100	Felix Camacho	Rooms for Firefighters	Purchase Card - LS
Farmers Market	300 N. Krome Ave. Florida City, FL 33034	305-242-0008	Anthony Bushemi	Lunches, Meals for Firefighters	Purchase Card - LS
Golden Corral	33525 S. Dixie Hwy. Homestead, FL 33034	305-246-8699	Jim Feliciano	Lunches, Meals for Firefighters	Purchase Card - LS
Cracker Barrel				Lunches, Meals for Firefighters	Purchase Card - LS
IHOP	399 Homestead Blvd. Homestead, FL 33033	561-632-0099	Joe	Lunches, Meals for Firefighters	Purchase Card - LS
Homestead Executive Jet Center	28790 SW 217 Ave. Homestead, FL 33033	305-248-3595	Darcy/Jillian	Aviation Command Center	Agreement #FL-EVP-008025_01
American Ice Co.	1350 W. Mowry St. Homestead, FL 33030	305-245-4777	Yvonne	Cooler & daily delivery of ice	Check needed
Port-O-Tech	224 NW 9th Ave. Homestead, FL 33030	305-258-0190		Portable toilets & handwash stations with daily service	Purchase Card - LJS
Enterprise Car Rental	29130 S. Dixie Hwy. Homestead, FL 33033	305-246-2056	Ty	Vehicles	Purchase Cards - Various
Dump All				Dumpsters	Purchase Card - LJS
A1A Ideal	3672 Coral Way Miami, FL 33145	305-310-5406	Gus	Copier	Purchase Card - LJS
Dion's Quick Mart	16 N. Krome Ave. Florida City, FL 33034	(305) 245-8981		Fuel for Rental Vehicles	Purchase Card - LJS
Carrousel Party Rental	Homestead, Fl	305-246-4626		Tent	Purchase Card - LS
Gatortrax Adventure Tours, Inc.	71 NE 97 St., Miami Shores, FL 33138	(305) 756-1000	Buddy	Bus to transport firefighters	Check - LW
American Laundry	30324 Old Dixie Hwy. Homestead, FL 33033	305-248-0827	Leonard	Laundry service for cache & firefighters	Purchase Card - LS

Appendix L
Planned Treatment Notification

Everglades National Park
Fire & Aviation Management

Prescribed Fire Notification, subject to favorable conditions

Prescribed Fire Name:
Prescribed Fire Location:
Primary Objective:
Planned Ignition Date:
Planned Ignition Time:
Target Acreage:

Map Insert

If you have questions or need more information regarding this prescribed fire, please contact Everglades Fire Dispatch at 305-242-7850.