Biological Opinion and Conference Opinion

CORAL REEF COMMONS PROJECT
INCIDENTAL TAKE PERMIT
TE15009C-0

FWS Log #: 04EF1000-2017-F-0699

Prepared by:

U.S. Fish and Wildlife Service
North Florida Ecological Services Field Office
7915 BAYMEADOWS WAY, SUITE 200
JACKSONVILLE, FLORIDA 32256-7517

Jay Herrington, Field Office Supervisor

11/30/2017
Date

TABLE OF CONTENTS

Abbreviations/Acronyms iii
EXECUTIVE SUMMARY v
CONSULTATION HISTORY vii

BIOLOGICAL OPINION AND CONFERENCE OPINION 1

1. INTRODUCTION 1

2. PROPOSED ACTION 4

3. INFORMATION COMMON TO MULTIPLE SPECIES AND CRITICAL HABITAT ANALYSES 21

4. BARTRAM'S SCRUB-HAIRSTREAK BUTTERFLY 30

5. FLORIDA LEAFWING BUTTERFLY 49

6. CRITICAL HABITAT for BARTRAM'S SCRUB-HAIRSTREAK BUTTERFLY and FLORIDA LEAFWING BUTTERFLY 53

7. MIAMI TIGER BEETLE 67

8. EASTERN INDIGO SNAKE 89

9. GOPHER TORTOISE 96

10. RIM ROCK CROWNED SNAKE 103

11. FLORIDA BONNETED BAT 109

12. DELTOID SPURGE 128

13. TINY POLYGALA 135

14. OTHER LISTED PLANTS 140

15. CRITICAL HABITAT FOR CARTER'S SMALL-FLOWERED FLAX and FLORIDA BRICKELL-BUSH 163

16. INCIDENTAL TAKE STATEMENT 172

17. CONSERVATION RECOMMENDATIONS 173

18. REINITIATION NOTICE 173

19. LITERATURE CITED 174

Abbreviations/Acronyms

Applicants	Coral Reef Retail LLC, Coral Reef Resi PH I LLC, Ramdev LLC, and the University of Miami
BMP	Best Management Practices
BO/CO	Biological Opinion/Conference Opinion
BSHB	Bartram's scrub hairstreak butterfly
CSFF	Carter's small-flowered flax
CFR	Code of Federal Regulations
CH	Critical Habitat
Corps	United States Army Corps of Engineers
CRC	Coral Reef Commons Project
DOD	U.S. Department of Defense
EEL	Environmentally Endangered Lands
ENP	Everglades National Park
ESA	Endangered Species Act of 1973
FSPSP	Fakahatchee Strand Preserve State Park
FBB	Florida bonneted bat
FB-B	Florida brickell-bush
FDOT	Florida Department of Transportation
FWC	Florida Fish and Wildlife Conservation Commission
GIS	Geographic Information System
HOA	Home Owner Association
HCP	Habitat Conservation Plan
HCP Plan Area	All areas within the boundary of CRC and the Off-site Mitigation Area (188.86 ac)
HVU	Habitat Value Unit (unit of measure in the habitat functional assessment)
ITP	Incidental Take Permit
IENSA	Illuminating Engineering Society of North America
Leafwing	Florida leafwing butterfly
MDC	Miami-Dade County
MTB	Miami tiger beetle
NCA	National Climate Assessment
NFC	Natural Forest Community
NFESO	North Florida Ecological Services Office, U.S. Fish and Wildlife Service
NOAA	National Oceanic and Atmospheric Administration
Preserves	On-site Preserve Areas, and Off-site Preserve
PBF	Physical and biological features (pertaining to critical habitat designation)
PCE	Primary constituent elements (pertaining to critical habitat designation)
Ram Coral Reef	Coral Reef Retail LLC, Coral Reef Resi PH I LLC, and Ramdev LLC
RO	Southeast Regional Office, United States Fish and Wildlife Service
Richmond Area	Approximately a 4-square mile area, roughly bound by S.W. 152nd Street to S.W. 184th Street, and S.W. 117th Avenue to S.W. 137th Avenue in which the CRC Property and Off-site Mitigation Area are located Dade County
Service	United States Fish and Wildlife Service
SFESO	South Florida Ecological Services Office, U.S. Fish and Wildlife Service

SOCSOUTH	U.S. Army Special Operations Command Center South
UM	University of Miami
USCG	United States Coast Guard
USDA	United States Department of Agriculture

EXECUTIVE SUMMARY

This Endangered Species Act (ESA) Biological Opinion and Conference Opinion (BO/CO) of the U.S. Fish and Wildlife Service (Service) addresses our pending decision whether to issue Incidental Take Permit (ITP) TE15009C-0 to the proponents of the Coral Reef Commons (CRC) Project (the Applicants) in response to their ITP application and its associated Habitat Conservation Plan (HCP) (the Action). ESA §10(a)(1)(B) provides the authority to issue an ITP, which exempts lawful non-federal actions from prohibitions against taking endangered and threatened species.

To comply with ESA §7(a)(2), the BO herein provides the Service's findings as to whether this ITP Action is likely to jeopardize the continued existence of endangered or threatened species, or result in the destruction or adverse modification of designated critical habitat. The CO herein provides equivalent findings relative to certain species that are not listed as endangered or threatened. Compliance with the ITP would exempt the taking of the non-listed species if and when each is listed as endangered or threatened during the permit period.

The Applicants propose to construct and operate a mixed-use residential and commercial development in Miami-Dade County, Florida. The CRC development plan includes about 900 residential units, stores and other commercial buildings, a school, associated landscaping, and infrastructure improvements that would collectively occupy 86.49 acres. The Applicants request that the ITP for the CRC development and its associated HCP cover the following 22 species (the Covered Species):

Common Name	ESA Classification
Animals	
Bartram's scrub-hairstreak butterfly	endangered
eastern indigo snake	threatened
Florida bonneted bat	endangered
Florida leafwing butterfly	endangered
gopher tortoise	candidate - Florida threatened
Miami tiger beetle	endangered
rim rock crowned snake	none - listing petition pending
white-crowned pigeon	none - Florida threatened
Plants	
Blodgett's silverbush	threatened
Carter's small-flowered flax	endangered
clamshell orchid	none - Florida endangered
crenulate lead-plant	endangered
deltoid spurge	endangered
Everglades bully	threatened
Florida brickell-bush	endangered
Florida bristle fern	endangered
Florida pineland crabgrass	threatened

Florida prairie clover	endangered
Garber's spurge	threatened
sand flax	endangered
Small's milkpea	endangered
tiny polygala	endangered

In the HCP, the Applicants propose various conservation measures to minimize the impacts of CRC construction and operation to the Covered Species. To mitigate the unavoidable impacts to the Covered Species, the Applicants propose to restore and manage 51.41 acres in four on-site Preserves adjacent to the development area, plant 3.88 acres with native species in several "Stepping Stone" areas within the development footprint, and expand the conservation management on a 50.96-acre off-site Preserve.

The Applicants determined that the Action is not likely to adversely affect the white-crowned pigeon and the clamshell orchid. Due to the small extent of potential habitat, no evidence that either species is reasonably certain to occur in the HCP plan area, and the likelihood that management of the proposed Preserves would benefit these species should they occur in the plan area during the permit period, the Service concurs with these determinations.

For the other 20 Covered Species, the BO/CO reviews their status, baseline conditions within the HCP plan area, effects of the Action, and cumulative effects. Our BO/CO concludes for each species that the Action is not likely to jeopardize its continued existence.

Critical habitat designated for four of the Covered Species occurs in the HCP plan area: Bartram's scrub-hairstreak butterfly, Florida leafwing butterfly, Carter's small-flowered flax, and Florida brickell-bush. The BO/CO reviews the status of these critical habitats, baseline conditions within the HCP plan area, effects of the Action, and cumulative effects. For each designation, our BO/CO concludes that the Action is not likely to destroy or adversely modify critical habitat.

These findings with respect to the 22 Covered Species and their designated critical habitats fulfill the consultation requirements under ESA §7(a)(2) that are applicable to the Service's Action.

When a BO concludes that a proposed Federal action would not violate ESA §7(a)(2), the Service must provide a statement concerning incidental take. The proposed CRC HCP and its associated documents identify impacts to the Covered Species that are likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the proposed HCP, together with the terms and conditions of any ITP the Service issues, are incorporated by reference in the Incidental Take Statement of this BO as reasonable and prudent measures and terms and conditions. Such terms and conditions are non-discretionary. The amount or extent of incidental take anticipated under the proposed CRC HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying ITP.

CONSULTATION HISTORY

This section lists key events and correspondence during the course of this consultation, which involved three offices of the U.S. Fish and Wildlife Service (Service):

- South Florida Ecological Services Field Office (SFESO);
- Southeast Regional Office, Ecological Services (RO); and
- North Florida Ecological Services Field Office (NFESO).

The SFESO provided technical assistance to the Applicants (Ramdev LLC, Coral Reef Retail LLC, Coral Reef Resi PH I LLC and the University of Miami) during development of their Incidental Take Permit (ITP) application and the associated Coral Reef Commons Habitat Conservation Plan (CRC HCP). The RO has decision authority for issuing ITPs in the Service's Southeast Region. The RO assigned the role of consulting office for this intra-Service consultation to the NFESO, with technical assistance as necessary from the SFESO.

On July 15, 2014, the SFESO contacted Ram Realty Services to express concern about the potential for the proposed CRC development to take species that are protected under the Endangered Species Act (ESA). This letter initiated a series of meetings and discussions between the SFESO and the Applicants, which resulted in the development of the CRC HCP.

The Applicants provided several drafts of the HCP to the SFESO:

1) May 2015;
2) May 31, 2016;
3) August 31, 2016;
4) January 20, 2017; and
5) February 24, 2017.

On March 23, 2017, the Service published a Notice of Availability in the Federal Register announcing the receipt of the Applicants' ITP application, including the HCP, and providing the Service's Environmental Assessment (EA) for public comment. The Service accepted comments from March 23–May 22, 2017. We received over 3,000 comments.

On April 27, 2017, the Service conducted a public information webinar from 7:00–8:00 pm, during which we explained our ITP application review process under the ESA and associated responsibilities under NEPA. The Applicants' representatives presented information about their Project proposal. We received additional comments following the webinar, which we combined with those received during the comment period for the HCP and EA.

Following the close of the public comment period and webinar, the Service and Applicants discussed the comments received and potential changes to the HCP. On October 16, 2017, the Applicants submitted their final HCP for Coral Reef Commons.

The RO initiated intra-service consultation with the NFESO on August 30, 2017. The NFESO holds the complete record of this consultation, *i.e.*, the record upon which this opinion is based. The SFESO holds the record of technical assistance with the Applicants prior to receipt of the ITP application. The RO holds the record of the Service's decision about the ITP application.

BIOLOGICAL OPINION AND CONFERENCE OPINION

1. INTRODUCTION

A biological opinion (BO) is the document that states the opinion of the U.S. Fish and Wildlife Service (Service) under section 7 of the Endangered Species Act of 1973, as amended (ESA), as to whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated critical habitat (CH).

The proposed Federal action addressed in this BO is the Service's issuance of an Incidental Take Permit (ITP) to the proponents of the Coral Reef Commons (CRC) Project (Ramdev LLC, Coral Reef Retail LLC, Coral Reef Resi PH I LLC and the University of Miami; collectively, the Applicants), in response to their ITP application and the associated Habitat Conservation Plan (HCP) (the Action). This document also contains a conference opinion (CO) that similarly addresses the effects of the Action on certain species identified in the HCP that are not classified as endangered or threatened.

This BO/CO addresses the Action as proposed in the Applicants' HCP. The Service's decision under ESA section 10(a)(1)(B) to issue the requested ITP is presented and analyzed in a separate findings memorandum, that will rely, in part, on the findings of this BO/CO.

The Applicants prepared the ITP application and HCP with technical assistance from the Service's South Florida Ecological Services Office. The authority to issue ITPs in the Service's Southeast Region resides with the Southeast Regional Office (RO). The RO has requested consultation with the North Florida Ecological Services Field Office (NFESO) to review the Action for compliance with ESA §7(a)(2), which is a permit issuance criterion. For this intra-Service consultation and conference, the RO is proposing the Federal Action, and the NFESO is providing the opinion for the Action.

Covered Species

The Applicants request that the ITP cover the following 22 species (the Covered Species):

Common Name	Scientific Name	ESA Classification
Animals		
Bartram's scrub-hairstreak butterfly (BSHB)	*Strymon acis bartrami*	endangered
eastern indigo snake	*Drymarchon couperi*	threatened
Florida bonneted bat (FBB)	*Eumops floridanus*	endangered
Florida leafwing butterfly	*Anaea troglodyta floridalis*	endangered
gopher tortoise	*Gopherus polyphemus*	candidate - Florida threatened
Miami tiger beetle (MTB)	*Cicindelidia floridana*	endangered

rim rock crowned snake	*Tantilla oolitica*	none - listing petition pending
white-crowned pigeon	*Patagioenas leucocephala*	none - Florida threatened
Plants		
Blodgett's silverbush	*Argythamnia blodgettii*	threatened
Carter's small-flowered flax (CSFF)	*Linum carteri* var. *carteri*	endangered
clamshell orchid	*Encyclia cochleata* var. *triandra*	none - Florida endangered
crenulate lead-plant	*Amorpha crenulata*	endangered
deltoid spurge	*Chamaesyce deltoidea* ssp. *deltoidea*	endangered
Everglades bully	*Sideroxylon reclinatum* ssp. *austrofloridense*	threatened
Florida brickell-bush (FB-B)	*Brickelia mosieri*	endangered
Florida bristle fern	*Trichomanes punctatum* ssp. *floridanum*	endangered
Florida pineland crabgrass	*Digitaria pauciflora*	threatened
Florida prairie clover	*Dalea carthagenensis* var. *floridana*	endangered
Garber's spurge	*Chamaesyce garberi*	threatened
sand flax	*Linum arenicola*	endangered
Small's milkpea	*Galactia smallii*	endangered
tiny polygala	*Polygala smallii*	endangered

Concurrence with "Not likely to Adversely Affect" Determinations

In an intra-Service consultation/conference on an ITP decision, the HCP serves as the document describing the manner in which the Action may affect the Covered Species. The Applicants determined that the Action may affect all 22 of the Covered Species, but determined that the Action is not likely to adversely affect the white-crowned pigeon (*Patagioenas leucocephala*) and the clamshell orchid (*Encyclia cochleata* var. *triandra*). Both species are not presently listed under the ESA.

The white-crowned pigeon breeds on mangrove islands, and feeds primarily in tropical hardwood hammocks, and to a lesser extent in pinelands, and has not been observed within the HCP plan area. The clamshell orchid grows on the trunks and branches of trees in swamps and hammocks and was not detected in rare plant surveys of the CRC property. The HCP plan area includes 3.72 acres of rockland hammock on the CRC property. Due to:

(a) the small extent of potential hammock habitat;
(b) no evidence that either species is reasonably certain to occur in the HCP plan area; and
(c) the likelihood that management of the proposed Preserves would benefit these species should they occur in the plan area during the permit period;

the Service concurs with the Applicants' determinations for the pigeon and the orchid. Therefore, our CO for the Action does not address the pigeon and the orchid, and this concurrence fulfills the Service's responsibilities as an action agency under ESA §7(a)(2) with respect to these species.

Biological Opinion and Conference Opinion Framework

For the five animal species named above as Covered Species that are presently classified as endangered or threatened under the ESA, the Action would authorize take that may occur incidental to implementation of the CRC HCP consistent with the permit conditions. Our BO for the Action addresses these five animal species.

The ESA and its implementing regulations do not prohibit take of animal species that are not classified as endangered or threatened. However, the Action would authorize take of the three animal species named above that are not presently listed if and when each is listed while the proposed 30-year ITP is effective. Take authorization in an ITP in advance of ESA listing considers that an animal species is already listed, and that all conservation measures applicable to that species described in the HCP are fully implemented for the duration of the permit. An ITP may authorize take of animal species that is otherwise lawful in advance of ESA listing if the Service determines that the action is not likely to jeopardize the continued existence of such species. Our CO for the Action addresses the gopher tortoise and rim rock crowned snake.

ESA §10(a)(1)(B), which provides the authority for issuing an ITP, does not apply to listed plant species. ESA §9(a)(2) prohibits certain acts with respect to endangered plant species, including:

(a) remove and reduce to possession from areas under Federal jurisdiction;
(b) maliciously damage or destroy on areas under Federal jurisdiction; and
(c) remove, cut, dig up, or damage or destroy on any other area in knowing violation of any law or regulation of any State or in the course of any violation of a State criminal trespass law.

Regulations issued under ESA §4(d) extend the prohibition under (a) above to threatened plant species (50 CFR §17.71). The damage or destruction of endangered and threatened plants that is incidental to (not the purpose of) an otherwise lawful activity is not prohibited. A Federal action that is likely to jeopardize the continued existence of listed plant species is not lawful; therefore, our BO evaluates the effects of the Action to the 14 listed plant species included in the Covered Species.

ESA §10(a)(1)(B) does not apply to designated CH. However, a Federal action that is likely to destroy or adversely modify designated CH is not lawful; therefore, our BO also evaluates the effects of the Action to CH. Within the areas that are included in the HCP, the Service has designated CH for two of the listed animal species and for two of the listed plant species:

- Bartram's scrub-hairstreak butterfly;
- Florida leafwing butterfly;
- Carter's small-flowered flax; and
- Florida brickell-bush.

A BO/CO evaluates the effects of a Federal action along with those resulting from interrelated and interdependent actions, and from non-Federal actions unrelated to the proposed action (cumulative effects), relative to the status of listed species and the status of designated CH. A Service opinion that concludes a proposed Federal action is *not* likely to jeopardize species and is *not* likely to destroy or adversely modify CH fulfills the Federal agency's responsibilities under §7(a)(2) of the ESA.

"*Jeopardize the continued existence*" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02). "*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of designated CH for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features (PBFs) essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

Document Organization

We have organized this BO/CO using hierarchical numeric section headings. Primary (level-1) sections are labeled sequentially with a single digit (*e.g.*, 11. FLORIDA BONNETED BAT). Secondary (level-2) sections within each primary section are labeled with two digits (*e.g.*, 2.1. Action Area), and so on for level-3 and level-4 sections.

Section 2 describes the proposed Action. Section 3 provides information that is common to our analyses for several of the species and CHs, including our assessment of cumulative effects, which we reference thereafter as necessary. Sections 4–15 contain our review of the species' or CH's status, environmental baseline, effects of the Action, and our conclusion, in the following order: (a) insects and their critical habitat (sections 4–7); (b) reptiles (sections 8–10); (c) Florida bonneted bat (section 11); and (d) plants and their critical habitat (sections 12–15).

Our review of CH for the two butterfly species is combined in section 6, and for two of the listed plant species in section 15. We review plants for which the HCP documents occurrence within the Action Area in section 12 and 13. We combine our review of the remaining 11 plant species that may be dormant in the seed bank of the Action Area in section 14. Sections 16–19 are the standard ending sections of a BO/CO: Incidental Take Statement, Conservation Recommendations, Reinitiation Notice, and Literature Cited.

2. PROPOSED ACTION

Three corporations (Ramdev LLC, Coral Reef Retail LLC, and Coral Reef Resi PH I LLC) and the University of Miami (UM) (collectively, the Applicants) have applied to the Service for a 30-year Incidental Take Permit (ITP) covering the Coral Reef Commons Project (CRC) in unincorporated Miami-Dade County (MDC), Florida (application no. TE15009C-0). The proposed Federal action addressed in this BO/CO is the Service's Southeast Regional Office (RO) issuance of an ITP in response to this application and the associated Habitat Conservation

Plan (HCP) (the Action). As we explained in the Introduction, the Service's NFESO has prepared this BO/CO for the required intra-Service consultation under ESA §7.

Our description of the Action throughout this section 2 of the BO/CO is based on the HCP, required as part of the Applicants' request to the Service for an ITP. A determination that the incidental taking associated with implementing the HCP, as proposed, is not likely to jeopardize the continued existence of species covered under the ITP is a criterion for permit issuance. The Service must also ensure that the Action would not jeopardize the continued existence of listed plant species or adversely modify designated CH.

The Applicants propose to construct and operate a mixed-use residential and commercial development. The CRC development plan includes about 900 residential units, stores and other commercial buildings, a school, associated landscaping, and infrastructure improvements (*e.g.*, improvements to the existing main road through the development) that would collectively occupy 86.49 acres. The Applicants propose in the HCP to restore and manage 51.41 acres in four on-site Preserves, plant 3.88 acres with native species in several "Stepping Stone" areas within the development footprint (labeled collectively as "On-site Conservation Areas" in the HCP), and manage a single 50.96-acre off-site Preserve (labeled as the "Off-site Mitigation Area" in the HCP) (HCP Table 1-0). We refer to the conservation areas in this BO/CO as the Stepping Stones, the on-site Preserves, and the off-site Preserve. Revenue from the CRC development would fund the restoration and perpetual conservation management of these conservation areas. The stated purpose of the Stepping Stones and the Preserves is to offset the adverse effects on the Covered Species resulting from CRC construction and operation. Table 2-1 reports the acreage of the CRC development and its associated Preserves as proposed in the HCP (note: all tables and figures for section 2 are included at the end under section 2.6).

This BO/CO considers the environmental changes that the Action is reasonably certain to cause that are relevant to the Covered Species and the four designated CHs we identified in the Introduction (section 1), except for the two species (white-crowned pigeon and clamshell orchid) for which we concur with the Applicants' "not likely to adversely affect" determination. In the following sections, we organize our description of the Action and our analysis of effects to these species and CHs (sections 4–15) according to where and when Action-caused changes are likely to occur, in either:

a) the development areas during CRC construction;
b) the development areas following CRC construction, resulting from operations over the 30-year duration of the ITP; or
c) the Preserves and Stepping Stones, resulting from initial restoration activity and management for the duration of the ITP.

In this Proposed Action section, we repeat (as necessary) or summarize aspects of the Applicants' HCP document that are relevant to formulating the Service's BO for the Action. We evaluate the Applicants' preferred alternative only among the six described in the HCP document, which is the proposal the Service must consider for permit issuance. Please refer to the HCP for additional details about the CRC development proposal.

2.1. Action Area

For purposes of consultation under ESA §7(a)(2), the action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR §402.02). The "Action Area" for this consultation is the 188.86-acre "Plan Area" described in the Applicants' HCP, which is located in Sections 25 and 26, Township 55, Range 39, in unincorporated MDC, Florida (Figure 2-1).

Smoke from proposed prescribed burning in the on- and off-site Preserves may extend beyond the immediate Plan Area of the HCP. The increase in human activity associated with the CRC development would affect the surrounding urbanized areas. However, delineating the extent of such effects outside of the Plan Area is not necessary to formulate this opinion, as we do not expect any such effects to influence the status of the Covered Species or their designated CH outside the HCP Plan Area. Therefore, our use of the term Action Area in this BO/CO coincides with the Applicants' 188.86-acre Plan Area.

The Action Area is centrally located within the coastal developed portion of MDC. Most of the existing habitat within the Action Area for the Covered Species and the plants considered in this BO/CO is pine rockland habitat with varying degrees of disturbance and degradation. Pine rockland habitat is a rare and diminishing upland habitat type found only in Florida and the Bahamas.

The Action Area is comprised of two non-contiguous land parcels:

a) the 137.90-acre CRC property, which contains the CRC development (86.49 acres) and the on-site Preserves (51.41 acres); and
b) the 50.96-acre parcel that serves as the off-site Preserve (referred to as the "Off-site Mitigation Area" in the HCP), which is located about 2,000 feet southeast of the CRC property on lands associated with the Richmond Campus of the University of Miami (UM).

Figure 2-2 is an annotated aerial photo at a larger scale than Figure 2-1 that shows both parcels.

2.1.1. Land Cover

The 137.90-acre CRC property presently contains a mix of:

- developed areas (33.30 acres);
- uplands dominated mostly by exotic hardwoods (20.91 acres);
- pine rockland habitat (79.97 acres) of variable quality based on time since fire and exotic plants cover; and
- rockland hammock (3.72 acres).

Section 2.3 of the HCP describes existing conditions in these cover types. The 50.96-acre off-site Preserve on UM property (Richmond Campus) is entirely pine rockland habitat.

The proposed Action would expand the existing development footprint within the Action Area from 33.30 acres to 86.49 acres. Within the expanded development footprint, the Applicants would establish several "Stepping Stone" habitats with a total area of 3.88 acres. New

development would occur on the CRC property within: (a) the existing developed areas; (b) all 20.91 acres of upland exotic hardwood habitat; and (c) 32.28 acres of the pine rockland habitat. The Applicants propose to protect and manage for conservation purposes the remaining 47.69 acres of pine rockland habitat and 3.72 acres of rockland hammock habitat on the CRC property, the 3.88 acres of Stepping Stone habitats, and the 50.96-acre off-site Preserve, as described in section 2.4 below.

2.2. CRC Construction

The Action involves construction and other related activities to create a mixed-used residential and commercial development on the CRC property of the Action Area. The CRC development plan includes about 900 residential units, stores and other commercial buildings, a school, landscaping, and infrastructure improvements (*e.g.*, improvements to the existing main road through the development) that would collectively occupy 86.49 acres, including all 33.30 acres of existing developed portions of the Action Area. As we noted in section 2.1.1, the expansion of developed areas within the Action Area would occur on 20.91 acres of upland exotic hardwood habitat and 32.28 acres of pine rockland habitat. Therefore, the primary environmental change caused by construction that we examine in this BO is the permanent loss of 53.19 acres of existing habitat.

The Applicants propose four categories of conservation measures intended to reduce impacts to the Covered Species and other resources that are caused by construction:

1) pre-construction surveys for the Florida bonneted bat (FBB) and listed plant species that would inform subsequent pre-construction actions to reduce impacts;
2) construction worker education about requirements of the HCP;
3) general and resource-specific best management practices (BMPs); and
4) building and landscaping design elements.

Category #4 above is described in the "Operations" section of the HCP (section 6.2.3), but we include it here with our description of proposed construction, because some of the proposed operational conservation measures apply to how development features are designed and built, not how they are operated. We summarize the all of the proposed construction conservation measures in the following sections. Please refer to section 6.2.2 and section 6.2.3 of the HCP for additional details.

2.2.1. Pre-Construction Surveys

Florida Bonneted Bat

Existing developed portions of the Action Area contain buildings and other structures that the Applicants propose to demolish before CRC construction begins. These structures and trees slated for removal in construction areas may provide roosts for FBBs. The Applicants propose to survey construction areas for FBB roosts less than 60 days before construction commences. Methods for the surveys and follow-up actions based on survey results are described in section 6.2.2.1 of the HCP, which we discuss in greater detail in section 11 of this BO.

Plants

The Applicants commissioned and completed a rare plant and floristic survey of the CRC property in 2014. The results of this survey are provided in Appendix D of the HCP. Also in 2014, the Applicants lawfully authorized Fairchild Tropical Botanic Gardens to collect seeds from, take cuttings, and remove numerous plants from the areas proposed for construction, including three specimens of the endangered tiny polygala. A listing of the species and number of plants involved in this activity is provided in Appendix E of the HCP.

The Applicants propose no further plant surveys or plant salvage in the construction areas. The removal of some, but not all, tiny polygala from the construction areas has already occurred. Therefore, we consider this change in the Action Area as part of the environmental baseline of this BO and not as an effect of the proposed Action.

2.2.2. Construction Worker Education

The Applicants would ensure that construction personnel are aware of the requirements of the ITP by:

a) providing the general contractor a copy of the ITP and Covered Species identification materials;
b) requiring the general contractor to include the ITP and Covered Species identification materials in all sub-contractors' contracts;
c) displaying at the entrance and within the construction areas large weather-resistant posters with information about the ITP and Covered Species; and
d) providing laminated cards to workers for quick identification of Covered Species.

The Applicants' educational material is provided in Appendix E1 of the HCP.

2.2.3. Best Management Practices

The Applicants would ensure that contractors and construction workers implement the following BMPs during construction:

1) Eastern Indigo Snake Standard Protection Measures (HCP Appendix H);
2) the same measures as under #1 above with additional identification and education materials for the rim rock crowned snake;
3) post and enforce vehicle speed limits of 15 mph within the CRC property;
4) install silt fencing around all ground disturbing activities;
5) stage construction materials and equipment within previously disturbed areas located outside of the on-site Preserves boundaries;
6) survey and flag the limits of construction activity before commencing construction;
7) mark the boundaries of all on-site Preserves boundaries with orange fencing at least 3 feet tall and secured with a minimum of 1 x 1-inch wood stakes or steel rods;
8) post signs every 300 feet along the on-site Preserves boundaries stating "Nature Preserve Area – Unauthorized Access Prohibited";
9) Storm Water Pollution Prevention Plan (SWPPP) required under the National Pollutant Discharge Elimination System permit, which will specify site-specific BMPs to prevent

runoff into the on-site Preserves (SWPPP template included as Appendix H1 of the HCP);

10) prohibit pets on-site during construction;
11) report all observations of Covered Species to the HCP Coordinator, who will relay these observations to the Service;
12) direct light required for night-time construction or safety toward the intended target for illumination and not toward the on-site Preserves; and
13) follow Florida Fish and Wildlife Conservation Commission (FWC) requirements for relocating any gopher tortoises found on site during construction.

2.2.4. Development Design

Firewise Design

To accommodate prescribed burning in the East and West Preserves, the Applicants propose to follow "firewise" construction and landscaping guidelines posted at www.firewise.org. Specifically, the layout of the development and landscaping would observe the Home Ignition Zone guidance about establishing and maintaining a defensible space between residential units and the on-site Preserves where the prescribed fire would occur. Further, CRC construction plans include fire hydrants placed strategically along the on-site Preserves boundaries to use during prescribed burns and to suppress any wildfires.

Dog Park

To minimize free-roaming dogs on the CRC property, the development design includes a fenced dog park located away from the on-site Preserves. Residents may allow dogs off-leash on the CRC property only within this dog park.

Structures

Building designs would incorporate features that discourage bats and other wildlife from using development structures for roosting and nesting.

Outdoor Lighting

The Applicants propose to install lighting for streets and parking lots that comply with applicable municipal requirements, and that achieve the Illuminating Engineering Society of North America (IESNA) "cutoff" classification. An IESNA cutoff light fixture directs light mostly downward, emitting no more than 10 percent of the total luminous intensity above 80 degrees from nadir (vertical line between the fixture and the ground), and no more than 2.5 percent above 90 degrees from nadir (horizontal plane at the light source).

2.3. CRC Operations

Commercial and residential use of the CRC development (*i.e.*, long-term operations) following construction would change the levels of noise, traffic, pets, garbage, artificial lighting, and

pesticide use within the developed portions of the Action Area. People and buildings in close proximity to conservation areas, such as the proposed on- and off-site Preserves, may also limit the application of prescribed fire in such areas. We evaluate in this BO/CO the extent to which these changes may affect the Covered Species and other species within the habitats of the Action Area (the on-site Preserves and Stepping Stones) following construction. To reduce the impacts of CRC operations, the HCP proposes: (a) several community practices; (b) measures that would facilitate prescribed burning in the East and West on-site Preserves; and (c) several pest management practices.

2.3.1. Community Practices

CRC property management would implement and enforce the following practices on the CRC property.

1) Post a speed limit of 15 mph within the residential complex and 25 mph within the commercial areas.
2) Prohibit unleashed pets.
3) Obtain written acknowledgment from all tenants (commercial and residential) of receipt and acceptance of:
    a. CRC pet and waste disposal regulations; and
    b. CRC pesticide use and storage regulations.
4) Provide waste and recycling containers throughout the community and commercial areas, and contract with a service to maintain these containers.
5) Use native and non-invasive plant species in all landscaping.
6) Provide tenants identification materials for the Covered Species.
7) Educate tenants about eastern indigo snakes and gopher tortoises and request tenants to report any observations of these animals in the community to the HCP Coordinator.

2.3.2. Firewise Community

CRC property management and the HCP Coordinator would take the following steps to make the CRC development a “firewise” community.

1) Require all lessees, property owners, and/or tenants to sign documentation acknowledging that fire management activities will occur on the CRC property and on adjacent properties in the Richmond Area.
2) Post signs at the entrance of the CRC property giving notice of the expected dates of prescribed burning in the East and West Preserves.
3) Provide to designated contacts of adjacent landowners and Home Owner Associations (HOAs) the HCP Administrative Report that includes the recommendations for prescribed fire on the Preserves.
4) Notify the HOA President of residential communities within 0.5 mile to the north in advance of CRC prescribed burns.
5) Post signs along SW 152nd Street with planned dates of burns.
6) Provide upon request electronic or hard copies of the HCP Administrative Report, which would document on-site Preserves management and prescribed burning.

2.3.3. Pesticide Use

The Applicants propose to identify pest problems in the developed portions of the CRC property and take appropriate action as needed. When such action requires the use of pesticides (insecticides, fungicides, rodenticides, herbicides, etc.), the Applicants propose to apply the standards and practices listed below.

1) All contractors and workers will receive educational and species identification materials referenced in the construction section of the HCP (described in section 2.2.2 of this BO).
2) All pesticide use and storage will comply with the label instructions.
3) Application of insecticides within the Stepping Stone habitats (which are embedded within the developed areas) is restricted to those that target insects that are problematic to the Covered Species.
4) Contractors and workers will maintain all pesticide application equipment in good working order and check all equipment for leaks and malfunctions before use.
5) Contractors and workers will rinse pesticide application equipment in a manner to minimize drainage into waterbodies.

Mosquito control is not part of the proposed HCP. The Applicants state that the MDC Mosquito Control District would provide any mosquito control within the CRC property (HCP section 8.3.4). We discuss in section 2.5 (Interrelated and Interdependent Actions) our understanding of how MDC mosquito control in the Action Area would occur.

2.4. Preserves and Stepping Stones Management

Section 7 of the HCP describes the habitat enhancement goals, design, and methods for the Applicants' proposed conservation program within the Action Area, which includes the on- and off-site Preserves and the Stepping Stones of native species plantings within the development footprint. Section 6.2.4 of the HCP describes practices the Applicants would apply to avoid and minimize adverse effects to the Covered Species that may occur while restoring and managing the on- and off-site Preserves. We summarize both HCP sections in this section of the BO to provide an overview of the CRC conservation program. As necessary, we reference additional details from the HCP within the effects analyses for particular species.

The CRC conservation program is comprised of the following components:

1) FBB roost surveys prior to initiating management and at bat boxes;
2) conditions and practices applicable to management of the on-site Preserves and Stepping Stones;
3) on-site Preserves;
4) Stepping Stones of native species landscaping within the developed areas;
5) off-site Preserve; and
6) community education and outreach.

The education and outreach component of the conservation program overlaps with the education and outreach activities described previously for CRC construction and operations but is focused more specifically on communicating the conservation purposes of the Preserves and Stepping Stones. Please refer to section 7.3 of the HCP for additional details.

The Applicants' plans for the Preserves and Stepping Stones include habitat management actions, conditions and practices applicable to those actions, conservation success criteria, monitoring to measure success, and legal encumbrances to secure the Preserves (on- and off-site) as conservation lands in perpetuity. The stated goal of the Preserves and Stepping Stones is to fully offset the impacts of incidental take of the Covered Species caused by the CRC development and provide a net conservation benefit.

The Service will review the proposed encumbrances for the Preserves to ensure that they would meet ITP issuance criteria for conservation assurances. In this BO, we consider that the proposed encumbrances would secure a conservation purpose for the Preserves for the duration of the ITP and do not address them further. We describe the plans for the conservation areas in the following sections.

2.4.1. Florida Bonneted Bat Surveys

The Applicants propose to conduct surveys for Florida bonneted bat roosts in both the on- and offsite Preserves less than 60 days before canopy thinning and fuel reduction activities, which would precede the initial prescribed burns (HCP Section 6.2.4.1). Burn crews would establish a 100-foot buffer around any occupied roosts, within which crews would remove understory vegetation by hand, limit chemical use, rake fine fuels away from the base of the roost structure, and create a wet line.

2.4.2. Conditions and Practices Applicable to the Preserves

Section 6.2.4 of the HCP describes conditions and practices the Applicants' propose to apply to activities conducted within the Preserves. General conditions include:

1) standard protection measures for the eastern indigo snake, adapted and applied also for the rim rock crowned snake;
2) a coordination protocol for annual Preserves management planning and reporting;
3) prohibiting all unauthorized access to the Preserves; and
4) marking and signage for the on-site Preserve boundaries.

Additional conditions and practices proposed in the HCP address:

1) on-site prohibitions for contractors (5 listed);
2) contractor education;
3) land management activities (29 listed); and
4) smoke management (14 listed).

Some of the land management conditions and practices mirror the BMPs proposed for CRC construction and operations (*e.g.*, the general conditions governing pesticide use), but provide additional specificity appropriate within the Preserves. We reference details about these conditions and practices as necessary in the applicable effects analyses of this BO.

2.4.3. On-Site Preserves

The Applicants propose to protect and manage for conservation purposes 51.41 acres of the CRC property in four permanent on-site Preserves, named in the HCP as the East, West, Southern Corridor, and Rockland Hammock Preserves. Table 2-2 lists the existing and proposed land cover conditions in these areas, and Figure 2-3 is an aerial photo of the property showing the location of the on-site Preserves.

To enhance existing habitat conditions for the Covered Species within the on-site Preserves, the Applicants propose to reduce and control invasive exotic plants, plant native pine rockland species, periodically burn the ground cover of the East and West Preserves, and install bat boxes to support Florida bonneted bat roosting. The Applicants propose to monitor the on-site Preserves to determine whether success criteria for habitat enhancement are achieved.

Invasive Exotic Plant Management

The pine rockland and rockland hammock habitats on the CRC property are degraded to varying degrees with invasive exotic plants, including Burma reed, Brazilian pepper, ear-leaf acacia, and Australian pine. The Applicants' plan to reduce and control these invasive plants involves a combination of herbicides, cutting and removal by mechanical methods, and prescribed fire. The particular combination and sequence of these treatments varies according to the distribution and density of the target species. Section 7.5 of the HCP describes the methods planned for particular management units within the on-site Preserves, subject to the conditions described in section 6.2.4 of the HCP.

Pine Rockland Planting

Planting pine rockland plant species is proposed initially for the 0.39-acre of sod along the southern boundary of the CRC property, and as needed elsewhere within the on-site Preserves to achieve the success criteria. Species include those listed as pine rockland species in Appendix I of the HCP, forage plants for the Bartram's scrub-hairstreak butterfly listed in Table 7-2 of the HCP, and possibly others that are native to the area and associated with pine rocklands. If available, plantings would include tiny polygala and deltoid spurge.

Prescribed Burning

The Applicants propose prescribed burning within 45.24 acres (88.6 percent) of the East and West Preserves on a 3–7-year rotation by management unit. Burning is not proposed for the Rockland Hammock area on the northern edge of the CRC property, or for the Southern Corridor. The prescribed burning program is described in Appendix J of the HCP.

The burn plan describes measures to avoid and minimize harm to the FBB and the Miami tiger beetle (MTB) caused by the use of prescribed fire. Burn crews would reduce fuel, limit chemical use, and create a wet line around any FBB roost trees identified during surveys (see section 2.4.1). Most burns would occur between October and December to avoid the flight period of the MTB.

Although pineland croton responds well to prescribed fire, burning a large fraction of the on-site Preserves in a relatively short period could substantially reduce its availability as a forage and larval host plant for the Bartram's scrub-hairstreak butterfly. Therefore, burn crews would create a 0.5-acre wet line around pineland croton patches during the first burns of some of the management units that support this species.

Bat Boxes

The Applicants propose to install, monitor, and maintain six bat boxes in the on-site Preserves to provide roosting opportunities for FBB. Installation of all six boxes, two per year, would occur within 3 years of permit issuance, after completing the initial burn of the on-site Preserves. The Applicants would coordinate with the Service to determine the specific locations for the boxes, considering the potential for disturbance and other factors. The Applicants would inspect and maintain the boxes during the annual monitoring events, and report any use of the boxes to the Service and the FWC.

Success Criteria and Monitoring

The purpose of the on-site Preserves is to enhance existing habitat conditions for the Covered Species. Several of the Covered Species are strongly associated with pine rockland habitats, and 88.6 percent of the on-site Preserves are degraded pine rockland habitats. Pine rockland is a fire-adapted habitat with a sparse slash pine canopy, an understory of palms and tropical shrubs, and a partial ground cover of native grasses and wildflowers on thin soils over limestone. Without periodic fire, invasive exotic plant species fill the voids of the otherwise relatively open physical structure of the habitat, which serves the breeding, feeding, and sheltering behaviors of several Covered Species. Therefore, success criteria for the on-site Preserves involve measures of the physical structure and the species composition of habitats following restoration and management.

Successful restoration and management of the on-site Preserves would exhibit the following characteristics (from Table 7-3 of the HCP):

Characteristic	Success Measure
1) Canopy cover	1–15%
2) Total cover of non-native plants	< 5%
3) Fire frequency	3–7 yr
4) Bare rock or soil cover	25%
5) Pine rockland desirable herbaceous species cover	≥ 85%
6) Pineland croton density	9–17 plants/acre

The Applicants' describe the proposed monitoring for these criteria in section 7.6 of the HCP. Success in restoring the Rockland Hammock Preserve on the north edge of the CRC property is measured only by criterion #2 above, where the goal is to largely eliminate exotic species. Quantitative monitoring would occur annually until the success criteria are achieved, and every 5 years thereafter. Qualitative monitoring would occur annually for the duration of the ITP. Failure

to achieve the success criteria would prompt adjustments to the management plans and activities. The Applicants anticipate success within 3–5 years of ITP issuance.

2.4.4. Stepping Stones

At several locations within and along the margins of the 86.49-acre CRC development footprint, the Applicants propose to plant pine rockland species on a total of 3.88 acres (4.5 percent of the footprint) (see Figure 2-3). These Stepping Stones are intended to enhance connectivity between the on-site Preserves, primarily for the Bartram's scrub-hairstreak butterfly. Section 7.2 of the HCP describes the plantings, invasive species management, success criteria and monitoring for the Stepping Stones.

The primary species (50–75 percent coverage) for planting in the Stepping Stones is pineland croton, along with saw palmetto and a variety of pine rockland herbaceous species. Success is considered achieving and maintaining more than 85 percent coverage by desirable pine rockland species (less than 15 percent invasive exotics), assessed by annual qualitative monitoring.

2.4.5. Off-Site Preserve

The proposed off-site Preserve is a contiguous 50.96-acre parcel on the UM Richmond Campus (see Figure 2-2). This area is pine rockland habitat that is already designated for conservation purposes, but without regular fire, has become overgrown (canopy closure in some portions and ground cover exceeds levels desired for conservation purposes). The Applicants propose to expand the existing conservation deed restriction and implement a 3–7 year rotation prescribed burning plan on 45.60–48.65 acres (89–95 percent) of the property to enhance its conservation value for the Covered Species.

Appendix J1 of the HCP contains the off-site Preserve burn plan. The plan calls for thinning the pine trees in some areas and fuel reduction in others by mowing and other mechanical methods, but not by roller chopping. BMPs that apply to burning methods, equipment, and smoke management on the off-site Preserve align with those declared for the on-site Preserves. Burn crews would reduce fuel, limit chemical use, and create a wet line around any Florida bonneted bat roost trees identified during surveys (see HCP section 6.2.4.1). As with burning for the on-site Preserves, burning for the off-site Preserve would occur preferentially in the months of October–December to avoid the flight period for the MTB.

2.5. Interrelated and Interdependent Actions

A BO/CO evaluates the effects of a proposed Federal action. For purposes of consultation under ESA §7(a)(2), the effects of a Federal action on listed species or CH include the direct and indirect effects of the action, plus the effects of interrelated or interdependent actions. "Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration" (50 CFR §402.02).

We have considered whether mosquito control in the Action Area, which is not proposed in the Applicants' HCP, is a non-federal action that is interrelated with the proposed Action. The Applicants state in their HCP that the MDC Mosquito Control District would provide mosquito control within the CRC property.

MDC does not currently control mosquitos by aerial or truck spraying within the pine rocklands of the Richmond area, including the CRC property. The Service provides technical assistance to MDC Mosquito Control about avoiding and minimizing the adverse effects of its program to listed species. Based on this assistance, MDC Mosquito Control established in 2015 no-spray buffers of 250 meters (m) for truck-based applications and 400 m for aerial applications around occupied designated CH for the Bartram's scrub-hairstreak butterfly (BSHB). MDC has not applied for an ITP that would exempt its mosquito control operations from ESA §9 prohibitions against taking ESA-listed species.

The introduction of 900 residential units, a school, and commercial activity in the CRC development could prompt a departure from the established MDC no-spray zones. Residents may expect the same mosquito control practices that other urbanized portions of the County receive and contact MDC Mosquito Control to request spraying. The proposed on-site Preserves are completely within BSHB CH and completely within a 250 m buffer around the CRC development. Pesticides would drift into the on-site Preserves if sprayed by truck within the development area, and would kill individuals of the three ESA-listed insects that we consider in this consultation. Impacts from spraying insecticides within the CRC development would negate partially or wholly the conservation value of the Applicants' proposed HCP for the listed insect species.

In a meeting at the Service's RO on October 18, 2017, the Service and the Applicants discussed the limitations of mosquito spraying in the CRC development considering the current MDC Mosquito Control commitment to observe no-spray buffers around occupied BSHB CH. The Applicants understand that continued implementation of the MDC no-spray buffers would limit mosquito control within the CRC community to spot treatments at source locations, such as open water containers. Section 6.2.3.3 of the HCP states that the Applicants expect any Service-imposed requirement on MDC Mosquito Control to apply to the CRC property.

The current MDC no-spray zones represent a voluntary conservation measure to protect the BSHB and other species within occupied BSHB CH, and not a Service-imposed requirement. However, MDC Mosquito Control confirmed to the Service that it intends to continue to observe the BSHB no-spray buffers (Vasquez 2017). Combined with the Applicants' commitment in the CRC HCP to minimize impacts to the Covered Species within the development areas and to enhance habitat conditions within the Preserves, we do not expect MDC mosquito control to affect the Covered Species in the Action Area. We are unaware of any other actions that are interrelated or interdependent to the proposed Action; therefore, we do not discuss such actions further in this BO/CO.

2.6. Tables and Figures for Proposed Action

Table 2-1. Land components of the CRC-HCP (source: HCP Table 1-0).

CRC HCP Component	Acres
CRC Property	
Development Areas (minus the embedded "Stepping Stone" habitats)	82.61
Stepping Stones (native-species landscaping within the Development Areas)	3.88
Total Development Footprint	86.49
On-site Preserves	
West Preserve	23.92
East Preserve	21.61
Southern Corridor	2.16
Rockland Hammock	3.72
Total On-Site Preserves	51.41
Total CRC Property	137.90
Off-Site Preserve (University of Miami Richmond Campus)	50.96
Total Conservation Areas (On-Site & Off-Site Preserves + Stepping Stones)	106.25
Total CRC HCP Area (Development Areas + Conservation Areas)	188.86

Table 2-2. On-site Preserves (excluding the Stepping Stones within the proposed development areas) existing and proposed conditions (source: HCP Table 7-1).

Existing Condition	Proposed Condition	Acres
Pine rockland - degraded	Pine rockland - enhanced	
Less than 50% Burma reed		15.22
Burma reed dominated		19.22
Historically scraped with pine canopy		5.33
Historically scraped with pine canopy, Burma reed dominated		4.68
Fire suppressed		1.13
Severely fire suppressed, Burma reed dominated		1.16
Historically scraped w/o canopy		0.32
	Subtotal	47.06
Cleared and sodded	Pine rockland plantings	0.39
Historically marl prairie, exotic dominated	Upland - enhanced	0.13
Rockland hammock, Burma reed dominated		3.72
	Subtotal	3.85
Impervious surface	Firebreak and preserve access	0.11
	Total on-site Preserves	51.41

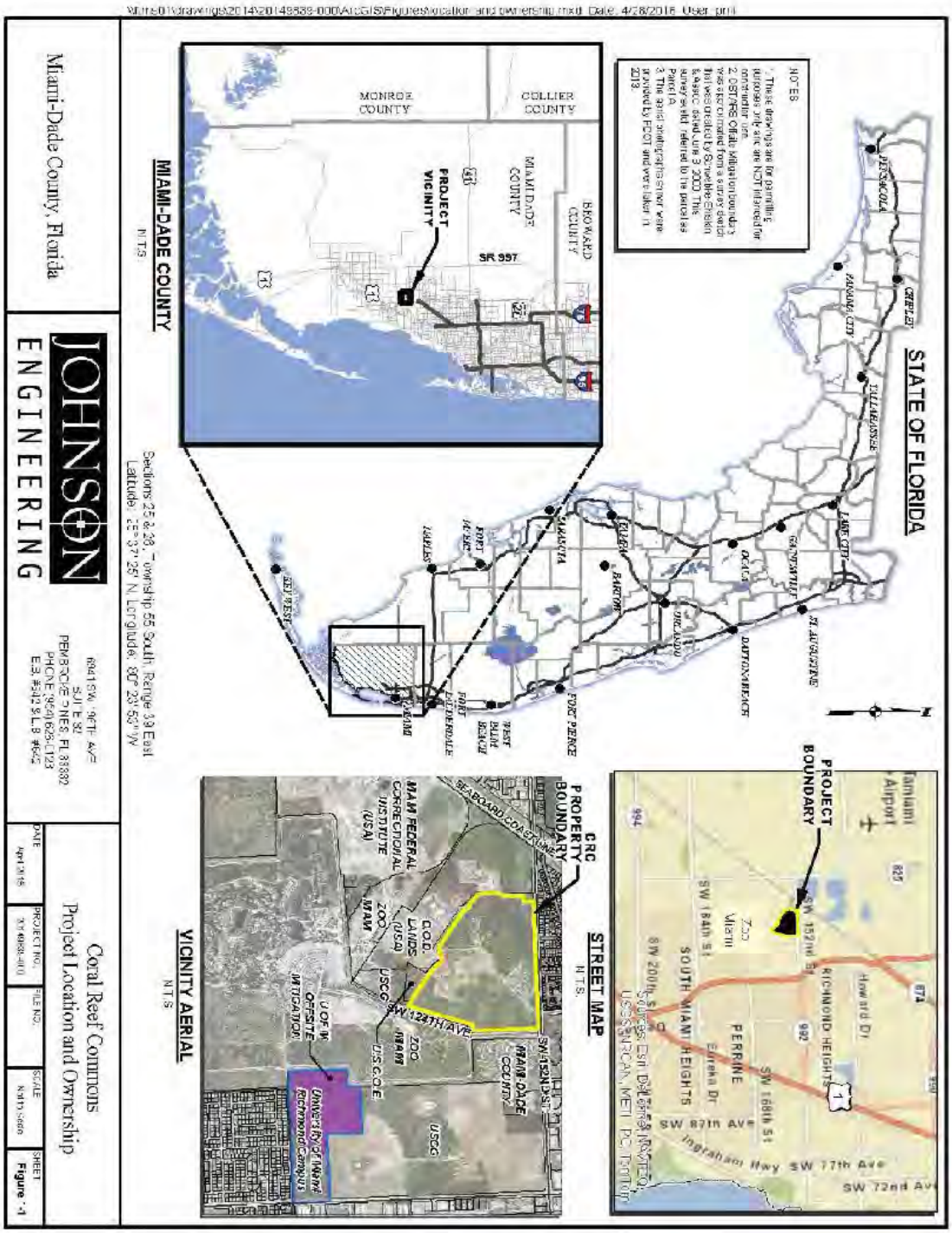

Figure 2-1. Maps showing the location of the areas included in the Coral Reef Commons Habitat Conservation Plan (source: HCP Figure 1-1).

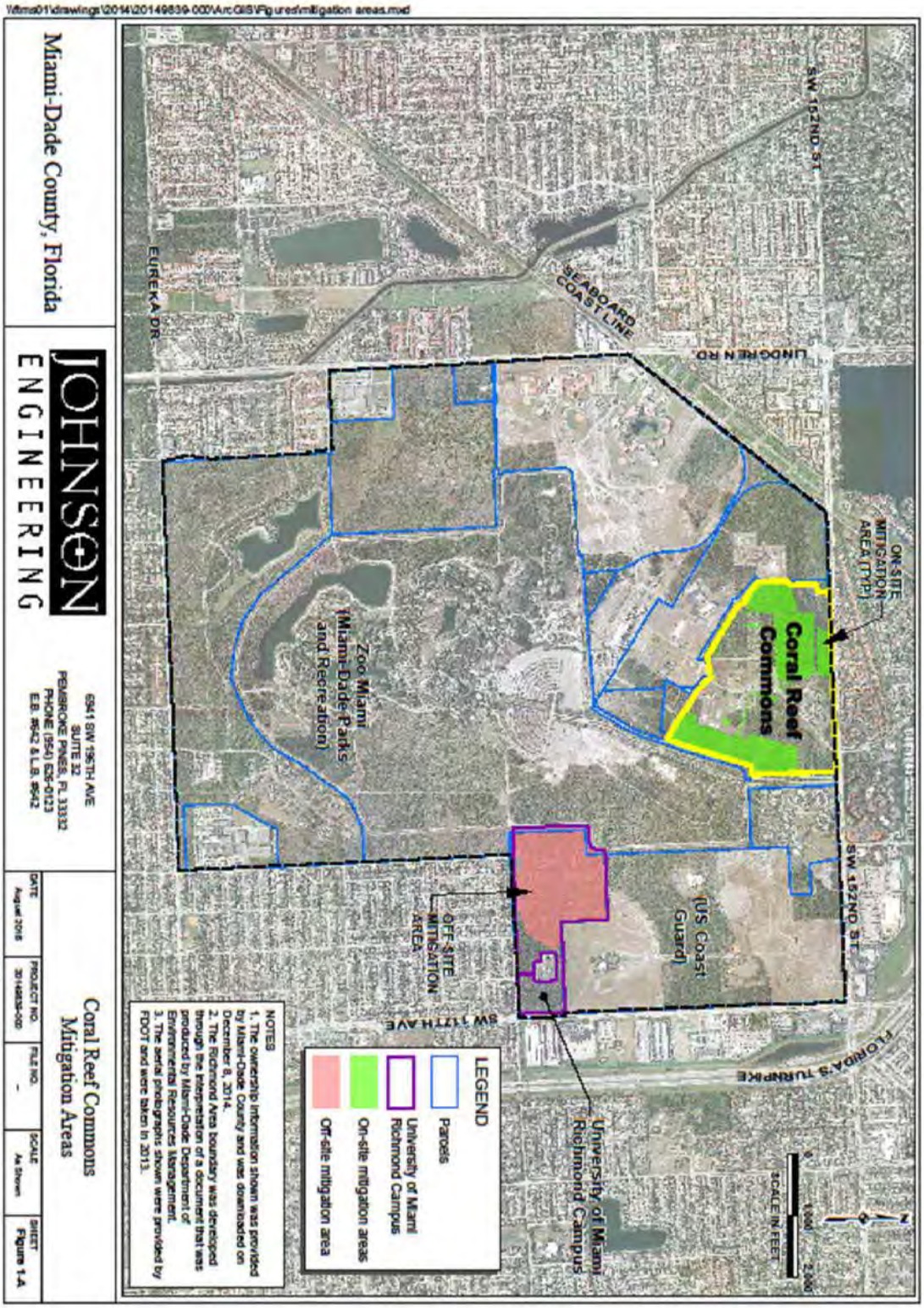

Figure 2-2. Annotated aerial photo showing the location of the Coral Reef Commons development area, on-site mitigation areas, and off-site mitigation area (source: HCP Figure 1-A).

Figure 2-3. Annotated aerial photo showing the location of the Coral Reef Commons on-site Preserves, including the Stepping Stones (source: HCP Figure 7-1).

3. INFORMATION COMMON TO MULTIPLE SPECIES AND CRITICAL HABITAT ANALYSES

To minimize redundancy throughout this BO/CO, we provide in this section information about four topics that are relevant to our review of the Action for several of the species and CHs covered in sections 4–16 of this BO/CO: (1) pine rocklands ecology and conservation; (2) climate change; (3) the Applicants' functional habitat assessment; and (4) cumulative effects. We reference this section within various "Status" and "Environmental Baseline" sections, summarizing and supplementing the discussion here as necessary.

3.1. Pine Rocklands Ecology and Conservation

Most of the species we consider in this BO/CO are associated primarily or exclusively with pine rockland habitats. Pine rocklands are found only in southern Florida and the Bahamas (Service 1999). Pine rocklands have a sparse canopy of slash pine, an understory of palms and tropical shrubs, and a diverse, but partial ground cover of native grasses and wildflowers on thin soils over limestone. In Florida, pine rocklands occur on the Miami Rock Ridge, the Florida Keys, and Big Cypress Swamp.

Destruction of pine rocklands for economic development has reduced this habitat in MDC, including Everglades National Park (ENP), to about 11 percent of its pre-development extent, from about 183,000 acres to about 20,100 acres in 1996 (Kernan and Bradley 1996). Outside of ENP, only about 1 percent of the Miami Rock Ridge pine rocklands remain, mostly in small tracts that are isolated from other natural areas (Herndon 1998).

Fire maintains the species composition and structure of the plant community in pine rocklands by precluding the establishment and growth of hardwood trees that would otherwise dominate these areas. Without fire, a thick duff layer accumulates in pine rocklands that transforms the organic-poor mineral soils to organic-rich humic soils (Alexander 1967; Wade *et al*. 1980; Loope and Dunevitz 1981; Snyder *et al*. 1990). In 20–30 years, this process causes a successional change from pine rockland to hardwood hammock. Exotic invasive species accelerate the successional change. Although herbicides and mechanical methods are useful and sometimes necessary, prescribed fire is the superior and preferred method to maintain pine rocklands for conservation purposes (Snyder *et al*. 2005; URS 2007). A lightning-ignited fire frequency of 3–7 years maintained plant community composition and structure prior to development in south Florida and the Florida Keys.

The challenges of managing smoke and ensuring public safety that are associated with prescribed fire severely constrain its application in urban environments. MDC has an environmentally endangered lands program that includes prescribed fire for pine rocklands (URS 2007). MDC Parks and Recreation has burned several of its larger conservation lands at a frequency of 3–7 years. However, liability concerns and limited resources have hindered the MDC prescribed burning program, especially on smaller parcels (URS 2007). Permitting difficulties and the cost of hazard insurance limit the extent to which non-profit organizations can implement prescribed burning, and few private landowners have the means face these challenges (Bradley and Gann 2008).

3.2. Climate Change

The purpose of consultation is to compare the status of species and CH with and without a proposed Federal action relative to the definitions of "jeopardize the continued existence" and "destruction or adverse modification," respectively. Climate change will likely influence the status of most of the species and CHs that the Action of this consultation may affect, especially those primarily or exclusively associated with pine rocklands. Therefore, we must interpret the effects of the Action in light of expected changes in the status of species and CHs caused by climate change.

Our description and analysis of climate change effects that are relevant to this consultation are based on data from three sources:

- *Climate Change Impacts in the United States: The Third National Climate Assessment* (National Climate Assessment [NCA] 2014);
- *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. (IPCC 2013), specifically the "*Summary for Policymakers*"; and
- *Global and Regional Sea Level Rise Scenarios for the United States* (National Oceanographic and Atmospheric Administration [NOAA] 2017).

Climate change is expected to alter pine rocklands in the remainder of this century by:

- increasing temperatures;
- changing precipitation patterns, including the frequency and intensity of tropical storms that make landfall in south Florida; and
- rising sea levels.

Because temperature and precipitation are drivers of processes at all levels of biological system organization (ecosystem to individual), changes in the long-term patterns of either or both will likely affect to some degree all of the Covered Species. Because all of the remaining pine rocklands in southern Florida are near existing coastlines, and most of these lie just a few feet above existing sea levels, species associated primarily with pine rocklands will also experience the effects of long-term changes in hurricane frequency/intensity and rising sea levels. The Covered Species that are not exclusively dependent on pine rocklands, *e.g.*, the eastern indigo snake and Florida bonneted bat, are less vulnerable to changes in hurricanes and sea levels, because they occur also in more inland habitats.

Temperature

According to the NCA, average temperatures in the U.S. have increased 1.3°–1.9°F since record keeping began in 1895 (the range reflects differences in comparison methods), and most of the increase has occurred since about 1970. The decade of 2000–2009 was the warmest on record, and 2012 was the warmest year on record for the contiguous U.S. Temperature changes vary by location. Since 1991, the average increase in south Florida temperatures has exceed 1.5ºF. Relative to the period 1986–2005, the severity and duration of extreme heat events in Florida are projected to increase. By the late 21st century, the hottest days will be 3ºF to 8°F hotter, and the

number of days per year with daily high temperatures exceeding 95°F will increase by 30–40 days.

Although the predictions about a warming climate in Florida and elsewhere are relatively certain, we are unable to predict at this time how such changes may alter the pine rocklands. Tolerance to temperature extremes, both hot and cold, varies widely among species. Those better adapted to a warmer regime will gain a competitive advantage, which may alter the relative abundance of species within pine rocklands. Those that loose a cooler microclimate that they require for one or more life history processes will decline. The net effect of such community-level changes to the status of the Covered Species is uncertain. However, managing pine rocklands to control invasive species that gain a competitive advantage in a warmer climate is likely to become an even more important conservation measure for the Covered Species.

Changes in Precipitation and Storms

The NCA reports that average annual precipitation has increased by 5–10 percent since 1900 in south Florida. Precipitation predictions among climate models are more variable and less certain than temperature predictions. The most recent simulations using the "Coupled Model Inter-Comparison Project, Phase 5" model predict the following seasonal precipitation changes for south Florida:

- winter, 0–10 percent increase;
- spring, 0–10 percent decrease;
- summer, 20–30 percent decrease; and
- fall, 10–20 percent increase.

Long-term seasonal changes in precipitation of this magnitude could alter vegetation composition and structure in pine rocklands, and alter the normal breeding, feeding, and sheltering behaviors of animals, either directly or indirectly through habitat changes.

Florida is the U.S. State most vulnerable to hurricanes and tropical storms (http://climatecenter.fsu.edu/topics/tropical-weather). Models are in agreement regarding changes in tropical storm and hurricane rainfall events. Greater rainfall amounts are expected, with about a 20 percent increase near the center of storms. Tropical storms and hurricanes are projected to be fewer in number but stronger in force, with more Category 4 and 5 hurricanes. Stronger winds cause greater damage and increase storm surge.

We have no specific data about how Hurricane Andrew in 1992 affected the Covered Species that occur in the Richmond Pine Rocklands. We do know that the BSHB, FBB, MTB, eastern indigo snake, rim rock crowned snake, gopher tortoise, deltoid spurge, and tiny polygala persisted in the area following a direct hit by a Category 5 hurricane. Hurricanes play a significant role in maintaining a sparse canopy cover in pine rocklands. Most recently, Hurricane Irma in 2017 downed many trees in pine rocklands throughout southern Florida, especially those in the Florida Keys. However, flooding and extensively damaged vegetation cause a substantial disruption of normal breeding, feeding, and sheltering behaviors. It is unknown whether the predicted changes in the frequency and intensity of hurricanes will significantly alter the status of the Covered Species.

Sea Level Rise

The NCA predicts that sea levels will rise 1–4 ft in this century, noting that studies are still ongoing to understand processes that drive the melting of polar ice sheets. The most recent sea level predictions include an "extreme" scenario of an 8-ft global sea level rise by 2100 (NOAA 2017). The full effects of sea level rise include storm and tidal surge relative to a rising "normal" sea level. The latest tidal information from NOAA for Florida gauges indicate that the 5-year recurrence interval (20 percent chance of occurring in any given year) for the medium-high high tide is 1.6 ft above historical levels. Sea level rise will also push saltwater intrusion farther inland in coastal rivers, marshes, and aquifers.

To estimate the effects of sea level rise on pine rocklands, we used geospatial data and models from the "Sea Level Scenario Sketch Planning Tool" developed by the University of Florida GeoPlan Center (June 2017). We examined a range of available scenarios from the lowest to the highest sea level rise projections, including:

- C1– U.S. Army Corps of Engineers (Corps) Low/ National Oceanic Atmospheric Administration (NOAA) Low;
- C2– Corps Intermediate/ NOAA Intermediate Low;
- C3– NOAA Intermediate High;
- C4– Corps High; and
- C5– NOAA High

In Table 3-1 and Figure 3-1, we present the projections for the years:

- 2050 (33 years from present), which represents conditions at about the end of the 30-year ITP duration;
- 2070 (53 years from present), which represents conditions at about the end of an expected ITP extension request; and
- 2100 (83 years from present), which is the projection limit of the current model.

These projections indicate a loss of 7–821 acres of pine rocklands with a 0.5–2.2 ft rise in sea levels by 2050 (scenarios C1 and C5, respectively). Habitat in the Florida Keys is inundated first. By 2070, habitat in ENP is also affected, and under the worst-case scenario (C5; 3.7 ft rise), 26.34 percent (3,521 acres) of all existing Florida pine rocklands are inundated.

Under the GeoPlan model C5 scenario, the effects of sea level rise could reach the Richmond Pine Rocklands by 2050, with a 0.01 percent acreage loss (Table 3-2). By 2100, inundation loss is 0–2.88 percent under the various scenarios. Prior to inundation, a rising water table of higher salinity beneath the Miami Rock Ridge could alter the composition of overlying pine rockland plant communities, and in turn the associated animal communities. Possibly exacerbating these changes, inundation of lower-lying urban areas would increase development pressure on remaining higher-lying remnants of pine rockland habitats.

NOAA released new modeling in 2017 that predicts an accelerated pace of sea level rise compared to the scenarios used in the University of Florida Geoplan spatial model. We compare the high and extreme projections of the NOAA 2017 model with the C5 scenario of the GeoPlan

model in Figure 3-2. Spatial data representing the results of the NOAA 2017 model are not available that allow us to examine the extent of pine rockland habitat inundation over time. Therefore, we use the GeoPlan model to quantify such inundation, recognizing that the NOAA 2017 models predict that similar effects will occur sooner. For example, sea levels do not rise by more than 3 ft until after 2060 under the GeoPlan C5 scenario, but some of the NOAA 2017 model scenarios exceed a 3-ft rise soon after 2050, almost 10 years earlier. The GeoPlan C5 scenario exceeds a 6-ft rise between 2090 and 2100, whereas the NOAA 2017 extreme scenario exceeds a 6-ft rise 20 years earlier.

Table 3-1. Projected loss of pine rockland habitat in Monroe and Miami-Dade Counties as a result of sea level rise.

Sea level Rise (feet)	Year/Scenario[a]	Inundated Pine Rockland Habitat (acres)	Percent Inundated (acres)
0.5	2050 / C1	6.66	0.05%
0.8	2050 / C2	28.12	0.21%
1.4	2050/ C3	212.75	1.59%
1.7	2050 / C4	396.48	2.97%
2.2	2050 / C5	821.04	6.14%
0.6	2070 / C1	11.30	0.08%
1.1	2070 / C2	85.40	0.64%
2.3	2070 / C3	942.44	7.05%
2.9	2070 / C4	1965.55	14.71%
3.7	2070 / C5	3520.75	26.34%
0.8	2100 / C1	28.12	0.21%
1.9	2100 / C2	536.90	4.02%
4.2	2100 / C3	5,397.24	40.38%
5.2	2100 / C4	8,458.81	63.29%
6.8	2100 / C5	10,242.01	76.63%

[a] Scenarios from "Sea Level Scenario Sketch Planning Tool Geographic Information System (GIS) Data: Sea Level Rise Inundation Surfaces;" University of Florida GeoPlan Center (June 2017) (see narrative for scenario identification).

Table 3-2. Projected loss of pine rockland habitat within the Richmond Pine Rocklands as a result of sea level rise.

Sea level Rise (feet)	Year/scenario[a]	Inundated Pine Rockland Habitat (acres)	Percent Inundated (acres)
2.2	2050 / C5	0.12	0.01%
2.3	2070 / C3	0.13	0.01%
2.9	2070 / C4	0.15	0.01%
3.7	2070 / C5	0.23	0.02%
0.8	2100 / C1	0.00	0.00%
1.9	2100 / C2	0.00	0.00%
4.2	2100 / C3	0.53	0.04%
5.2	2100 / C4	1.10	0.08%
6.8	2100 / C5	40.53	2.88%

[a] Scenarios from "Sea Level Scenario Sketch Planning Tool GIS Data: Sea Level Rise Inundation Surfaces;" University of Florida GeoPlan Center (June 2017) (see narrative for scenario identification).

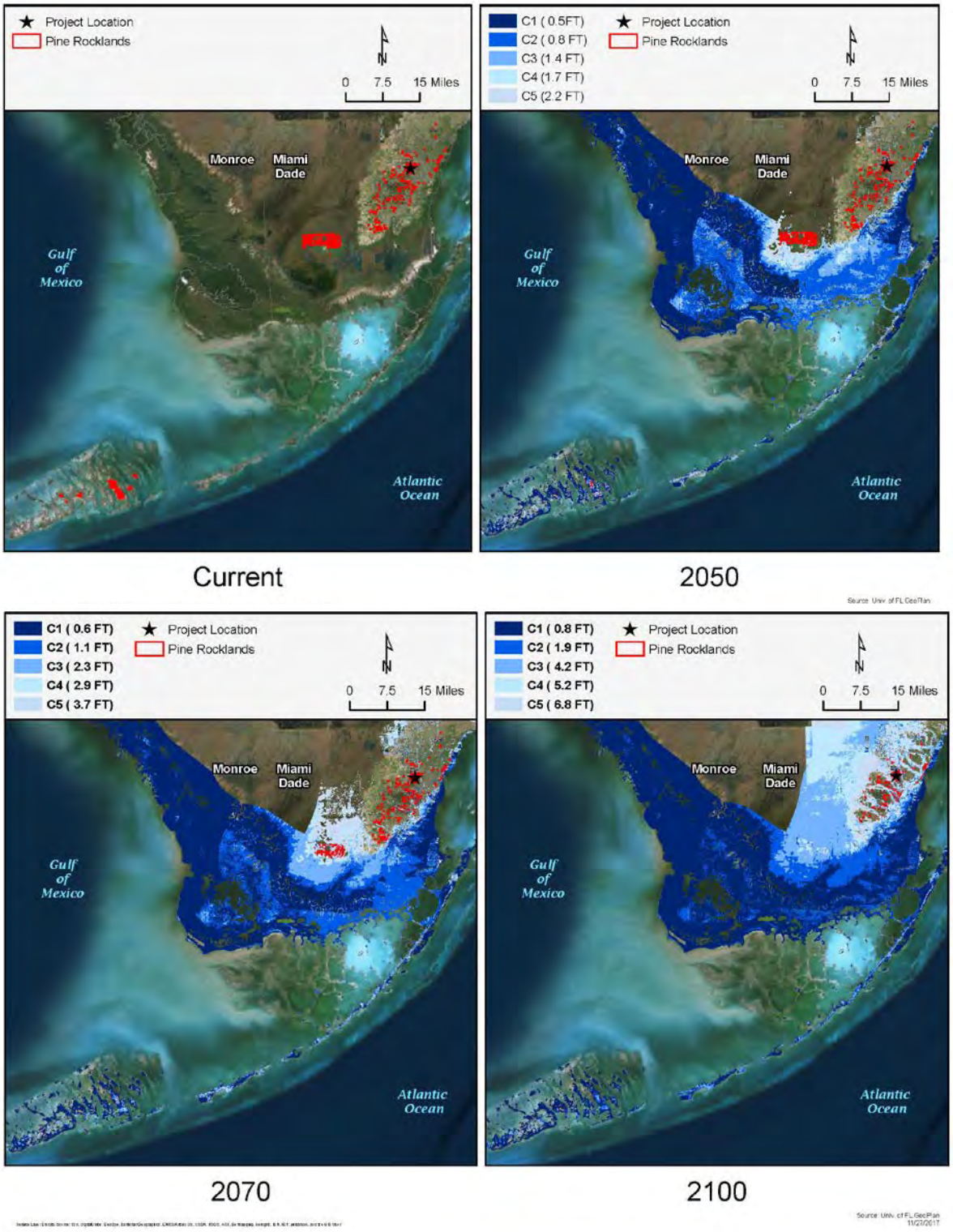

Figure 3-1. Existing pine rocklands (2017) displayed with sea level rise projections (2050, 2070, and 2100) for Miami-Dade and Monroe Counties. Source: "Sea Level Scenario Sketch Planning Tool GIS Data: Sea Level Rise Inundation Surfaces;" University of Florida GeoPlan Center (June 2017) (see narrative for scenario identification).

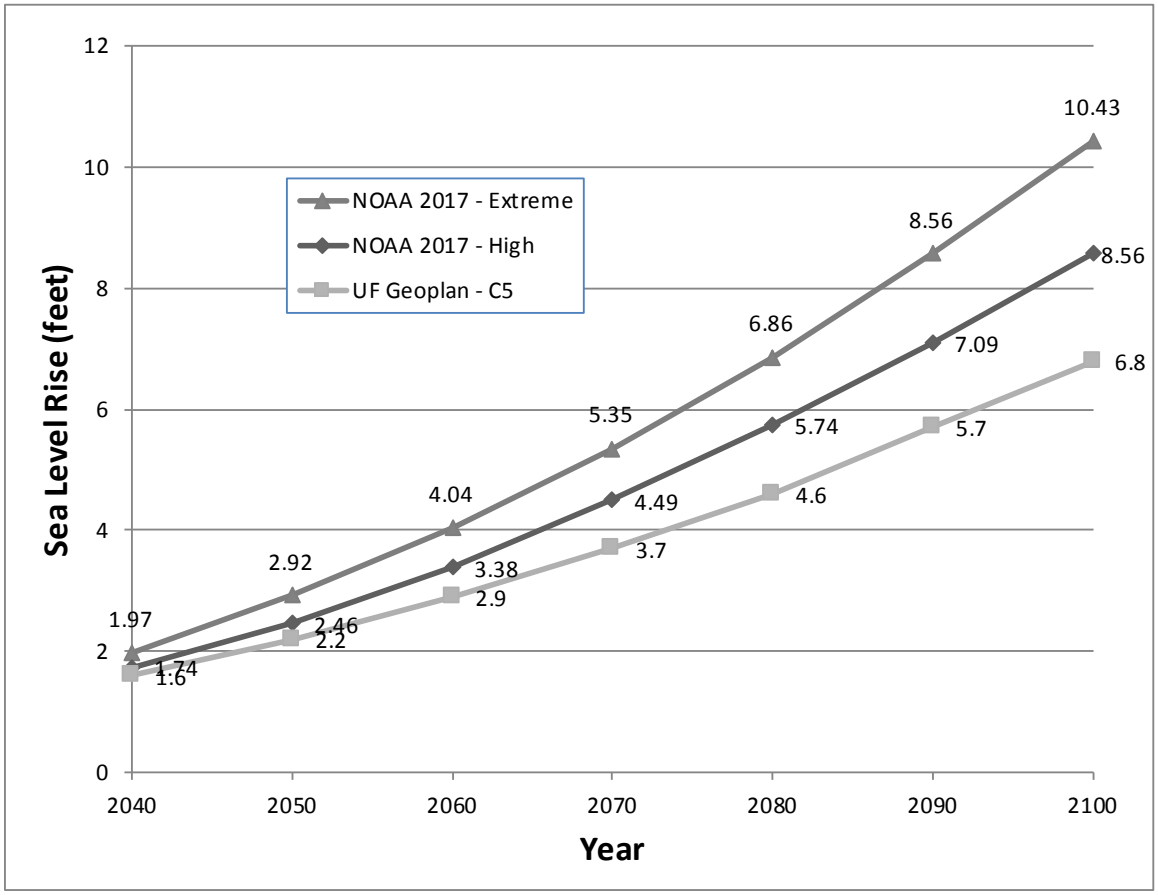

Figure 3-2. Comparison of sea-level rise predictions from the "Sea Level Scenario Sketch Planning Tool GIS Data: Sea Level Rise Inundation Surfaces" (University of Florida GeoPlan Center, June 2017, C5 scenario) and from the NOAA (2017) "High" and "Extreme" scenarios.

3.3. Applicants' Habitat Functional Assessment

Section 5.0 of the HCP describes the Applicants' habitat functional assessment for the CRC property, which includes the on-site Preserves. This assessment is intended to predict how HCP implementation (development and habitat management) would change the value of pine rockland habitats on the CRC property for the Covered Species. The Applicants' model is spatially explicit, but not species-specific, and computes habitat value units (HVUs) with and without the proposed Action. It incorporates physical and biological characteristics that correspond to the measures we list in section 2.4.3 under "Success Criteria and Monitoring." The model estimates a relative change in pine rockland habitat value, with some areas losing all or partial value due to development or reduced connectivity, and some areas gaining value due to habitat enhancement, assuming the proposed management is successful.

The Applicants' model estimates that fully successful management of the on-site Preserves would provide an overall pine rockland habitat improvement from a baseline condition of 40.72

HVUs to 43.83 HVUs, a net increase of 3.10 HVUs (7.64 percent) (Table 3-3). This net increase accounts for the loss of all existing value within the development footprint, and a 66 percent gain in existing value within the on-site Preserves. The Applicants expect that the net improvement in habitat quality would over time increase the abundance of Covered Species on the CRC property. We interpret the significance of the Applicants' assessment within the effects analysis sections for each species and CH.

Table 3-3. Summary results of Applicants' functional habitat assessment (source: HCP Table 5-2).

Location	Acres	Habitat Value Units (HVU)		
		Existing Value	Post- Value	Functional Change
CRC property	137.89	40.72	43.82	+3.10
Development footprint	86.49	14.37	0	-14.37
On-site Preserves	51.41	26.35	43.82	+17.47

Off-Site Preserve

The Applicants did not apply the habitat assessment model to the off-site Preserve, where the primary proposed change is implementing a prescribed burning plan without any loss of habitat from development. The off-site Preserve is already under management to control invasive exotic plant species, but does not receive fire on the 3–7 year return interval that is most effective at maintaining pine rocklands. HCP Appendix K (a consultant's report dated 2014) notes that the most recent burns involved wildfires during 2004 and 2006, and that prescribed fire was applied most recently in 2003 within two of the eight management cells of the proposed off-site Preserve area. The pine canopy appears relatively open in most of the off-site Preserve on aerial imagery of the UM property; however, the proposed prescribed burn plan (HCP Appendix J1) calls for some pine thinning during the first year of management.

Although the Applicants did not evaluate the off-site Preserve within the functional assessment model, it is useful to us in this BO/CO to estimate its potential habitat enhancement in terms that are comparable to the functional assessment of the on-site Preserves, so that we may better interpret total effects of the Action. The management plan for the off-site Preserve (HCP Appendix J1) proposes to achieve some of the same success criteria adopted for the on-site Preserves in HCP Table 7-3. Burning would occur on 45.60–48.65 acres of the 50.96 acres of the off-site Preserve. We expect that burning would increase the conservation value of this area for the species considered in this BO/CO that are primarily associated with pine rocklands. Due to ongoing invasive plant control, the off-site Preserve currently provides a greater conservation value to pine rockland species than the on-site Preserves. Therefore, we expect less than the 66 percent increase in functional habitat value that the Applicants estimated for the on-site Preserves.

Habitat improvement in the off-site Preserve would build from a higher baseline condition than the on-site Preserves, but because the 3–7 year fire frequency applies to both the on- and off-site Preserves, we expect a similar conservation value per acre in both areas following management.

The Applicants predict that the 51.41 acres of the on-site Preserves would realize a functional gain of 17.47 HVUs (see Table 3-1), or 0.34 HVU's per acre. This gain includes the benefits of substantially reducing exotic invasive plants, which are already at lower levels in the off-site Preserve (HCP Appendix K). Lacking data for the other parameters of the HVU model for the off-site Preserve, but knowing that invasive species are already at much lower levels, we assume that burning would provide about half of the functional gain per-acre estimated for the on-site Preserves. A gain of 0.34 ÷ 2 = 0.17 HVU per acre applied to 45.60–48.65 acres of the off-site Preserve (the portion that would receive burning) would result in a total gain of 7.75–8.27 HVUs. We use this rough extrapolation from the HVU model results to the off-site Preserve, in addition to the results for the on-site Preserves, in our analyses of effects of the Action in species- and CH-specific sections that follow.

3.4. Cumulative Effects

For purposes of consultation under ESA §7(a)(2), cumulative effects are those caused by future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions that are unrelated to the proposed action are not considered, because they require separate consultation.

The Applicants are owners of the Action Area, and they propose with the HCP to operate the CRC development and the Preserves in the manner we analyze in this BO/CO. We are unaware of additional non-federal actions within the Action Area that are unrelated to the proposed Action, reasonably certain to occur, and relevant to the Covered Species. Therefore, we do not address cumulative effects further in this BO/CO.

4. BARTRAM'S SCRUB-HAIRSTREAK BUTTERFLY

4.1. Status of Bartram's Scrub-Hairstreak Butterfly

This section summarizes best available data about the biology and current condition of Bartram's scrub-hairstreak butterfly (BSHB) (*Strymon acis bartrami*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the BSHB subspecies as endangered on August 12, 2014 (79 FR 47222–47244).

4.1.1. Description of Bartram's Scrub-Hairstreak Butterfly

The BSHB is a small butterfly about 1 inch (25 mm) long with a forewing length of 0.4–0.5 inch (10–12.5 mm). The upper wing is brownish gray, and the underside is gray with bold white stripes and two distinct white spots near the abdomen. The BSHB is a rapid flyer, but is readily observed if present, because it alights often, and the underside of its wings provide a flash of color against the foliage of its only known larval host plant, pineland croton (*Croton linearis*).

4.1.2. Life History of Bartram's Scrub-Hairstreak Butterfly

The egg, larva, and pupa life stages of the BSHB occur entirely on (or beneath) the only known host plant for the egg and larval life stages, pineland croton (Minno and Emmel 1993; Smith *et*

al. 1994). Pineland croton is associated with pine rockland habitats in south Florida. BSHB occur only within pine rocklands that retain pineland croton (Schwartz 1987; Worth *et al*. 1996; Salvato and Salvato 2008).

Adult females lay eggs singly on the flowering stems of pineland croton (Worth *et al*. 1996; Salvato and Hennessey 2004). Larvae feed exclusively upon pineland croton before forming a pupa. The pale-colored first and second instars (larval developmental stages between molts) are camouflaged among the white croton flowers before the subsequent greenish instars forage more extensively on the leaves. Larvae drop into the ground litter to pupate (Worth *et al*. 1996).

Adults are nectar feeders and pollinators of pineland croton. BSHB are most often observed visiting pineland croton flowers, but also the flowers of pine acacia, Spanish needles, saw palmetto, button sage, Bloggett's swallowwort, Everglades Key false buttonwood, locustberry, and starrush whitetop (Minno and Emmel 1993; Worth *et al*. 1996; Calhoun *et al*. 2000; Salvato and Hennessey 2004; Salvato and Salvato 2008; Anderson 2010).

Researchers have observed adult BSHB during every month of the year; however, the annual number of generations appears variable (Salvato and Hennessey 2004; Salvato and Salvato 2010a). Salvato and Salvato (2010a) reported that BSHB adults are most abundant in the spring and early summer throughout the subspecies' range. On Big Pine Key, the subspecies is often uncommon during the fall and early winter (Salvato 1999; Anderson and Henry 2015; Salvato 2015).

Habitat

The BSHB occurs in pine rocklands, and occasionally in rockland hammock and hydric pine flatwoods interspersed in pine rocklands, that contain patches of pineland croton. Pine rockland is a fire-adapted habitat with a sparse slash pine canopy, an understory of palms and tropical shrubs, and a partial ground cover of native grasses and wildflowers on thin soils over limestone (see section 3.1).

Pineland croton is a perennial shrub that reaches a height of about 1 m and prefers full sun. It is typically displaced during the successional transition from pine rockland to rockland hammock. It grows most densely on pine rockland edges and within clearings created by fires, hurricanes, and human activity (*e.g.*, access roads) (Schwarz *et al.* 1996). Resprouting after fire is a primary mechanism by which perennial shrubs like the pineland croton persist in various pinelands (Olson and Platt 1995).

The BSHB is rarely encountered more than 5 m from its host plant and the pine rockland interface (Schwartz 1987; Worth *et al*. 1996; Salvato and Salvato 2008). Worth *et al*. (1996) and Salvato and Hennessey (2004) indicate that the BSHB may have limited dispersal abilities. However, the need to evade natural disturbance (fires, storms) and subsequently recolonize disturbed areas suggests that adult BSHB, perhaps as a function of age, sex, or density, are likely adapted for dispersal throughout the pine rockland habitat and associated ecosystems.

4.1.3. Numbers, Reproduction, and Distribution of Bartram's Scrub-Hairstreak Butterfly

Distribution

The BSHB is endemic to south Florida and the lower Florida Keys. Historically, the subspecies was common in the pine rocklands of Miami-Dade and Monroe Counties; and less common in the pinelands of Collier, Palm Beach, and Broward Counties (Kimball 1965; Baggett 1982; Schwartz 1987; Hennessey and Habeck 1991; Minno and Emmel 1994; Smith *et al.* 1994; Emmel *et al*. 1995; Worth *et al*. 1996; Schwarz *et al*. 1996; Salvato and Hennessey 2004). Pineland croton formerly occurred throughout the pine rocklands of the lower Florida Keys (Dickson 1955; Hennessey and Habeck 1991; Salvato 1999), but is presently limited to Big Pine Key (Salvato 1999), which retains the largest undisturbed tracts of pine rockland habitat in the Keys (Zhong *et al.* 2010; Roberts 2012).

The distribution of BSHB populations has become increasingly localized as urban and agricultural development have displaced and fragmented pine rocklands (Baggett 1982; Hennessey and Habeck 1991; Schwarz *et al.* 1996; Salvato and Hennessey 2004). During the last 50 years, breeding populations of BSHB are known only from:

- Long Pine Key within ENP;
- Big Pine Key with the Florida Keys; and
- various remnants of MDC pine rockland habitat outside of ENP.

The extent of occupied designated CH units for the BSHB provides an estimate of the size of subspecies' range in these three areas (79 FR 47189):

- Long Pine Key – 7,994 acres
- Big Pine Key – 1,382 acres
- MDC remnants –
    - Navy Wells Pineland Preserve – 502 acres
    - Camp Owaissa Bauer – 359 acres
    - Richmond pine rocklands – 1,082 acres

The total size of these areas is 11,319 acres (4,581 ha). Several of the CH units are comprised of multiple non-contiguous parcels. The minimum area known to support an extant population of BSHB and designated as CH rule is 18 acres (79 FR 47190).

Surveyors on Big Pine Key, the only island of the Florida Keys known to support the BSHB in the past 50 years, have failed to detect adults since 2015 (see "Numbers" below), which suggests the subspecies is, or could soon become, extirpated from the Florida Keys altogether. If so, this range size estimate shrinks to 9,937 acres (4,022 ha). Exacerbating a long-term trend in declining habitat suitability in the Florida Keys, Hurricane Irma in 2017 substantially damaged the remaining pine rocklands on Big Pine Key and elsewhere.

Within MDC outside of ENP, the Service analyzed 2014 land cover data collected by the Institute for Regional Conservation (2006) to estimate that about 370 acres in 77 pine rockland habitat fragments appear to support pineland croton. In 2012, the Service funded Fairchild Tropical Botanic Gardens to survey MDC pine rockland remnants for pineland croton. These

surveys identified pineland croton populations at 11 of 13 locations. The largest of these were on the Navy Wells Pineland Preserve and the Richmond Pine Rocklands, where each location supported more than 21,000 plants (Maschinski *et al*. 2013; Possley *et al*. 2016).

Numbers and Reproduction

Although the BSHB is generally found on or near pineland croton, which is not difficult to locate within relatively open pine rockland habitats, many croton patches are not occupied, and BSHB numbers at occupied locations are highly variable, but typically low. This makes estimating the subspecies' abundance inherently difficult. We summarize available data on numbers and density in the three principal areas known to support BSHB populations in the following paragraphs.

On Big Pine Key, Hennessey and Habeck (1991) documented 0.1–1.1.adult BSHB per acre (0.3–2.7 per ha) on various transects within National Key Deer Refuge (NKDR) in 1988–1989. Salvato (1999; 2001) re-surveyed these transects and additional NKDR locations, reporting densities of 0.7–3.4 adult BSHB per acre (1.7–8.6 per ha). Surveys of these NKDR locations in the early 2000's noted a precipitous decline in BHSB across the island (Salvato 2017).

More recently, Henry and Haddad (2013) collaborated with the Service to develop monitoring methods for estimating BSHB abundance within NKDR. Application of these methods during 2013 measured densities of 0.0–1.1 ± 0.13 adults per acre (0.0–2.8 ± 0.33 adults per ha), and estimated a peak abundance of 159 adults during the early summer months (Anderson 2014). BSHB numbers at NKDR have declined in surveys taken since 2013. In 2014, 2015, and 2016, surveyors detected 0, 1, and 0 BSHB, respectively (Breaux 2015; Salvato 2017). Watts (2017) found signs of BSHB larval herbivory at one NKDR location during the summer of 2017, but has not observed adults since 2015. As noted above under "Distribution," these results suggest that the subspecies is, or would soon become, extirpated from Big Pine Key.

Salvato and Salvato (2010a; 2017) and ENP biologists have regularly surveyed the Long Pine Key region of ENP (west of Homestead, Florida) every year since 1997. BSHB numbers documented annually is highly variable due to a number of factors (*e.g.*, recovery from disturbance), with densities ranging from no individuals observed to a high 2.6 per acre (6.3 per ha). Data that could support an area-wide population estimate with a statistical confidence interval are not available. Salvato and Salvato (2010a; 2017) have observed an average density of 0.57 adult BSHB per acre (1.4 per ha) within the Everglades over a 20-year period. An average abundance of 0.57 adult BSHB per acre (1.4 per ha) throughout the Long Pine Key CH unit (7,994 acres) would yield an area-wide population estimate of 4,556 adult butterflies. A density of 0.57 per acre (1.4 adult per ha) is low for patches of suitable habitat in which the species is observed. We use this density for purposes of this consultation to provide an explicit basis for considering the subspecies' numbers in pine rockland habitats that contain multiple occupied patches, where the subspecies is not present in some areas and more abundant in others.

Density measurements for BSHB in the pine rockland remnants of MDC outside ENP are not available. Records consist mostly of incidental observations of one or a few adult individuals and an occasional (*i.e.*, not regular) survey for adult BSHB on the larger properties managed for conservation purposes. These properties include:

- Navy Wells Pineland Preserve;
- Camp Owaissa Bauer; and
- various public and private properties of the Richmond Pine Rocklands area.

These properties contain a total of 1,943 acres (786 ha) within designated CH units. A mean density of 0.57 adults per acre (1.4 adult per ha) throughout these designated units would yield an area-wide population estimate of 1,108. Combined with the Long Pine Key numbers estimated using the same density assumption, range-wide numbers of the BSHB would be about 5,664 adults.

4.1.4. Conservation Needs of and Threats to Bartram's Scrub-Hairstreak Butterfly

We summarize in this section best available data about the conservation needs of the BSHB and threats to its survival that are relevant to this consultation. The Service has not yet completed a recovery plan for the BSHB, which we listed as endangered in 2014. The Service has prepared a "recovery outline" document that describes a preliminary course of action until a more comprehensive recovery plan is approved (Service 2014a). This outline describes surveys, studies, habitat management needs, habitat acquisition and restoration needs, protection from the impacts of pesticides, and various other actions. The primary threats and conservation needs that are relevant to this consultation are habitat loss, habitat management (especially with prescribed fire), and climate change. For further details about threats and conservation needs, please refer to the recovery outline and the final listing rule (79 FR 47222-47244), which documents the factors that contributed to its current classification as an endangered species.

Habitat Loss

In peninsular Florida outside of ENP, urban and agricultural land uses have replaced 98 percent of pine rockland habitat (O'Brien 1998). With some exceptions, mainland populations of the BSHB occur on lands, both public and private, that are managed for conservation purposes (79 FR 47230). However, populations that may persist on habitat remnants under private ownership are vulnerable to further habitat loss.

Habitat loss from residential and commercial development has similarly reduced the extent of pine rocklands in the Florida Keys (Hodges and Bradley 2006). Most remain in publicly-owned tracts on Big Pine Key. Zwick and Carr (2006) predict eventual development on all remaining undeveloped land in the Keys that is not preserved for conservation purposes, including islands that are not connected to the Overseas Highway.

Prescribed Fire

Pineland croton, the host plant for BSHB, is one of the plant species displaced in the successional transition from pine rockland to rockland hammock (see "Habitat" under section 3.1.2). Lightning-ignited fire prevented this transition in the historic distribution of pine rockland habitats (Loope and Dunevitz 1981; Slocum *et al*. 2003; Snyder *et al.* 2005; Salvato and Salvato 2010a). Wildfire suppression is the norm in the modern landscape of south Florida and elsewhere. Instead, controlled prescribed fire is necessary to prevent destructive wildfire and to

maintain the conservation value of the remaining pine rockland habitats, which is a primary conservation need of the BSHB.

Although the BSHB is associated with a fire-adapted habitat, fire that consumes a pineland croton plant kills any eggs and larvae present on it, and some fraction of the pupae in the ground cover. Adults, especially those at the periphery of fires, will disperse during a burn to adjacent pine rocklands or unburned areas (refugia) within the treatment zone. Recognizing the need to both maintain BSHB habitat conditions with fire and minimize harm to a very rare subspecies, Salvato and Hennessey (2004) and Salvato and Salvato (2010a) recommended a spatial and temporal pattern of burning that retains refugia within burned areas and adjacent unburned pine rocklands to which adult BSHB may disperse to during fires. Under this approach, BSHB may recolonize recently burned areas from unburned refugia and adjacent areas when the treated pine rocklands and vegetation (such as crotons) have recovered.

Fire was largely suppressed during the past decade on the pine rocklands of the Long Pine Key region within ENP while the Park updated its fire management plan. The current plan (NPS 2014) describes cyclic burns and multiyear treatment intervals that are designed to burn the pine rocklands in a mosaic pattern. Prescribed fire returned to Long Pine Key in early 2016. At 3–6 months post-burn, BSHB were observed in burned areas (Sadle 2017; Salvato 2017). The combination of prescribed burns and natural fires is likely to improve conditions for the BSHB within ENP.

On Big Pine Key and in the remnant pine rocklands of MDC, the use of prescribed fire is frequently constrained by the proximity of small habitat fragments to residential and commercial properties. These constraints and land management resource shortages are limiting the scale of prescribed burning programs and not keeping pace with vegetative succession on many pine rockland tracts in both areas. The extent and frequency of burning on Big Pine Key and adjacent islands within NKDR appears insufficient to maintain the pine rockland habitats (79 FR 47231). Liability concerns and limited resources have similarly hindered the prescribed burning program in MDC, especially on smaller parcels (URS 2007).

When fire is not feasible, mechanical clearing methods must control vegetation density and prevent the successional change to hardwood hammock conditions. Such methods are more difficult than prescribed fire, and less effective for conservation purposes. Unlike mechanical methods, fire immediately returns nutrients from plant material to the soil and stimulates the germination of various pine rockland species, including pineland croton (Anderson and Henry 2015).

Climate Change

We discussed in section 3.2 how sea level rise is likely to reduce the extent of pine rocklands during the remainder of this century. Under the “C5” scenario of a 6.8-ft rise by the year 2100, 76.63 percent of the existing pine rocklands (10,242 acres) are inundated, mostly in the Florida Keys and ENP. The more recent NOAA 2017 models predict that inudation to this degree could occur as early as 2080. Whenever a rise greater than about 6 ft occurs, the pine rockland remnants in MDC would become the primary areas that may support the BSHB. In the timeframe

of the proposed 30-year ITP, sea level rise by the year 2050 is 2.20–2.92 ft under the most extreme scenarios, inundating about 6–15 percent of pine rocklands, mostly in the Florida Keys.

4.2. Environmental Baseline for Bartram's Scrub-Hairstreak Butterfly

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the BSHB, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

4.2.1. Action Area Numbers, Reproduction, and Distribution of Bartram's Scrub-Hairstreak Butterfly

The Richmond Pine Rocklands support the northern-most population of BSHB in its current range. To investigate the extent to which the CRC property may support the BSHB, the Applicants surveyed the CRC property for pineland croton in September and October of 2014 using the methods of Maschinski *et al*. (2013). The off-site Preserve was not surveyed.

Of the 322 pineland croton locations documented on the CRC property, 133 (41.3 percent) were within the proposed CRC development footprint (HCP section 3.2.1), almost all within the areas classified as pine rockland. This occurrence frequency (133 locations in 32.28 acres of pine rockland = 4.12 per acre) is about the same as in the proposed on-site pine rockland Preserves (189 locations in 47.69 acres = 3.96 per acre). Numbers of plants at each location are not reported. If each location represents only one plant, a density of about 4 per acre is low for pine rockland habitat.

During the pineland croton surveys, the surveyors observed an unspecified number of BSHB on three occasions at two locations:

- the proposed West Preserve (9/8/2014 and 9/22/2014) in pine rockland with less than 50 percent Burma reed cover; and
- in the proposed development footprint (10/6/2014) in scraped pine rockland without a pine canopy (HCP section 3.2.1).

These data support considering both the development footprint and the on-site Preserves as occupied BSHB habitat supporting a similar density of the subspecies in both areas. Because the development footprint contains about 40 percent of the pine rocklands and about 40 percent of the pineland croton locations, we expect the development footprint to contain about 40 percent of the BSBH on the CRC property. The remaining 60 percent of the pineland croton locations are within the on-site Preserves, which we expect to support 60 percent of the BSHB on the CRC property.

The 50.96-acre off-site Preserve is pine rockland habitat that is currently managed under deed restrictions intended to conserve the deltoid spurge, an endangered plant species that we consider in this BO/CO. We are unaware of any surveys for BSHB on this property; however, the Preserve is adjacent to properties with known BSHB occurrence records, including the USCG property and Larry and Penny Thompson Memorial Park (Salvato 2017). Surveys have record

pineland croton on sites throughout the Richmond Pine Rocklands and adjacent to the off-site Preserve (Maschinski *et al*. 2013, Possley *et al*. 2016). This proximity, and ongoing management of the off-site Preserve to control invasive exotic plants, strongly suggest that pineland croton is present on the off-site Preserve. Therefore, we believe BSHB is reasonably certain to occur on the off-site Preserve, but data regarding its total numbers and distribution within the property are not available. As we discussed in section 3.1 and 3.3, the pine rockland habitat on the off-site Preserve is in better condition than the CRC property, due ongoing control of invasive exotic plants, but infrequent fire.

The Action Area contains a total of 130.93 acres of pine rockland habitat (about 80 acres on the CRC property and 51 acres on the UM property off-site Preserve). We expect the degraded conditions on the CRC property to support a slightly lower BSHB density, and the off-site Preserve to support a slightly higher density, than the density of 0.57 adults per acre we used to estimate numbers range wide in section 4.1.3. For purposes of our analysis in this BO/CO, we assume that the CRC property supports a density 10 percent less (0.51 per acre), and the off-site Preserve supports a density 10 percent more (0.63 per acre) than the long-term average of 0.57 adults per acre measured in the Long Pine Key area. At these densities, the 80 acres of pine rocklands on the CRC property would support about 41 adult BSHB, and the 51 acres on the off-site Preserve would support about 32 adult BSHB. Therefore, our rough estimate of Action Area BSHB numbers is about 73 adults.

4.2.2. Action Area Conservation Needs of and Threats to Bartram's Scrub-Hairstreak Butterfly

The threat of further habitat loss and the need for prescribed fire that we describe in section 4.1.4 are relevant in the Action Area. The Action Area is privately owned, and this BO/CO evaluates the effect of habitat loss on the CRC property. As we described in section 3.1, an effective prescribed fire program is needed in the Action Area to restore and maintain the pine rockland habitats for the conservation of the BSHB and other species. Although climate change will affect the Action Area, we do not expect sea level rise to directly cause habitat loss by inundation (see section 3.2).

4.3. Effects of the Action on Bartram's Scrub-Hairstreak Butterfly

This section analyzes the direct and indirect effects of the Action on the BSHB. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

4.3.1. Effects of CRC Construction on Bartram's Scrub-Hairstreak Butterfly

The proposed CRC development would collectively occupy 86.49 acres, including all 33.30 acres of existing developed portions of the Action Area. The expansion of developed areas within the Action Area would occur on 20.91 acres of upland exotic hardwood habitat and 32.28 acres of pine rockland habitat (see section 2.1.1). The BSHB is associated with pine rocklands; therefore, the primary environmental change caused by construction that would affect the BSHB

is the permanent loss of 32.28 acres of pine rockland habitat. Within the 86.49-acre development footprint, the Applicants' propose to establish 3.88 acres of pine rockland plantings, consisting mostly of pineland croton, and occurring mostly on locations within the existing developed areas. The Applicants refer to these plantings as the "Stepping Stones," which are intended primarily to facilitate the movement of the BSHB and Florida leafwing butterfly across the developed areas between the on-site Preserves. We discuss the Stepping Stones under section 4.3.3.

Habitat Loss

The Applicants would use heavy equipment to clear and grade all areas within 32.28 acres of pine rocklands habitat that the BSHB is likely to occupy. Larval BSHB feed upon and complete their development entirely on pineland croton plants. Therefore, we expect that CRC construction would crush all BSHB larvae that are present as clearing and grading activity proceeds across the development footprint (take in the form of harm). Adult BSHB are nectar feeders and capable fliers. Therefore, we expect that CRC construction would displace all BSHB present as clearing and grading activity proceeds across the development footprint. Displaced adults would likely flee to the adjacent Preserve areas, where some percentage is likely to experience reduced survival or reproductive success due to disorientation and competition for scarce resources (take in the form of harassment).

Using a density of 0.51 per acre (see section 4.2.1), and a permanent loss of 32.28 acres of pine rockland habitat, we expect construction to harass about 16 BSHB adults and kill all eggs, larvae, and pupae they produced in this footprint.

Habitat Fragmentation

The CRC construction footprint would separate pine rocklands on the east side of the CRC property from those on the west side (see Figure 2-3). Pineland croton is distributed sporadically, or in dense clusters, across the east-west breadth of the property. The Applicants propose the Southern Corridor Preserve and the Stepping Stones pineland croton plantings to provide a linkage between the East and West Preserves. Although the possible isolation of BSHB on the West Preserve from those on the East Preserve is an effect caused by CRC construction, we analyze this effect instead under "Habitat Connectivity" in section 4.3.3 below, which addresses the effects of the Preserves, including the role of the Southern Corridor Preserve and Stepping Stones as BSHB dispersal pathways.

Other Effect Pathways

Construction activities would cause a variety of stressors that are relevant to the BSHB, but most of these are moot within the construction footprint itself, because permanent habitat loss would extirpate the subspecies from the developed areas. Construction activities that may cause stressors extending beyond the construction footprint include noise, altered surface water runnoff, and discharge of oil, fuel, solvents, cement, fertilizers, and other chemical products used during construction. We have no information on the effects of noise on butterflies and do not address it further. We believe the Applicants' proposed construction BMPs (*e.g.*, silt fencing,

measures to prevent construction site runoff, see section 2.2.3) would limit the severity of other construction-caused stressors within the on-site Preserves to insignificant levels, or would reduce the likelihood of exposure to such stressors to a discountable probability.

4.3.2. Effects of CRC Operations on Bartram's Scrub-Hairstreak Butterfly

CRC construction would initially eliminate the BSHB from the CRC development footprint (see section 4.3.1). BSHB remaining on the CRC property following construction would occupy suitable microhabitats in the adjacent undeveloped areas, which the Applicants propose as on-site Preserves.

BSHB adults may fly from the on-site Preserves into the developed areas following construction, particularly along the proposed Stepping Stones planted with pineland croton and other pine rockland species (see section 4.3.3 below). Using and traversing the Stepping Stones would expose BSHB to increased vehicle traffic within the developed areas. The Applicants propose to post speed limits of 15 mph and 25 mph within the residential and commercial areas, respectively. The CRC property provides an existing throughway only to the adjacent DOD property south of the CRC property, which would be permanently blocked following development of CRC. Therefore, residents and users of the proposed development, and not additional throughway travelers, would cause any traffic increase within the Action Area. We consider the probability of lethal BSHB collisions caused by local traffic only at these low speeds as discountable.

Additional effects of CRC operations on the BSHB are limited to activities that cause stressors that extend into the adjacent on-site Preserves. CRC operations, *i.e.*, residential and commercial use of the development, that may cause such stressors include:

- increased pesticide use;
- increased human use of the on-site Preserves (including unauthorized take of BSHB by butterfly collectors); and
- increased numbers or introduction of BSHB predators or parasites.

We believe the Applicants' proposed conservation measures for pesticide use (see section 2.3.3) would limit the drift or runoff of pesticides from the developed areas into the Preserves to levels that are insignificant to the BSHB. The Applicants propose to post an unauthorized access prohibition for the on-site Preserves (see section 2.4.2). Without fences and locked gates, this measure should reduce, but would not entirely preclude, unauthorized access and the risk of illegal take of BSHB. We have no information about current levels of illegal collection (take) of BSHB, if any, that is occurring on the CRC property. The property would receive an increase in human use following development, but this does not change the number of people who are likely to engage in illegal take of BSHB, which is subject to a civil penalty of up to $25,000 for each violation. With the proposed posting of the on-site Preserve boundaries, we believe that the level of illegal BSHB collection on the CRC property, if any, would not change.

We considered whether increased human use of the developed areas might introduce potential BSHB predators that are absent or present at low levels currently. We have no information that suggests increased human presence in the Action Area is likely to increase known natural

mortality of BSHB, which include a variety of predators and parasites to the immature stages. Minno and Minno (2009) identify non-native ants as a threat to BSHB. The Applicants' only proposed use of insecticides within the Preserves is to target insects that pose a threat to the Covered Species. We believe it is unlikely that common human pets, such as cats and dogs, would prey upon any life stage of the BSHB. The Applicants propose to prohibit unleashed pets within the development outside of the fenced dog park, and discourage the outdoor feeding of cats. Rats are not known to prey upon any of the life stages of butterflies, and pest control and waste management within the development are likely to control rats at levels that do spill over into the on-site Preserves.

CRC operations are unlikely to affect the off-site Preserve, because it is located about 2,000 feet away from the CRC development.

4.3.3. Effects of Preserves and Stepping Stones Management on Bartram's Scrub-Hairstreak Butterfly

We describe the proposed Preserves and Stepping Stones in sections 2.4.3–5. The remainder of this section describes how the proposed management of the Preserves and Stepping Stones would cause changes to the Action Area, and how the BSHB is likely to respond upon exposure to these changes. We summarize the Applicants' assessment of these changes, and then analyze each component of the proposed management activities that is relevant to the BSHB.

Applicants' Habitat Functional Assessment

We describe the Applicants' habitat assessment in section 3.3. Despite the loss of 32.28 acres of pine rockland habitat within the development footprint, the Applicants expect that a 7.6 percent overall improvement in habitat value resulting from the on-site Preserves management would over time increase the abundance of Covered Species on the CRC property, including the BSHB. The habitat assessment did not include the off-site Preserve.

The parameters for valuing habitat parcels in the Applicants' assessment are relevant to the conservation of the BSHB. In particular, the success criteria for percent canopy cover (1–24), percent non-native plant cover (<5), fire frequency (3–7 years), and percent pine rockland herbaceous species cover (≥85) correspond with favorable BHSB habitat conditions.

Invasive Exotic Plant Management

The Applicants' plan to reduce and control invasive exotic plants involves a combination of herbicides, cutting and removal by mechanical methods, and within the pine rockland areas, prescribed fire. The particular combination and sequence of these treatments varies according to the distribution and density of the target invasive species. Section 7.5 of the HCP describes the methods planned for particular management units within the on-site Preserves, subject to the conditions described in section 6.2.4 of the HCP. Similar invasive plant control methods are already implemented on the off-site Preserve and are not part of the proposed Action. The Action would instead implement a more aggressive prescribed burning plan on the off-site Preserve, which we address under "Prescribed Burning" below.

The relatively open canopy areas that support pineland croton and BSHB would need less mechanical and chemical treatments to reduce canopy cover and invasive exotic plants, such as Burma reed. However, some foot and heavy equipment traffic through occupied pineland croton patches is likely, which would crush eggs, larvae, and pupae present, and displace adults. Several proposed conservation measures in HCP section 6.2.4.4 would reduce, but not entirely eliminate, the probability of harming BSHB, including:

- hand removal when feasible;
- no roller-chopping;
- use of vehicles with rubber tires, unless unavailable or infeasible;
- use of the smallest and lightest equipment capable of performing the work; and
- access the Preserves only via the developed areas and established fire breaks.

We do not expect significant effects on the BSHB from the use of herbicides, which management crews would apply to invasive exotic species, not pineland croton. We believe that the general conditions governing insecticide and other pesticide use in the Preserves (HCP section 6.2.4.4) (*e.g.*, hand application of insecticides), would limit impacts to levels that are insignificant to the BSHB.

The Applicants would continue to employ mechanical and chemical treatments in the Preserves to control invasive exotics over the duration of the ITP as necessary to achieve the pine rockland habitat success criteria. The Applicants anticipate the most extensive use of these methods during the initial 1–3 years, with substantially lesser use thereafter as prescribed burning becomes effective as the primary method for maintaining the habitat.

Reducing invasive exotic plants, thinning pine stand density, and clearing new fire breaks are necessary precursors to prescribed burning in the pine rocklands, which is an important conservation need for the BSHB (see section 4.1.4). Therefore, we estimate the overall effects of managing the pine rocklands to reduce invasive exotic plants, decrease vegetation encroachment, and control vegetation succession under "Prescribed Burning" below.

Pine Rockland Planting

Planting pine rockland plant species is proposed initially for a 300–400 foot long (0.39-acre) strip of sod along the southern boundary of the CRC property (see Figure 2-3), and as needed elsewhere thereafter within the on-site Preserves to achieve the success criteria. Planting this sod strip fills a gap in the proposed Southern Corridor Preserve, The sod strip did not contain pineland croton during the surveys described in section 4.2.1; therefore, we do not expect adverse effects to BSHB resulting from the initial preparation of this site for planting. We expect this strip to provide habitat value for BSHB proportional to the density of pineland croton that is established and maintained within it. This strip would not receive prescribed fire. As a small and narrow strip, its beneficial effect is primarily as a potential pathway for movement between larger habitat parcels, which we address below under "Habitat Connectivity."

The Applicants also propose planting pine rockland species, primarily pineland croton, in several Stepping Stones (total area 3.88 acres) within the development footprint. Like the sod strip along

the southern boundary of the CRC property, these plantings are intended as a potential pathway for movement between larger habitat parcels, which we address below under "Habitat Connectivity."

Prescribed Burning

The Applicants propose prescribed burning within 45.24 acres (88.6 percent) of the on-site Preserves (the East and West Preserves) and 45.60–48.65 acres (89–95 percent) of the off-site Preserve; a total of up to 93.89 acres. Both would receive fire on a 3–7 year rotation by management unit. Burning is not proposed for the rockland hammock area on the northern edge of the CRC property, or for the narrow corridor along the southern edge (the Southern Corridor Preserve). The prescribed burning program for the on-site Preserves and the off-site Preserve is described in Appendix J and Appendix J1 of the HCP, respectively.

Prescribed fire is the superior and preferred method to maintain pine rocklands for conservation purposes, including conservation of the BSHB (see section 3.1 and "Prescribed Fire" under section 4.1.4). In the long-term, fire maintains pineland croton, the sole host plant for the BSHB. In the short-term, fire itself and the measures necessary to manage it in an urban setting are likely to kill, injure, or displace individual BSHB that are exposed to various stressors associated with prescribed burning. These stressors include:

- creating and maintaining fire breaks (may crush BSHB);
- foot and vehicle traffic on fire breaks and elsewhere (may crush BSHB); and
- lethal heat levels during a fire.

Conservation measures proposed in the prescribed burning plans that should reduce the extent or intensity of these stressors or reduce the probability of exposure include:

- use and maintain existing fire breaks to the maximum extent practicable;
- burn patches in a mosaic pattern, so that unburned habitat is available nearby for individuals that are able to flee the fire; and
- prepare and manage burns to ensure low-intensity fires.

To ensure that the first prescribed fires are low-intensity would require application of the practices described above under "Invasive Exotic Plant Management." The impacts from this vegetation removal would occur mostly in the first 1–3 years, and thereafter as needed. Burning impacts would occur within burn patches every 3–7 years (the proposed fire frequency), which is the historic pattern in the fire-adapted pine rockland habitat. However, we expect that the long-term benefits of these habitat management activities would exceed the short-term impacts to BSHB numbers and reproduction, which is the underlying purpose of the management activities. We expect the management program to increase BSHB density within the on- and off-site Preserves to some degree by increasing the extent of pineland croton for larvae and adults, and increasing other species that provide nectar for adults.

We assumed an adult BSHB density of 0.51 per acre on the CRC property and 0.63 per acre on the off-site Preserve (see section 4.2.1). On 47.69 acres of the CRC property, we expect exposure of a baseline population of about 24 adult BSHB to the various management practices, including both invasive exotic plant control and prescribed fire. On up to 48.65 acres of the off-site

Preserve, we expect exposure of a baseline population of about 31 adult BSHB to prescribed burning. Burning would not occur on the entire 50.96-acre off-site Preserve, which we estimate supports baseline numbers of about 32 adult BSHB.

The Applicants' habitat assessment provides a prediction of the improvement in habitat value that successful management may accomplish (see section 3.3). Their model calculates a gain of 17.47 HVUs for the on-site Preserves (a 66 percent increase). As we explain in section 3.3, we estimate that an improvement equivalent to about 8 HVUs is likely for the off-site Preserve, which begins from a better baseline condition than the on-site Preserves.

The parameters of the HVU assessment and associated success criteria for management correspond with favorable habitat conditions for the BSHB. For purposes of estimating how habitat improvements may increase BSHB numbers in this BO/CO, we treat the projected 66 percent increase in HVUs as a comparable increase in BSHB numbers. A comparable increase in the baseline BSHB population of 24 adults (see section 4.2.1) exposed to habitat improvements in the on-site Preserves is an additional 16 adults (24 × 0.66; total = 24 + 16 = 40 adults), minus those harmed by the vegetation removal and burning necessary to accomplish the improvements. Density in the enhanced on-site Preserves would become 40 adults on 47.69 acres, or 0.84 per acre.

Following enhancement from a higher baseline BSHB density, we expect the off-site Preserve to support a similar density of adult BSHB as the on-site Preserves following enhancement. A density of 0.84 per acre on 45.60–48.65 acres of the off-site Preserve (the portion that would receive prescribed burning) is 38–41 adults, which is an increase of 6–9 over baseline numbers of 32 (see section 4.2.1).

Based on these analyses, we expect the on- and off-site Preserves to support about 78–81 adult BSHB (40 + 38–41, respectively). The combined increase over baseline numbers for both the on- and off-site Preserves is 22–27 adult BSHB (16 + 6–9).

Habitat Connectivity

We addressed the initial clearing and grading of the development footprint that precedes establishing the proposed Stepping Stones as an effect of CRC construction in section 4.3.1. This activity would kill or displace BSHB from the 3.88 acres of the Stepping Stones. This discussion addresses the subsequent effects of establishing and managing the Stepping Stones, and whether these habitat patches, along with the proposed Southern Corridor Preserve, would facilitate BSHB movement between the larger East and West on-site Preserves.

The Stepping Stones are narrow strips or small blocks of pineland croton (50–75 percent cover) and other pine rockland species along the edges and within the development footprint. Figure 2-3 shows the arrangement of the Stepping Stones. Section 7.2 of the HCP describes management and monitoring of the Stepping Stones, which would not involve burning. The success criterion for Stepping Stones management is achieving 85 percent cover by native pine rockland plant species.

The proposed Southern Corridor Preserve is also intended to facilitate movement of the Covered Species across the CRC property. Unlike the Stepping Stones, the Southern Corridor is a nearly continuous narrow strip of pine rockland habitat retained and planted (see "Pine Rockland Plantings" above) along the property's southern edge. The continuity of the strip is broken by the existing road that extends from Coral Reef Drive to the U.S. Department of Defense (DoD) property south of the CRC property. The Applicants propose to improve this road as part of the CRC development, but it would no longer connect to the DoD property.

The layout of the development footprint would reduce the area available as habitat for BSHB and separate the remaining habitat into two primary blocks within the East and West Preserves on either side of the CRC property. The Action would reduce the pathways for potential movement between these blocks to the Stepping Stones and the Southern Corridor, which would reduce existing habitat connectivity. The East Preserve is adjacent to pine rockland habitat on the Zoo Miami property, but is separated from the latter by SW 124th Avenue. Whether this road and other development features already isolate BSHB on the CRC property from others in the Richmond Pine Rocklands is unknown, but we believe the species is adapted for dispersal within and between pine rockland habitats in response to frequent natural disturbance by fire and hurricanes.

Whether the degree of BSHB movement between the East and West Preserves via the Stepping Stones and Southern Corridor is sufficient to prevent a genetic isolation of the West Preserve from other occupied areas is uncertain. However, we believe the availability of pineland croton and other flowering plants within these pathways should attract foraging adult BSHB that are present nearby. The size of the West Preserve (23.92 acres) exceeds the minimum size (18 acres) known to support an extant BSHB population (79 FR 47180–47220; BSHB CH final rule). Therefore, it is our judgement that the Southern Corridor and Stepping Stones and the size of the West Preserve would avoid its loss as viable habitat within the larger Richmond Pine Rocklands.

Other Effect Pathways

Authorized access to the Preserves (*e.g.*, by habitat management crews) is governed by the Applicants' proposed conservation measures in the HCP, which include various prohibitions, contractor education, etc. (see section 2.4.2). We believe these measures would limit the adverse effects of human activity, apart from those activities addressed above, to insignificant levels or discountable probability.

4.3.4. Summary of the Effects of the Action on Bartram's Scrub-Hairstreak Butterfly

Table 4-1 summarizes the findings of our analysis of the effects of the proposed Action on the BSHB. The Action sub-components listed in the table correspond to the sub-headings of the narrative in section 4.3. As applicable for each sub-component, we report our estimated amount or extent of BSHB responses to the Action in terms of a change (increase or decrease) in BSHB adult numbers.

Based on an assumed BSHB density of 0.51 adults per acre in the pine rockland habitats of the CRC property, CRC construction would harass about 16 adults, and harm (kill or injure) their

eggs, larvae, and pupae in the construction footprint. This impact occurs only once, but permanently removes 32.28 acres of pine rockland habitat from the known occupied range of the subspecies.

Take caused by habitat management of the Preserves, in the form of both harm and harassment during management activity, is likely to occur, but the amount or extent is not determinable with available data. However, BSHB population increases that we expect to accompany habitat improvements in the Preserves should exceed the numbers lost during habitat management, which is the reason for undertaking such management. Based on:

a) the Applicants' habitat assessment model results showing a 66 percent increase in habitat value in the on-site Preserves;
b) a baseline density in the on-site Preserves of 0.51 per acre;
c) a baseline density of 0.63 per acre in the off-site Preserve; and
d) a density of 0.84 per acre in both areas following successful management;

we expect an increase of up to 22–27 adult BSHB over time in the Preserves, minus those harmed annually by management activity.

An uncertainty associated with our analysis concerns the fragmentation of existing pine rockland habitat caused by construction, and whether the proposed Southern Corridor Preserve and Stepping Stone habitats prevent an isolation of BSHB in the West Preserve. The proposed development footprint would reduce connectivity, but we believe that achieving the habitat management success criteria for the Southern Corridor and the Stepping Stones would facilitate BSHB movement to and from the West Preserve. Further, the size of the West Preserve (23.92 acres) exceeds the minimum size (18 acres) known to support an extant BSHB population (79 FR 47180–47220 [BSHB CH final rule]).

Our analysis suggests that the Action would cause over time a small increase in BSHB numbers within the Action Area, because the improvement of habitat conditions in the Preserves that would support an additional 22–27 BSHB would more than offset the loss of habitat for about 16 BSHB in the development footprint. This finding is associated with uncertainty about habitat connectivity and the degree of harm caused by habitat management activity. It relies also on our use of the Applicants' estimation of habitat improvements, which we believe would facilitate a proportional increase in BSHB density and numbers.

Table 4-1. Summary of Action effects on the Bartram's scrub-hairstreak butterfly.

Action Component	Sub-Component	Effect Characterization	Estimated Change in BSHB Numbers
Construction	Habitat loss	Adverse - permanent loss of 32.28 acres pine rockland habitat.	Displace 16 adults; loss of their reproduction in the construction footprint.
	Habitat fragmentation	Reduced connectivity within the CRC property (see "Habitat connectivity" below)	
	Other effect pathways	Not likely to adversely affect.	
Operations	Various	Not likely to adversely affect.	
Preserves Management	Invasive exotic plant management	Beneficial and Adverse - Effects coextensive with prescribed burning.	
	Pine rockland planting	Beneficial - planting 0.39 acres with pineland croton and other species will provide BSHB habitat.	
	Prescribed burning	Beneficial and Adverse - Management of 98.65 acres (all practices) will increase BSHB habitat quality, but kill, injure, or harass some BSHB during management activity.	Increase of up to 22-27 adults over time, minus those harmed by management activity.
	Habitat connectivity	Reduced connectivity, but proposed southern corridor and steppping stones should prevent isolation of BSHB in the western on-site Preserve.	
	Other effect pathways	Not likely to adversely affect.	

4.4. Conclusion for Bartram's Scrub-Hairstreak Butterfly

In this section, we summarize and interpret the findings of the previous sections (status, baseline, effects, and cumulative effects) for the Bartram's scrub-hairstreak butterfly (BSHB) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

The historical range of the BSHB probably spanned the extent of pine rocklands in south Florida, including the Florida Keys, coextensive with the distribution of the host plant for its larval stage, the pineland croton. Extensive loss of this habitat type has reduced the occupied range to three primary areas: Long Pine Key within ENP, Big Pine Key of the Florida Keys, and various remnants of pine rockland habitats in MDC outside of ENP. However, surveys in recent years suggest the possible extirpation of the BSHB from Big Pine Key. Using occupied designated CH as an estimate of the size of the subspecies' extant range, the BSHB may persist on 9,937 acres.

A range-wide estimate of BSHB numbers with a statistical confidence interval is not available. Many locations that contain suitable habitat are not occupied, and BSHB numbers at occupied locations are highly variable, but typically low. Densities at locations known to support the subspecies range from 0–3.4 adults per acre. For purposes of this consultation, we use an average density of 0.57 adults per acre in the 9,937 acres of occupied CH in the Long Pine Key and the MDC pine rocklands to estimate range-wide numbers conservatively at 5,664 adult BSHB.

The primary threats to the survival and recovery of the BSHB are continued habitat loss, habitat degradation resulting from fire suppression or infrequent fire, and climate change. Although most locations that currently support the subspecies are protected from further development, some are not. Constraints on burning in close proximity to developed areas and land management agency resource shortages are limiting the scale of prescribed burning programs on many pine rockland tracts. These programs are not keeping pace with vegetative succession on many tracts, which is further shrinking suitable habitat for the BSHB. Sea level rise is projected to reduce the extent of BSHB habitat in the Florida Keys and Long Pine Key area. Under the worst-case scenarios in 2050, sea level rise inundates 6–15 percent of existing pine rocklands. As early as 2080, sea level rise of about 6.8 ft would inundate 76.63 percent of existing pine rocklands.

Baseline

The Action Area is within the Richmond Pine Rocklands, which is the largest and northern-most of the MDC remnant habitats that support the BSHB. The subspecies is known to occur in the Action Area, but an estimate of BSHB numbers with a statistical confidence interval is not available. For purposes of this consultation, we use a density of 0.51 adults per acre on the CRC property and 0.63 per acre on the off-site Preserve to estimate BSHB numbers at 73 adults.

The threat of further habitat loss and the need for prescribed fire are relevant in the Action Area. The Action Area is under the Applicants' ownership. This BO/CO evaluates the effect of habitat loss on the CRC property and management of the proposed on- and off-site Preserves with prescribed fire and other practices. Although climate change will affect the Action Area, we do not expect sea level rise to cause significant habitat loss by inundation in the next 30–50 years.

Effects

We estimate that CRC construction would harass about 16 BSHB adults, and harm (kill or injure) their eggs, larvae, and pupae in the construction footprint. This impact occurs only once, but permanently removes 32.28 acres of pine rockland habitat from the known range of the subspecies.

Habitat management of the proposed Preserves would cause adverse effects to BSHB, but greater beneficial effects, which is the purpose of the management. We expect an increase of up to 22–27 adult BSHB in the Preserves over time, minus those harmed annually by management activity.

We believe that all other effects of the Action would not cause a change in BSHB numbers, reproduction, or distribution that we can meaningfully evaluate. Although the consequences of habitat fragmentation caused by CRC construction are uncertain, we believe that the proposed measures to provide BSHB movement pathways (the Southern Corridor and Stepping Stones) between the eastern and western Preserves, and the size of the western Preserve, would avoid its loss as viable habitat within the larger Richmond Pine Rocklands.

Several uncertainties and simplifications underlie our estimations, and the difference between total adverse and beneficial effects is narrow (an increase in BSHB numbers from 73 to about 80). Our results are consistent with the Applicants' habitat assessment, which predicted a modest net increase in habitat value within the Action Area. The means by which the Action would accomplish a small net benefit to the species addresses its primary conservation need, which is to secure habitat conditions that can support viable populations via prescribed fire and other measures that reduce invasive exotic plants and prevent vegetative succession to rockland hammock habitat.

Opinion

The Action would reduce the current 9,000-acre range-wide distribution of the BSHB by about 32 acres. This range is likely to shrink further due to sea level rise in the remainder of the century. We estimate conservatively range-wide numbers at about 5,600 adult BSHB in the pine rocklands within Everglades National Park and Miami-Dade County outside of the Park. We believe the Action would offset the loss of 32 acres of occupied BSHB habitat by addressing a primary conservation need of the subspecies, which is to better manage remaining pine rockland habitats. We estimate that this management would cause a small net increase in BSHB numbers within the Action Area (less than 10 adult BSHB). We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the BSHB (cumulative effects; see section 3.4).

After reviewing the current status of the subspecies, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the Bartram's scrub-hairstreak butterfly.

5. FLORIDA LEAFWING BUTTERFLY

5.1. Status of Florida Leafwing Butterfly

This section summarizes best available data about the biology and current condition of the Florida leafwing butterfly (*Anaea troglodyta floridalis*) (leafwing) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the leafwing as endangered on August 12, 2014 (79 FR 47222-47244).

5.1.1. Description of Florida Leafwing

The leafwing is a medium-sized butterfly about 2.75 to 3 inches (76 to 78 mm) in length. The upper wing surface color is red to reddish-brown and the lower surface is gray to tan. At rest on vegetation with wings closed and a tapered outline, the adult looks like a dead leaf. Females are slightly larger with darker coloring along the wing margins than the males.

5.1.2. Life History of Florida Leafwing

Adults are rapid, strong, and wary fliers that are able to disperse over large areas. The leafwing life cycle is about 2–3 months, with multiple generations per year (Hennessey and Habeck 1991) and immature stages (eggs, larvae, or pupae) present throughout the year (Salvato 1999). The larval stages feed on pineland croton (*Croton linearis*). Females lay eggs singly on both the upper and lower surface of pineland croton leaves, usually on developing flowers (Baggett 1982; Hennessey and Habeck 1991; Worth *et al.* 1996; Salvato 1999; Minno *et al.* 2005). The leafwing occurs only within pine rocklands that retain its only known larval hostplant, pineland croton. Adults are also known to venture into rockland hammock and hydric pine flatwood habitats that are interspersed within pine rocklands. Adults are nectar feeders, but are not frequently attracted to flowers besides those of pineland croton (Baggett 1982; Opler and Krizek 1984; Worth *et al.* 1996).

5.1.3. Numbers, Reproduction, and Distribution of Florida Leafwing

The leafwing is endemic to south Florida, including the lower Florida Keys. The species was locally common within pine rockland habitat in Miami-Dade and Monroe Counties, and less common and sporadic within croton-bearing pinelands in Collier, Martin, Palm Beach, and Broward Counties. The distribution of leafwing populations became increasingly localized as urban and agricultural development displaced and fragmented pine rocklands throughout its historical range (see section 3.1). For about the past 25 years, breeding populations of the leafwing have been limited to the Long Pine Key area within ENP.

Salvato and Salvato's (2017) surveys in ENP from 1997-2016 measured an average abundance of 7.3 adult leafwings per ha (2.9 per acre) in occupied areas. However, many areas within the nearly 8,000 acres of pine rockland habitat in the Long Pine Key area appear unoccupied, such that total abundance is likely in the range of a few hundred adults, and numbers vary greatly depending upon season and other factors. Ongoing studies designed to evaluate causes of

mortality to the immature life stages have identified a suite of predators, parasites, and pathogens that may substantially influence population dynamics.

The ecological niche of the leafwing overlaps substantially with that of the BSHB (see section 4.1), because both inhabit pine rocklands and rely on pineland croton as the host plant for their larval life stages. However, the leafwing appears to require larger patches of croton-bearing pine rockland habitat to persist than the BSHB. The smallest of the patches that supported a breeding leafwing population for many years was the Navy Wells Pineland Preserve in MDC, which contains 296 acres of pine rockland habitat.

5.1.4. Conservation Needs of and Threats to Florida Leafwing

We summarize in this section best available data about the conservation needs of the leafwing and threats to its survival that are relevant to this consultation. The Service has not yet completed a recovery plan for the leafwing, which we listed as endangered in 2014. The Service has prepared a "recovery outline" document that describes a preliminary course of action until a more comprehensive recovery plan is approved (Service 2014b). This outline describes surveys, studies, habitat management needs, habitat acquisition and restoration needs, developing reintroduction methods, and various other actions. For further details about threats and conservation needs, please refer to the recovery outline and the final listing rule (79 FR 47222–47244), which documents the factors that contributed to its current classification as an endangered species.

Threats to the survival and recovery of the leafwing that are relevant to this consultation are the same as we described for the BSHB in section 4.1.4: habitat loss, inadequate fire regimes in pine rocklands, and climate change. As we discussed in section 3.2, sea level rise is likely to inundate a portion of the pine rocklands of the Long Pine Key area in ENP in the remainder of the 21st century. Because this is the only area that currently supports breeding populations of the leafwing, reintroducing the species to other locations is essential to ensure its survival into the next century. Remnants of pine rocklands on higher ground in the urbanized portions of MDC, *i.e.,* those designated as unoccupied CH (see section 6), are the areas that are most likely to serve the leafwing's conservation needs.

5.2. Environmental Baseline for Florida Leafwing Butterfly

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the leafwing, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

5.2.1. Action Area Numbers, Reproduction, and Distribution of Florida Leafwing

The leafwing is not known to presently occur in the Action Area or in adjacent portions of the Richmond Pine Rocklands.

5.2.2. Action Area Conservation Needs of and Threats to Florida Leafwing

The leafwing's sole conservation need in the Action Area is to maintain and enhance the area's potential to provide habitat if and when the species is reintroduced to the Richmond Pine Rocklands. This need is best served by avoiding further habitat loss, and by implementing an effective prescribed fire program within the Action Area to restore and maintain its pine rockland habitats. The Action Area is privately owned, and this BO/CO evaluates the effect of habitat loss on the CRC property and the effect of managing its pine rockland habitats.

5.3. Effects of the Action on Florida Leafwing Butterfly

This section analyzes the direct and indirect effects of the Action on the Florida leafwing. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

5.3.1. Effects of CRC Construction on Florida Leafwing

Because we believe that the leafwing does not currently occupy the Action Area, and the species' reintroduction to or recolonization of the Action Area is unlikely before CRC construction is completed, this component of the Action would have no effect on leafwing individuals. Construction would cause the permanent loss of 32.28 acres of pine rockland habitat (see section 2.2). We discuss the impact of this loss to the conservation value of unoccupied designated CH for the leafwing in section 6.3.1.

5.3.2. Effects of CRC Operations on Florida Leafwing

If and when the leafwing is reintroduced to the Action Area, the remaining butterfly habitat would be limited to the on- and off-site Preserves. CRC operations are unlikely to affect the off-site Preserve, because it is located about 2,000 feet away from the CRC development. Any effects of operations on the leafwing are limited to activities that cause stressors that extend into the adjacent on-site Preserves. CRC operations, *i.e.*, residential and commercial use of the development, that may cause such stressors include:

- increased pesticide use;
- increased human use of the on-site Preserves (including unauthorized take of leafwings by butterfly collectors); and
- increased numbers or introduction of leafwing predators or parasites.

We discussed the effects of these potential stressors to the ecologically similar BSHB in section 4.3.2. We expect the same causal pathways for effects to the leafwing as for the BSHB, and our findings are the same as for the BSHB. We expect the Applicants' proposed conservation measures for pesticide use (see section 2.3.3) to limit the drift or runoff of pesticides from the developed areas into the on-site Preserves to levels that are insignificant to the leafwing, and that CRC operations would not change the levels of illegal collection, predation, or parasitism.

5.3.3. Effects of Preserves and Stepping Stones Management on Florida Leafwing

Our assessment of the manner in which the BSHB is likely to respond to management of the Preserves and Stepping Stones (see section 4.3.3) is generally applicable to the leafwing, should this species recolonize or be reintroduced to the Action Area. A difference with the BSHB assessment is that the leafwing appears to require tracts of at least 296 acres of pine rockland habitat to support a breeding population (see section 5.1.3), compared to 18 acres for the BSHB (see section 4.1.3). The on-site Preserves (51.41 acres), the off-site Preserve (50.96 acres), and the Stepping Stones (3.88 acres) are singly and collectively smaller than 296 acres. However, both are adjacent to habitats in the larger Richmond Pine Rocklands that could support the leafwing. Whether enhanced habitat conditions in the collective Preserves would contribute to the conservation of the leafwing will likely depend on maintaining and enhancing habitat conditions on the adjacent Richmond Pine Rockland properties.

If the Richmond Pine Rocklands support the leafwing in the future, we expect the management of the Preserves and the Stepping Stones to cause a net benefit to the species that is comparable to our analysis for the BSHB. Habitat management activities would harm and harass a fraction of the population, but would promote conditions that support a higher density of leafwings than without such management.

5.4. Conclusion for Florida Leafwing Butterfly

In this section, we summarize and interpret the findings of the previous sections for the leafwing (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

The current distribution of the leafwing is limited to the Long Pine Key area within ENP, where total abundance is likely in the range of a few hundred adults. The primary threat to its survival is sea level rise that is likely to inundate substantial portions of this area in the remainder of the 21st century. Remnants of pine rockland habitat on higher ground in the urbanized portions of MDC, *i.e.,* those designated as unoccupied CH, are the areas that are most likely to serve the leafwing's future conservation needs.

Baseline

The leafwing is not presently known to occur in the Action Area or in adjacent portions of the Richmond Pine Rocklands. The leafwing's sole conservation need in the Action Area is to

maintain and enhance the area's potential to provide habitat if and when the species is reintroduced to the Rickmond Pine Rocklands.

Effects

CRC construction would not affect the leafwing, and if it is reintroduced to the Action Area, CRC operations are unlikely to adversely affect the leafwing. If the leafwing recolonizes or is reintroduced to the Action Area , we expect management of the on- and off-site Preserves and Stepping Stones to harm and harass a fraction of the future population, but to create conditions that support a higher density of leafwings than without management, and cause an overall net benefit.

Opinion

The leafwing is not known to presently occur in the Action Area. If the species recolonizes or is reintroduced to the Action Area, we expect management of the on- and off-site Preserves and Stepping Stones to contribute to its conservation in the Richmond Pine Rocklands. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the leafwing (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the leafwing.

6. CRITICAL HABITAT for BARTRAM'S SCRUB-HAIRSTREAK BUTTERFLY and FLORIDA LEAFWING BUTTERFLY

6.1. Status of Bartram's Scrub-Hairstreak and Florida Leafwing Butterfly Critical Habitat

This section summarizes best available data about the current condition of all designated units of CH for BSHB and leafwing that are relevant to formulating an opinion about the Action. The Service published its decision to designate CH for both species on August 12, 2014 (79 FR 47180–47220). We combine the analyses for both species' CH in this section, because the two designations identify a common suite of PBFs that are essential to the conservation of both species. Sharing identical PBFs allows us to apply a common analytical framework for evaluating potential PBF responses to the Action. However, the geographic extent of the two CH designations are different; therefore, our analyses identify separate findings about the effects of the Action on the CH for each species.

6.1.1. Description of Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

Geographic Extent

CHCH for BSHB is comprised of 11,539 acres in seven separate units located in MDC and Monroe County, Florida. Table 6-1 lists these units and identifies the acreage of each that is under Federal, State, or private ownership. At the time of the designation, the BSHB occupied the four units in MDC, and the Big Pine Key Unit in Monroe County. Recent survey data suggests that the BSHB may be extirpated from Big Pine Key (see section 4.1.3).

CH for leafwing is comprised of 10,561 acres in four separate units located in MDC and Monroe County, Florida. Table 6-1 lists these units and identifies the acreage of each that is under Federal, State, or private ownership. At the time of the designation, the leafwing occupied only the Everglades National Park (ENP) Unit (the Long Pine Key area). The leafwing units overlap wholly or partially with four of the seven BSHB units.

The boundaries of two of the four leafwing units are the same as two of the BSHB units: ENP (Leafwing1 and BSHB1) and Big Pine Key (Leafwing4 and BSHB5). The boundaries of the larger contiguous parcels in the Navy Wells Unit (Leafwing2 and BSHB2) and in the Richmond Unit (Leafwing3 and BSHB4) are the same for both the leafwing and BSHB designations, but the BSHB designation includes some additional smaller and disjunct parcels. The units designated for the BSHB include pine rockland habitat (and associated rockland hammock and hydric pine flatwood habitat) parcels that are at least 18 acres in size, which represents the minimum area known to support an extant population at the time of the final rule. The minimum area necessary to support a leafwing population appears substantially larger. The leafwing persisted on a 296-acre parcel of the Navy Wells area long after its extirpation from all other smaller pine rockland habitat fragments in MDC. Therefore, the Service used 296 acres as the minimum size for designating unoccupied CH units for the leafwing.

Physical and Biological Features

CH designation for the BSHB and leafwing used the term "primary constituent elements" (PCEs) to identify the key components of CH that are essential to its conservation and may require special management considerations or protection. Revisions to the CH regulations in 2016 (81 FR 7214–7440; 50 CFR §424) discontinued the Services' use of the term PCEs. We now rely exclusively on the term PBFs to refer to these key components, because it is the term used in the statute. This shift in terminology does not change how the Service conducts a "destruction or adverse modification" analysis. In this BO, we use the term PBFs to label the key components of CH that provide for the conservation of the BSHB and leafwing that we labeled as PCEs in the 2014 CH designation rule.

Our final rule designating CH for the BSHB and leafwing identified six PBFs (79 FR 47180–47220):

(1) Areas of pine rockland habitat, and in some locations, associated rockland hammocks and hydric pine flatwoods.
    (A) Pine rockland habitat contains:
        (1) Open canopy, semi-open subcanopy, and understory.
        (2) Substrate of oolitic limestone rock.
        (3) A plant community of predominately native vegetation.
    (B) Rockland hammock habitat associated with pine rockland habitat contains:
        (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory.
        (2) Substrate with a thin layer of highly organic soil covering limestone or organic matter that accumulates on top of the underlying limestone rock.
        (3) A plant community of predominately native vegetation.
    (C) Hydric pine flatwood habitat associated with pine rockland habitat contains:
        (1) Open canopy with a sparse or absent subcanopy, and dense understory.
        (2) Substrate with a thin layer of poorly drained sands and organic materials that accumulates on top of the underlying limestone or calcareous rock.
        (3) A plant community of predominately native vegetation.
(2) Competitive non-native plant species in quantities low enough to have minimal effect on survival of the BSHB/leafwing.
(3) The presence of the butterfly's hostplant, pineland croton, in sufficient abundance for larval recruitment, development, and food resources, and for adult butterfly roosting habitat and reproduction.
(4) A dynamic natural disturbance regime or one that artificially duplicates natural ecological processes (*e.g.*, fire, hurricanes or other weather events, at appropriate intervals) that maintains the pine rockland habitat and associated rockland hammock and hydric pine flatwood plant communities.
(5) Pine rockland habitat and associated rockland hammock and hydric pine flatwood plant communities sufficient in size to sustain viable BSHB/leafwing populations.
(6) Pine rockland habitat and associated rockland hammock and hydric pine flatwood plant communities with levels of pesticide low enough to have minimal effect on the survival of the butterfly or its ability to occupy the habitat.

CH does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on September 11, 2014.

The Service determined that designating unoccupied units was essential the conservation of both the BSHB and the leafwing. The BSHB occurs in only four areas, and the leafwing occurs in only one area, which renders both highly vulnerable to extinction by a natural disaster (*e.g.*, a major hurricane) or other catastrophic event. The Long Pine Key area in ENP constitutes the majority of the currently occupied range for the BSHB (about 70 percent) and the entire occupied range for the leafwing. Suitable habitat for these species in the ENP Unit and the Florida Keys units is likely to shrink substantially with sea level rise in the next 30–50 years (see section 3.2); therefore, reintroducing these species to other portions of their historical range is likely vital to ensuring their long-term survival.

Table 6-1. Designated CH units for the Bartram's scrub-hairstreak butterfly (BSHB) and Florida leafwing butterfly (leafwing) (source: 79 FR 47180–47220; Tables 1 and 2).

	Unit Number			Acres		
Unit Name	Leafwing	BSHB	Ownership	Leafwing Acres	BSHB Acres	Unit Occupied?
Everglades National Park	1	1	Federal	7,994	7,994	yes
Navy Wells Pineland Preserve	2		State	85		no
			Private-Other	211		
		2	State		153	yes
			Private-Other		349	
Camp Owaissa Bauer		3	State		71	yes
			Private-Other		288	
Richmond Pine Rocklands	3		Federal	122		no
			Private-Other	767		
		4	Federal		122	yes
			State		79	
			Private-Other		881	
Big Pine Key	4	5	Federal	901	901	no
			State	223	223	
			Private-Other	258	258	
No Name Key		6	Federal		75	no
			State		22	
			Private-Other		26	
Little Pine Key		7	Federal		97	no
			Total Federal	9,017	9,189	
			Total State	308	548	
			Total Private-Other	1,236	1,802	
			Total All Owerships	10,561	11,539	

6.1.2. Conservation Value of Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

The first five of the six PBFs of CH listed in section 6.1.1 above address various aspects of a pine rockland habitat that supports a plant community comprised predominantly of native species. This plant community includes pineland croton, which is the host plant for the larval life stage and an adult nectar source for both BSHB and leafwing. Pine rockland is a fire-adapted habitat with a sparse slash pine canopy, an understory of palms and tropical shrubs, and a partial ground cover of native grasses and wildflowers on thin soils over limestone (see section 3.1)

We discussed in section 3.1 how fire serves as the primary disturbance that maintains pine rockland plant communities and prevents a successional change to rockland hardwood hammock. In combination with fire suppression, exotic invasive species accelerate this successional change. A lighting-ignited fire frequency of 3–7 years, in combination with periodic hurricanes, maintained plant community structure and composition in pine rocklands prior to urban development on the Miami Rock Ridge and in the Florida Keys.

Data about the current condition of each PBF in every designated unit (*e.g.*, pineland croton abundance, pineland croton non-native competitor abundance, area of suitable habitat) are not available. However, the fire regime within a CH unit strongly influences the condition of the other PBFs, except for pesticide levels (PBF #6). We characterize in general terms the status of fire management and pesticide use in the CH units in the following paragraphs.

Fire was largely suppressed during the past decade on the pine rockland habitat in the Long Pine Key region within ENP (Units BSHB1 and Leafwing1) while ENP updated its fire management plan. The current plan (NPS 2014) describes cyclic burns and multiyear treatment intervals that are designed to burn the pine rockland habitat in a mosaic pattern. Prescribed fire returned to Long Pine Key in early 2016. The combination of prescribed burns and natural fires is likely to improve butterfly PBFs within ENP. ENP does not spray pesticides for mosquito control in the Long Pine Key area, except occasionally within developed areas that are excluded from the CH designations. Due to this management regime, the conservation value of BSHB1 and Leafwing1 is relatively high among all the designated units. The ENP units constitute about 70 and 76 percent of the acreage of designated CH for the BSHB and leafwing, respectively.

The conservation value of the units outside of ENP and within MDC is variable. Some portions of BSHB units 2, 3, and 4, and Leafwing units 2 and 3, and, receive periodic prescribed fire. These units constitute about 17 and 11 percent of the acreage of designated CH for the BSHB and leafwing, respectively. We discuss in section 3.1 the MDC Parks and Recreation prescribed fire program, and the challenges that both public and private land managers face in burning pine rockland habitat in this urban setting. Where fire and other measures are insufficient to arrest vegetation succession and control invasive exotic plant species, pineland croton abundance declines, which reduces the conservation value for BSHB and leafwing.

Since the designation of CH for the butterflies, the Service and MDC Mosquito Control have coordinated on measures to avoid adverse effects to CH through the implementation of buffers around CH units for aerial and truck-based pesticide application (see section 2.5, Interrelated and Interdependent Actions). The Service considers the MDC-adopted buffers sufficient to avoid adverse effects to the BSHB and leafwing from pesticide drift. The measures are as follows:

1) Institute a 250-m buffer around critical habitat units during truck-based spraying activities.
2) Institute a 400-m buffer around critical habitat units during aerial spraying activities. Wind direction and magnitude must be considered during aerial applications to ensure that drift does not extend beyond the 400-m buffer zone.
3) If MDC Mosquito Control determines application is necessary within the buffer zones described above, such applications should be coordinated with the Service prior to the initiation of treatment activities.

CH unit BSHB2 in the Navy Wells area is an exception to the buffers. A subset of the parcels within this unit receive truck-based mosquito control application in response to requests from the public (referred to herein as Florida City South East parcels; FCSE). Upon closer review by the Service, the habitat quality within the FCSE parcels is degraded, the host plant for the BSHB is not present, and we do not believe that the listed butterfly species currently occupy the unit. The

Service understands that BSBH2 also is within the treatment zone for aerial applications. MDC Mosquito Control adheres to the buffer zones outlined above in order to avoid the direct targeting or drift of aerial applications into Navy Wells Pineland Preserve or conservation areas within the BSBH2 CH unit. Consequently, the Service has not objected to truck-based mosquito control applications in and around the FCSE parcels or overall aerial applications up to the 2017 mosquito control season. We have requested MDC to coordinate with us on future mosquito control operations in the vicinity of butterfly CH.

The extent and frequency of burning on Big Pine Key and adjacent islands within Key Deer National Wildlife Refuge (units BSHB5 and Leafwing4) appears insufficient to maintain pine rocklands (79 FR 47231). No Name Key (BSHB6) and Little Pine Key (BSHB7) supported pineland croton until the early 1990s (Dickson 1955; Hennessey and Habeck 1991; Carlson *et al*. 1993), but disappeared from these islands soon thereafter (Emmel *et al*. 1995; Salvato and Salvato 2010b). Pesticide drift from mosquito control practices is a concern on Big Pine Key (Leafwing4 and BSHB6) and No Name Key (BSHB6), where pine rockland habitats are interspersed with, or not far removed from, residential and commercial areas (79 FR 47240). The poor condition of pine rockland habitats in all of the units in the Florida Keys provides minimal conservation value for the two butterfly species. These units constitute about 14 and 13 percent of the acreage of designated CH for the BSHB and leafwing, respectively.

In summary, about three quarters of the designated CH acreage provides a relatively high degree of conservation value for the two butterfly species (the ENP units). About one eighth provides moderate conservation value (the MDC units outside of ENP), and about one eighth provides minimal value (the Florida Keys units).

6.1.3. Conservation Needs for and Threats to Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

The primary threat to the conservation value of BSHB and leafwing CH is projected sea level rise that will affect the ENP units (BSHB1 and Leafwing1) and the Florida Keys units (BSHB5–7 and Leafwing4), which we discuss in section 3.2. Under various scenarios, up to about 15 percent of existing pine rocklands are inundated by 2050, and up to about 77 percent as early as 2080. Losses would occur first in the Florida Keys units, and then the ENP units. Any improvements to the minimal conservation value of the Florida Keys units would not last into the next century.

The units in the urbanized portions of MDC (BSHB2–4 and Leafwing2–3) are on higher ground, but may experience hydrologic and other changes due to rising seas and water tables (see section 3.2). These units contain 17 and 11 percent of the full acreage of designated CH for the BSHB and leafwing, respectively. The current conservation value of these units is mixed, depending on management to maintain pine rockland habitat conditions and protection from harmful pesticide use. The relative importance of these units will increase as CH units in ENP and the Florida Keys shrink with rising seas. Lands under private and local government ownership constitute 83 percent of Leafwing2–3, and 78 percent of BSHB2–4 (see Table 6-1). Possible development of these properties would cause a proportionally greater impact on the collective conservation value of butterfly CH as the units in ENP and the Florida Keys loose value.

We discussed in section 2.5 and in section 6.1.2 MDC mosquito control operations relative to butterfly designated CH. With the exception of the Navy Wells Pineland Preserve units, the MDC CH units outside of ENP are protected from mosquito control operations under current practices.

Therefore, the primary needs to maintain and enhance the conservation value of the urban MDC units are: (a) more comprehensive control of vegetation succession and invasive exotic plants through prescribed fire and other means (see section 3.1), and (b) more comprehensive protection from harmful pesticide use.

6.2. Environmental Baseline for Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of designated CH for BSHB and leafwing within the Action Area. The environmental baseline is a "snapshot" of the condition of the PBFs that are essential to the conservation of the species within designated CH of the Action Area at the time of the consultation, and does not include the effects of the Action under review.

The 188.86-acre Action Area includes 141.16 acres (90.20 acres of the CRC property plus all 50.96 acres of the UM property) of CH for the leafwing and BSHB, specifically the Richmond Pine Rocklands Unit of both designations (Leafwing3 and BSHB4). Unit Leafwing3 does not include the Nixon-Smiley tract of the BSHB designation, which is located about 2 miles north of the CRC property, but the boundaries of Leafwing3 and BSHB4 are identical within the Action Area. The Action Area covers 15.9 percent of unit Leafwing3, and 13.0 percent of BSHB4. The Action Area represents 1.3 percent of all Leafwing units combined, and 1.2 percent of all BSHB units.

6.2.1. Action Area Conservation Value of Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

The Applicants classify most of the butterfly CH within the CRC property as pine rockland habitat in various conditions, *e.g.*, scraped, fire suppressed, dominated by Burma reed, with or without a pine canopy, *etc*. CH within the CRC property also includes some smaller areas classified as rockland hammock, developed (cleared and sodded), and disturbed upland (historically marl prairie, exotic dominated) (HCP Figures 2-2, and 3-2). The Applicants describe the off-site Preserve on the UM property as entirely pine rockland habitat, but do not classify it into finer categories.

In section 3.2.1 of the HCP under "Site-Specific Information," the Applicants summarize the results of their pineland croton surveys, which documented 322 pineland croton locations within the CRC property. The off-site Preserve was not surveyed. About 90 percent of the pineland croton locations on the CRC property are within the butterfly CH boundaries (HCP Figure 3-2). The Applicants report that pineland croton occurrence and density was negatively correlated with canopy cover and invasive plant cover, *i.e.*, the surveys detected more pineland croton in areas

with less canopy cover and less invasive plant cover, primarily Burma reed. Of the 322 pineland croton locations, 192 (60 percent) occurred in two pine rockland habitat cover types: "Less than 50 percent Burma reed" and "Historically scraped with pine canopy." These two cover types represent 35 percent of the CRC property pine rockland habitat (see Table 2-2). The other 65 percent of the CRC pine rockland habitat has greater canopy closure, greater invasive plant cover, or both. Pineland croton persists in some of these other cover types, including some with a ground cover dominated by Burma reed.

Conditions relative to the PBFs of butterfly CH in the off-site Preserve are not specifically described in the HCP. This property is pine rockland habitat under management to conserve the deltoid spurge, primarily via mechanical and chemical control of invasive exotic plant species, and relatively infrequent prescribed fire. HCP Appendix K (a consultant's report dated 2014) noted that the most recent burns involved wildfires during 2004 and 2006, and that prescribed fire was applied most recently in 2003 within two of the eight management cells of the proposed off-site Preserve. The pine canopy appears relatively open in most of the off-site Preserve on aerial imagery of the UM property; however, the proposed prescribed burn plan (HCP Appendix J1) calls for some pine thinning during the first year of management.

Pesticides are not presently a factor limiting the conservation value of butterfly CH in the Action Area, due to the no-spray buffers MDC Mosquito Control has adopted and applies in the Richmond area (see section 2.5 and 6.1.2).

In summary, these data suggest that the PBFs of designated butterfly CH within the Action Area provide a moderate level of conservation value to the Richmond Pine Rocklands Unit, with much potential for enhancement through management that reduces invasive exotic plants and canopy closure.

6.2.2. Action Area Conservation Needs for and Threats to Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

As we discussed in sections 6.1.2 and 6.1.3, the conservation value of the Florida Keys butterfly CH units is minimal due to loss of pineland croton from some units and a general degradation of pine rocklands in all units. We expect a gradual reduction in the conservation value of butterfly CH in the ENP Unit due to sea level rise (see section 3.2). Sea level rise will further reduce the value of the Florida Keys units. These changes will elevate the importance of the CH units on higher ground in MDC, including the portion of CH that lies within the Action Area. Therefore, the primary conservation needs for butterfly CH in the Action Area are to preserve habitat and enhance the PBFs as much as possible.

The environmental baseline does not include the effects of the Action under review, and the Applicants' control land use within the entire Action Area. In the following section 6.3, we evaluate the Applicants' HCP proposal to develop some portions of the Action Area and enhance habitat conditions in other portions, both of which include areas designated as butterfly CH.

6.3. Effects of the Action on Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

This section analyzes the direct and indirect effects of the Action on CH for BSHB and leafwing. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

6.3.1. Effects of CRC Construction on Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

Habitat Loss and Fragmentation

The proposed CRC development would collectively occupy 86.49 acres, including 39.47 acres of butterfly CH (Service 2017). Development would initially remove all PBFs from this portion of butterfly CH. Thereafter, the proposed Stepping Stone habitats would restore pineland croton (PBF #3) within 3.88 acres of the development footprint, mostly within the CH boundaries. We do not expect the Stepping Stones to support all aspects of the BSHB lifecycle, but may function as pass-through habitat. The development of 39.47 acres would reduce the acreage that can support butterfly PBFs in BSHB4 by 3.6 percent and by 4.4 percent in Leafwing3. It would reduce the acreage that can support butterfly PBFs throughout all designated units for the BSHB and leafwing by 0.34 and 0.37 percent, respectively.

Connectivity is not a PBF of butterfly CH, but it was a criterion for delineating the size of CH parcels within the designated units and the distance between parcels. The permanent loss of PBFs from 39.47 acres of CH (minus the pineland croton plantings in the Stepping Stones) would enlarge a spatial gap between areas that may support PBFs on the East and West Preserves of the CRC property. The Service drew the CH boundaries around existing developed areas that cannot support PBFs, including the existing developed areas within the Action Area. The CRC development would expand these existing developed areas into the CH boundaries. This expansion would not reduce the size of parcels that may continue to support PBFs below the minimum size of 18 acres that we used as a delineation criterion (see section 6.1.1).

The proposed Stepping Stones would provide some connectivity across the CRC property, albeit a narrow strip of planted pineland croton and other native species. The configuration of the Stepping Stones would reduce the distance between CH parcels that contain the pineland croton PBF to the width of the main CRC development access road, which is comparable to the separation between other parcels that are included in the Richmond Pine Rocklands Unit. The impact of CRC construction on butterfly CH is primarily a reduction in the area that may support PBFs, with a much lesser impact on the spatial configuration of the remaining areas that may continue to support PBFs.

The Applicants' functional habitat assessment (see section 3.3) attributes 14.37 HVUs to the 86.49 acres proposed for development, but only 39.47 acres of butterfly CH occur within these areas. The Applicants' assessment did not partition the results of the analysis according to the CH boundaries. Because the Service delineated CH based on the presence of PBFs, which

generally align with the parameters used in the HVU model, we believe that the portions of the proposed development areas that are within CH likely provide a disproportionate share of the total HVUs for the developed areas. For purposes of our summary of effects below in section 6.3.4, we conservatively attribute all 14.37 HUVs of the developed areas to those portions that are within butterfly CH.

6.3.2. Effects of CRC Operations on Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

CRC construction would eliminate butterfly CH PBFs from 39.47 acres of butterfly CH within the CRC development footprint (see section 6.3.1). PBFs remaining on the CRC property following construction would occur only within the areas the Applicants propose as on-site Preserves and the Stepping Stones. Therefore, any additional effects of CRC operations on butterfly PBFs are limited to activities that cause stressors that extend into the adjacent on-site Preserves. CRC operations, *i.e.*, residential and commercial use of the development, may increase pesticide use and affect PBF #6, which relates to pesticide levels. However, we believe the Applicants' proposed conservation measures for pesticide use (see section 2.3.3) would limit the drift or runoff of pesticides from the developed areas into the on-site Preserves to levels that are insignificant to butterfly CH.

Concerns about property damage and smoke often deters the use of prescribed fire in areas adjacent to human development. This is a possible effect of CRC operations on PBF #4, which addresses fire and other disturbances that maintain the pine rockland plant community. However, the Applicants' HCP requires all lessees, property owners, and/or tenants to sign documentation acknowledging that fire management activities would occur on the CRC property and on adjacent properties in the Richmond Area (see section 2.3.2). Therefore, we believe that CRC operations are unlikely to adversely affect PBF #4 within the proposed on-site Preserves.

The other four PBFs relate to various aspects of pine rockland habitat condition (*e.g.*, abundance of pineland croton and pineland croton competitors), which CRC operations would not affect.

6.3.3. Effects of Preserves and Stepping Stones Management on Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

The proposed Preserves include 101.69 acres of butterfly CH (50.73 acres of the on-site Preserves and all 50.96 acres of the off-site Preserve) (Service 2017). Our analyses in section 4.3.3 of the effects of the proposed invasive exotic plant management and prescribed fire on BSHB habitat conditions apply to the PBFs of butterfly CH. However, our analysis of the proposed pine rockland plantings in the narrow strip of existing sod along the southern boundary of the CRC property does not apply, as this area is outside the boundaries of designated CH.

As we discussed in section 4.3.3, we expect the proposed Preserves management to enhance habitat conditions for the BSHB and any leafwing that may occupy the Preserves in the future. Relative to CH for both the BSHB and leafwing, we believe the proposed management will:

a) maintain open-canopy pine rockland habitat with a predominantly native plant species community (PBF #1) ;

b) reduce invasive plants (PBF #2);
c) maintain and increase pineland croton (PBF #3); and
d) restore a natural fire regime that is compatible with pine rocklands (PBF #4).

On-site Preserves

The Applicants' functional habitat assessment (see section 3.3) estimates the degree of habitat enhancement that management actions would achieve once "Level 3" success criteria of the on-site Preserves is accomplished. The assessment predicts a 66 percent increase from 26.35 HVUs to 43.82 HVUs. The success criteria used in the assessment that relate to butterfly CH PBFs included canopy cover, percent cover non-native plants, fire frequency, and percent cover of pine rockland herbaceous species. As we discussed in section 3.3, this degree of enhancement is predicated on full success, "Level 3", *e.g.*, increasing fire frequency to a 3–7 year return interval on each pine rockland parcel within the on-site Preserves.

Stepping Stones

The Applicants did not account for any potential benefits from the Stepping Stone plantings in their functional habitat assessment. As we discussed in section 6.3.1 above, by providing pineland croton in strips and islands within the development footprint, the Stepping Stones would provide a habitat link to reduce the spatial separation between CH parcels in the East and West Preservers that contain PBFs.

Off-site Preserve

The Applicants did not evaluate the potential enhancement of the off-site Preserve. As we described in section 6.2.2, the off-site Preserve is already under management to control invasive exotic plant species, but does not receive fire on the 3–7 year return interval that is most effective at maintaining pine rockland habitats. The management plan for the off-site Preserve (HCP Appendix J1) proposes to enhance habitat quality by implementing prescribed fire on the same interval as the "Level 3" success criterion for fire, 3-7 years.

Burning would occur on 45.60–48.65 acres of the 50.96 acres of the off-site Preserve. We expect that burning would increase the conservation value of butterfly CH within the off-site Preserve. Due to ongoing invasive plant control, the off-site Preserve currently provides a greater conservation value to butterfly CH than the on-site Preserves. Therefore, we expect less than the 66 percent increase in functional habitat value that the Applicants estimated for the on-site Preserves.

Given common management goals of reducing exotics and maintaining a 3-7 year fire rotation for both the on- and off-site Preserves, we expect a similar per-acre conservation value in both Preserve areas following management. The Applicants predict that the 51.41 acres of the on-site Preserves would realize a functional gain of 17.47 HVUs (see Table 3-1), or 0.34 HVU's per acre. This gain includes the benefits of substantially reducing exotic invasive plants, which are already at lower levels in the off-site Preserve (HCP Appendix K). Lacking data for the other parameters of the HVU model for the off-site Preserve, we assume that burning would provide

about half of the per-acre functional gain estimated for the on-site Preserves, but this gain would add to a better baseline condition. A gain of 0.34 ÷ 2 = 0.17 HVU per acre applied to 45.60–48.65 acres of the off-site Preserve (the portion that would receive burning) would result in a total gain of 7.75–8.27 HVUs. We compare this rough estimate with the results for the other portions of the Action Area in section 6.3.4 below.

6.3.4. Summary of the Effects of the Action on Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

The proposed CRC development would collectively occupy 86.49 acres, including 39.47 acres of butterfly CH (Service 2017). This development would reduce the acreage that can support butterfly PBFs in Unit BSHB4 by 3.6 percent and by 4.4 percent in Unit Leafwing3. It would reduce the acreage that can support butterfly PBFs throughout all designated units for the BSHB and leafwing and by 0.34 and 0.37 percent, respectively.

We consider the Applicants' functional habitat assessment a reasonable surrogate measure of butterfly CH conservation value, because the parameters of the assessment are comparable to several of the butterfly PBFs. The Applicants estimate that the CRC development would cause a loss of 14.37 Habitat Value Units (Table 3-1), which we conservatively attribute entirely to a loss of PBFs in butterfly CH.

We believe that CRC operations would have either no effect on the remaining PBFs of butterfly CH or that the proposed conservation measures would limit the adverse effects to a level that is insignificant or to a probability that is discountable (*e.g.*, drift or runoff of pesticides from the developed areas into the on-site Preserves).

The quality of habitat for butterflies in the off-site Preserve is presently better than the on-site Preserves, due to ongoing invasive exotic plant management, but it is rarely burned. The Applicants did not apply the functional habitat assessment to the off-site Preserve. To facilitate an estimation of habitat value change for the entire Action Area, we assume that the off-site Preserve would receive about half of the "habitat lift," that the on-site Preserves would receive, because it is starting at a higher baseline condition. We expect that the proposed management of the on-site and off-site Preserves would enhance the conservation value of butterfly CH to a comparable functional level in both areas. We attribute all of the loss of conservation value resulting from the CRC development to CH located within the development footprint. Combining these inferences results in the following overall characterization of the change in CH conservation value:

Area	Change in HVUs
CRC Development	-14.37
On-site Preserves	+17.47
Off-site Preserve	+8.05
Net change	+11.15

6.4. Conclusion for Bartram's Scrub-hairstreak and Florida Leafwing Butterfly Critical Habitat

In this section, we summarize and interpret the findings of the previous sections for BSHB and leafwing CH (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of designated CH for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

Status

CH for BSHB is comprised of 11,539 acres in seven separate units located in MDC and Monroe County, Florida. CH for leafwing is comprised of 10,561 acres in four separate units located in MDC and Monroe County, Florida. The Service's designation of CH for both species identifies a common set of six PBFs that are essential to their conservation and may require special management considerations or protection. Five of these PBFs relate to various conditions of pine rockland habitat, and in some locations, associated rockland hammocks and hydric pine flatwoods. The sixth PBF relates to pesticide levels.

About three quarters of the designated CH acreage, specifically the BSHB and leafwing units within ENP, provide a relatively high degree of conservation value for the two butterfly species. About one eighth provides moderate conservation value (the units in MDC outside of ENP), and about one eighth provides minimal value (the Florida Keys units).

The primary threat to the conservation value of BSHB and leafwing CH is projected sea level rise that would affect the ENP units (BSHB1 and Leafwing1) and the Florida Keys units (BSHB5–7 and Leafwing 4). Loss of function in these units would increase the importance of the MDC units located outside ENP. The urban setting of these units presents challenges to maintaining pine rockland habitats with prescribed fire, and to protecting areas from pesticides used to control mosquitos. To maintain and enhance the conservation value of these urban MDC units would require: (a) more comprehensive control of vegetation succession and invasive exotic plants through prescribed fire and other means; and (b) more comprehensive protection from harmful pesticide use.

Baseline

The 188.86-acre Action Area includes 141.16 acres (90.20 acres of the CRC property plus all 50.96 acres of the off-site Preserve) of CH for the BSHB and leafwing, specifically the Richmond Pine Rocklands Unit of both designations (BSHB4 and Leafwing3). The Action Area covers 13.0 percent of BSHB4 and15.9 percent of unit Leafwing3. The Action Area represents 1.2 percent of all BSHB units combined and 1.3 percent of all leafwing units. Available data on

the condition of CH within the Action Area suggest that the PBFs present provide a moderate level of conservation value to the Richmond Pine Rocklands Unit, with much potential for enhancement through management that reduces invasive exotic plants and canopy closure.

Effects

The proposed CRC development would collectively occupy 86.49 acres, including 39.47 acres of butterfly CH. This development would reduce the acreage that can support butterfly PBFs in BSHB4 by 3.6 percent and by 4.4 percent in Leafwing3. It would reduce the acreage that can support butterfly PBFs throughout all designated units for the BSHB and leafwing by 0.34 and 0.37 percent, respectively.

We consider the Applicants' functional habitat assessment a reasonable surrogate measure of butterfly CH conservation value, because the parameters of the assessment are comparable to several of the butterfly PBFs. This assessment predicts Action-caused changes in HVUs for the loss of habitat features in the development areas, and for the enhancement of habitat features in the on-site Preserves. The Applicants did not assess HVUs for the off-site Preserve. The quality of habitat for butterflies in the off-site Preserve is presently better than the on-site Preserves, but management under the same success criteria should create similar conditions in both areas over time. We roughly estimate the benefits of managing the off-site Preserve from a higher baseline condition as half of the per-acre enhancement measured by the assessment of the on-site Preserves. This results in the following overall characterization of the change in CH conservation value:

Area	Change in HVUs
CRC Development	-14.37
On-site Preserves	+17.47
Off-site Preserve	+8.05
Net change	+11.15

Opinion

By developing 39.47 acres of CH, the Action would reduce the acreage that can support butterfly CH PBFs throughout all designated units for the BSHB and leafwing by 0.34 and 0.37 percent, respectively. Due to sea level rise in the remainder of this century, the CH acreage that can support butterfly PBFs may shrink substantially in the ENP and Florida Keys units. If we discount the future conservation value to the ENP and Florida Keys units entirely, the proportional impact of the loss of 39.47 acres increases to 2.0 percent and 3.3 percent for BSHB and leafwing CH, respectively.

However, we believe the Action would offset the loss of 39.47 acres of area that can support butterfly PBFs by addressing a primary conservation need of this CH, which is to better manage the remaining pine rockland habitats. Because wildfire that historically maintained pine rocklands is now suppressed, these habitats loose functional value without active management. Habitat enhancement accomplished in the on- and off-site Preserves would provide a net increase in the conservation value of CH in the Action Area. We are unaware of other non-federal actions

in the Action Area that are reasonably certain to occur and that may affect butterfly CH (cumulative effects; see section 3.4).

After reviewing the current status of the CH, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to destroy or adversely modify designated CH for BSHB and leafwing.

7. MIAMI TIGER BEETLE

7.1. Status of Miami Tiger Beetle

This section summarizes best available data about the biology and current condition of the Miami tiger beetle (*Cicindelidia floridana*) (MTB) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the MTB as endangered on October 5, 2016 (81 FR 68985). The Service has not proposed or designated CH for this species.

7.1.1. Description of Miami Tiger Beetle

The adult MTB is a small (6.5–9.0 millimeters [mm]) oval-shaped beetle with bulging eyes and large jaws (mandibles). The underside of the abdomen is orange or orange-brown. The combination of features that uniquely identify an adult MTB are: (a) a shiny dark green dorsal surface that may appear almost black, sometimes with a bronze cast; (b) green hardened forewings (elytra) that cover the abdomen; and (c) a small white patch at the posterior tip of each elytra.

MTB larvae have a white, slender, grub-like body, dark metallic head, and large mandibles. Larvae develop in permanent burrows that are flush with the ground surface. Two pairs of hooks on an enlarged dorsal portion of the fifth abdominal segment anchor a larva to its burrow while the upper portion of the body extends to capture prey.

7.1.2. Life History of Miami Tiger Beetle

The lifecycle of the MTB occurs entirely within or adjacent to pine rockland habitats. The species relies almost exclusively on open patches of sandy soil associated with these habitats for thermoregulation (avoiding or seeking sources of heat to regulate body temperature), feeding upon small arthropods, and reproduction (Knisley 2015a).

Feeding

Knisley (2015a) describes the feeding habits of the MTB. The adult is an active diurnal predator that captures small arthropods with keen vision, speed, and well-developed jaws. The larva ambushes small arthropods from its burrow by quickly seizing small arthropods that pass within a few centimeters of the mouth of the burrow, which is flush with the ground surface. Ants are the most common prey for both adults and larvae.

Reproduction and Development

Mating and egg-laying (oviposition) in tiger beetles occurs during the adult flight period, which is typically 2-3 months during the spring or summer. An adult female determines the habitat and microhabitat of its larvae by selecting an oviposition site (Knisley and Schultz 1997). Adults and larvae generally occupy the same microhabitats. Willis (1967) reported that a female tiger beetle touches the soil with its antennae, bites the soil, and may even dig trial holes, likely to determine soil suitability for oviposition, before using its ovipositor to dig a shallow (1–2 centimeter [cm]) burrow for a single egg (Willis 1967). The egg hatches, apparently after sufficient soil wetting, and then the first instar larva (developmental stage between molts) deepens its burrow. Knisley (2013) reported the results of a laboratory rearing trial for MTB in which females produced a mean of 6 first instars. Development in tiger beetles involves three larval instars followed by the pupa and adult stage. Development from the larval stages to the adult stage occurs in less than 1 year, and the adult stage is typically present on the landscape for 2–3 months.

Knisley (2015a) reported that the adult flight period for the MTB extends from May 15 through October 17 based on field observations over several years. This exceeds the typical 2–3 month flight period of most other tiger beetles, including three other similar species that occur in the Florida Keys. To account for the extended flight period, Knisley suggests that two cohorts of MTB adults emerge during this period, *i.e.*, that the MTB generation time is less than 1 year. Under this hypothesis, the first adult cohort emerges in May and June to mate and produce larvae that develop and emerge as a second adult cohort in late July and August, while the first cohort is dying. Larvae from the second cohort develop through fall and winter, emerging as adults the following May. Development of the first cohort's larvae to the adult stage within 2–3 months is possible given the species' small size, consistently warm temperatures in south Florida, and abundant prey during the summer rainy season.

Dispersal

Knisley and Hill (1996) described a positive correlation among tiger beetles between flight distance and body size, *i.e.*, larger species fly farther. The MTB is one of the smallest tiger beetles, and is likely a weak flier. The slightly larger Highlands tiger beetle (*C. highlandensis*) flies distances of 5–10 m (Knisley and Hill 2013). Although the dispersal range of a tiger beetle exceeds the distance it can cover in a single flight, flight distance and dispersal range are likely correlated. Tiger beetle species associated with woodland and scrub habitats, such as the MTB, appear to disperse shorter distances than those associated with habitats at the edge of water bodies (Knisley and Hill 1996). Tiger beetles generally occupy ephemeral habitats; therefore, as occupied habitat patches become unsuitable, a species' persistence in an area requires dispersal to more suitable patches (Knisley 2015b). Local populations decline and are extirpated when no suitable habitat patches are available or accessible within the species' dispersal range.

Knisley and Hill (2013) reported a movement range of 70-150 m by 9 of 135 marked Highlands tiger beetle adults between areas of suitable habitat during relatively brief periods between initial marking and subsequent recapture. All other beetles in this study were recaptured in the areas where they were marked, moving 10-50 m from the initial marking location.

Habitat

As a group, tiger beetles are predators of small arthropods on bare or sparsely vegetated ground in various ecological settings, where adults pursue and larvae ambush their prey. Unshaded patches with sparse ground cover in these settings allows adults to attain a high body temperature and to chase and capture prey. Occupied patches contain soils suitable for constructing larval burrows. Available data indicates that the MTB is associated exclusively with bare or sparsely-vegetated sandy patches within or adjacent to pine rockland habitats in the North Biscayne Pinelands of MDC, Florida (see "Distribution" under section 7.1.3 below). Pine rockland is a fire-adapted habitat with a sparse slash pine canopy, an understory of palms and tropical shrubs, and a partial ground cover of native grasses and wildflowers on thin soils over limestone. The soil type associated with MTB locations is the Opalocka Sand-Rock Complex.

Although the association with open patches in or adjacent to the pine rockland habitat type is consistent, microhabitat conditions (patch size, soil characteristics, prey availability) that support the MTB are otherwise not well studied. Limited microhabitat data is available for the population on the Richmond pine rocklands, where Knisley (2015a) found adults and larvae in multiple patches of relatively open ground. These patches, bounded by encroaching and overhanging vegetation, ranged in size from 2–6 m^2, with 15–30 percent ground cover within the patches. Knisley did not observe adults in patches smaller than 2 m^2. Some occupied patches were apparently trails, possibly maintained by animal activity. Soils within the occupied patches were:

- white to gray sands or loamy sands;
- very fine to medium particle size (0.13–0.50 mm);
- less than 5 percent organic matter;
- greater than 15 cm deep; and
- moist below the surface.

This microhabitat differs from that of the Highlands tiger beetle (*C. highlandensis*) and scrub tiger beetle (*C. scabrosa*), which are typically found in much larger open patches (> 25 m^2) or along open paths, roads, and scrub edges (Knisley 2015a). The soil types associated with these species are deep, dry, white "sugar" sands, with minimal organic matter content. The soils of the North Biscayne Pinelands, the likely historical range of the MTB, are classified as Opalocka sand-rock outcrop complex (Knisley 2015a).

In the 1940s, the U.S. Navy built the Richmond Naval Air Station on property that is currently Zoo Miami and where the MTB was rediscovered in 2007. The Navy cleared and scraped much of the area that the MTB currently occupies to create runways and blimp hangars (Wirth 2015). The species' presence in this area a few decades following this substantial alteration demonstrates the restoration potential for disturbed pine rocklands (Possley 2015; Wirth 2015).

Knisley (2015a) suggests that the soils and open vegetative structure of pine rocklands are possibly more important to MTB conservation than the plant species composition of the rocklands. This idea is consistent with finding the species along unpaved roads through pine rockland vegetation, and in open fields on the USCG property in the Richmond Pine Rocklands. On the Miami Rock Ridge, fire is generally the disturbance that maintains an open vegetative structure and prevents a transition from mineral to organic soils, which results in the species

composition of the pine rockland vegetative community. Mowing maintains the openness of the USCG property fields that support the MTB, but these are adjacent to areas with pine rockland vegetation. Regardless whether physical or biological characteristics are more important, the known range of the MTB is restricted to areas that either bear some resemblance to the pine rockland plant community or are immediately adjacent to such areas. Knisley reports that the deltoid spurge and tiny polygala (see sections 12 and 13), which occupy the same microhabitat within pine rocklands as the MTB, are likely good indicators of MTB habitat.

7.1.3. Numbers, Reproduction, and Distribution of Miami Tiger Beetle

Distribution

Information about the range of the MTB before its rediscovery in 2007 (Brzoska *et al*. 2011; Knisley 2011a) is limited to collections of the species in 1934 from the northern end of the Miami Rock Ridge. The Miami Rock Ridge is the limestone outcrop between the City of North Miami and Long Pine Key (Long Pine Key is an area within Everglades National Park west of Homestead, Florida, and not an island of the Florida Keys). Robertson (1955) recognized three regions of the Miami Rock Ridge based on soils and vegetation. Extensive pockets of quartz sand overlay the limestone of the northern end (about 45 miles) of the Ridge, which Robertson termed the Northern Biscayne Pinelands. The 1934 MTB collections near the northern end of the Northern Biscayne Pinelands, and the 2007 rediscovery of the MTB near the southern end, suggests that the historical distribution of the species probably encompassed the full extent of this habitat type.

Whether the range of the MTB once extended beyond the Northern Biscayne Pinelands further south into the other two regions of the Miami Rock Ridge is unknown. “Redland” soils overlay the middle region of the Ridge that Robertson (1955) termed the Southern Biscayne Pinelands, as opposed to the lighter-colored quartz sands to the north. The third and southern-most region of the Ridge is the Long Pine Key area within ENP. Long Pine Key has scant soil deposits and a lower elevation than the other two regions. Surveys within Long Pine Key did not find the MTB, and the surveyors considered habitat conditions there unsuitable for the species (Knisley 2015a). Outside of ENP, urban development and agriculture have displaced about 99 percent of the pinelands on the Miami Rock Ridge (Herndon 1998).

The current known distribution of the MTB is limited to five properties in the Richmond Heights area of MDC, where the species was rediscovered in 2007. This area contains the largest remaining assemblage of pine rockland habitat on the Miami Rock Ridge outside of ENP. Four of the properties are adjacent, but the fifth is separated from the others by urban development. We do not identify the fifth property in this BO due to the threat of unauthorized collection (see section 7.1.4 below), and disclosing its location is not necessary to formulate our opinion for the Action.

Knisley (2015a) reports observations of the MTB on four properties in the Richmond Heights area:

1) Zoo Miami;
2) Larry and Penny Thompson Park;

3) USCG, and
4) UM Richmond Campus.

These four properties contain most, but not all, of the pine rockland habitat in the Richmond area. Figure 7-1 shows property ownership and the distribution of pine rockland vegetation in the Richmond area.

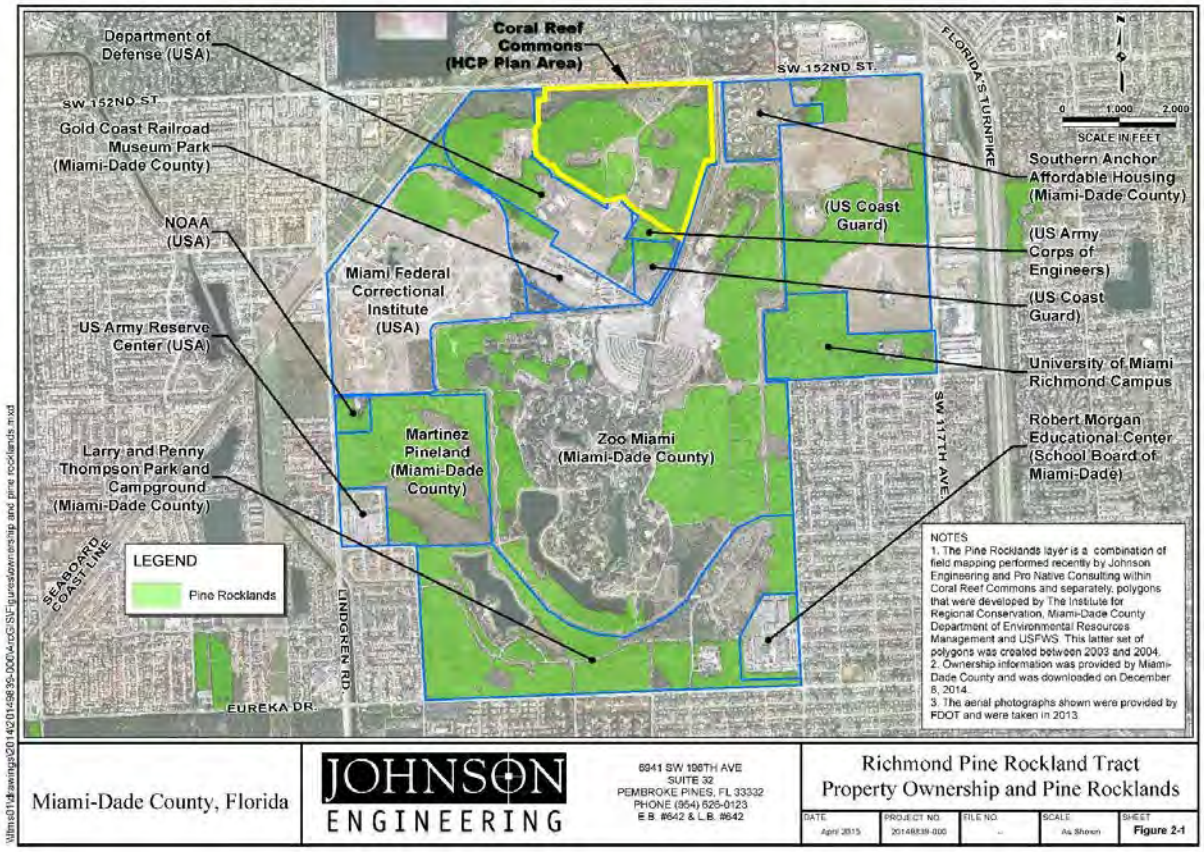

Figure 7-1. Properties containing pine rockland habitats in the Richmond area (source: HCP Figure 2-1).

On the four properties listed above, Knisley (2015a) found MTB in multiple patches of open ground in close proximity to each other, with no impassable barriers to movement between patches. Knisley considers the MTBs observed on these four properties a single population. Urban development between these properties and the fifth property entirely precludes the movement of individuals between the two; therefore, we consider the fifth property as supporting a second distinct population.

Although habitat connectivity between the four Richmond properties suggests that it supports a single MTB population, most of the pine rockland habitat on these properties does not retain the openness (extensive patches of sparsely vegetated sandy soil) that is characteristic of this fire-adapated habitat type. Knisley (2015a) estimates that less than 10 percent of pine rockland habitats on the four Richmond properties supports the species.

The fifth property that supports the MTB is pine rockland habitat that is similar to that on the Richmond properties, but covers a much smaller area. Several sites with microhabitat conditions suitable for MTB were surveyed in 2010-2013 without detecting the species. Subsequent surveys in 2015 at different sites detected 13 adult MTB.

Numbers

To date, MTB surveys have employed the "visual index count" method of Knisley and Hill (2013). The primary purpose of this survey method is to locate tiger beetles in an area. This method is not designed specifically to collect provide data that may directly estimate beetle density in occupied areas or the occupied percentage of the habitat surveyed. Visual index counts fail to detect a majority of the adult individuals present, based on a comparison with removal/resurvey methods (Knisley and Hill 2013). Tiger beetles are small, elusive, capable of flying away undetected, and easily obscured by vegetation in overgrown areas. Actual numbers present at a site may exceed survey counts by a factor of 2–3 (Knisley and Schultz 1997; Knisley 2009; Knisley and Hill 2013). Counts from all sites surveyed by the visual index method have ranged from 0–42 MTB per site, and these sites contain a variable number of discrete patches of open ground where MTB were observed (Knisley 2015a; Mays and Cook 2015).

Generally, surveyors detect only 1 or 2 adults per patch of open ground. Mays and Cook (2015) detected 12 in a single relatively large patch with a measured area of 60 m^2 (0.015 acres); *i.e.,* an observed density of 1 adult per 5 m^2. This patch was 10 times larger than the range of occupied patch sizes that Knisley (2015a) reports (2–6 m^2); therefore, we do not consider it as representative of the species' microhabitat density in other locations. Regardless of the probable variability in density within occupied patches, understanding the species' abundance depends on somehow quantifying the extent of suitable microhabitat within larger tracts.

To quantify the collective size of the larger tracts that support the MTB, we examined land cover conditions around all confirmed MTB records on recent aerial imagery. The Richmond Heights area contains more than 1,000 acres of pine rockland habitat; however, the full extent of similar cover conditions surrounding each MTB record is only 317 acres. More than half of this area (175 acres) is on the USCG property, where many of the MTB points lie in fields without a pine canopy. These fields show evidence of soil scraping in the past, probably when the Navy developed the area as the Richmond Naval Air Station during the 1940s, and are now periodically mowed. Therefore, saw palmetto and other mid-story species are reduced or absent, but the fields support other native pine rockland plant species.

The remaining 142 acres of the 317 acres of similar habitat surrounding the MTB records is more clearly recognizable as pine rocklands. Knisley (2015a) suggests that suitable microhabitat for the MTB constitutes about 10 percent of the pine rockland tracts where he has detected the species. Suitable microhabitat is widely scattered in relatively small patches. If Knisley's estimate is an accurate characterization of the 142 acres we delineated, suitable microhabitat in these areas is about 14.2 acres.

We have no data about the extent of suitable microhabitat patches in the fields of the USCG property. Distribution of the MTB records includes both the open fields and adjacent areas with a

pine canopy. Knisley's (2015a) surveys of the USCG property did not include the open fields, but he included the pine rockland habitat of the USCG property in his estimate that only 10 percent of these habitats support the species. For purposes of this consultation, we consider that suitable microhabitat is limited to 10 percent of all 317 acres (31.7 acres) that we delineated around the MTB records, including the records on the USCG property. An analysis of high-resolution aerial imagery that specifically measures the extent of bare patches within the areas known to support the MTB would refine this estimate of 10 percent microhabitat availability, but is not available at this time.

Although Knisley (2015a) reports the range of patch sizes in which MTB were detected in surveys (2–6 m^2), specific data that pairs MTB numbers and patch sizes is not available from which to compute density and then abundance across larger areas. We believe the density measurement of 1 adult per 5m^2 for the single patch described above (Mays and Cook 2015) is probably higher than for most occupied patches. For purposes of a consultation, it is more cautious to underestimate range-wide abundance and thereby overestimate the relative impact of an action to the status of the species. If the average density for all patches is about 1 adult per 10 m^2 (404 per acre) instead of 1 per 5 m^2, MTB abundance in the sites known to support the species is about 13,000 adults. Although this is a very rough estimate without a measure of statistical confidence, it provides a reasoned basis for making comparisons. A large fraction of the pine rockland habitat in the vicinity of the known MTB occurrences has not been surveyed; therefore, the total area that encompasses known occurrences would increase if additional MTB sites are identified.

Reproduction

Knisley (2013, 2015a) surveyed the Zoo Miami property for occupied MTB larval burrows during the winter months of 2010–2015. The January 2010 survey detected 63 larval burrows containing 5 first instars, 36 second instars, and 22 third instars. All burrows were found in open sandy patches where adults were also observed. In March 2010, most of the second instar larvae observed in January had progressed to the third instar.

Surveys of the same areas during January or February of 2011–2015 detected 15 or fewer larval burrows each year, but the reason for this decline is unknown. Possible explanations are reduced survival to the adult stage during 2010–2014; reduced burrow detectability due to vegetation growth, leaf litter accumulation, or other environmental factors; or some or a combination of these factors (Knisley 2015a). Vegetation encroachment was apparent during the January 2015 survey of the "Zoo B" area, where tags marking larval burrows previously identified were covered by plant growth and leaf litter. Prescribed fire in the "Zoo A" area during November 2014 had reduced ground vegetation, but Knisley found no larvae in this area.

7.1.4. Conservation Needs of and Threats to Miami Tiger Beetle

The Service has not yet completed a recovery plan for the MTB, which was listed as endangered in 2016. The goal of a recovery plan is to improve the status of a species so that it no longer warrants classification as threatened or endangered under the ESA. To achieve this goal, recovery plans specify: (a) criteria for measuring progress; (b) necessary site-specific

management actions; and (c) estimates of the time and cost required to carry out such actions. Absent a recovery plan for the MTB, we summarize in this section best available data about the conservation needs of the MTB and threats to its survival that are relevant to this consultation. The final listing rule (81 FR 68985) provides additional details about the factors that contributed to its current classification as an endangered species.

At this time, we know that four contiguous properties and fifth disjunct property each support a small population of the MTB. These two locations are among several small remnants of pine rockland habitat on the Miami Rock Ridge within the urbanized portions of Miami-Dade County, but the Richmond Pine Rocklands is the largest of these remnants. Without adjacent populations within a species' dispersal abilities, small and isolated populations are vulnerable to extirpation caused by catastrophic events, such as hurricanes. With only two known and small populations, the MTB is especially vulnerable to extinction.

Habitat conditions that support MTB feeding, breeding, and sheltering behaviors are degraded to varying degrees at the two MTB locations. Knisley (2015a) documented a decline in the number and size of open sandy patches in the Richmond Pine Rocklands in recent years. We believe that securing the ability of the two MTB locations to support a viable local population is the species' most urgent conservation need. The primary threat to meeting this need is an ongoing reduction in microhabitat availability through vegetation succession that eliminates open patches within the pine rockland macrohabitat. Reducing this threat is best addressed via prescribed fire, which we discuss below.

In 2013, MDC posted an "Invitation to Negotiate" notice soliciting proposals to develop the "Zoo Miami Entertainment Area" (ZMEA) (also referred to as "Miami Wilds") (https://www.miamidade.gov/dpmww/SolicitationDetails.aspx?Id=Invitation%20To%20Negotiate%20(ITN)). The notice described the ZMEA as "multiple attractions, amusements, lodging, food service and retail establishments within Zoo Miami, Gold Coast Railroad Museum Park and USCG properties...." Two of these three properties contain the majority of the sites that are known to support the MTB. The invitation to negotiate has expired. Whether this project will proceed is unknown, and further details that might indicate the full scope of potential impacts to the MTB are not available to the Service at this time.

Prescribed Fire

We describe in section 3.1 the role of fire in maintaining pine rockland habitats. A lighting-ignited fire frequency of 3–7 years maintained plant community composition and patches of open soil in pine rocklands prior to urban development on the Miami Rock Ridge. Most of the properties that are known to support the MTB have not received this fire frequency in the past 20 years. As we also describe in section 3.1, implementing prescribed fire on a 3–7 year cycle is challenging throughout the distribution of remaining pine rocklands in the urbanized portions of MDC. Therefore, any other undetected populations of the MTB that may persist at pine rockland locations besides the five properties known to support the species are likely also threatened by habitat degradation resulting from fire suppression or an infrequent fire regime.

Collection

Collection is a potentially serious threat to the MTB. Tiger beetles are a favorite of collectors, and rare species are of greater value and in greater demand than common species. The federally endangered Ohlone tiger beetle (*Cicindela ohlone*) was collected from its type locality in California after its description in the scientific literature (66 FR 50340; Knisley 2015a). Collection of 500 to 1,000 adult Highlands tiger beetles likely contributed its extirpation from its type locality in Florida (Knisley and Hill 1992).

Removing individuals from an extremely small population may have a significant impact on its viability. Recognizing this concern, Brzoska *et al*. (2011) did not disclose the type locality for the MTB in the published taxonomic description of the species to protect it from collectors. Despite this omission, the species' discovery in the Richmond Pine Rocklands became widely known in the tiger beetle collecting community. We are aware of postings on social media about MTB specimens (9 individuals) in collections. Recognizing the futility of withholding information about the Richmond Pine Rocklands, we identified the area in the 2016 final rule listing the MTB.

Collecting a listed animal species without an ESA §10(a)(1)(A) permit is unlawful, subject to a civil penalty of up to $25,000 for each violation, which should deter most collectors. However, undetected accessibility to some properties in the Richmond Pine Rocklands is a concern. The USCG and UM properties are fully gated and accessible only by permit; however, the Zoo Miami property is partially gated and only periodically patrolled (Knisley 2015a).

Human Disturbance

Knisley (2011b) reviewed the effects of human disturbance on tiger beetles. Vehicles, bicycles, and human foot traffic may crush adults and larvae or disrupt normal feeding, breeding, and sheltering behavior. Significant levels of exposure to such disturbance has likely contributed to the decline and extirpation of other tiger beetle populations in some beach and dune habitats.

Known occurrences of the MTB on the Richmond properties are in areas that are not open to the public for recreational use, and vehicle traffic through these properties is infrequent. At Zoo Miami, Knisley (2015a) reports observing a few MTB adults along a little-used dirt road and along the main gravel road, both adjacent to interior patches where adults were more common, but where vegetation was encroaching upon the habitat openings. Adult MTB were also found along little-used dirt roads on the UM and USCG properties, as well as an open field on the USCG property.

Climate Change

We describe in section 3.1 how climate change may affect pine rockland habitats in south Florida, including the Action Area. Sea level rise in the next 30–50 years is not expected to inundate the known MTB locations, but could eventually alter the level and salinity of the water table in the Miami Rock Ridge. Altered water table depth and salinity could alter the composition of pine rockland plant communities, and in turn the associated animal communities.

Possibly exacerbating these changes, inundation of lower-lying urban areas would increase development pressure on remaining higher-lying remnants of pine rockland habitats.

Climate change is predicted to increase the severity of hurricanes. The two known MTB populations are within 5 miles of the Atlantic coast and are therefore likely to experience hurricanes. It is likely that substantial amounts of downed vegetation would disrupt normal feeding, breeding, and sheltering behavior of individuals that survive a hurricane, which would depress survival rates and reproductive success until the habitat recovers. The MTB was presumed extinct until 2007; therefore, it is unknown how Hurricane Andrew in 1992 affected MTB populations. It is evident only that the MTB somehow persisted following a direct hit by a Category 5 hurricane. We have not yet been able to assess the effects on the MTB of the most recent tropical storm, Hurricane Irma, to make landfall in the range of the MTB.

7.2. Environmental Baseline for Miami Tiger Beetle

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the Miami tiger beetle (MTB), its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

7.2.1. Action Area Numbers, Reproduction, and Distribution of Miami Tiger Beetle

The Action Area is comprised of two disjunct properties: the CRC property, which contains the development and the on-site Preserves, and the UM property, which contains the off-site Preserve. The MTB is known to occur on the UM property (Knisley 2015a) within the proposed 50.96 acre off-site Preserve.

Knisley (2013) reports the following results from a survey of a portion of the proposed East Preserve on the CRC property:

> "An extensive survey of the area west of zoo entrance road (Fig. 1) produced no tiger beetles. This area seems to have marginal or unsuitable habitat and although there are some smaller and/or connected bare patches, these were probably too limited to support beetles. There was also extensive cane in much of area and other parts had considerable rock substrate."

"Fig. 1" referenced in this excerpt shows a waypoint that is within the CRC property, although Knisley believed at the time that he was on Zoo Miami property (Knisley 2014). His report does not specifically describe the scope of the survey effort associated with this waypoint, except to say, as quoted above, that it was "extensive."

To date, the "visual index" survey methods of Knisley and others qualified to identify the species in the field have informed virtually all of our knowledge about where the species occurs. These methods do not provide a high level of confidence that tiger beetles are absent from a site. As we explained in section 7.1.3, the visual index surveys have a relatively low probability of detecting the species (*i.e.*, numbers observed are likely 2–3 times less than numbers present). Survey results from several locations visited several times report negative results on some dates and positive results on other dates, and the positive results are highly variable. The difficulty of

detecting this tiny and rare species in pine rockland habitats was evident with the discovery of the second MTB population. Portions of this location were surveyed initially with negative results, but subsequent surveys detected the species in 2015. For these reasons, we do not consider Knisley's single survey on a portion of the CRC property as a definitive finding that the species does not occur on the CRC property.

Despite negative results from a single survey effort, we believe the species is reasonably certain to occur on the CRC property for the following reasons.

1) Proximity to known occurrences – the CRC property is within 300 feet of MTB occurrences on the Zoo Miami property. Similar habitat conditions surrounding these occurrences extend to SW 124th Avenue, which forms the eastern CRC property boundary.
2) No impassable barriers to movement – SW 124th Avenue (a two-lane road) is the only development feature that separates the CRC property from occupied sites on the Zoo Miami property. The width of this road is less than the dispersal range noted for the similar Higlands tiger beetle (see "Dispersal" under section 7.1.2).
3) Suitable pine rockland habitat and open areas although habitat conditions are degraded to varying degrees, portions of the CRC property are similar to occupied sites elsewhere. The entire property is underlain by Opalocka Sand-Rock Complex soils, which is the soil type associated with MTB sites. Plant species that share the same open-sandy microhabitat as the MTB, tiny polygala and deltoid spurge, are documented on the CRC property.

To estimate the likely extent of suitable MTB habitat on the 137.90-acre CRC property, we used the data compiled for the Applicants functional habitat assessment (see section 3.3). The Applicants mapped the property as 103 polygons of similar land cover, and assessed the conditions within each polygon according to the parameters described in section 5 of the HCP. We used the data for each polygon to remove from further consideration those that are unlikely to support the MTB.

We first eliminated polygons with greater than 75 percent canopy cover, because the MTB requires sunlight at ground level for thermoregulation (see section 7.1.2). We then eliminated polygons with a cover of Burma reed and other exotic plants greater than 89 percent. It is highly unlikely that ground not covered with exotics in these polygons is entirely bare soil, which the MTB requires for its breeding, feeding, and sheltering behaviors. Finally, we eliminated polygons to which the Applicants assigned ratings of less than 0.6 for the "soil condition" parameter (*i.e.,* ratings of 0, 0.2, and 0.4). The HCP (page 86) describes these ratings as follows:

a) 0 – Impervious surface such as an existing building, concrete pad or asphalt road.
b) 0.2 – Soil alteration is such that it no longer represents and supports vegetation associated with a pine rockland community and is indicative of a non-pyrogenic community.
c) 0.4 – Soils with high levels of organic accumulation not yet exhibiting characteristics of a non-pyrogenic community.

Our basis for excluding impervious surfaces is self-evident. We excluded soil ratings 0.2 and 0.4 due to the elevated organic content. MTB soils are sandy with less than 5 percent organic content (see section 7.1.2 under "Habitat").

The polygons remaining after the filtering described above cover 57.85 acres of the CRC property. The general land cover classification for all polygons that remained, except 1.76 acres classified as "Disturbed Upland," is "Pine Rockland." Although we did not explicitly exclude polygons classified as "Developed," all were eliminated by the exotic plant cover criterion (20.54 acres) or a soils rating of 0 (impervious surface) (12.76 acres).

Consistent with our estimation of MTB abundance at all known occupied sites in section 7.1.3, we assume that only 10 percent of the 57.85 acres (5.785 acres) on the CRC property that could support the MTB contains suitable microhabitat for the species. The proposed off-site Preserve on the UM property is known to support the species at this time, and is included in the range-wide population estimate of section 7.1.3. The contribution of the 50.96-acre off-site Preserve to our rough range-wide estimate is also 10 percent of its total acreage, or 5.096 acres.

Using the density (1 per $10m^2$, or 404 per acre) that we applied to the estimated extent of suitable microhabitat at all sites known to support the MTB in section 7.1.3, we estimate that the CRC property may support about 2,337 adult MTB (404 × 5.785). By the same methods, the off-site Preserve may support about 2,059 adult MTB (404 × 5.096). Baseline MTB numbers for the Action Area are therefore about 4,396 adults.

7.2.2. Action Area Conservation Needs of and Threats to Miami Tiger Beetle

The proposed off-site Preserve is confirmed as a location that supports the MTB, but the CRC property is not. As we explain in section 7.2.1, we believe that the species is reasonably certain to occur on the CRC property. On both properties included in the Action Area, the primary and most urgent conservation need of the MTB is the same as elsewhere within its known range: securing habitat conditions that can support viable populations (see section 7.1.4). The primary threat to meeting this need is an ongoing reduction in microhabitat availability caused by vegetation succession that shrinks and eliminates open patches within its pine rockland macrohabitat. Reducing this threat is best addressed via prescribed fire and other measures to reduce invasive exotic plants and prevent the transition to a rockland hammock habitat.

The other threats to the species' range-wide survival and recovery that we describe in section 7.1.4 are also relevant in the Action Area. These include unauthorized collection of MTB, human disturbance, and climate change.

7.3. Effects of the Action on Miami Tiger Beetle

This section analyzes the direct and indirect effects of the Action on the Miami tiger beetle (MTB). Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

7.3.1. Effects of CRC Construction on Miami Tiger Beetle

The proposed CRC development would collectively occupy 86.49 acres, including all 33.30 acres of existing developed portions of the Action Area. The expansion of developed areas within the Action Area would occur on 20.91 acres of upland exotic hardwood habitat and 32.28 acres of pine rockland habitat (see section 2.1.1). In section 7.2.1, we estimate that 57.85 acres of the CRC property contains conditions that may support the MTB, of which all but 1.76 acres are classified as pine rockland habitat. The MTB would occur in open patches within these areas. The Applicants have not designed, and we do not expect, the proposed Stepping Stone habitats (3.88 acres established within the 86.49 development footprint following site preparation; see section 2.4.4) to serve as MTB habitat.

The 57.85 acres we consider as potential MTB habitat is less than the total acreage of pine rockland habitats on the CRC property (79.97 acres; see section 2.1.1), due to substantial canopy closure, nearly complete coverage by exotic invasive plants, or soils with a high organic content. The CRC development footprint overlaps with 21.25 acres of the areas that we believe may support MTB; therefore, the primary impact of CRC construction is permanent loss of these acres.

Habitat Loss

Adult MTB are small predatory ground-dwelling insects with seasonal and limited flight ability. Larval MTB occupy a single burrow for the duration of their development. The Applicants would use heavy equipment to clear and grade all areas within the entire 86.49-acre development footprint to accommodate new buildings, new and improved infrastructure, and new landscaping. Based on their ground-dwelling life history and limited flight ability, we expect that CRC construction would kill, injure, or displace all MTB present within this development footprint. MTB occupancy within this footprint is most likely limited to 21.25 acres of mostly pine rockland habitat within the overall development footprint. Suitable microhabitats (open patches) are unlikely to exceed 10 percent of these areas, or 2.125 acres (see section 7.2.1).

Consistent with our assumptions for roughly computing a range-wide population estimate in section 7.1.3, and an Action Area population estimate in section 7.2.1, we expect 2.125 acres of the CRC property to support a density of 1 adult per 10 m^2 (404 per acre), or about 859 individual MTB when the adult life stage is present. Construction activity would kill, injure, or displace these adults, or would kill their larvae, depending on the timing of construction relative to the species' life cycle. Regardless of the timing, construction would extirpate the species from these areas.

Habitat Fragmentation

The CRC construction footprint would separate undeveloped areas on the east side of the CRC property from those on the west side (see Figure 2-3), both of which contain habitats that we consider as reasonably certain to support the MTB. The Applicants propose the Southern Corridor Preserve to provide a linkage between the East and West Preserves. Although the possible isolation of MTB on the West Preserve from those on the East Preserve is an effect

caused by CRC construction, we analyze this effect instead under "Habitat Connectivity" in section 7.3.3 below, which addresses the effects of the Preserves, including the role of the Southern Corridor Preserve as a MTB dispersal pathway.

Other Effect Pathways

Construction activities would cause a variety of stressors that are relevant to the MTB, but most of these are moot within the construction footprint itself, because habitat loss would ultimately extirpate the species from the developed areas. Construction activities that may cause stressors extending beyond the construction footprint include noise, altered surface water runnoff, and discharge of oil, fuel, solvents, cement, fertilizers, and other chemical products used during construction. We have no information on the effects of noise on tiger beetles and do not address it further. We believe the Applicants' proposed construction BMPs (*e.g.*, silt fencing, measures to prevent construction site runoff, see section 2.2.3) would limit the severity of other construction-caused stressors within the on-site Preserves to insignificant levels, or would reduce the likelihood of exposure to such stressors to a discountable probability.

7.3.2. Effects of CRC Operations on Miami Tiger Beetle

CRC construction would eliminate the MTB from the CRC development footprint (see section 7.3.1). MTB remaining on the CRC property following construction are expected to occupy suitable microhabitats in the adjacent undeveloped areas, which the Applicants propose as on-site Preserves. We believe the probability of MTB dispersal into the developed areas following construction is discountable, because the developed areas would not contain suitable microhabitats (patches of open ground in a pine rockland matrix) that attract the species. Therefore, any effects of CRC operations on the MTB are limited to activities that cause stressors that extend into the adjacent on-site Preserves. CRC operations, *i.e.*, residential and commercial use of the development, that may cause such stressors include:

- increased pesticide use; and
- increased human use of the on-site Preserves (including unauthorized collection of MTB).

We believe the Applicants' proposed conservation measures for pesticide use (see section 2.3.3) would limit the drift or runoff of pesticides from the developed areas into the on-site Preserves to levels that are insignificant to the MTB. We address the potential effects of mosquito control, which is not part of the proposed Action, as an interrelated action in section 7.3.4 below.

The Applicants propose to post an unauthorized access prohibition for the on-site Preserves (see section 2.4.2), which should reduce, but in the absence of fences and locked gates, would not entirely preclude unauthorized access and the possibility of illegal MTB collection. The CRC property is currently vulnerable to unauthorized access, and it would host greater numbers of residents and visitors following development. With posting, however, we do not believe that the level of illegal collection on the CRC property, if any, would significantly change.

We considered whether increase human use of the developed areas might introduce potential MTB predators that are not present or at low levels without the CRC development. Ants are

known predators of Highlands tiger beetle larvae, as well as parasitic flies of the genus *Anthrax* and others (Knisley and Hill 2013), but we do not expect increased human presence in the Action Area to increase these predators. We believe it is unlikely that common human pets, such as cats and dogs, would prey upon the tiny and fast-moving MTB adults, or pose a threat to larval burrows. The Applicants propose to prohibit unleashed pets within the development outside of the fenced dog park. Rats are not known to prey upon tiger beetles, and pest control and waste management within the development are likely to control rats at levels that do spill over into the on-site Preserves.

7.3.3. Effects of Preserves and Stepping Stones Management on Miami Tiger Beetle

The Applicants have not designed, and we do not expect, the proposed Stepping Stone habitats (3.88 acres; see section 2.4.4) to serve as MTB habitat. Clearing and grading the development footprint would kill, injure, or displace MTB from these areas before the Stepping Stones are established (see section 7.3.1). This impact is described in section 7.3.1; therefore, we do not further discuss the Stepping Stones in this section.

We describe the proposed on-site Preserves and off-site Preserve in sections 2.4.3 and 2.4.5, respectively. The remainder of this section describes how the proposed management of these Preserves would cause changes to the Action Area, and how the MTB is likely to respond upon exposure to these changes. We summarize the Applicants' assessment of these changes, and then analyze each component of the proposed management activities that is relevant to the MTB.

Applicants' Habitat Functional Assessment

We described the Applicants' habitat assessment in section 3.3. Of particular relevance to the MTB in this assessment is the "bare rock or soil cover" parameter, where Level-3 success is considered 25 percent. Rather than rely on the predicted change in habitat value units of the Applicants' model, we consider achieving 25 percent bare rock or soil cover as the primary enhancement to MTB habitat that the Applicant's management of the Preserves may achieve. As described in section 7.2.1, we consider the baseline condition for this parameter as 10 percent in the areas that may support the MTB.

Invasive Exotic Plant Management

Within the East and West Preserves, the Applicants' plan to reduce and control invasive exotic plants involves a combination of herbicides, cutting and removal by mechanical methods, and prescribed fire. The particular combination and sequence of these treatments varies according to the distribution and density of the target invasive species. Section 7.5 of the HCP describes the methods planned for particular management units within the on-site Preserves, subject to the conditions described in section 6.2.4 of the HCP.

Operations to reduce and control invasive exotic plants are not necessary in the open patches that the MTB occupy; however, personnel and equipment would at times pass through such patches. Foot and heavy equipment traffic involved in mechanical and chemical treatments may crush adults and larvae, although adults may fly away from disturbance. Several proposed conservation

measures in HCP section 6.2.4.4 would reduce, but not entirely eliminate, the probability of crushing MTB, including:

- hand removal when feasible;
- no roller-chopping;
- use of rubber-tracked vehicles, unless unavailable or infeasible;
- use of the smallest and lightest equipment capable of performing the work; and
- access the Preserves via the developed areas.

We are unable to estimate the numbers of MTB that manual and mechanical methods for removing and controlling invasive exotic plants may harm, as these activities are not directed specifically at the microhabitats that are likely to support MTB. These activities are necessary precursors to prescribed burning in the pine rockland habitat, which is a primary conservation need for the species (see section 7.1.4). Therefore, we estimate the overall effects of managing the pine rockland habitat to reduce invasive exotic plants, decrease vegetation encroachment, and control vegetation succession under "Prescribed Burning" below.

We do not expect significant effects on the MTB from the use of herbicides, which management crews would spot apply in densely vegetated areas that are highly unlikely to support the species. The primary impact of herbicide treatments on the MTB is the foot and equipment traffic necessary to access such areas. We believe that the general conditions governing insecticide and other pesticide use in the Preserves (HCP section 6.2.4.4) (*e.g.*, hand application of insecticides), would limit the impacts to levels that are insignificant to the MTB.

The Applicants would continue to employ mechanical and chemical treatments in the on-site Preserves to control invasive exotics over the duration of the ITP as necessary to achieve the pine rockland habitat success criteria. The Applicants anticipate the most extensive use of these methods during the initial 1–3 years, with substantially less use thereafter as prescribed burning becomes effective as the primary method for maintaining the habitat.

Pine Rockland Planting

Planting pine rockland plant species is proposed initially for a 300–400 ft long (0.39 acre) strip of sod along the southern boundary of the CRC property (see Figure 2-3), and as needed elsewhere within the on-site Preserves to achieve the success criteria. If available, plantings would include tiny polygala and deltoid spurge, which are associated with the same microhabitat as the MTB. Planting the 0.39-acre sod strip is intended to fill a gap in the Southern Corridor for Covered Species movement between the East and West Preserves.

Based on exotic species cover greater than 89 percent, we eliminated the sod strip as potential habitat for the MTB on the CRC Property in our filtering by habitat characteristics described in section 7.2.1. Therefore, we do not expect adverse effects to MTB resulting from planting this area with pine rockland species.

Restoring pine rockland characteristics to the sod strip could support MTB thereafter, if sufficient patches of bare sandy soil are maintained. Fire is not proposed for the Southern Corridor; therefore, achieving the success criterion of 25 percent open ground would require

other methods. Using the same density we have applied to estimate range-wide and baseline numbers, achieving this success criterion would create microhabitat that would support up to 0.25 × 0.39 acres × 404 per acre = 39 adult MTB.

Prescribed Burning

The Applicants propose prescribed burning within 45.24 acres (88.6 percent) of the on-site Preserves (the East and West Preserves) and 45.60–48.65 acres (89–95 percent) of the off-site Preserve; a total of up to 93.89 acres. Both would receive fire on a 3–7 year rotation by management unit. Burning is not proposed for the rockland hammock area on the northern edge of the CRC property, or for the narrow corridor along the southern edge (the Southern Corridor Preserve). The prescribed burning program for the on-site Preserves and the off-site Preserve is described in Appendix J and Appendix J1 of the HCP, respectively.

Prescribed fire is the superior and preferred method to maintain pine rocklands for conservation purposes, including conservation of the MTB (see section 3.1). Over the long-term, fire maintains openings within pine rockland vegetation that the MTB requires for feeding, breeding, and sheltering. In the short-term, fire itself and the measures necessary to manage it in an urban setting are likely to kill, injure, or displace individual MTB that are exposed to various stressors associated with prescribed burning. These stressors include:

- creating and maintaining fire breaks (may crush MTB);
- foot and vehicle traffic on fire breaks and elsewhere (may crush MTB);
- lethal heat levels during a fire; and
- flooding of burrows during “mop up” activities.

Conservation measures proposed in the prescribed burning plans that should reduce the extent or intensity of these stressors or reduce the probability of exposure include:

- conduct most burns in the winter months to avoid the mid-May through mid-October MTB flight period;
- burn patches in a mosaic pattern, so that unburned habitat is available nearby for individuals that are able to flee the fire; and
- prepare and manage burns to ensure low-intensity fires.

We are unable to quantify the short-term impacts on MTB numbers and reproduction associated with prescribed burning over the 30-year duration of the ITP. These impacts would occur within burn patches every 3–7 years (the proposed fire frequency), which is the historical pattern in the fire-adapted pine rockland habitat. We expect the long-term benefits of prescribed burning to exceed these short-term impacts to MTB numbers and reproduction. We expect prescribed burning (in combination with the invasive exotic plant management described above) to expand MTB distribution within the on- and off-site Preserves by increasing and then maintaining the extent of suitable microhabitat within these areas.

Burning is proposed for a total of up to 93.89 acres in the on- and off-site Preserves. These same areas would receive treatments to reduce invasive exotic plants described previously. Consistent with the assumptions we applied to estimate MTB numbers range-wide (section 7.1.3) and in the Action Area (section 7.2.1), we believe that currently no more than 10 percent of these areas

(9.389 acres) are likely to support MTB at a density of about 1 adult per 10 m^2 (404 per acre). These assumptions yield an estimate of 3,793 adult MTB exposed to changes caused by habitat management for the portions of the Preserves that would receive both fire and exotic plant control treatments. This includes exposure to stressors that may harm MTB individuals (crushing, burning), and to changes in physical and biological habitat features that should benefit MTB individuals (reduced shading, increased bare soil cover).

Success criteria for managing the Preserves include achieving a goal of 25 percent open ground within a matrix of pine rockland vegetation. Therefore, successful management via exotic plant control and burning should increase MTB microhabitat from 9.389 acres to 23.47 acres (0.25 × 93.89), and increase adult MTB numbers in the Preserves from 3,793 to 9,483. Although based on several assumptions, these estimates provide a common basis for comparing the status of the MTB with and without the proposed Action.

Habitat Connectivity

The CRC development would divide the pine rockland habitat on the CRC property, possibly isolating MTB in the West Preserve from MTB in the East Preserve and adjacent properties to the east and south. The dispersal range of the MTB is unknown, but studies of a similar, but slightly larger tiger beetle species reported movements of 70–150 m between areas of suitable habitat (see "Dispersal" under section 7.1.2). The separation of the East and West Preserves by intervening buildings, pavement, and landscaping, exceeds 150 m. Small and isolated populations are more vulnerable to extirpation and the adverse effects of reduced genetic diversity (in breeding).

The proposed East Preserve is adjacent to undeveloped land on the Zoo Miami property that is known to support MTB. SW 124th Avenue lies between these properties, which likely reduces MTB movement between these areas, but which we believe does not preclude it entirely. The proposed West Preserve is adjacent to pine rockland habitat on DoD property, but it is unknown whether this property supports MTB. The DoD property lies in the northwest corner of the Richmond Pine Rocklands, and is far removed from the four properties that are known to support MTB in the eastern and southern portions of the area.

To avoid isolating the West Preserve, the Applicants propose to retain and manage pine rocklands along the southern boundary of the CRC property, and to plant a narrow strip of pine rockland species in a gap between the East and West on-site Preserves (see "Pine Rockland Planting" discussion above). The resulting Southern Corridor Preserve is intended to provide a safe movement pathway for the Covered Species, including the MTB (see Figure 2-3). The 2.16-acre Southern Corridor (about 50 ft wide and 2,000 ft long) would not receive prescribed fire due to its proximity to adjacent developed areas. The Applicants would apply mechanical and chemical methods to achieve and maintain the success criteria for the Preserves, including open ground of 25 percent.

Corridor width is positively associated with abundance and species richness for birds, mammals, and invertebrates (Lindenmayer and Franklin 2002). Wider is better than narrower, but we did not find data that helps us determine whether the proposed corridor width (50 ft) is sufficient to

accommodate tiger beetle movement. The MTB is very small (6.5–9.0 mm), and occupies open patches as small as 2 m^2 (a circle diameter of 5.2 ft) (see "Habitat" under section 7.1.2). If management of the Southern Corridor achieves the success criteria, it is our judgement at this time that it would serve to some degree as a functional pathway for MTB movement and avoid a total isolation of the West Preserve. We also expect that property adjacent to the Southern Corridor outside of the Action Area would provide opportunities for movement.

Other Effect Pathways

Authorized access to the on-site Preserves (*e.g.*, by habitat management crews) is governed by the Applicants' proposed conservation measures in the HCP, which include various prohibitions, contractor education, etc. (see section 2.4.2). The off-site Preserve is already fully gated and accessible only by permit. We believe these measures would limit the adverse effects of human activity, apart from those habitat management activities addressed above, to insignificant levels or discountable probability.

7.3.4. Summary of the Effects of the Action on Miami Tiger Beetle

Table 7-1 summarizes the findings of our analysis of the effects of the proposed Action on the MTB. The Action sub-components listed in the table correspond to the sub-headings of the narrative. As applicable for each sub-component, we report our estimated amount or extent of MTB responses in terms of change in MTB adult numbers. An estimate of incidental take caused by habitat management, which would take the form of both harm and harassment, is not determinable, but we believe the numbers of MTB taken is substantially less than the population increases that we expect to accompany an expansion of suitable MTB microhabitat.

We believe the greatest uncertainty associated with our analysis is our estimation of occupied MTB microhabitat on the CRC property as 10 percent (5.785 acres) of the potentially suitable macrohabitat from our analysis in section 7.2.1. Due to a history of fire suppression, this is likely an overestimate of open patches within these CRC pine rocklands, but we use it for consistency with our estimation of MTB numbers range wide. If the MTB occupies less than 5.785 acres on the CRC property, we have overestimated the impacts of habitat loss and underestimated the benefits of habitat management. If the MTB occupies more than 5.785 acres on the CRC property, the opposite is true. We believe it is more likely that we have overestimated MTB occupancy, which is the more conservative approach in formulating this opinion.

Lacking multiple measures of MTB density across its range, we have treated density in occupied areas as a constant (1 adult per 10 m^2), when actual density values are probably highly variable. Lack of such data has also necessitated that we consider MTB numbers directly proportional to the spatial extent of available microhabitat, *e.g.*, 10 m^2 supports 1 adult, and 20 m^2 supports 2 adults. Lastly, we recognize that an increase in MTB microhabitat depends on successful restoration, which may or may not occur quickly, and that other factors we have not considered may cause a variable MTB response to this increase.

Given these uncertainties and necessary simplifications, our analysis suggests that the Action would cause a net increase in the MTB population of the Action Area. The increase in MTB

numbers resulting from habitat enhancement exceeds the decrease resulting from habitat loss. Our results are consistent with the Applicants' functional habitat assessment, which predicted an increase in pine rocklands habitat value.

Table 7-1. Summary of Action effects on the Miami tiger beetle.

Action Component	Sub-Component	Effect Characterization	Estimated Change in Adult MTB Numbers
Construction	Habitat loss	Adverse - permanent loss of 21.25 acres of habitat that support MTB.	Loss of 859 adults; loss of their reproduction in the construction footprint.
	Habitat fragmentation	Not likely to adversely affect - see "Habitat Connectivity" under Preserves Management below.	
	Other effect pathways	Not likely to adversely affect.	
Operations	Various	Not likely to adversely affect.	
Preserves Management	Stepping stones	NE - MTB extirpated from these areas by construction before they are established.	
	Invasive exotic plant management	Beneficial and Adverse - Effects coextensive with prescribed burning.	
	Pine rockland planting	Beneficial - Achieving success criteria for this 0.39-acre area will likely support MTB or MTB movement.	Colonization by up to 39 adults.
	Prescribed burning	Beneficial and Adverse - Management of 93.89 acres will increase MTB microhabitat availability, but, harass, kill or injure some MTB during management activity.	Increase of up to 5,690 adults over time, minus those harmed by management activity.
	Habitat connectivity	Not likely to adversely affect - proposed Southern Corridor expected to prevent MTB isolation.	
	Other effect pathways	Not likely to adversely affect.	

7.4. Conclusion for Miami Tiger Beetle

In this section, we summarize and interpret the findings of the previous sections (status, baseline, effects, and cumulative effects) for the MTB relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

The MTB is known to occur on four adjacent properties and a fifth property isolated from the others by urban development. Both areas are remnants of pine rockland habitat in MDC. The four adjacent properties are within the Richmond Pine Rocklands, which is the largest remaining assemblage of this habitat type on the Miami Rock Ridge outside of Everglades National Park.

The extent of similar macrohabitat conditions around locations in which surveyors have located the species is about 317 acres. Patches of bare or sparsely vegetated sandy soil within, or adjacent to, a pine rockland plant community are the microhabitat of the MTB. We believe about 10 percent of the 317-acre known range of the MTB (31.7 acres) contains this microhabitat, which is characteristic of the fire-adapated pine rockland habitat. For purposes of this consultation, we use an average MTB density of 1 adult per 10 m^2 (404 adults per acre) to estimate numbers in areas that contain the MTB microhabitat. Therefore, our range-wide estimate of MTB abundance is about 13,000 adults.

The primary and most urgent conservation need of the MTB is securing habitat conditions that can support viable populations. The primary threat to meeting this need is an ongoing reduction in microhabitat availability caused by vegetation succession that shrinks and eliminates open patches within the pine rockland macrohabitat. Reducing this threat is best addressed via prescribed fire and other measures to reduce invasive exotic plants and prevent the transition to a rockland hammock habitat.

Baseline

The Action Area is comprised of two disjunct properties: the CRC property, which contains the development and the on-site Preserves, and the UM property, which contains the off-site Preserve. The MTB is known to occur on the UM property. The MTB is not confirmed as present on the CRC property, but the Service believes the species is reasonably certain to occur there based on its proximity to known locations and habitat conditions.

We used data from the Applicants' habitat assessment to estimate that 57.85 acres of the CRC property and all 50.96 acres of the UM property (the off-site Preserve) contain the general characteristics of MTB habitat. As with locations that are known to support the MTB, including the UM property, we used 10 percent of the area that contains these general characteristics as a measure of the extent of suitable MTB microhabitats in the Action Area. Accordingly, we expect the MTB to occur on approximately 6 acres of scattered open patches within the CRC property and on approximately 5 acres of the off-site Preserve. Assuming a density of 1 adult beetle per 10m^2 (404 per acre) in these patches, the Action Area MTB population is 4,396 adults. The portion of this estimate from the CRC property (2,337 adult MTB) is not included in the range-

wide population estimate, which we limited to areas that are confirmed as supporting the species at this time.

The primary and most urgent conservation need of the MTB in the Action Area is the same as elsewhere within its known range: securing habitat conditions that can support viable populations via prescribed fire and other measures that reduce invasive exotic plants and prevent vegetative succession to rockland hammock habitat.

Effects

The Action would cause both beneficial and adverse effects to the MTB. Permanent habitat loss caused by construction would harm MTB in the areas affected by these activities. Preserves management would expand suitable microhabitat for the MTB and likely increase MTB numbers. The level of incidental take caused by habitat management, which would take the form of both harm and harassment during invasive plant removal and prescribed burning, is not determinable. However, we believe the numbers of MTB taken during habitat management operations are substantially less than the population increases that we expect to accompany an expansion of suitable MTB microhabitat.

Our estimate of the number of MTB harmed by CRC construction is 859 adult MTB (and loss of their reproduction). Habitat improvements in the on- and off-site Preserves should support an increase of 5–6,000 MTB, minus those harmed by management activity.

Several uncertainties and simplifications underlie these estimations, but the difference between total adverse and beneficial effects is wide enough for us reasonably to expect the Action to cause a net benefit to the MTB. Our results are consistent with the Applicants' habitat assessment, which predicted a net increase in habitat value within the Action Area. The means by which the Action would accomplish a net benefit to the species addresses its primary conservation need, which is to secure habitat conditions that can support viable populations via prescribed fire and other measures that reduce invasive exotic plants and prevent vegetative succession to rockland hammock habitat.

Opinion

The 137.90-acre CRC property is not confirmed as a site that supports the MTB; however, we believe it is reasonably certain to occur on approximately 58 acres of the property. Elsewhere, we estimate that the MTB is present on about 371 acres of five properties, including the proposed off-site Preserve on the UM property. The Action would reduce the 58 acres that we believe are occupied on the CRC property by about 21 acres. The land management components of the Action would improve habitat conditions on the remaining CRC property within the on-site Preserves and the off-site Preserve on the UM property. We believe the Action would offset the loss of 21 acres of MTB macrohabitat by addressing a primary conservation need of the subspecies, which is to better manage remaining pine rockland habitats. We estimate that this management would cause a net increase in MTB numbers within the Action Area. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the MTB (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the MTB.

8. EASTERN INDIGO SNAKE

8.1. Status of Eastern Indigo Snake

This section summarizes best available data about the biology and current condition of the eastern subspecies of indigo snake (*Drymarchon corais couperi*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the eastern indigo snake as threatened on January 31, 1978 (43 FR 4026–4029).

We used supporting documentation from the status of the species section within the *Environmental Assessment for the Coral Reef Commons Project Incidental Take Permit Application* (Service 2017), and other sources cited herein, to inform this section.

8.1.1. Description of Eastern Indigo Snake

The eastern indigo snake is the largest native snake species in North America with a maximum recorded length of 8.5 feet (ft) (2.6 m) (Moler 1992). Its color is uniformly lustrous-black, dorsally and ventrally, except for a red or cream-colored suffusion of the chin, throat, and sometimes cheeks. Its scales are large, hexagonal, and smooth in 17 scale rows at mid-body (the central 3 to 5 scale rows are lightly keeled in adult males). Its anal plate is undivided (Holbrook 1842). In the Florida Keys, adult indigo snakes seem to have less red on their faces or throats compared to mainland specimens (Lazell 1989).

8.1.2. Life History of Eastern Indigo Snake

Relative to other snake species, adult eastern indigo snakes have very large activity ranges and can move considerable distances in short periods of time (Service 2008). Home range is variable depending on the ecoclimate and availability of habitat in the region (Breininger *et al.* 2011; Dodd and Barichivich 2007; Moler 1992; Bauder and Jenkins 2013; Ceilley *et al.* 2014; Hyslop 2007; Kehl *et al*. 1991; Layne and Steiner 1996; Legare and Breininger 2002; Moler 1985a; Smith 1987; Speake *et al.* 1978). Male eastern indigos are known to have larger home range sizes than females, likely due to searching for mates in the area or due to their larger size (Dodd and Barichivich 2007; Moler 1985b, Smith 1987). Home range size for the species ranges from 1.6–1,530 ha (Layne and Steiner 1996; Breininger *et al.* 2011).

In southern parts of their range, eastern indigo snakes are habitat generalists. Movements between habitat types in northern areas of their range may relate to the need for thermal refugia. In extreme south Florida (*i.e.*, the Everglades and the Florida Keys), indigo snakes also use tropical hardwood hammocks, pine rocklands, freshwater marshes, abandoned agricultural land, coastal prairie, mangrove swamps, and human-altered habitats. Though eastern indigo snakes have been found in all available habitats of south Florida, 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).

Throughout the entire range, eggs are laid from late May through August, and young hatch in approximately 3 months. Peak hatching activity occurs between August and September, and yearling activity peaks in April and May (Groves 1960, Smith 1987). Limited information on the reproductive cycle in south-central Florida suggests that the breeding and egg-laying season may be extended.

8.1.3. Numbers, Reproduction, and Distribution of Eastern Indigo Snake

Historically, the eastern indigo snake occurred throughout Florida and in the coastal plain of Georgia, Alabama, and Mississippi (Loding 1922; Haltom 1931; Carr 1940; Cook 1954; Diemer and Speake 1983; Lohoefener and Altig 1983; Moler 1985a). Most, if not all, of the remaining viable populations of the eastern indigo snake occur in Georgia and Florida (Service 2008).

Due to their use of subterranean refugia and frequent long-distance dispersal, detectability of eastern indigo snakes is low and estimates of mortality difficult (Hyslop *et al.* 2012). Consequently, the size and viability of populations range-wide is unknown (Service 2008). However, we have no information indicating that the range of eastern indigo snake has either expanded or retracted.

8.1.4. Conservation Needs of and Threats to Eastern Indigo Snake

Throughout the eastern indigo snake's range, expanding urban areas are creating barriers to the dispersal of individuals and gene flow between populations, and habitat loss and degradation are a threat to the species (Lawler 1977; Moler 1985b). In northern areas of its range in Georgia and peninsular Florida, the species is impacted by a decline in longleaf pine forests, gopher tortoises, and gopher tortoise habitat (Van Lear *et al.* 2005). In central and southern Florida, the eastern indigo snake is less dependent on any one habitat type, but does avoid developed areas (Lawler 1977; Moler 1985a; Hyslop 2007.) At the time of listing, other threats to the eastern indigo snake included commercial collection for the pet trade and mortality during the gassing of gopher tortoise burrows by individuals attempting to drive rattlesnakes out for collection. Since listing, additional potential threats to the species have expanded to include disease, road mortality, kills of indigo snakes by land owners and pets, and ATV use in gopher tortoise habitat (Service 2008).

Major threats to the eastern indigo snake include habitat fragmentation, destruction, and reduced gene flow. At this time, the range-wide status of the species is uncertain. Range-wide surveys and monitoring are required to help understand the current status of the species. The recovery strategy for the eastern indigo snake consists of maintaining and enhancing existing populations; monitoring the status of existing populations; identifying and securing additional eastern indigo snake populations and habitat; establishing new populations through translocations or reintroductions, and supporting research that guides land management and provides demographic and ecological data. Management plans should be developed and implemented for all recovery populations. Appropriate habitat management includes maintaining road-less corridors allowing dispersal between occupied upland and wetland habitats; minimizing soil disturbance and loss of

native herbaceous groundcover vegetation; conducting prescribed burning, particularly during the growing season; maintaining appropriate wetland habitat; and restoring degraded upland habitat.

Monitoring programs to track population trends and the response of this species to habitat management activities are needed for all recovery populations. Gopher tortoise populations should be regularly monitored, and augmented if necessary, at areas where both indigo snakes and tortoises co-occur. Monitoring programs should be critically evaluated and revised as needed. Since recovery of the eastern indigo snake will necessitate finding or creating new, currently unknown populations, assessment of potentially suitable habitat within the range of the species and additional presence/absence surveys are needed. Suitable habitat for translocations/reintroductions needs to be identified, and programs developed and implemented to establish and monitor these new populations and manage the habitat that supports them.

Additional research is needed to gain a better understanding of the natural history of the eastern indigo snake and its habitat for use in developing and implementing management plans. Data gathered from these studies would ensure that recovery efforts are supported by the best available scientific information.

8.2. Environmental Baseline for Eastern Indigo Snake

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the eastern indigo snake, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

8.2.1. Action Area Numbers, Reproduction, and Distribution of Eastern Indigo Snake

There are no site-specific survey data for indigo snakes on the CRC property or the off-site Preserve. Eastern indigos are often difficult to detect during surveys based on the biology of the species and its cryptic nature. Many species observations in the Service's records are opportunistic or are from long-term surveys performed by researchers.

One eastern indigo sighting occurred within the Richmond area, and a contiguous habitat corridor is present between the CRC property and adjacent undeveloped properties. Presently, there are no studies on the longevity of wild eastern indigo snakes, though the oldest published record in captivity for eastern indigo snakes is 25 years and 11 months (Shaw 1959). Other information from captive breeding populations indicates some individuals may have lived up to 28 years old in captivity, though the date of acquisition of specimens older than 26 are not vouchered (Hoffman 2017). Because wild eastern indigos experience higher environmental and anthropogenic pressures than in captivity, life spans are likely reduced.

Considering the information about eastern indigo snake life span, contiguous habitat corridor, and the limited urbanization within the Richmond area, it is possible the Action Area is occupied by the species. The single individual detected in 2000 is evidence that the species persisted in the Richmond Pine Rocklands at least until that time. We assume that the indigo snake is

reproducing in the Richmond area, which requires additional individuals, whose home range includes some portion of the Action Area.

Without reliable survey methods, it is difficult to estimate numbers of eastern indigos in areas of suitable habitat. We rely on data from a long-term study by Layne and Steiner (1996) at Archbold Biological Station, Lake Placid, Florida, which determined the average home range size for a female was about 46 acres and that of a male was 184 acres. Considering home range overlap between males and females, we estimate the 137.90-acre CRC property supports up to one male and three females. Using the same home range sizes, we expect the off-site Preserve to support one female and a part of one male's home range. With four female snakes in the Action Area, we expect it to support four nests with eggs during the breeding season.

8.2.2. Action Area Conservation Needs of and Threats to Eastern Indigo Snake

As we explain in section 8.2.1, the species has been documented within the Richmond area. Major threats to the eastern indigo snake include habitat fragmentation, destruction, and reduced gene flow. The other threats to the species' range-wide survival and recovery that we describe in section 8.1.4 are also relevant in the Action Area.

8.3. Effects of the Action on Eastern Indigo Snake

This section analyzes the direct and indirect effects of the Action on the eastern indigo snake. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

8.3.1. Effects of CRC Construction on Eastern Indigo Snake

Development of CRC would convert 73.73 acres of vegetated land (86.49 acres of development minus 12.76 acres of currently impervious surfaces) into residential and commercial facilities and their associated infrastructure. Construction of the proposed project may harm eastern indigo snakes by injuring or causing mortality. While the density of eastern indigos within the Action Area is unknown, we estimate there could be up to three females and one male on the 137.90-acre CRC property (see section 8.2.1). The development footprint would contain of two of these females and part of the male's home range. The proposed action would involve clearing, mass grading, vegetation removal, earth moving and piling, transport of aggregate by trucks, and construction of residential and commercial buildings. These actions are reasonably certain to cause harm to eastern indigos, nests or eggs that are present at the time of those actions.

The timing and duration of clearing would vary with the activities proposed at specific locations. Construction personnel would have worker education and implement the "Standard Protection Measures for the Eastern Indigo Snake" (Service 2013), which directs them to avoid eastern indigo snakes. However, the operation of equipment in brushy, grassy, or otherwise vegetated areas may disturb, injure, or kill snakes that are not readily visible above ground or beneath the surface. Based on the number of female home ranges that may be present and depending on the timing of the construction, this could be up to 2 nests with eggs.

Harassment may occur if an eastern indigo snake is flushed from a hiding place, or disturbance may occur due to the vibration of construction equipment. The increased human activity and vibration may result in a disruption of breeding, feeding, or sheltering behavior, and displacement from the CRC property.

Enlarging the developed areas on the CRC property would increase impervious surfaces by 73.73 acres, which is a permanent habitat loss. Although indigo snakes use a variety of habitats within and adjacent to human-altered altered areas, the new buildings and pavement would not provide such habitats. However, we do not believe this loss would isolate indigo snakes in any portion of the Action Area. The proposed Southern Corridor Preserve and vegetated areas on adjacent properties should afford indigo snakes the ability to move between remaining undeveloped habitats.

8.3.2. Effects of CRC Operations on Eastern Indigo Snake

As stated in section 8.1.2, eastern indigo snakes in south Florida use a variety of habitats including developed areas. We expect that eastern indigo snakes would be able to persist on the CRC Property following construction, using suitable habitat within the on-site Preserves (51.41 acres), in combination with the development footprint and habitat on adjacent lands. We expect development to reduce baseline numbers. Instead of one male and three females, we expect the CRC property to 1-2 females and part of the home range of one male. These snakes may use the Southern Corridor Preserve or the developed lands to access the on-site Preserves areas. Snakes within the development area and in the on-site Preserves may encounter the following stressors during CRC operations:

- increased physical disturbance;
- increased potential for predation from domestic dogs and cats; and
- increased pesticide use.

Activities that could result in take of an individual include traffic (vehicle strikes), poisoning from consumption of a contaminated rodent, or death/injury by domestic pets. To reduce the likelihood of these impacts, the Applicant would implement and enforce community practices listed in section 2.3.1. Based on the anticipated number of snakes within the Action Area (1–2 females and 1 male), and enforcement of the community practices, we believe the potential for take of an indigo snake from CRC operations is discountable.

8.3.3. Effects of Preserves on Eastern Indigo Snake

Restoring degraded upland habitat and maintaining habitat corridors that link occupied habitat is one of the conservation needs of the species. We describe the proposed on-site Preserves and off-site Preserve in sections 2.4.3 and 2.4.5, respectively. The remainder of this section describes how the proposed management of the Preserves would cause changes to the Action Area, and how the eastern indigo snake is likely to respond upon exposure to these changes. We summarize the Applicants' functional habitat assessment in section 3.1. The following is our analysis of each component of the proposed management activities.

Invasive Exotic Plant Management

The Applicants' plan to reduce and control invasive exotic plants involves a combination of herbicides, cutting and removal by mechanical methods, and within the pine rockland areas, prescribed fire. The particular combination and sequence of these treatments varies according to the distribution and density of the target invasive species. Section 7.5 of the HCP describes the methods planned for particular management units within the on-site Preserves, subject to the conditions described in section 6.2.4 of the HCP.

Several proposed conservation measures in HCP section 6.2.4.4 would reduce, but not entirely eliminate, the probability of harming eastern indigo snake, including:

- hand removal when feasible;
- no roller-chopping; and
- access the Preserves only via the developed areas and established fire breaks.

Indigo snakes or their nests present during mechanical clearing would be exposed to disturbance possible injury or mortality by crushing. The Applicants is avoiding clearing methods that pose the greatest risk of injury or mortality. There is some risk for unintentional injury, displacement or alteration of normal behavior during the establishment of the fire breaks. We anticipate that exposure from these methods would be the most substantial during the initial 1–3 years, until prescribed burning is the primary method for maintaining the habitat. In general, however, we believe that reducing invasive exotic plants would benefit the indigo snake. Although it is a relative habitat generalist in the southern end of its range (see section 8.1.2), it is most often associated with fire-adapted open pine forests.

Prescribed Fire

Prescribed fire would be the preferred method for long-term management of the on-site Preserves, because pine rocklands are a fire-adapted ecosystem. When fire advances quickly, indigo snakes can be consumed by an advancing fire; however, the proposed burn strategy would minimize the likelihood that indigo snakes would be killed in a prescribed fire by implementing the burns in a mosaic pattern that creates refugia for individuals to escape during the burn. In addition, the fire techniques proposed and the size of the burns would reduce the intensity of the fire, which would increase the likelihood that any indigo snake taking refuge within the burn would survive the fire.

Any indigo snake occupying a burn unit could incur a brief period of disturbance to its patterns of feeding, breeding, or sheltering. Disturbance from prescribed burns would occur for about a day on each of the burn units, and the burn units proposed are a small fraction the home range of any individual occupying the area. Consequently, disturbance from prescribed fire would be expected to be negligible.

As with the effects of managing invasive exotic plants, we believe managing the Preserves with prescribed fire would benefit the indigo snake. Although it is a relative habitat generalist in the southern end of its range (see section 8.1.2), it is most often associated with fire-adapted open pine forests.

8.3.4. Summary of the Effects of the Action on Eastern Indigo Snake

We estimate CRC construction would harm up to two female indigo snakes by altering all or most of their home range, and a part of one male's home range. This harm may include direct mortality or injury by clearing and grading activity, and by crushing females and eggs in nests, depending on the timing of the activity relative to the breeding season. CRC operations are unlikely to adversely affect indigo snakes.

Management of the on- and off-site Preserves would affect indigo snakes that continue to occupy suitable habitat after construction. We expect this to be 2 females and 1 male on CRC property. The Applicant is proposing clearing measures that have the least anticipated impacts (*i.e*. no roller chopping, using developed areas for access). We anticipate that mechanical methods would decrease once prescribed fire is the primary method for maintaining the habitat. The likelihood that indigo snakes would be killed or injured during prescribed fire is negligible due to the size and scope of the prescribed fires within the Preserves. In general, Preserves management is likely to benefit the indigo snake by maintaining conditions that align more closely with the open pine forests that resemble the species' habitat in most of its range.

8.4. Conclusion for Eastern Indigo Snake

In this section, we summarize and interpret the findings of the previous sections for the eastern indigo snake (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

Most, if not all, of the remaining populations of the eastern indigo snake occur in Georgia and Florida. Due to their use of subterranean refugia and frequent long-distance dispersal, detectability of eastern indigo snakes is low and estimates of mortality difficult. Consequently, the size and viability of the range-wide population is unknown.

Baseline

We have no Action Area specific data on indigo snakes. The species has been documented within the Richmond Area about a mile from the Action Area. Considering the species' long life span and connectivity with the larger Richmond Pine Rocklands, it is possible the indigo snake is present in the Action Area. Threats to the eastern indigo snake include habitat degradation, fragmentation, destruction, and reduced gene flow.

Effects

We estimate CRC construction may harm up to two female indigo snakes, directly by crushing or by substantially altering all or most of their home range, and a part of one male's home range. We believe CRC operations thereafter are unlikely to adversely affect indigo snakes.

Management of the on- and off-site Preserves would affect indigo snakes that continue to occupy suitable habitat after construction, which is likely to be 2 females and 1 male on the CRC property. The Applicant is proposing clearing measures that have the least anticipated impacts (*i.e*. no roller chopping, using developed areas for access). The likelihood that indigo snakes would be killed or injured during prescribed fire is negligible due to the size and scope of the prescribed fires within the Preserves. In general, Preserves management is likely to benefit the indigo snake by maintaining conditions that align more closely with the open pine forests that resemble the species' habitat in most of its range.

Opinion

We believe that only a few indigo snakes could occur in the Action Area. The Action may harm as many as two or three, most likely during construction of the CRC development. We believe that managing the Preserves would likely benefit the species' population in the Richmond Pine Rocklands. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the eastern indigo snake (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the eastern indigo snake.

9. GOPHER TORTOISE

9.1. Status of Gopher Tortoise

This section summarizes best available data about the biology and current condition of the gopher tortoise (*Gopherus polyphemus*) that are relevant to formulating an opinion about the Action. The species is classified under the ESA as a threatened species in the western portion of its range, and as a candidate species (listing is warranted, but precluded by higher listing priorities) in the eastern portion of its range. This consultation considers effects of the Action on the eastern (candidate) portion of the species' range.

The Service listed the gopher tortoise in 1987 as a threatened species in the western part of its range, from the Tombigbee and Mobile Rivers in Alabama west to southeastern Louisiana on the lower Gulf Coastal Plain (52 FR 25376–25380). The Service has not designated or proposed CH for the western portion of the species' range. The Service's most recent range-wide status assessment, published July 27, 2011, was a 12-month positive finding in response to a petition to protect the eastern populations under the ESA (76 FR 45130–45162). The Service determined that the current listing of the gopher tortoise as threatened in the western portion of its range was

appropriate, and that listing the species in the eastern portion of its range was warranted, but precluded by higher-priority listing actions.

Based on information current as of May 25, 2016, the Service finds that listing the gopher tortoise in the eastern portion of its range is still warranted, and still precluded by higher-priority listing actions (Service 2016).

9.1.1. Description of Gopher Tortoise

The gopher tortoise is the only tortoise (family Testudinidae) east of the Mississippi River; one of five species in the genus in North America. It is larger than any of the other terrestrial *Gopherus* turtles in this region, with a domed, dark brown to grayish-black carapace (upper shell), and is typically 10 to 12 in (25.4 to 30.5 cm) long (Ashton and Ashton 2008). A fossorial species, its hind feet are elephantine or stumpy, and the forelimbs are shovel-like, with claws used for digging. In comparison to females, males are generally smaller; with a larger gland under the chin, a longer gular (throat) projection, and more concave (curved in) plastron. Hatchlings are up to 2 in (5 cm) in length, with a somewhat soft, yellow-orange shell.

The burrows of a gopher tortoise are the center of its feeding and activity. Gopher tortoises can excavate many burrows over their lifetime, and often use several each year. Burrows typically extend 15-25 ft (4.6 to 7.6 m), with a record burrow measuring 67 ft (20.5 m; Ashton and Ashton 2008), can be up to 12 ft (3.7 m) deep, and provide shelter from predators, winter cold, fire, and summer heat. Tortoises spend most of their time within burrows and emerge during the day to bask in sunlight, to feed, and reproduce. Tortoises breed from March through October (McRae *et al.* 1981; Wright 1982; Eubanks *et al.* 2002), but females do not reproduce every year (estimated at 80 to 85 percent; Smith *et al.* 1997). Females excavate a shallow nest to lay and bury eggs, typically between early May and late June, and usually in the apron of soil at the mouth of the burrow. Range-wide, average clutch size varies from about 4 to 10 eggs per clutch, and incubation lasts 85 to 100 days.

9.1.2. Life History of Gopher Tortoise

Gopher tortoises require well-drained, sandy soils for burrowing and nest construction, an abundance of herbaceous ground cover for food, and a generally open canopy that allows sunlight to reach the forest floor (Landers 1980; Auffenberg and Franz 1982). Longleaf pine and oak uplands, xeric hammock, xeric Florida scrub, maritime scrub, and ruderal (disturbed) habitat most often provide the conditions necessary to support gopher tortoises (Auffenberg and Franz 1982). Ruderal (*i.e.*, disturbed or atypical) habitats include roadsides and utility rights-of-way, grove/forest edges, fencerows, and clearing edges. Historical gopher tortoise habitats were open pine forests, savannahs, and xeric grasslands that covered the coastal plain from Mexico and Texas to Florida.

Gopher tortoises have a well-defined activity range where all feeding and reproduction take place and that is limited by the amount of herbaceous ground cover (Auffenberg and Iverson 1979). Tortoises are herbivores eating mainly grasses, plants, fallen flowers, fruits, and leaves.

Gopher tortoises prefer grassy, open-canopy microhabitats (Boglioli *et al.* 2000), and their population density directly relates to the density of herbaceous biomass (Auffenberg and Iverson 1979; Landers and Speake 1980; Wright 1982;) and a lack of canopy (Breininger *et al.* 1994; Boglioli *et al.* 2000). Grasses and grass-like plants are important in gopher tortoise diets (Auffenberg and Iverson 1979; Landers 1980; Garner and Landers 1981; Wright 1982; Macdonald and Mushinsky 1988; Mushinsky *et al.* 2006; Birkhead *et al.* 2005). A lack of vegetative diversity reduces the long-term sustainability of gopher tortoise populations (Ashton and Ashton 2008).

9.1.3. Numbers, Reproduction, and Distribution of Gopher Tortoise

The current range for the eastern (candidate) population of the gopher tortoise aligns with the historical range which includes Alabama (east of the Tombigbee and Mobile Rivers), Florida, Georgia, and South Carolina. The core of the current distribution of the gopher tortoise in the eastern portion of its range includes central and north Florida and southern Georgia. Although most state-wide estimates of gopher tortoise abundance have not been calculated directly from survey results, some estimates have been made based on available habitat and extrapolation of existing population data. These estimates include approximately 785,000 in Florida (FWC 2012); 250,000 in Georgia (Elliott *et al.* 2013); and 30,000–130,000 in Alabama (Guyer *et al.* 2011). Many surveys indicate that tortoise populations often occur in fragmented and degraded habitat, and densities of individuals are low within populations; however, there are also many populations of tortoises in the eastern portion of the range that appear to be sufficiently large enough to persist long-term if proper management and protections are secured (Service 2011a). The size of gopher tortoise populations in south Florida is unknown.

Home range size and movements increase with age and body size, and home range area tends to vary with habitat quality, becoming larger in areas of poor habitat (Auffenberg and Iverson 1979). Males typically have larger home ranges than females. Mean home ranges of individual tortoises in Alabama, Florida, and Georgia have varied from 1.3–5.2 ac (3.2–2.2 ha) for males and 0.2–2.5 ac (0.09–1.0 ha) for females (McRae *et al.* 1981; Diemer 1992; Tuma 1996; Eubanks *et al.* 2002).

9.1.4. Conservation Needs of and Threats to Gopher Tortoise

The primary threat to the gopher tortoise is from habitat destruction and modification in the form of conversion of native pine forests to intensively managed silvicultural pine forests, urban development, and habitat degradation due to lack of fire management. Overutilization for commercial, recreational, scientific, or educational purposes resulting from ongoing rattlesnake roundups are likely to continue to threaten the gopher tortoise now and into the future in the vicinity of roundup events (Service 2011a). Disease is expected to become more problematic for gopher tortoises as additional habitat is lost and fragmentation increases. Stressors are likely to elevate the risk of upper respiratory tract disease, but these effects would likely be localized (Service 2011a).

9.2. Environmental Baseline for Gopher Tortoise

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the gopher tortoise, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

9.2.1. Action Area Numbers, Reproduction, and Distribution of Gopher Tortoise

The Applicants negative survey results for the gopher tortoise on the CRC property, conducted by qualified personnel according to FWC guidelines, support a finding that the species does not occupy this site at this time. The off-site Preserve was not surveyed, but the Applicants believe the species is absent from this portion of the Action Area as well "due to the lack of suitable burrowing habitat" (HCP section 3.2.5). Pine rockland soils are shallow and not ideal for the gopher tortoises burrowing habits; however, pine rocklands are known to support gopher tortoises, including the adjacent Zoo Miami property. It is unknown whether the species occurs on the off-site Preserve, but we expect that gopher tortoises would colonize the on- and off-site Preserves Preserve during the permit period, based on proximity to known occurrences, available corridors for movement, reproduction of existing populations within the Richmond area, and the expected improvement of habitat within the Preserves. Such colonization of the nearly 100 acres of pine rockland habitat on the Preserves could support several tortoises with a home range size of about 1–5 acres (see section 9.1.3) in areas that provide burrowing opportunities.

9.2.2. Action Area Conservation Needs of and Threats to Gopher Tortoise

The primary threats to the gopher tortoise are from habitat loss and habitat degradation due to lack of fire management. The Action Area is at the southernmost range of the gopher tortoise and is likely isolated from source populations outside of the Richmond Pine Rocklands.

9.3. Effects of the Action on Gopher Tortoise

This section analyzes the direct and indirect effects of the Action on the gopher tortoise. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

9.3.1. Effects of CRC Construction on Gopher Tortoise

Based on negative survey results (see section 9.2.1), we believe the gopher tortoise is unlikely to occur on the CRC property during construction of the CRC development. Although construction would cause the permanent loss of 32.28 acres of pine rockland habitat (see section 2.2), we do not anticipate any direct impacts to gopher tortoise individuals.

9.3.2. Effects of CRC Operations on Gopher Tortoise

As outlined in the section 9.2.1, during the permit period, gopher tortoises may enter the CRC development area or access the on-site Preserves. Gopher tortoises that enter the within the development area and in the Preserves would be exposed to the following stressors during the CRC operations:

- increased physical disturbance; and
- increased potential for predation from domestic dogs and cats.

The Applicants propose to implement the community practices listed in section 2.3.1, which would reduce the likelihood of harm resulting from exposure to these stressors. Community practices include speed limits, tenant/residential educational information, and designated areas for pets. If residents observe a gopher tortoise outside of the Preserve, they are advised to contact the HCP coordinator and instructed to not collect or move the individual. The HCP coordinator and/or Preserve biologist would be responsible for safely collecting the gopher tortoise and placing it in the on-site Preserves. Take in the form of capture would occur when the individual is carried to the Preserves. This take is not expected to result in injury or mortality and would benefit the species by placing it in a safer area. We expect that relocating tortoises to the Preserves would be a rare occurrence, and that the potential for lethal or injurious take from the operations of the CRC community is negligible.

9.3.3. Effects of Preserves on Gopher Tortoise

Restoring degraded upland habitat and maintaining habitat corridors that link occupied habitat is one of the conservation needs of the species. A gopher tortoise that wanders into the development would be placed in the Preserves (see section 9.3.2). We believe increased habitat quality in the Preserves is likely to attract gopher tortoises to the Preserves. We describe the proposed on-site Preserves and off-site Preserve in sections 2.4.3 and 2.4.5, respectively. The remainder of this section describes how the proposed management of the Preserves would cause changes to the Action Area, and describes how the gopher tortoise is likely to respond upon exposure to these changes. We summarized the Applicants' functional habitat assessment in 3.1. We analyzed each component of the proposed management activities relative to the eastern indigo snake in section 8.3.3. We anticipate gopher tortoise exposure to the same stressors as those outlined for the indigo snake.

Invasive Exotic Plant Management

The Applicants' plan to reduce and control invasive exotic plants involves a combination of herbicides, cutting and removal by mechanical methods, and within the pine rockland areas, prescribed fire. The particular combination and sequence of these treatments varies according to the distribution and density of the target invasive species. Section 7.5 of the HCP describes the methods planned for particular management units within the on-site Preserves, subject to the conditions described in section 6.2.4 of the HCP.

It is unknown how many gopher tortoises may occupy the Preserves in the future, but we expect low numbers based on the small source population in the Richmond Pine Rocklands and the

species' slow reproductive rate. Section 8.3.3 details the effects of invasive/exotic plant management on the eastern indigo snake, and we anticipate similar effects to gopher tortoises that may enter the Preserves. Several proposed conservation measures in HCP section 6.2.4. would reduce the probability of harming a gopher tortoise.

Prescribed Fire

The number of individual gopher tortoises that the proposed burning may harm or harass is not determinable; however, tortoises are a fire-adapted species and we expect a negligible impact on the species with implementation of the proposed conservation measures. Fire is likely to increase gopher tortoise food availability by reducing the density of exotic invasive plants and increasing native ground cover species in a more open setting favorable to tortoise foraging.

9.3.4. Summary of the Effects of the Action on Gopher Tortoise

Gopher tortoises are likely absent from the CRC property at present; therefore, we anticipate no direct impacts resulting from construction. Based on occupancy within the Richmond Pine Rocklands, resident gopher tortoises may enter the development area during operations, and take in the form of capture may occur when the individual is relocated to the Preserves. Management of the Preserves includes removal of invasive species by various methods and prescribed fire. There is some risk for unintentional injury, displacement, or alteration of normal behavior during Preserves management. The proposed conservation measures for Preserves management would reduce the probability of harming a gopher tortoise. Because tortoises are a fire-adapted species, we anticipate negligible disturbance from prescribed fire, and that the proposed Preserves management would improve habitat conditions for the species.

9.4. Conclusion for Gopher Tortoise

In this section, we summarize and interpret the findings of the previous sections for the gopher tortoise (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

The gopher tortoise inhabits longleaf pine and oak uplands, xeric hammock, xeric Florida scrub, maritime scrub, and ruderal (disturbed) habitat, as well as human-altered habitats such as roadsides, vacant lots, and pastures with shrubby growth and pines. Its geographic range is current range for the eastern (candidate) population of the gopher tortoise aligns with the historical range which includes Alabama (east of the Tombigbee and Mobile Rivers), Florida,

Georgia, and South Carolina. The primary threat to the gopher tortoise is the habitat destruction and modification in the form of conversion of native pine forests to intensively managed silvicultural pine forests, urban development, and habitat degradation due to lack of fire management. Conservation needs include acquisition, restoration, and management of suitable habitat.

Baseline

The Action Area is at the southern-most range of the gopher tortoise and likely isolated from source populations. There is a small resident population within the Richmond Pine Rocklands adjacent to the Action Area. Despite negative results from a single survey effort, we believe the species could colonize either the on-site Preserves at the CRC properties or the off-site Preserve area during the duration of the permit. The primary threat to the gopher tortoise within the Action Area is habitat degradation or habitat loss.

Effects

Gopher tortoises have not been documented on the property proposed for the development of CRC; consequently, there are not anticipated to be any effects during construction. Based on occupancy within the Richmond Pine Rocklands, resident gopher tortoise may enter the development area. During operations, take in the form of capture may occur when the individual is relocated to the Preserves. Management of the Preserves includes mechanical means, removal of invasive species or prescribed fire. There is some risk for unintentional injury, displacement or alteration of normal behavior during Preserve management. The expected low numbers in the Richmond Pine Rocklands numbers coupled with the proposed conservation measures in HCP section 6.2.4. would reduce the probability of harming a gopher tortoise. Gopher tortoise is a fire adapted species and would benefit from the management of the Preserves. Management of native vegetation structure should increase foraging habitat for the tortoise.

Opinion

The Action Area is at the southern-most range of the Gopher Tortoise and likely isolated from source populations. There is a small resident population within the Richmond Pine Rocklands adjacent to the Action Area. If the species moves into Action Area, there are measures to address the operational effects and relocate tortoises from potential harm. We expect management of the Preserves to be a benefit and enhance foraging habitat within the Richmond Pine Rocklands. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the gopher tortoise (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the gopher tortoise.

10. RIM ROCK CROWNED SNAKE

10.1. Status of Rim Rock Crowned Snake

This section summarizes best available data about the biology and current condition of rim rock crowned snake (*Tantilla oolitica*) throughout its range that are relevant to formulating an opinion about the Action. The rim rock crowned snake has been petitioned for listing, and, therefore, CH has not been designated or proposed at this time. The Service's review of information in the petition is not yet concluded.

We used supporting documentation from the status of the species section within the *Environmental Assessment for the Coral Reef Commons Project Incidental Take Permit Application* (Service 2017). These documents are incorporated by reference and contain detailed information about the Covered Species used for our jeopardy analysis.

10.1.1. Description of Rim Rock Crowned Snake

Three species of burrowing snakes belonging to the genus *Tantilla* occur in Florida, including the rim rock crowned snake. The rim rock crowned snake is non-venomous and can reach a length of up to 11.5 inches (29 cm) (Ernst and Ernst 2003). It has a tan to beige dorsum (back) and pinkish-white to cream-colored belly (FWC 2013). Its head and neck are dark brown or black, and its scales are smooth (FNAI 2001). Individuals from the Florida Keys may have a pale neckband that is not present in mainland snakes (Porras and Wilson 1979).

10.1.2. Life History of Rim Rock Crowned Snake

Rim rock crowned snakes inhabit pine rockland and tropical hardwood hammocks, as well as human-altered habitats such as roadsides, vacant lots, and pastures with shrubby growth and pines (Duellman and Schwarz 1958, Campbell and Moler 1992, Hines and Bradley 2009). They can be found in holes and depressions in the oolitic limestone, but they can also be found periodically in rotten logs and under rocks and trash (Enge *et al.* 2003, Campbell and Moler 1992). It is not known what the rim rock crowned snake eats; however, if similar to other members of the genus *Tantilla*, it likely feeds on insects and other small invertebrates (Ernst and Ernst 2003).

Much of the life history of this species is unknown because of its secretive, fossorial nature. Based upon reproductive ecology and longevity of the similar southeastern crowned snake (*Tantilla coronata*), the rim rock crowned snake likely reaches reproductive maturity at 2 years of age and lays up to six eggs per year (three eggs per clutch; two clutches per year), with a lifespan of at least 5 years in the wild (Todd *et al.* 2008; Ernst and Ernst 2003).

10.1.3. Numbers, Reproduction, and Distribution of Rim Rock Crowned Snake

The rim rock crowned snake is a rare species with only 12 individuals recorded between 1991 and 2009, (does not include the Zoo Miami record) (Hines and Bradley 2009). Very few sightings have been reported for the elusive rim rock crowned snake. Hines and Bradley (2009)

interviewed observers (professional herpetologists and hobbyists) and found that many had never seen a rim rock crowned snake despite extensive searching. They found that the number of observations has been highest in the last two 20-year periods but only averages 10 individuals per 20-year period. Only six observations were documented from 1930 to 1950; likewise, six were documented from 1951 to 1970 (Hines and Bradley 2009). From 1971 to 1990, 18 were reported, while only 12 were observed between 1991 and 2009 (Hines and Bradley 2009). This increase in documented observations may be the result of greater exposure of residents to this species due to urban expansion and human population growth in South Florida. Because only two individuals were documented during extensive searches and there are no areas known to consistently support them, it's unlikely that the snake population is experiencing growth (Hines and Bradley 2009).

Rim rock crowned snakes inhabit pine rockland and tropical hardwood hammocks near fresh water and, of the more than 40 species of this genus extending from the southeastern United States down to northern Argentina into South America, the rim rock crowned snake has the most limited distribution (Wilson 1982, Scott 2004). Its geographic range is confined to the southern tip of Florida, including the Florida Keys (FWC 2013). Limited to the Miami Rock Ridge in southeastern Miami-Dade County and southern Monroe County, this species has been impacted by rapid human growth and urbanization (Hines and Bradley 2009). Rim rock crowned snakes are known from various mainland locations in Miami, including Brownsville, Coconut Grove, Coral Gables, Cutler, Cutler Ridge, Kendall, Leisure City, North Miami, and Perrine (Duellman and Schwartz 1958, FNAI 2001). The species is also known to occur in the Upper and Middle Florida Keys with only one confirmed occurrence in the Lower Florida Keys (Campbell and Moler 1992, Yirka *et al.* 2010), and Zoo Miami (FWC 2011).

A 1-year study in the Florida Keys (Monroe County) yielded no new records of rim rock crowned snakes (Mays and Enge 2016). Surveys conducted by Enge *et al.* (2004) in six Miami-Dade County parks failed to locate any rim rock crowned snakes. Staff at Zoo Miami began herpetological trapping efforts with coverboards and drift fence arrays with pitfall traps in 2004, and, despite 1,640 hours of trapping effort, they found only one individual in a pitfall trap in August 2009 (FWC 2011). Hines (2011) deployed 84 coverboards over a 3-year period and only located two individuals. Because of the difficulty of finding this species, population size estimates are nearly impossible to determine; however numbers observed over the 10 years of her study were similar to those from the previous 10-year period (Hines 2011).

Based upon observations over the years, the species appears to be able to adapt to a multitude of habitats, including rockland habitats, dump sites, urban and agricultural landscapes, and hammock habitat with closed canopy and loose, dark, moist soil (Hines and Bradley 2009). A sighting record on Big Pine Key was documented at a pineland-hammock ecotone where construction and household waste (*i.e.*, carpet, old plywood boards, etc.) provided dependable moisture in an otherwise dry landscape (Hines and Bradley 2009). Hines and Bradley (2009) also documented observations at Barnacle Historic State Park, which is comprised of fewer than 4 acres of hammock habitat. This record suggests that a large expanse of habitat may not be necessary for survival, most likely because home range sizes appear to be small.

10.1.4. Conservation Needs of and Threats to Rim Rock Crowned Snake

The primary threat to the rim rock crowned snake is the fragmentation and degradation of their habitat (FWC 2011). Conservation needs include acquisition, restoration, and management of suitable habitat, removal of non-native species and research the species' life history (FWC 2013). The proximity of the species' habitat to coastal Florida carries the increasing threat of damage and loss from hurricanes, tropical storms, and sea level rise due to global climate change.

10.1.5. Summary of Rim Rock Crowned Snake Status

The rim rock crowned snake is a rare species that inhabit pine rockland, tropical hardwood hammocks, as well as human-altered habitats such as roadsides, vacant lots, and pastures with shrubby growth and pines. Its geographic range is confined to the southern tip of Florida, including the Florida Keys. We have limited information on status of the species and very few sightings have been reported for the elusive with only 13 individuals recorded between 1991 and 2009. Because of the difficulty of finding this species, population size estimates are nearly impossible to determine. The primary threat to the rim rock crowned snake is the fragmentation and degradation of their habitat. Conservation needs include acquisition, restoration, and management of suitable habitat, removal of non-native species and research the species' life history.

10.2. Environmental Baseline for Rim Rock Crowned Snake

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the rim rock crowned snake, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

10.2.1. Action Area Numbers, Reproduction, and Distribution of Rim Rock Crowned Snake

There is no site-specific survey data for rim rock crowned snake on the CRC property or the off-site Preserves. Zoo Miami conducted herpetological trapping efforts starting in 2004, and found one individual in a pitfall trap in August 2009 (FWC 2011). Because of the proximity to known occurrence, the snakes preference to pine rocklands, and the continuous suitable habitat corridor connecting the Zoo Miami property and the CRC property and off-site Preserve, we conclude that it is possible that the Action Area is occupied by the species.

10.2.2. Action Area Conservation Needs of and Threats to Rim Rock Crowned Snake

As we explain in section 10.2.1, there are records of the species occurring within the Richmond Pine Rocklands. Major threats to the rim rock crowned snake include habitat degradation and fragmentation. Conservation needs within the action area include restoration, management of suitable habitat, and removal of non-native species. Restoration is best addressed via prescribed fire and other measures to reduce invasive exotic plants.

10.3. Effects of the Action on Rim Rock Crowned Snake

This section analyzes the direct and indirect effects of the Action on the rim rock crowned snake. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

10.3.1. Effects of CRC Construction on Rim Rock Crowned Snake

Development of CRC would convert 73.73 acres of vegetated land (86.49 acres of development minus 12.76 acres of currently impervious surfaces) into residential and commercial facilities and their associated infra-structure. Construction of the proposed project may harm rim rock crowned snakes by injuring or causing mortality. While the density of rim rock crowned snake within the action area is unknown, an individual was reported adjacent to the CRC, at the Zoo Miami property.

The proposed action would involve clearing, mass grading, vegetation removal, earth moving and piling, transport of aggregate by trucks, and construction of residential and commercial buildings. These actions are reasonably certain to cause harm to any snake, nests or eggs that are present at the time of those actions.

The timing and duration of clearing would vary with the activities proposed at specific locations. Although construction personnel would have worker education and implement a variation of the Eastern Indigo Standard Protection measures tailored for the identifying rim rock crowned snakes, the operation of equipment in brushy, grassy, or otherwise vegetated areas may disturb, injure, or kill snakes that are not readily visible. Because of its fossorial nature, snakes or their nests and eggs may be unintentionally entombed by construction machinery or injury, mortality to rim rock crowned snake may occur due to vehicular, or construction machinery strikes.

Harassment may occur during construction if a snake is flushed from their refugia, or disturbance may occur due to the vibration of construction equipment. The increased human activity and vibration may result in a disruption of breeding, feeding, or sheltering behavior, and subsequent extirpation from the Action Area.

10.3.2. Effects of CRC Operations on Rim Rock Crowned Snake

We anticipate the same the effects and stressors during the CRC operations as analyzed in the eastern indigo snake section, 8.3.2. In addition, rim rock crowned snakes that continue to reside in the Preserves would be exposed to the following stressors during the CRC operations:

- increased risk of collection; and
- increased risk of predation by fire ants (*Solenopsis invicta*).

Because of its fossorial nature and small size, the rim rock crowned snake and its eggs and offspring may be susceptible to fire ants. However, we anticipate that the development would not increase the presence of fire ants beyond the baseline because the development is in an

urbanized, previously disturbed area. If pesticides are used in the development area to curtail fire ants during operations, CRC would utilize the standards and practices listed in section 2.3.3, and we anticipate that controlling fire ants in the development area would be beneficial.

Accessibility would increase within the CRC area, and there is a potential that increased accessibility would increase the risk of collection of this rare species. We expect that the on-site Preserve would be marked with signage and frequently monitored by management and or the HCP Preserve biologist. With this on-going presence, we expect this to deter collectors. Based on the low number of anticipated number of snakes within the Action Area and the enforcement of the Community Practices, the potential for take or collection of a rim rock crowned snake during the operation of the CRC community is considered negligible.

10.3.3. Effects of Preserves on Rim Rock Crowned Snakes

Restoring degraded upland habitat and maintaining habitat corridors that link occupied habitat is one of the conservation needs of the species. We describe the proposed on-site Preserves and off-site Preserve in sections 2.4.3 and 2.4.5, respectively. The remainder of this section describes how the proposed management of the Preserves would cause changes to the Action Area and how the rim rock crowned snake is likely to respond upon exposure to these changes. We summarize the Applicants' functional habitat assessment in 3.1, and section 8.3.3 analyzes each component of the proposed management activities and we anticipate the stressors would be the same as those outlined in the eastern indigo section.

Invasive Exotic Plant Management

The Applicants' plan to reduce and control invasive exotic plants involves a combination of herbicides, cutting and removal by mechanical methods, and within the pine rockland areas, prescribed fire. The particular combination and sequence of these treatments varies according to the distribution and density of the target invasive species. Section 7.5 of the HCP describes the methods planned for particular management units within the on-site Preserves, subject to the conditions described in section 6.2.4 of the HCP.

It is unknown how many individuals may occupy the Preserves in the future but the numbers are expected to be low based the species rarity and surveys results within the Miami Zoo. Section 8.3.3 details the effects invasive/exotic plant management and we anticipate the effects would be the same to rim rock crowned snake. Several proposed conservation measures in HCP section 6.2.4 would reduce the probability of harming a snake.

Prescribed Fire

While the exact amount of individual rim rock crowned snake that would be taken is difficult to predict, this number is expected to be minimal with implementation of the proposed conservation measures. We anticipate that by restoring degraded habitat within the Preserves that it would address some of the known conservation needs of the species by enhancing habitat.

10.3.4. Summary of the Effects of the Action on Rim Rock Crowned Snake

The construction period would have negative effects on the species. Rim rock crowned snakes, nests or eggs that are present at the time may be harmed by clearing, mass grading, vegetation removal, and construction of residential and commercial buildings. Based on the low number of anticipated number of snakes within the Action Area and the enforcement of the Community Practices, the potential for take or collection of a rim rock crowned snake from the operation of the CRC community is considered negligible. There is some risk for unintentional injury, displacement or alteration of normal behavior during mechanical clearing methods and invasive/exotic species removal. The likelihood that snakes would be killed during prescribed fire would be negligible due to the size and scope of the prescribed fires within the Preserves.

10.4. Conclusion for Rim Rock Crowned Snake

In this section, we summarize and interpret the findings of the previous sections for the rim rock crowned snake (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

The rim rock crowned snake is a rare species that inhabits pine rocklands, tropical hardwood hammocks, as well as human-altered habitats such as roadsides, vacant lots, and pastures with shrubby growth and pines. Its geographic range is confined to the southern tip of Florida, including the Florida Keys. Sightings of only 13 individuals have been recorded between 1991 and 2009. Because of the difficulty of finding this species, population size estimates are nearly impossible to determine. The primary threat to the rim rock crowned snake is the fragmentation and degradation of their habitat. Conservation needs include acquisition, restoration, and management of suitable habitat, removal of non-native species and research the species' life history.

Baseline

There are no surveys within the Action Area, but there are several records of the species occurring within the Richmond Pine Rocklands. Major threats to the rim rock crowned snake include habitat degradation and fragmentation. Conservation needs within the Action Area include restoration, management of suitable habitat, and removal of non-native species.

Effects

We anticipate the same the effects and stressors during the CRC operations as analyzed in the eastern indigo snake section, 8.3.2. Other potential effects include accessibility for collectors and increased non-native ants that may prey on the snake and its eggs. Based on the anticipated low number of number of snakes within the Action Area and the enforcement of the Community Practices, the potential for take from collection of a rim rock crowned snake during operations of the CRC community is considered negligible. We anticipate that fire ants would not increase beyond baseline levels, and any pesticide use to control fire ants would be beneficial to the species.

Any adult snakes, eggs, or juveniles present during Preserve management activities, *i.e.*, exotic species removal or prescribed fire, may be exposed to disturbance, injury, or mortality. It is unknown how many individuals may occupy the Preserves in the future, but the numbers are expected to be low based the species rarity and survey results within Zoo Miami. Several proposed conservation measures in HCP section 6.2.4. would reduce the probability of harming a snake. Potential beneficial effects include enhancement of habitat through management and habitat preservation.

Opinion

The rim rock crowned snake is a rare species that may occur in the Action Area. Construction activity would harm any that are present. We believe that managing the Preserves would likely benefit the species' population in the Richmond Pine Rocklands by improving the species' primary habitat type. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the eastern indigo snake (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the rim rock crowned snake.

11. FLORIDA BONNETED BAT

11.1. Status of Florida Bonneted Bat

This section summarizes best available data about the biology and current condition of the Florida bonneted bat (*Eumops floridanus*; FBB) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the FBB as endangered on October 2, 2013 (78 FR 61003–61043). No CH has been designated for the FBB. Additional information on the status of the species can be found in the listing rule and the Environmental Assessment (Attachment 5).

11.1.1. Description of Florida Bonneted Bat

The FBB is approximately 130–165 mm (5.1–6.5 in) long (Timm and Genoways 2004), and the largest bat in Florida (Owre 1978; Belwood 1992; FBC 2005). Males and females are not significantly different in size and there is no pattern of size-related geographic variation in this species. The FBB's fur is short and glossy, with hairs sharply bicolored with a white base (Belwood 1992; Timm and Genoways 2004). The color is highly variable; color varies from black to brown to brownish-gray or cinnamon brown with ventral pelage paler than dorsal (Owre 1978; Belwood 1992; Timm and Genoways 2004). Members of the genus *Eumops* have large, rounded pinnae (ears), arising from a single point or joined medially on the forehead (Best *et al.* 1997) and wings are among the narrowest of all molossids (Freeman 1981, as cited in Best *et al.* 1997). This wing structure is conducive to high-speed flight in open areas as well as rapid, prolonged flight (Findley *et al.* 1972, as cited in Best *et al.* 1997; Vaughan 1959, as cited in Best *et al.* 1997).

11.1.2. Life History of Florida Bonneted Bat

Relatively little is known about the FBB's life history. Lifespan is not known. Based upon the work of Wilkinson and South (2002), Gore *et al.* (2010) inferred a lifespan of 10 to 20 years for the FBB, with an average generation time of 5 to 10 years. The FBB is active year-round and does not have periods of hibernation or torpor. The species is not migratory, but may shift roosting sites seasonally (Timm and Genoways 2004).

The maternity season for most bat species in Florida occurs from mid-April through mid-August (Marks and Marks 2008a). FBB breeding is not well understood, and the species appears to be aseasonally polyestrous. In one study on Babcock-Webb WMA, the percent of pregnant females observed varied between captures with 10 percent in August, 0 percent in December, and 95 percent in April, and non-volant pups were observed from May through December (Ober *et al.* 2016).

Foraging in open spaces, these bats use echolocation to detect prey at relatively long range, roughly 3–5 m (10–16 ft) (Belwood 1992). Based upon limited information, FBBs feed on flying insects of the following orders: Coleoptera (beetles), Diptera (true flies), Hemiptera (true bugs), and Lepidoptera (moths) (Belwood 1981; Belwood 1992**;** FBC 2005). An analysis of bat guano (droppings) from the colony using the pine flatwoods in Punta Gorda indicated the sample (by volume) contained coleopterans (55 percent), dipterans (15 percent), and hemipterans (10 percent) (Belwood 1981; Belwood 1992). Additional analyses of bat guano collected from occupied bat houses at Babcock-Webb Wildlife Management Area (WMA) indicated that the samples contained high percentages of Lepidoptera and Coleoptera (Marks 2013). The species is likely dependent upon a constant and sufficient food supply, consisting of insects, to maintain its generally high metabolism.

Molossids, in general, seem adapted to fast flight in open areas (Vaughan 1966). The FBB's morphological characteristics make it capable of dispersing large distances and generally adapted for low cost, swift, long distance travel from roost site to foraging areas (Norberg and Rayner 1987; Gillies 2012; Ober 2012). Limited information on FBB foraging behavior is currently available. In one study using GPS-satellite tags at Babcock-Webb WMA, researchers found that

most FBB locations were within one mile of the roost (point of capture) (Ober 2015). However, FBBs also tended to take one longer foray, up to 7 miles, shortly after sunset each (Ober 2015, Ober 2016). Assuming a foraging area centered on a roost with a 1 mile radius, FBBs likely forage throughout 2,010 acres, and could forage up to 98,470 acres (7 mile radius), on any given night. It is unknown how foraging behavior and needs differ among individuals (*e.g.*, ages, sexes), seasonally and in different habitat types. The quality of habitat and the prey availability and other factors likely greatly influences the relative importance of any particular area. FBB foraging areas are expected to be greater in areas with lower quality foraging habitat in order to meet their biological needs; which at some point would be expected to lead to a loss in fitness.

Habitat

Relatively little is known of the ecology of the FBB, and long-term habitat requirements are poorly understood (Robson 1989; Robson *et al.* 1989; Belwood 1992; Timm and Genoways 2004). Habitat for the FBB mainly consists of foraging areas and roosting sites, including artificial structures.

FBB foraging habitat is comprised of relatively open (*i.e.,* uncluttered) areas to find and catch prey, and sources of drinking water. This includes: open fresh water, permanent or seasonal freshwater wetlands, wetland and upland forests, and wetland and upland shrub. In urban and residential areas, suitable foraging conditions (*i.e.,* open habitat structure) and drinking water can be found in relatively small patches of natural or semi-natural habitat. Bonneted bats are "fast hawking" bats that rely on speed and agility to catch target insects in the absence of background clutter, such as dense vegetation (Simmons *et al.* 1979; Belwood 1992**;** Best *et al.* 1997).

At present, only four locations are known to have active natural roost sites; one location having 3 known roosting trees at one time (Halupa 2017). Roosting habitat includes forest and other areas with tall, mature trees or other areas with suitable roost structures. Forest is defined as all types including: pine flatwoods, scrubby flatwoods, pine rocklands, royal palm hammocks, mixed or hardwood hammocks, cypress, sand pine scrub, or other forest types. More specifically, this includes habitat in which suitable structural features for breeding and sheltering are present. In general, roosting habitat contains one or more of the following structures: tall mature live or dead trees, tree snags, and trees with cavities, hollows, deformities, decay, crevices, or loose bark. Structural characteristics are of primary importance. FBBs have been found roosting in habitat with the following structural features, but may also occur outside of these parameters:

a) trees greater than 20 ft (6 m) in height, greater than 8 inches (20.3 cm) in diameter at breast height (DBH), with cavity elevations higher than 15 ft (4.6 m) above ground level;
b) areas with a high incidence of large or mature live trees with various deformities (*e.g.*, large cavities, hollows, broken tops, loose bark, and other evidence of decay) (*e.g.*, pine flatwoods);
c) rock crevices (*e.g.*, limestone in Miami-Dade County); and/or
d) artificial structures, mimicking natural roosting conditions (*e.g.*, bat houses, utility poles, buildings), situated in natural or semi-natural habitats.

Structures similar to the above (*e.g.,* bridges, culverts) are expected to also provide roosting habitat, based upon the species' morphology and behavior. FBB roosts would be situated in areas with sufficient open space for these bats to fly (*e.g.,* open or semi-open canopy, canopy gaps, and edges which provide relatively uncluttered conditions).

11.1.3. Numbers, Reproduction, and Distribution of Florida Bonneted Bat

Distribution

Endemic to Florida, the FBB has one of the most restricted distributions of any species of bat in the New World (Belwood 1992; Timm and Genoways 2004). Although numerous acoustical surveys for the FBB have been conducted in the past decade by various parties, the best scientific information indicates that the species exists only within a very restricted range, confined to south Florida (Timm and Genoways 2004; Marks and Marks 2008a, 2012).

Records indicating historical range are limited. Late Pleistocene remains are known from Melbourne, Brevard County, and Monkey Jungle Hammock in Miami-Dade County (Allen 1932; Martin 1977, as cited in Belwood 1981 and Timm and Genoways 2004; Morgan 1991). Holocene remains are known from Vero Beach, Indian River County (Ray 1958; Martin1977; and Morgan 1985, 2002, as cited in Timm and Genoways 2004; Morgan 1991), and also Monkey Jungle Hammock (Morgan 1991). The largest fossil sample (9 specimens) was reported from the Holocene stratum at Vero Beach (Morgan 1985, as cited in Morgan 1991). The fossil records from Brevard County and Indian River County are considerably farther north than where living individuals have typically been recorded (Timm and Genoways 2004; Marks and Marks 2008b).

Most of the historical records and sightings for this species are several decades old from the cities of Coral Gables and Miami in extreme southeastern Florida, where the species was once believed to be common (Belwood 1992; Timm and Genoways 2004; Timm and Arroyo-Cabrales 2008). Recent specimens are known only from extreme southern and southwestern Florida, including Miami-Dade County on the east coast and Charlotte, Collier, and Lee Counties on the Gulf coast (Timm and Genoways 2004).

Based upon available information, the FBB appears to be restricted to south, southwest, and south-central Florida. The core range may primarily consist of habitat within Charlotte, Lee, Collier, Monroe, and Miami-Dade Counties. Recent data also indicate use of portions of Okeechobee, Polk, DeSoto, Hendry, and Broward Counties and possible use of areas within Glades and Highlands Counties.

Numbers and Reproduction

Little information exists on historical population levels. The FBB was considered common in the Miami-Coral Gables area because of regular collection of specimens from 1951–1965 (Robson 1989; Belwood 1992). Jennings (1958) indicated the species was not abundant, noting a total of 20 individuals had been taken from 1936–1958. A 6-week field trip in 1980 to locate other occurrences was unsuccessful and led to the belief this species was “probably extinct in Florida” (Belwood 1992). A status survey conducted in 1989, encompassing 25 sites within natural areas within a nine county area, found no new evidence of this species (Robson 1989).

Results of the 2006–2007 range-wide survey suggested that the FBB is a rare species with limited range and low abundance (Marks and Marks 2008a). Based upon results of both the range-wide study and survey of select public lands, the species was found at 12 locations (Marks

and Marks 2008b), but the numbers and status of the bat at each location are unknown. Based upon the small number of locations where calls were recorded, the low numbers of calls recorded at each location, and the fact that the species forms small colonies, Marks and Marks (2008a) stated that the entire population of FBBs may number less than a few hundred individuals.

Results of the 2010 to 2012 surveys and additional surveys by other researchers identified new occurrences within the established range (*i.e.*, within the Miami area, areas of ENP and Big Cypress National Park) (Snow 2011a, 2011b, 2012; Arwood 2012; Marks and Marks 2012); however, not in sufficient numbers to alter previous population estimates. In their 2012 report on the status of the species, Marks and Marks (2012) provided an updated estimation of population size, based upon 120 nights of surveys at 96 locations within peninsular Florida, results of other known surveys, and personal communications with others involved in FBB work. Based upon an average colony size of 11 and an estimated 26 colonies within the species' range, researchers estimated the total FBB population at 286 bats at that time (Marks and Marks 2012). Additional roosts have been located (natural, bat houses, and urban environment) since 2012, indicating that FBB numbers are more likely in the hundreds or low thousands (Ober *et al.* 2016).

Ober *et al.* (2016) investigated several aspects of the social organization the species roosting in bat houses in southwest Florida, including group size, group composition, group stability, and seasonality of reproduction. They found that the species has characteristics more common to tropical than temperate bat species, such as a harem social structure, with an average roost size of 10 individuals (Ober *et al.* 2016).

Information on reproduction and demography is sparse. The FBB has low fecundity; litter size is one (FBC 2005; Timm and Arroyo-Cabrales 2008). Observations at roosts in natural cavities have observed a range of 1–54 individuals during emergence (Braun de Torrez 2016). The FBB colony using bat houses on private property in Lee County consisted of 8 to 25 individuals (Trokey 2006a, 2006b; 2008a, 2008b, 2012). Ober *et al.* (2016) found an average roost size of 10 individuals in the bat boxes on Babcock-Webb WMA. Some movement between the houses has been observed, and periodic simultaneous counts taken at bat houses at Babcock-Webb WMA suggest that use fluctuates among the seven artificial roost structures (Ober *et al.* 2016).

In summary, we cannot accurately estimate population size at this time. This is in part because so few roosts are known, roost switching can occur, emergence counts are not conducted simultaneously (or even at the same time of year), and precise counts are difficult to obtain due to environmental conditions and the propensity for some individuals to remain within roosts during counts. Total abundance is likely in the hundreds or low thousands.

11.1.4. Conservation Needs of and Threats to Florida Bonneted Bat

Extensive conservation efforts are underway by researchers, government agencies, non-profit organizations, stakeholders, and private individuals. Efforts are focusing on: (1) filling information gaps regarding the species and its habitat needs and preferences; (2) conserving roosting and foraging habitats; (3) reducing known threats, wherever possible; and (4) increasing public awareness about the species.

Habitat

Loss of native forested habitat and roost sites are major threats to the FBB (Belwood 1992; Timm and Arroyo-Cabrales 2008). As a result of the growth in human population, approximately 90 percent of the forested habitats in Florida have been altered or eliminated, and losses are expected to continue (Wear and Greis 2002). The retention of old trees with hollows and cavities are particularly important to this species. 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; Timm and Arroyo-Cabrales 2008).

Although species occurrences on conservation lands are inherently more protected than those on private lands, habitat alteration during management practices may affect 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 unknown roost sites. Loss of an active roost or removal during critical life-history stages (*e.g.*, when females are pregnant or rearing young) can have ramifications, considering the species' small population size, low fecundity, and roost site fidelity. FBBs using urban or suburban areas may be negatively impacted by activities such as: routine landscaping, removing dead pine or royal palm trees, pruning or trimming trees (especially cabbage palms), sealing barrel-tile roof shingles with mortar, destroying abandoned buildings, and clearing lots of native vegetation (Robson 1989). In addition, routine maintenance and repair of bridges and overpasses or other infrastructure may affect FBB, as bats in general are known to roost in these locations.

Suitable natural roost sites in south Florida appear limited, and competition for available tree cavities may be greater now than historically. In 1992, Belwood (1992) stated that tree cavities were rare in southern Florida and that competition for available cavities from native wildlife (*e.g.*, southern flying squirrel, red-headed woodpecker, corn snake) was intense. Competition for cavities since that time has presumably increased, due largely to continued loss of cavity trees and habitat and the influx of nonnative or introduced species, which vie for available roosting or nesting locations.

Disease or Predation

The effects of disease and predation are not well known. White-nose syndrome (WNS) is an emerging infectious disease affecting insectivorous, cave-dwelling bats. At this time, it is difficult to assess whether disease is currently or likely to become a threat to the FBB. With anticipated climatic changes and increased environmental stress, it is possible that disease may have a greater impact on the FBB in the future.

In general, animals such as owls, hawks, raccoons, skunks, and snakes prey upon bats (Harvey *et al.* 1999). There is one record of natural predation on the FBB (Timm and Genoways 2004). A skull of one specimen was found in a regurgitated owl pellet at the Fakahatchee Strand Preserve State Park (FSPSP) in June 2000 (Timm and Genoways 2004; Marks 2006; Marks and Marks 2008a; Owen 2012a, 2012b). Although evidence of predation is limited, 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**;** Ludlow 2012; Timm 2012). Due to limited information, we are not able to determine the extent to which predation may be impacting the FBB 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 Natural or Manmade Factors Affecting its Continued Existence

Pesticides and Contaminants
The impacts of pesticides and other environmental contaminants on bat species are largely unstudied, particularly in the case of the FBB. The life history of the FBB may make it susceptible to pesticide exposure from a variety of sources. Mosquito control spraying activities commonly begin at dusk when mosquitoes are most active. Because the FBB forages at dusk and after dark, the possibility exists for individuals to be directly exposed to airborne mosquito control chemicals or to consume invertebrates containing pesticide residues from recent applications. Additionally, because the FBB has been documented to roost in residential areas, it is possible for individuals to be exposed, either directly or through diet, to a variety of undocumented, localized pesticide applications conducted by homeowners. The potential exposure to or impacts of agricultural chemical application on the FBB in Florida are largely unknown.

A reduction in the number of flying insects is a potential secondary effect to consider when evaluating the impact of pesticides on the FBB. In his status survey for the FBB, Robson (1989) suggested that mosquito control programs are contributing to reduced food supplies for bats.

Ecological Light Pollution
Depending upon scale and extent, ecological light pollution can have demonstrable effects on behavioral and population ecology of organisms by: (a) disrupting orientation (or causing disorientation); (b) affecting movements (attraction or repulsion); (c) altering reproductive behaviors; and (d) influencing communication (Longcore and Rich 2004). The effects of artificial lighting on bats and their prey have been partially studied. A wide array of insects are attracted to lights (Frank 1988; Eisenbeis and Hassel 2000; Kolligs 2000; as cited in Longcore and Rich 2004). Although the primary prey items for the FBB are not known, it is likely that artificial lighting may be affecting insect abundance or availability and prey base in some locations. Longcore and Rich (2004) suggested that increased food concentration at artificial light sources may be a positive effect for those species that can exploit such sources, but it also could result in altered community structure. The FBB's behavioral response to ecological light pollution has not been examined, and effects are not known. The species' fast-flight and long range flight capabilities may make it more able to exploit insects congregated at artificial light sources or more susceptible to risks associated with such responses (*e.g.*, increased predation or harm from humans).

Environmental Stochasticity and Climate Change
The FBB is at risk from hurricanes, storms, or other extreme weather. Storms, storm surge, and coastal flooding can impact FBBs, roosting, and foraging habitat. Major impacts of intense

storms may include mortality during the storm, exposure to predation immediately following the storm, loss of natural or artificial roost sites, and impacts on foraging areas and insect abundance. As pregnant females have been found in June through September, hurricanes in Florida can occur at critical life-history stages—when females are pregnant or rearing young—possibly resulting in losses of pregnant females, newborns, or juvenile pups (Marks and Marks 2008a). Because the population is expected to be small, the FBB may not be able to withstand losses from intense storms or storms at a critical life-history stage. Alternatively, less intense hurricanes or mild, isolated storms may create roosting opportunities, if tree snags (dead trees) are left in place.

This species is also vulnerable to prolonged extreme cold weather events. Molossids, the family of bats which includes the FBB, appear to be an intermediate between tropical and temperate zone bat families (Arlettaz *et al.* 2000). Members of this family that inhabit the warmer temperate and subtropical zones incur much higher energetic costs for thermoregulation during cold weather events than those inhabiting northern regions (Arlettaz *et al.* 2000). At such temperatures, bats are likely unable to find food and cannot rewarm themselves. Such a stochastic, but potentially severe, event poses a significant threat to the entire population. Impacts of past cold weather events are evident, but the effect on all colonies is not known.

We discuss how a changing climate may affect pine rocklands and the Action Area in section 3.2. Sea level rise and coastal squeeze are relevant to the FBB by causing additional habitat loss, including the loss of roost sites and foraging habitat. Within the species' range, coastal areas and low-lying areas in Collier, Lee, Miami-Dade, and Monroe Counties will be most vulnerable to sea level rise and inundation. This means that large portions of occupied, suitable, and potential roosting and foraging habitat for the FBB in low-lying areas will likely be either submerged or affected by increased flooding. Conversely, drier conditions and increased variability in precipitation are also expected to increase the severity of wildfire events. Climate changes are forecasted to extend fire seasons and the frequency of large fire events throughout the Coastal Plain (Wear and Greis 2011). Increases in the scale, frequency, or severity of wildfires could also have severe ramifications on the FBB, considering its forest-dwelling nature.

11.2. Environmental Baseline for Florida Bonneted bat

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the FBB its habitat, and ecosystem within the Action Area. The environmental baseline is a “snapshot” of the species’ health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

11.2.1. Action Area Numbers, Reproduction, and Distribution of Florida Bonneted Bat

Based on acoustic monitoring conducted on Zoo Miami, FBB were expected to occur on the CRC property. To gather site-specific information on whether FBB were potentially roosting within the property, an intensive acoustic survey effort was conducted with 25 recording stations. The acoustic survey was supplemented by visual inspection of abandoned buildings and structures to determine whether roosts were present in those structures.

The acoustic surveys detected FBBs at all 25 stations (Table 3-2 in HCP). Although the total number of bats is unknown, FBB search, clutter, commute, and feeding calls were recorded. No roost chatter was heard. However, five individual calls were recorded within 30 minutes of sunset, indicative of roosting nearby (no calls were recorded within an hour of sunrise). Further evaluation of roosting was not conducted within the forested areas of the CRC property. Although roosting on the property is not confirmed, available data suggests it is possible. For the purposes of this consultation, we anticipate that pre-construction surveys would identify one roost. Given the number of FBB counted in urban roosts within MDC, and the average number of bats roosting in the boxes on Babcock-Webb WMA, we anticipate the roost could contain up to 10 bats. FBB are believed to roost in harems; therefore, we expect that any given roost would have no more than 9 females.

The Florida Bat Conservancy and the Applicants' consultant Johnson Engineering Inc. conducted roost surveys at the interior and exterior of all abandoned buildings, the chimney site, the pines adjacent to open areas, and the rock cavities within the Rockland Hammock area on September 2 and 3, 2014. The surveys included visual inspections of the building interior and exterior, use of handheld bat detectors (Echo Meter Touch™ and AnaBat SD2™), and visual observations on the exterior of the buildings for 1 hour after sunset. No roosting or other bat activity of any species was detected.

Because the Action Area contains natural vegetation within the urban matrix, it likely provides foraging opportunities that are not available in the more urbanized surrounding areas. Foraging calls recorded on the CRC property confirms its use as foraging habitat. In acoustic surveys for FBB in other portions of the Richmond Pine Rocklands, FBBs appeared to prefer foraging in large open spaces, with few obstructions and minimal artificial lighting (Ridgley *et al.* 2014). In that study, foraging locations all had intact pine rockland habitat bordering the open areas, suggesting that these areas provided sources for suitable or preferred prey. In general, natural or semi-natural habitat patches that contribute to prey base and provide suitable foraging conditions (*i.e.*, open habitat structure) are considered important in urban or residential areas.

The 50.96-acre off-site Preserve is pine rockland habitat that is currently managed under deed restrictions intended to conserve the deltoid spurge. No surveys for FBBs have been conducted on this property. Based on FBB presence on adjacent properties (Zoo Miami and CRC), at minimum, we expect the species to use the off-site Preserve for foraging.

11.2.2. Action Area Conservation Needs of and Threats to Florida Bonneted Bat

The threats of habitat loss and competition for tree cavities that we describe in section 11.1.4 above are relevant in the Action Area. This BO/CO evaluates the effect of roosting and foraging habitat loss on the CRC property. As we described in section 3.1, land management is needed in the Action Area to restore and maintain the pine rockland habitats for the conservation of several of the Covered Species, which would include tree thinning. For the FBB, tree removal could increase competition for tree cavities and could open up more habitat for foraging.

11.3. Effects of the Action on Florida Bonneted Bat

This section analyzes the direct and indirect effects of the Action on the FBB. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

11.3.1. Effects of CRC Construction on Florida Bonneted Bat

Habitat Loss

The Applicants' acoustic surveys detected the FBB at all 25 stations situated throughout the CRC property, in both existing developed areas and forested areas. The only areas that we believe have no utility to the FBB on the CRC property (besides commuting air space) are those with impervious surfaces, which can provide neither natural roosts nor insect production.

Existing impervious surface cover on the CRC property is about 13 acres (HCP Table 4-2). The proposed CRC development would expand impervious surface cover to a total of about 80 acres (86 acres total development foot print minus about 6 acres of Stepping Stones and other green space plantings). Therefore, the primary environmental change caused by construction that would affect the FBB is the conversion of about 67 acres (80 – 13) of vegetated land cover to impervious surface. For purposes of this consultation, we expect this conversion footprint to include one FBB roost of 10 bats (see section 11.2.1). The results of the proposed pre-construction FBB roost survey would then determine next steps and effects to the species (HCP section 6.2.2.1). We have no data that allow us to evaluate the loss of 67 acres of insect production on FBB foraging by either individuals that roost in the Action Area or elsewhere. FBBs forage up to 1–7 miles from their roosts, and it seems unlikely that prey availability would limit FBB use of the Action Area with or without the proposed Action. We believe reduced insect production caused by CRC construction would represent an insignificant effect on FBB foraging.

Pre-Construction Roost Surveys

If a FBB roost is identified during the pre-construction roost surveys, the Service would be contacted and additional measures described in section 6.2.2.1 of the HCP would be implemented to minimize injury and death of individuals. This would include the exclusion of the adults. Information is still lacking on site fidelity of FBBs. Occupied bat houses and roosts in homes have been known to subsist for many years; however observations at Babcock-Webb WMA have documented regular roost switching (Ober *et al.* 2016, Halupa 2017). Unless pups are present at the roost, this switching behavior suggests that seek and find alternative roosts, and that the probability of death or injury resulting from roost exclusion is low or discountable.

If pups are found within a roost, a series of minimization measures would be implemented in an effort to reduce the likelihood of injuring or killing any young (section 6.2.2.1 of the HCP). Preference would be given to avoidance of injury and mortality by establishing a 100-ft buffer around the roost and delaying removal of the roost structure until pups were able to fly and hunt

on their own. However, if this is not possible, pups would be translocated and/or collected. If at any time during construction a roost is inadvertently knocked down and live pups are found, the pups would be rescued as described in the HCP.

If a FBB roost is identified during construction, and cannot be avoided, this roost tree (or other structure) would be removed. The Applicants would follow the minimization measures to limit the likelihood that any bat would die during this process. Regardless, the removal of the roost would result in harassment and harm to the FBB that occupied the roost. In addition, while all precautions would be taken to avoid the loss of adults and non-volant young, ultimately, if young are present and salvage attempts fail, some FBB could die.

Other Effect Pathways

Nighttime lighting during construction of the proposed CRC has the potential to affect FBBs. The FBB's behavioral response to artificial lighting and ecological light pollution has not been examined, and effects are not known. The species' fast-flight and long range flight capabilities may make it more able to exploit insects congregated at artificial light sources (beneficial effect) or more susceptible to risks such as increased predation (adverse effect). The Applicants do not anticipate using nighttime lighting as part of general construction; however, it could be necessary for some elements. Any lighting required for night time construction for safety purposes would direct light towards the intended target for illumination, which is intended to reduce any effects to FBB. Given the minimal use of nighttime lighting and its directional focus during construction any adverse effect is expected to be insignificant.

11.3.2. Effects of CRC Operations on Florida Bonneted Bat

CRC construction would initially modify foraging habitat and eliminate roosting habitat for FBB within the CRC development footprint (see section 11.3.1). FBBs remaining on the CRC property following construction would occupy and use suitable habitat in the adjacent undeveloped areas, which the Applicants propose as on-site Preserves. These individuals would be subject to additional stressors including physical disturbance, increased potential of predation, lighting, and pesticide and mosquito control. These stressors are described in further detail below.

Physical disturbance

The development of the proposed CRC would result in an increased level of human activity and noise because of the increased presence of humans, vehicles, and/or machinery. These disturbances would be long-term and have the potential to affect the edges of the adjacent on-site Preserves. Increased human presence and associated activities have the potential to degrade foraging habitat quality over the development and foraging and roosting habitat in the adjacent on-site Preserves. Little is known about the effects of urbanization on FBB. Based on the knowledge that FBB currently reside in and use urban areas, the increase of human activities, including noise, are not expected to adversely affect the FBB.

Increased potential for predation

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; Ludlow 2012; Timm 2012). Increased human presence may increase the abundance of species such as raccoons that can live in urban areas and take advantage of human trash. If species such as raccoons become abundant, pest control measures would be implemented because of the desires of the community. Tenants would be educated on proper application regulations for pest control and any pesticide treatment. It is considered to be unlikely that the any predator population would become elevated enough in numbers because of the community's presence that it would result in adverse effects to the FBB.

Lighting

Section 6.2.3.1 of the HCP describes how lighting proposed for parking lots would be engineered to achieve Illuminating Engineering Society of North America requirements as well as would meet municipal/code requirements. These requirements would minimize the amount of ambient light and would be consistent with what the Service commonly refers to as "wildlife friendly" lighting. Similar to the discussion regarding lighting under *Other Effect Pathways for Construction*, the potential effects of lighting around the community are unknown but could have both beneficial and adverse effects to FBB by concentrating foraging opportunities and concentrating predation potential for FBB. The lighting on the proposed CRC would be consistent with what is present in the other residential communities in the area. FBB are believed to use these areas for foraging, although Ridgley *et al.* (2014) documented a preference in the Richmond Area for foraging in areas with little to no artificial lighting. However, FBB are known to use other residential areas for roosting and foraging. Therefore, based on the persistence of FBB in the urban environment, we expect that the lighting proposed for CRC may reduce foraging activity by increasing ambient light, but these effects would be minimal and not likely to adversely affect FBBs.

Pesticides

The impacts of pesticides and other environmental contaminants on bat species are largely unstudied, particularly in the case of the FBB. The life history of the FBB may make it susceptible to pesticide exposure from a variety of sources. Mosquito control spraying activities commonly occur at night and pre-dawn when mosquitoes are most active and to reduce exposing residents to pesticides. Because the FBB has been documented to roost in residential areas, it is possible for individuals to be exposed, either directly or through diet, to a variety of undocumented, localized pesticide applications conducted by homeowners.

Pesticides application also has the potential to adversely affect FBB by reducing the forage available to individuals. The Applicants have developed several BMPs for pesticide use in the community (section 6.2.3.3 of the HCP). Application would adhere to pesticide labels and insecticides would be restricted within the Stepping Stones. As previously stated, FBB are known to occur in residential areas where pesticide use and mosquito control is already taking

place. No information is available on the effects that these practices are having on FBB and the ability of FBBs to survive and reproduce in this environment. Based on information available, it appears that although pesticide use reduces the amount of forage available to FBB, individuals continue to survive and reproduce in these environments. The Applicants developed pesticide application protocol to reduce adverse effects to BSHB; therefore, it would be expected that pesticide use in the CRC community would be lower than surrounding residences. Consequently, pesticide application within the proposed CRC would be minimized and would not be anticipated to adversely affect FBB.

11.3.3. Effects of Preserves and Stepping Stones Management on Florida Bonneted Bat

We describe the proposed on-site Preserves and off-site Preserve in sections 2.4.3 and 2.4.5, respectively. The remainder of this section describes how the proposed management of the Preserves would cause changes to the Action Area, and how the FBB is likely to respond upon exposure to these changes. We analyze each component of the proposed management activities that are relevant to the FBB.

Applicants' Habitat Functional Assessment

We describe the Applicants' habitat assessment in section **3.3**. Despite the loss of 32.28 acres of pine rockland habitat within the development footprint, the Applicants expect that a 7.6 percent overall improvement in habitat value, as a result of on-site Preserves management, would over time increase the abundance of Covered Species on the CRC property, including the FBB. The habitat assessment did not include the off-site Preserve.

The FBB is not a pine rockland obligate species; however it is closely tied to forested habitat because of roosting opportunities. In the urban environment where FBB is known to use human structures for roosting, association with forested habitat may be less important for roosting; however, as discussed above FBBs observed in the Richmond area appeared to prefer foraging in large wide open spaces, which had few obstructions and very little to no artificial lighting (Ridgley *et al.* 2014). The success criteria for percent canopy cover (1-15) within the on-site Preserves would be expected to provide open foraging conditions favorable to the FBB. The other success criteria would support a healthy pine rockland and rockland hammock area, which should provide a healthy prey base for the species.

Prescribed Burning

The Applicants propose prescribed burning within 45.24 acres (88.6 percent) of the on-site Preserves (East and West Preserves) and 45.60 to 48.65 acres (89–95 percent) of the off-site Preserve; a total of 90.84 – 93.89 acres. Both would receive fire on a 3–7 year rotation by management unit. Burning is not proposed for the rockland hammock area on the northern edge of the CRC property, or for the narrow corridor along the southern edge (the Southern Corridor Preserve). The prescribed burning program for the on-site Preserves and the off-site Preserve is described in Appendix J and Appendix J1 of the HCP, respectively.

Prescribed fire is the preferred method for long-term management of the on-site Preserves because pine rocklands are a fire-adapted ecosystem. Prescribed fire can adversely affect FBBs if a roost tree is consumed by the fire and individuals are injured or killed or if individuals that occupy the roost escape but have no alternative shelter. If burns occur when non-volant (flightless) young are present in the roost, depending on the fire behavior, there is also a possibility that although adults would escape the fire, young would be killed.

In order to minimize the likelihood that FBB would be killed and/or a FBB roost would be destroyed, the Applicants would implement several measures identified in section 6.2.4.1 of the HCP. These include:

- conduct roost surveys following guidance from the Service to identify any FBB in the Southern Corridor and on-site Preserves no more than 60 days prior to canopy thinning and fuel reduction activities;
- identified roosts would be protected during management activities with a 100-ft buffer; and
- prior to burning activities, the Applicants would conduct hand removal of the subcanopy fuels within the 100-ft buffer, raking away of fine fuels from the base of the roost structure, and establishing a wetline around the roost structure.

In addition, because the fire management units would be small, the intensity of the fire is expected to be low and the likelihood of trees being consumed in the fire should be low.

Presence of smoke could result in temporary disturbance to resident FBBs. However, FBBs are large bats capable of long flights at higher altitudes than smaller bats and are anticipated to be able to flee an approaching fire and heavy smoke. On Avon Park Air Force Range and Babcock-Webb WMA, prescribed burning is conducted near FBB roosts on a 2–3 year fire return interval, and no negative impacts have been documented. Based on the minimization measures that would be implemented, the flight abilities of adult FBBs, and the information from other locations, the prescribed fire activities would not be expected to adversely affect adult FBBs in known roosts.

FBB breeding is not well understood; in one study on Babcock-Webb WMA the percent of pregnant females observed varied between captures with 10 percent in August, 0 percent in December, and 95 percent in April, and non-volant pups were observed from May through December (Ober *et al.* 2016). Therefore, non-volant young could be present in roosts during prescribed fire if a roost is documented on-site. Thus, there would be some potential that non-volant young could be adversely affected if heavy smoke inundates a known roost. Fuel loads would be reduced adjacent to any roost, and burn units would be small, which should reduce the likelihood of heavy smoke. Consequently, this potential adverse effect is expected to be discountable.

The Applicants would use annual monitoring of the bat houses and opportunistic identification of new roosts during other monitoring and activities to continue to gather information about FBB roosting in the on-site Preserves and off-site Preserve. Therefore, it would be possible that over time, a FBB roost could be established within the on-site Preserves or off-site Preserve that would not be identified prior to a prescribed burn. This roost could be at risk during a prescribed burn because the standard minimization measure for protection and fuel load reduction would not necessarily be in place at the roost. However, if the on-site Preserves and off-site Preserve

are maintained in a manner consistent with the Conservation Program, fuel loads would be expected to be low surrounding the roost from regular implementation of fire and maintenance of exotics. Regardless, in this situation, where the roost location would be unknown, it would be possible that a roost would be lost during a prescribed fire.

In addition, studies have shown that prescribed burning may initially reduce insect availability, but may increase long-term prey availability (Lacki *et al.* 2009). This is consistent with red-cockaded woodpecker (*Picoides borealis*) fire foraging work, as well. Some studies show that effects of fire on arthropods can vary by species, and fire can have negative, neutral, or positive effects on various insects (James *et al.* 1997, New and Hanula 1998, Collins 1998, Provencher *et al.* 1998, Provencher *et al.* 2001). Although some short-term impacts could occur from fire to FBB prey, effects would be expected to be mostly beneficial.

Establishing and maintaining firebreaks has the potential to adversely affect FBB by disturbing roosting bats with machinery and human activity. These effects would be similar to those that may be experienced during mechanical treatment of the Southern Corridor, on-site Preserves, and off-site Preserve (see below *Mechanical treatment*). In the on-site Preserves, a minimal amount of work would be conducted to create new firebreaks (5,397 ft) or enhance existing trails (4,413 ft). Overall, there would be 21,755 ft total of firebreaks, which includes permanent roadways. No additional firebreaks are needed for the off-site Preserve. Based on the avoidance and minimization measures that would be in place and the minimal amount of disturbance that would be conducted to create and maintain the firebreaks, mechanical treatment to establish firebreaks would not be expected to adversely affect FBB.

Mechanical Treatment

Restoration activities in the Southern Corridor, on-site Preserves, and off-site Preserve would commence in some areas with mechanical removal of vegetation to reduce exotics and lower the fuel load prior to implementing the first burn (HCP: Appendix J and J1); although not fire would be conducted in the Southern Corridor. Mechanical treatment would include bringing heavy equipment into the on-site Preserves to manipulate vegetation and thin the tree canopy to 1 to 15 percent and to thin the tree canopy per recommendations of the Burn Manger in off-site Preserve area. Thinning has the potential to remove roost trees and equipment noise could disturb FBB roosting in adjacent structures. The Applicants would conduct roost surveys within the Southern Corridor, on-site Preserves, and off-site Preserve based on Service guidance (section 6.2.4.1 of the HCP). If an occupied roost tree is found it would be marked and a 100-ft buffer would be established around the roost. Only hand clearing would be used for vegetation removal within the 100-ft buffer. Based on the avoidance and minimization measures that would be in place, mechanical treatments in the Southern Corridor, on-site Preserves and off-site Preserve would not be expected to adversely affect FBBs.

Pesticides

Pesticide use, other than herbaceous chemical treatment, in Southern Corridor, on-site Preserves, and off-site Preserve would not be expected to be a regular occurrence; however, pesticides could be needed to manage an invasive species. The life history of the FBB may make it

susceptible to pesticide exposure from a variety of sources. Pesticides could adversely affect FBB if they significantly reduce the forage available in the Action Area or if bioaccumulation were to occur from treated insects. Pest management of insects would be restricted to target those pests that are problematic to the species covered by the ITP and/or meeting success criteria and would be used as part of the adaptive management strategy. Because of the proposed restrictions in their use and the limited application, it would be unlikely that pesticide use in the Southern Corridor, on-site Preserves, and off-site Preserve would reduce the forage available or that bioaccumulation would be likely to occur in a manner that would adversely affect the FBB.

11.3.4. Summary of the Effects of the Action on Florida Bonneted Bat

Table 11-1 summarizes the findings of our analysis of the effects of the proposed Action on the FBB. The Action sub-components listed in the table correspond to the sub-headings of the narrative in section 11.3. As applicable for each sub-component, we report our estimated amount or extent of FBB responses in terms of a change, benefit or adverse (take) in FBB numbers.

The acoustic data collected during surveys does not allow us to extrapolate and estimate the number of FBB that could be foraging on the property. In addition, we would expect this number to vary as insect (prey) abundance varies overtime. Furthermore, until pre-construction surveys are conducted for roosts, we cannot confirm how many, if any, would be found. The proposed Action would convert about 67 acres of vegetated foraging habitat into impervious surface foraging habitat, which is expected to decrease prey abundance. Construction would also remove roosting habitat and any roost within the construction footprint.

Operation of the development would increase stressors such as disturbance, predation, lighting and pesticides. However, all of these stressors are expected to have minimal effect to FBB continuing to occupy the area and may affect, but are not likely to adversely affect the species.

Management of the on-site Preserves and off-site Preserve is expected to have beneficial effects to forging opportunities through the thinning of canopy for any and all FBB using these areas. Supplemental roosting structures (*i.e.,* bat boxes) would also be established. In the short-term, adverse effects to roosts would be avoided through the implementation of BMPs including surveys and establishing protection buffers. Long-term, any newly established roost outside of a supplemental box would be taken through prescribed fire or tree thinning if it goes undetected during opportunistic surveys and is not afforded the BMPs for known roosts.

Table 11-1. Summary of Action effects on the Florida bonneted bat.

Action Component	Sub-Component	Effect Characterization	Estimate Change in FBB
Construction	Habitat loss	Conversion of 67 acres of foraging habitat - may affect, not likely to adversely affect Permanent loss of roosting habitat and possible roost - adverse	Take: loss of any roost in development footprint
	Habitat fragmentation	Not likely to adversely affect	
	Other effect pathways	Not likely to adversely affect	
Operations	Various	Not likely to adversely affect	
On-site Preserves and Off-site Preserve Management	Prescribed burning	Management of 90.84–93.89 acres would increase foraging habitat quality and establish new artificial roost - beneficial harass some individuals during fire and loss of any unidentified roost - adverse	Benefit: Any and all foraging in the area; Take: any newly established roost and the individuals it contains, not including supplemental box
	Mechanical treatment	Not likely to adversely affect	
	Pesticides	Not likely to adversely affect	

11.4. Conclusion for Florida Bonneted Bat

In this section, we summarize and interpret the findings of the previous sections for the FBB (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

The FBB appears to be restricted to south, southwest, and south-central Florida. The core range may primarily consist of habitat within Charlotte, Lee, Collier, Monroe, and Miami-Dade Counties. Recent data also indicate use of portions of Okeechobee, Polk, DeSoto, Hendry, and Broward Counties and possible use of areas within Glades and Highlands Counties. We cannot accurately estimate population size at this time. This is in part because so few roosts are known, roost switching can occur, emergence counts are not conducted simultaneously (or even at the same

time of year), and precise counts are difficult to obtain due to environmental conditions and the propensity for some individuals to remain within roosts during counts. The population is estimated to be in the hundreds or low thousands.

The primary threats to the survival and recovery of the FBB are continued natural habitat loss, improper land management eliminating roosts and potential roosting habitat, pesticides reducing prey availability, light pollution altering foraging habitat, and climate change.

Baseline

The Action area is within Miami-Dade County, which is considered to be stronghold for the FBB where population numbers have been historically large and FBB continue to be reported. On the CRC property, acoustic surveys detected FBBs search, clutter, commute, and feeding calls. Although no roost chatter was heard, five individual calls within 30 minutes of sunset, indicates that roosting within the CRC property is likely. We cannot use the acoustic calls to estimate the number of FBB using the area, and it is expected to be variable based on prey abundance. Given recording of calls within 30 minutes, it is reasonable to expect that there is one roost on-site. Because we anticipate that this roost is in natural cavity, which is in the urban environment, we expect the number of bats within the roost to be less than 10. No surveys for FBBs have been conducted on off-site Preserve; however, based on FBB presence on adjacent properties (Zoo Miami and CRC) the species is expected to use the this area.

Further habitat loss, competition for tree cavities, and pesticides are threats relevant to the FBB in the Action Area. This BO/CO evaluates the effect of foraging and roosting habitat loss on the CRC property, as well as the land management with respect to increasing foraging opportunities and minimizing impacts from pesticides. Relevant effects of climate change within the Action Area during the 30-year duration of the permit include changes in frequency and intensity of storms.

Effects

The Project would convert 73.84 acres of FBB foraging habitat into development. The effects to FBBs from the conversion of foraging habitat into development would be minimized by the on-site Preserves, which would be managed to provide improved foraging habitat with an open canopy. In addition, although reduced, foraging opportunities are expected to remain with the CRC residential and commercial areas.

The CRC development with permanently remove the roosting habitat within the project footprint. Prior to construction the Applicants would conduct surveys to identify any roosts within the footprint and then implement minimization measures to reduce the likelihood that FBB residing in the roost would be injured or killed when the roost is removed. We expected that one roost with up to 10 bats is present on the site. All FBBs in the roost would be taken in the form of harm and harassment. Non-volant young present are likely to be taken in the form of capture if they are moved to an alternative location either a new roost (bat house) or rehabilitation center. With the implementation of the minimization measures we do not anticipate any adult FBB would be injured or killed; however, we do expect that some of the young present

would be injured or die if they are translocated and/or captured. Assuming a colony of 10 bats includes no more than 9 females and not every female would be of reproductive age or have a pup at the same time, we expect the number of young present to be small, less than half, and no more than 3 non-volant pups would be killed.

Habitat management in on-site Preserves and off-site Preserves is expected to have mostly beneficial effects to FBBs, increasing foraging opportunities and prey quality; however, any new natural roost established could be lost during prescribed burning. Fire management units would be small, and the intensity of the fire is expected to be low, therefore, the likelihood that the unprotected roost would be being consumed by fire should be minimal. However, in the abundance of caution, we anticipate that over the life of the permit one roost would be lost at both the on-site Preserve and off-site Preserve. Assuming the same size colony as discussed above (10 bats), we expect that two roosts with up to 6 non-volant pups would be lost during habitat management.

Opinion

FBB habitat is not restricted to pine rockland and rockland hammock habitat. It includes but is not limited to: open water, tropical hardwood, and mangrove habitats. Locally, within the Richmond Pine Rocklands there is 752.14 acres of pine rockland habitat available, and within southern Florida the amount of forested habitat is much greater. In addition, FBB use developed areas for foraging and roosting, providing even greater opportunities locally and county-wide and region-wide. The loss of 73.84 acres of vegetative and forested lands from the development of the CRC is a small fraction of the habitat available to the species locally and regionally and would not have a significant effect on the range of the species.

Currently, natural FBB roosts have been documented at four locations, with 1-3 roosts at each location. Roosts in artificial structures (bat houses and buildings) are more numerous. The loss of a natural roost, and potentially the non-volant young from the development of CRC and from prescribed fire or tree thinning in the on-site Preserves and off-site Preserve, would reduce roosting opportunities and population numbers locally. For most bats, the availability of suitable roosts is an important, limiting factor (Humphrey 1975). Although, the benefit of artificial roosts is unknown for FBBs, they are known to actively use the structures. The Applicants would minimize the effect of roost loss by establishing a minimum of 6 bat houses, making the loss of the 3 natural roosts likely discountable locally and range-wide. The expected mortality of up to nine young within those roosts is not expected to have a significant effect on the population numbers of FBBs locally or range-wide. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the FBB (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the FBB.

12. DELTOID SPURGE

12.1. Status of Deltoid Spurge

This section summarizes best available data about the biology and current condition of (*Chamaesyce deltoidea* ssp. *deltoidea*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list deltoid spurge as endangered on July 18, 1985 (50 FR 29345–293490).

12.1.1. Description of Deltoid Spurge

Deltoid spurge, a member of the *Euphorbiaceae* (spurge family), is an herbaceous, prostrate to barely ascending plant forming small mats to a few decimeters in diameter. The thin, wiry stems extend from a central woody taproot. Leaves are deltoid to ovate in shape, opposite, and up to 5 mm (0.2 in) long. Flowers are unisexual; male and female flowers are arranged in a cuplike structure (cyathium). The 3-seeded fruits are 1 to 2 mm (0.04 to 0.08 in) wide; seeds measure about 1 mm (0.04 in) wide. The density and distribution of hairs on the stems, leaves, and capsules distinguish varieties *deltoidea* and *adhaerens*. Variety *deltoidea* is essentially hairless; *adhaerens* is fairly hairy.

12.1.2. Life History of Deltoid Spurge

Studies into the life history of the deltoid spurge have only recently begun, and little is known about its reproduction. It is a perennial that flowers from April through November, peaking in July. Its extensive root system gives evidence it is a long-lived plant (DERM 1993). The reproductive ecology in *Chamaesyce* has been poorly studied, but it 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). Seed capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (Pemberton 1988).

The deltoid spurge tends to occur in areas with an open shrub canopy, exposed limestone (oolite), and minimal litter (pine needles, leaves, and other organic materials). It is most often found growing at the edges of sand pockets with plants growing both in sand (sometimes in association with the endangered tiny polygala) and on oolitic limestone. The soils in which it grows are classified as Opalocka-Rock Outcrop soils. The subspecies *C. deltoidea* ssp. *adhaerens* occurs in fine, reddish sandy loam over limestone. Dense colonies are sometimes found in pinelands that have undergone a slight mechanical disturbance, where little or no topsoil is formed and where productivity is low. The shrub canopy in this disturbed habitat is often poorly developed providing high light levels and low organic litter accumulation rates. The pine rocklands are often considered a fire subclimax, and are maintained with periodic fires (3 to 7 years). These periodic fires keep the shrub canopy down and eliminate the litter accumulations.

Annual recruitment rates range from 0.0 to 0.2 and mortality rates range from 0 to 0.39 (Herndon 2002). Survival in three study plots over the 3-year study period was 41, 46, and 65 percent. Low

seed germination rates were detected in both greenhouse conditions and field assessments, and seed production varied seasonally by rainfall amount. While Herndon's (2002) study evaluated parameters such as population size, recruitment, survival, and mortality, other information such as growth and reproductive characteristics are necessary for population modeling. A research project conducted at Larry and Penny Thompson Park in 1992 compared the growth rates of this subspecies in burned versus unburned plots (DERM 1993). Data on plant size and flower density was collected in each plot, and results indicated that plants respond to fire by allocating energy towards vegetative recovery immediately after fire, rather than to flowering.

12.1.3. Numbers, Reproduction, and Distribution of Deltoid Spurge

Current estimates of the number of individuals have not been obtained for the entire population, and population trends are not well understood. The NAM (Natural Areas Management) staff of MDC have reported plants on some of their sites have significantly declined with one site having only three plants, another having two populations containing no more than one or two plants, and a third site having only two distinct colonies remaining after reporting an abundance of plants in the late 1980s (Maguire 2006). In a study conducted in three plots located in the northern Biscayne pinelands, Herndon (2002) noted populations occur in small, dense, widely-separated clusters of 50 to 200 individuals. Population sizes varied 10 to 50 percent annually but no general decrease in population size was reported. He estimated 800 to 8,000 plants occurred in each population at the Deering Estate pinelands and Larry and Penny Thompson Park.

Deltoid spurge is a MDC endemic that was historically known to occur in pine rocklands of the Miami rock ridge from the Goulds area north to the center of the city of Miami. The northern portion of its range has been completely modified by urban expansion. In 1992-93, deltoid spurge plants were known to occur on 18 sites, including the Richmond pine rocklands classified as one site where several thousand individuals were recorded (DERM 1993). Seven of these sites were owned by MDC, and eight others were proposed for acquisition. According to recent updates, five sites located on private lands have been developed (Maschinski 2005).

Results of a project to map the remaining pine rockland habitat in 2006 reported deltoid spurge occurred on 11 public sites (IRC 2006). Currently, the species is known to remain on 14 public lands (12 County, 1 State, and 1 Federal) and an undetermined number of private lands from southern Miami to Homestead (Bradley 2010a). Even though the majority of the populations occur on public lands, they are fragmented, and habitat degradation continues to affect the extant populations. Because of habitat modification due to urban expansion in the northern portion of the range, deltoid spurge is now known only from south of Miami to the Homestead area. Its limited distribution renders the spurge vulnerable to random natural or human induced events, such as hurricanes and encroachment of invasive exotic species (IRC 2006). The current number of individuals in wild populations is not known, therefore, trend analysis is not available. Although some demographic information is available for deltoid spurge, additional long-term research is necessary to develop accurate population models.

Deltoid spurge is a MDC endemic that was historically known to occur in pine rocklands of the Miami rock ridge from the Goulds area north to the center of the city of Miami. Currently the

species is known to remain on 14 public lands (12 County, 1 State, 1 Federal) and an undetermined number of private lands from southern Miami to Homestead (Bradley 2010a).

Deltoid spurge occurs within the Richmond Pine Rocklands (Woodmansee 2014) in addition to 9 other sites within MDC: Bill Sadowski Park, the Deering Estate, Ludlum Pineland, Ned Glenn Pineland, Pine Shore, Quail Roost, Rockdale Pineland, Ron Ehman Park, and Trinity Pineland. The current number of individuals in wild populations is not known.

12.1.4. Conservation Needs of and Threats to Deltoid Spurge

Continued habitat loss and fragmentation threaten the existence of deltoid spurge, and less than 2 percent of the original acreage of pine rockland habitat remains (Maschinski *et al.* 2002). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management. Modification of pine rockland habitat on protected lands is also of concern (Maschinski *et al.* 2008). There is an ongoing effort to conduct prescribed burns at the publicly-owned sites. Management of these small preserves is difficult because exotic plants are present within and near the properties. Habitat degradation on these sites continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding (Service 2006).

12.2. Environmental Baseline for Deltoid Spurge

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the Deltoid Spurge, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

12.2.1. Action Area Numbers, Reproduction, and Distribution of Deltoid Spurge

The deltoid spurge was documented during the 2014 plant surveys, within the on-site Preserves of the CRC property. There are 11 locations (613 plants were observed and mapped) within the CRC property. Young plants, fruiting and flowering were observed. All but one population were documented within areas slated for on-site Preserves. Deltoid spurge has been observed on the off-site Preserve as documented within the baseline surveys for the deed restriction for the property.

12.2.2. Action Area Conservation Needs of and Threats to Deltoid Spurge

Habitat degradation within the Action Area is an ongoing threat. With the exception of one small population that occurred on the edge of pine rocklands-Burma reed dominated, near a firebreak; all of the deltoid spurge occurrences were within pine rocklands with less than 50% Burma reed. Fire suppression, invasive species, and habitat loss are contributing threats within the Action Area.

The 50.96-acre off-site Preserve, UM Richmond Campus, has a deed restriction which is limited to the listing of the deltoid spurge. The current agreement or proposed off-site Preserve plan does

not include defined success criteria for the management of the UM Richmond Property. Management has been limited to exotic vegetation removal as outlined in Appendix K (a consultant's report dated 2014),) and prescribed burning is not required through the deed restrictive covenants. The last prescribed burn was conducted in 2003 on about 1/3 of the property. Wildfires were recorded in August 2004 and in September 2006. Conservation needs include improving habitat within the Action Area and enhancing the current management of the off-site Preserve.

12.3. Effects of the Action on Deltoid Spurge

This section analyzes the direct and indirect effects of the Action on the deltoid spurge. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

12.3.1. Effects of CRC Construction on Deltoid Spurge

The proposed CRC development would collectively occupy 86.49 acres, including all 33.30 acres of existing developed portions of the Action Area. The expansion of developed areas within the Action Area would occur on 20.91 acres of upland exotic hardwood habitat and 32.28 acres of pine rockland habitat (see section 2.1.1). Construction would remove one of 11 locations that support deltoid spurge on the CRC property, and cause the permanent loss of 32.28 acres of pine rockland habitat that could support the species.

12.3.2. Effects of CRC Operations on Deltoid Spurge

Deltoid Spurge remaining on the CRC property following construction would occupy suitable microhabitats in the adjacent undeveloped areas that the Applicants propose as on-site Preserves. Therefore, any effects of CRC operations on the plant are limited to herbicide use, a stressor that may extend into the adjacent Preserves. We expect that the stressors from herbicide within the development area would be addressed by the practices listed in section 6.2.4.4 of HCP and would limit drift or herbicide exposure in the Preserves.

12.3.3. Effects of Preserves on Deltoid Spurge

We describe the proposed on-site Preserves, Stepping Stone, and off-site Preserve in sections 2.4.3, 2.4.4, and 2.4.5, respectively. The remainder of this section describes how the proposed management of the Preserves and Stepping Stones would cause changes to the Action Area and describes how deltoid spurge is likely to respond upon exposure to these changes. We summarize the Applicants' assessment of these changes, and then analyze each component of the proposed management activities that is relevant to deltoid spurge.

Invasive Exotic Plant Management

The Applicants' plan to reduce and control invasive exotic plants involves a combination of herbicides, cutting and removal by mechanical methods, and within the pine rockland areas,

prescribed fire. The particular combination and sequence of these treatments varies according to the distribution and density of the target invasive species and the location. Section 7.5 of the HCP describes the methods planned for particular management units within the on-site Preserves, subject to the conditions described in section 6.2.4 of the HCP.

In general, the proposed exotic plant management should benefit the deltoid spurge by helping to open the understory and reduce litter accumulation, which are habitat conditions associated with this species. The activity necessary to reduce exotics may also damage deltoid spurge that is present. Several proposed conservation measures in HCP section 6.2.4.4 would reduce, but not entirely eliminate, the probability of killing or injuring deltoid spurge, including:

- marking/flagging of federally listed plants;
- GPS locations of plant species during monitoring or field inspections;
- applying herbicide during ideal weather conditions to avoid drift and non-target damage during application; and
- no roller-chopping.

These measures would assist managers and heavy equipment operators avoid deltoid spurge or other covered plant species. There is a potential that heavy equipment can crush the unmarked or marked special status plants. Effects from heavy equipment would be minimized by using machinery that would be the smallest possible to complete the task (thereby reducing its disturbance footprint) and using rubber tracked and tired vehicles (to reduce the likelihood of crushing plants). Mechanical treatment would continue to be used within the on-site Preserves to reach success criteria if prescribed fire cannot be deployed.

The off-site Preserve site would continue to implement invasive species management, but we anticipate a more rigorous approach to ready cells for prescribed burning or maintain overgrown firebreaks. The following measures would avoid surface impacts and would reduce impacts to plants during firebreak maintenance:

- blacklining around plants;
- hand raking and chopping; and
- string trimmers.

Prescribed Fire

In general, the proposed use of prescribed fire should benefit the deltoid spurge by helping to open the understory and reduce litter accumulation, which are habitat conditions associated with this species. However, prescribed fire may also kill or injure deltoid spurge that are within the burn unit. Depending on the intensity of the fire at the location of the individual plant specimen, the fire could either:

- completely consume/destroy the plant and eliminate its ability to regrow;
- eliminate the above ground vegetation of the plant but leave the seed bank intact and able to germinate;
- “top kill” the plant (killing all or most of the vegetative structure above ground) and leave the root mass or remaining limbs to re-sprout; or
- minimally burn or scorch the vegetative structure of the plant and leave the remaining plant to continue to grow.

For both the on-site and off-site Preserve, prescribed burns would be conducted in a manner to promote a mosaic pattern. The Applicant would conduct fires with small burn units, and proposes fire techniques that would reduce the intensity of the fire and/or move it quickly through the landscape to reduce scorching. By using these techniques, the number of plants that would be completely consumed or destroyed would be minimized. Therefore, based on the proposed small burn units and fire techniques deployed to maintain a mosaic pattern within a burn unit, and the fact that the species is fire adapted, few if any of the individual plants would be expected to be completely lost (no ability to regrow from seed bank or root stock) as a result of the prescribed fires.

Deltoid spurge could also be damaged, crushed or trampled, and/or killed as a result of equipment, vehicles, and people moving in and out of burn units within the on-site Preserves. The Applicants would minimize the likelihood that plants would be damaged during these activities as outlined in the invasive species section. Workers would also be educated on the appearance of these plants and would be expected to avoid individual plants if they are observed. However, some plants could re-establish and go undetected during biological monitoring within the on-site Preserves and escape opportunistic detection.

Because there is not a botanical monitoring program associated with the off-site Preserve, if deltoid spurge or other covered species establish within the burn units (from the seed bank), the proposed measures that reduce the probability of damaging plants within the on-site Preserves (i.e. flagging or GPS location of the plants) are not proposed for the off-site Preserve. Consequently, there would be a potential that some deltoid spurge could be incidentally crushed, damaged or killed by equipment or an individual during implementation of prescribed fire.

12.3.4. Summary of the Effects of the Action on Deltoid Spurge

Construction would remove one of 11 locations that support deltoid spurge on the CRC property, and cause the permanent loss of 32.28 acres of pine rockland habitat that could support the species.

To mitigate this impact, the Applicants would place 51.41 acres of pine rockland habitat into a permanent conservation easement on the CRC property and enhance and further protect 50.96 acres on the off-site Preserve. Both Preserve properties would be managed to be high quality pine rockland habitat that can support deltoid spurge. The pine rockland Preserves would be managed through the implementation of prescribed fire. The introduction of prescribed fire into the ecosystem is expected to create and maintain habitat conditions that would benefit the deltoid spurge population.

12.4. Conclusion for Deltoid Spurge

In this section, we summarize and interpret the findings of the previous sections for the deltoid spurge (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or

- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

Deltoid spurge is an MDC endemic associated with pine rocklands. Currently the species is known to remain on 14 public lands (12 County, 1 State, 1 Federal) and an undetermined number of private lands from southern Miami to Homestead. Threats include habitat loss, especially on unprotected private lands, and habitat degradation from insufficient fire management.

Baseline

The deltoid spurge was documented during the 2014 plant surveys, within the on-site Preserves of the CRC property. There are 11 locations (613 plants were observed and mapped) within the CRC property. The deltoid spurge has also been observed on the off-site Preserve as documented within the baseline surveys for the deed restriction for the property.

Effects

The development of CRC would result in the permanent loss of 32.28 acres of pine rockland habitat that supports one of 11 locations with deltoid spurge on the CRC property. This loss of pine rockland habitat within the Richmond Pine Rockland reduces the amount of habitat available to deltoid spurge for population growth and recovery.

Managing the on- and off-site Preserves (invasive plant control and prescribed fire on about 90 acres) would kill and injure deltoid spurge by crushing and burning, but proposed conservation measures would reduce the extent of such damage. In general, the proposed Preserves management should benefit the deltoid spurge by helping to open the understory and reduce litter accumulation, which are habitat conditions associated with this pine rockland fire-adapted species.

Opinion

The Action would cause a mix of adverse and beneficial effects to deltoid spurge; however, the scale of the beneficial effects exceeds that of the adverse effects. We believe management of the Preserves as proposed would cause a net increase in deltoid spurge numbers within the Action Area. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the deltoid spurge (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the deltoid spurge.

13. TINY POLYGALA

13.1. Status of Tiny Polygala

This section summarizes best available data about the biology and current condition of tiny polygala (*Polygala smallii*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list tiny polygala as endangered on July 18, 1985 (50 FR 29345–29349).

13.1.1. Description of Tiny Polygala

Tiny polygala is one of nine species of *Polygala* native to Miami-Dade County and one of eleven from Palm Beach County (Wunderlin and Hansen 2004). The most similar species is *Polygala nana* (Bradley and Gann 1995), which is distributed through much of Florida. Bradley and Gann (1995) found existing identification keys were inadequate, but the two species could be distinguished by seed size. The seed body length (not including the rostrum) of tiny polygala is between 1.2 and 1.4 mm; the length for *Polygala nana* is between 0.6 and 0.8 mm (Bradley and Gann 1995). Bradley and Gann (1995) found both species occur at the Jupiter Ridge Natural Area in Palm Beach County, and the distribution maps in Wunderlin and Hansen (2004) show the distribution of *P. nana* extending south to Broward County.

13.1.2. Life History of Tiny Polygala

The life span of tiny polygala is short, averaging only 180 days, with only 9 percent of wild plants living beyond 1 year (Koptur *et al.* 1998). Plants typically appear, flower, and then disappear until the next fire or other suitable disturbance. Tiny polygala produces a seed bank that persists within the soil for at least 2 years (Kennedy 1998). Seedling emergence peaks from September-November, but a few seedlings emerge from May-June. Seed germination experiments have been conducted in the field, but few demographic studies have been initiated (Wendelberger and Frances 2004). Kennedy (1998) found *ex situ* seeds germinated within 3 weeks, and 80-100% of older, buried seeds germinated regardless of seasonal photoperiod (Koptur *et al.* 1998). Seeds buried to a depth of 1 cm for over 2 years had a high viability rate, suggesting seeds may persist for 10 years or more when slightly buried (Kennedy 2006). It is, therefore, important to manage not only for above-ground plants, but for the conservation of the seed bank.

Koptur *et al.* (1998) suggested that fire is a requirement for seed germination, because fresh seeds collected from the wild exhibited a 50 percent greater germination rate following soaking in a smoke extract. Fellows (2002a) repeated the experiment and found that initial germination rates of seeds treated with smoke extract averaged a rate that was 4.3 days faster than non-smoke treated seeds. Total percent germination was similar. Due to fragmentation of populations and the short generation time of tiny polygala, Wendelberger and Frances (2004) believe that the species may experience low genetic diversity. Current knowledge of this species' life history is presented in the Conservation Action Plan (Wendelberger and Frances 2004).

13.1.3. Numbers, Reproduction, and Distribution of Tiny Polygala

Because seeds may remain dormant in the soil until fire disturbs the site, abundance and population trends for this species are difficult to assess. There have been no new finds of tiny polygala since 1995, despite surveys of possible scrub sites (Bradley and Gann 1995, Bradley *et al.* 1999, Woodmansee *et al.* 2007, Maschinski *et al.* 2008, FNAI 2010), as well as a project to map the pinelands of Miami-Dade County (IRC 2006).

In 2004, thirteen sites contained approximately 22 populations in Miami-Dade, Broward, Palm Beach, and Martin Counties grouped into four population clusters, with the highest density of populations located in southern Miami-Dade County (Wendelberger and Frances 2004). Clusters of populations are separated by an average of 38 miles, and the distribution of this plant remains fragmented. The overall number of plants is estimated at approximately 11,000, with the majority of these occurring on a single site in Miami-Dade County (Maschinski 2010).

The species is currently known from four sites in Miami-Dade County (Maschinski *et al.* 2008, Maschinski 2010), two sites in Palm Beach County, and single occurrences in Martin and St. Lucie Counties (Bradley and Gann 1995, Walesky 2005, Woodmansee *et al.* 2007, FNAI 2010). Seven of eight known occurrences are on publicly owned lands, and all these sites are currently being managed for conservation of tiny polygala.

According to FNAI's 2015 *Element Tracking Summary* there are 14 populations of tiny polygala across 5 counties (Broward, Martin, MDC, Palm Beach, and St. Lucie) (FNAI 2015). For the purposes of FNAI's report, the Richmond Pine Rocklands would be considered 1 population, and, CRC contains 2 occurrences within the population. The smaller population of nine (9) plants was found within pine rocklands that occur within the Development Areas of the CRC property. This population was encountered during a plant relocation that occurred in June 2014 by staff at FTBG, during which time three (3) tiny polygala specimens were removed. Thus, this removal of plants within the action area has reduced the number of tiny polygala to six (6) within the development footprint. The other population of tiny polygala estimated at 100 plants, and is located within the on-site Preserves, specifically within the management unit 8. This is a small fraction of the total number of plants locally and range wide.

13.1.4. Conservation Needs of and Threats to Tiny Polygala

Fire suppression and invasion by exotic plant species continue to threaten tiny polygala. Management of pine rocklands in MDC is problematic because most of the remaining habitat occurs in small, fragmented areas surrounded by residential or disturbed areas. These environments are often a source of exotic plants. The small size of the pine rockland fragments, in particular the high perimeter to area ratio, make it easier for exotics to invade (Service 1999). At least 277 taxa of exotic plants are now known from pine rocklands in South Florida (Service 1999).

13.2. Environmental Baseline for Tiny Polygala

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the tiny polygala, its habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

13.2.1. Action Area Numbers, Reproduction, and Distribution of Tiny Polygala

The tiny polygala occurs within two areas within the CRC property, but it is unknown if it occurs at the off-site Preserve. Seedlings as well as flowering and fruiting adult plants were observed within the CRC property.

A population of nine plants was found within pine rocklands that occur within the Development Areas of the CRC property. This population was encountered during a plant relocation that occurred in June 2014 by staff at FTBG, during which time three tiny polygala specimens were removed. Thus, this removal of plants within the Action Area has reduced the number of tiny polygala to six within the development footprint. The other population of tiny polygala estimated at 100 plants, and is located within the on-site Preserves, within the management unit 8.

13.2.2. Action Area Conservation Needs of and Threats to Tiny Polygala

As we explain in section 13.2.1, we believe that the species is reasonably certain to occur within the Richmond area. Major threats to the tiny polygala with the Action Area are the same described in section 13.1.4., the largest onsite populations has an open canopy and about 25% Burma reed infestation and some organic accumulation because of fire suppression. Reducing these threats is best addressed via prescribed fire and other measures to reduce invasive exotic plants and prevent the transition to a rockland hammock habitat.

13.3. Effects of the Action on Tiny Polygala

This section analyzes the direct and indirect effects of the Action on the tiny polygala. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

13.3.1. Effects of CRC Construction on Tiny Polygala

The proposed CRC development would collectively occupy 86.49 acres, including all 33.30 acres of existing developed portions of the Action Area. The expansion of developed areas within the Action Area would occur on 20.91 acres of upland exotic hardwood habitat and 32.28 acres of pine rockland habitat (see section 2.1.1). One occurrence (totaling 6 plants) of tiny polygala was found in the pine rockland habitat within the proposed CRC development; therefore, construction would cause the permanent loss of 32.28 acres of pine rockland habitat that supports tiny polygala and destroy the plants therein. The other population of tiny polygala,

estimated at 100 plants, is located within the on-site Preserves (see section 2.4.3), where we do not anticipate effects from construction.

13.3.2. Effects of CRC Operations on Tiny Polygala

With the exception of the Stepping Stones, tiny polygala is not expected to persist within any portion of the residential and commercial community. The Stepping Stones would be cleared during construction and then re-planted with pine rockland species (50 to 75 percent of composition). There is a low likelihood that one or more tiny polygala would re-establish itself in a Stepping Stone from the seedbank. If established, the probability of tiny polygala dispersal into the developed areas following construction is discountable, because the developed areas would not contain suitable patches of open ground in a pine rockland matrix to recruit the species. The effects of managing the Stepping Stones are discussed in section 13.3.3.

Tiny polygala remaining on the CRC property following construction would occupy suitable microhabitats in the adjacent undeveloped areas that the Applicants propose as on-site Preserves. Therefore, any effects of CRC operations on the tiny polygala are limited to herbicide use, a stressor that may drift into the adjacent Preserves. We expect that the stressors from herbicide within the development area would be addressed by the practices listed in section 6.2.4.4 of HCP and would limit drift or herbicide exposure in the Preserves.

13.3.3. Effects of Preserves on Tiny Polygala

We describe the proposed on-site Preserves, Stepping Stone, and off-site Preserve in sections 2.4.3, 2.4.4, and 2.4.5, respectively. The remainder of this section describes how the proposed management of the Preserves and Stepping Stones would cause changes to the Action Area and describes how tiny polygala is likely to respond upon exposure to these changes.

Invasive Exotic Plant Management

Section 12.3.3 discusses the effects invasive exotic plant management on deltoid spurge and we anticipate the same effects to tiny polygala. The proposed conservation measures in HCP section 6.2.4.4 would reduce, but not eliminate, the probability of damaging tiny polygala. The off-site Preserve would continue to implement invasive species management, but we anticipate impacts beyond the environmental baseline to maintain existing overgrown firebreaks or mechanical treatments in preparation for prescribed fire. This may affect plants and the seedbank within the areas slated for mechanical treatment or firebreaks; however, measures listed in section would address the potential until the 3–7 year prescribed burn rotation is implemented, as described in Appendix J1 of the HCP.

Prescribed Fire

Prescribed fire would be anticipated to kill or injure to some degree tiny polygala that are within the on-site Preserves and off-site Preserve, but to maintain habitat conditions that ultimately benefit the tiny polygala. Section 12.3.4 details the effects from prescribed fire on deltoid spurge in the Action Area. We expect the same effects on the tiny polygala.

13.3.4. Summary of the Effects of the Action on Tiny Polygala

The development of CRC would result in the permanent loss of 32.28 acres of pine rocklands that support tiny polygala. This constitutes 3 percent of the occupied pine rockland habitat within the Richmond Pine Rocklands (1,013.1 acres). This loss of pine rockland habitat within the Richmond Pine Rockland reduces the amount of habitat available to tiny polygala for population growth and recovery.

To offset the loss of occupied habitat from project development, the Applicants would place 51.41 acres of pine rockland habitat into a permanent conservation easement on CRC and enhance and further protect 50.96 acres off-site. All the conservation lands would be managed to be high quality pine rockland habitat that can support tiny polygala. The pine rockland Preserves would be managed through the implementation of prescribed fire. The introduction of prescribed fire into the ecosystem is expected to create and maintain habitat conditions that would benefit the tiny polygala population.

13.4. Conclusion for Tiny Polygala

In this section, we summarize and interpret the findings of the previous sections for the tiny polygala (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

There are 14 populations of tiny polygala across 5 Florida counties: Broward, Martin, MDC, Palm Beach, and St. Lucie. Threats include habitat degradation from insufficient fire management and invasive exotic plant species.

Baseline

The Richmond Pine Rocklands is considered one tiny polygala population out of 14 range wide, and the CRC property contains two occurrences within this population. One occurrence of tiny polygala totaling six plants was found in the pine rockland habitat within the proposed CRC development area. The other population of tiny polygala estimated at about 100 plants is located within the on-site Preserves.

The primary conservation need of the tiny polygala in the Action Area is the same as elsewhere within its known range: securing habitat conditions that can support viable populations via

prescribed fire and other measures that reduce invasive exotic plants and prevent vegetative succession to rockland hammock habitat.

Effects

The Action would result in the loss of one occurrence with six individual plants (three tiny polygala specimens were removed in 2014) and the permanent loss of 32.28 acres of pine rocklands that can support tiny polygala. This is a small fraction of the total number of plants locally and range wide.

Preserves management activities (invasive plants management and prescribed fire) would kill or damage some plants, but proposed conservation measures would reduce the extent of such damage. In general, the proposed Preserves management should benefit the tiny polygala by helping to open the understory and reduce litter accumulation, which are habitat conditions associated with this pine rockland fire-adapted species.

Opinion

The Action would cause a mix of adverse and beneficial effects to tiny polygala; however, the scale of the beneficial effects exceeds that of the adverse effects. We believe management of the Preserves would cause a net increase in habitat value and tiny polygala numbers within the Action Area. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the tiny polygala (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the tiny polygala.

14. OTHER LISTED PLANTS

Besides the deltoid spurge and tiny polygala, which are confirmed as species that occur in the Action Area and which we address in sections 12 and 13, respectively, the Applicants' request to include an additional 11 listed plants as Covered Species in the ITP:

1) Blodgett's silverbush;
2) Carter's small-flowered flax;
3) crenulated lead-plant;
4) Everglades bully;
5) Florida brickell-bush;
6) Florida bristle fern;
7) Florida pineland crabgrass;
8) Florida prairie clover;
9) Garber's spurge;
10) sand flax; and
11) Small's milkpea

We combine these 11 species in this section of the BO/CO because all are associated with pine rocklands or rockland hammocks, but none were detected in the Applicants' surveys of the Action Area. We have no additional information about their presence in the Action Area; therefore, all share a common status within the Action Area (environmental baseline). Further, we expect the Action to affect these 11 species in a similar manner.

Designated CH for 2 of the 11 species occurs in the Action Area: Carter's small-flowered flax and Florida brickell-bush. We address effects of the Action on these CHs separately in section 15.

14.1. Status of the Listed Plants

14.1.1. Status of Blodgett's Silverbush

This section summarizes best available data about the biology and current condition of Blodgett's silverbush (*Argythamnia blodgettii*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Blodgett's silverbush as threatened on September 29, 2016 (81 FR 66842–66865).

14.1.1.1. Description of Blodgett's Silverbush

Bradley and Gann (1999) describe Blodgett's silverbush as:

> "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; 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)."

14.1.1.2. Life History of Blodgett's Silverbush

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

The pine rockland habitat where it occurs in MDC and the Florida Keys requires periodic fire to maintain an open, sunny understory with a minimum amount of hardwoods. Bradley and Gann (1999) indicated this species does tolerate some degree of human-induced disturbance and it can often be found along disturbed edges of pine rockland, rockland hammock, and coastal berm, or in completely scarified pine rockland. Reproduction is sexual; flowering and fruiting apparently takes place throughout the year (Bradley and Gann 1999).

14.1.1.3. Numbers, Reproduction, and Distribution of Blodgett's Silverbush

The current range for Blodgett's silverbush includes MDC and the Keys. Although the total extent of the former range is unknown, approximately 12 mi (19 km) of habitat has been lost near the northern end of the range in MDC and 43 mi (69 km) has been lost in Monroe County (Bradley and Gann 1999). More recently, Hodges and Bradley (2006) indicated that species' verified range extends from MDC to Boca Chica Key.

According to data from Institute for Regional Conservation (IRC), the estimated population of Blodgett's silverbush in MDC is 375-13,650 plants (*i.e.*, total of low and high estimates from log10 scale) (Bradley 2007a); however, this may be an overestimate of the actual population size because it was based upon a log10 scale. The range in MDC has contracted approximately 12 mi, all at the northern end of its range, the heaviest developed portion of MDC (Bradley and Gann 1999). Based upon Hodges and Bradley (2006) and data from IRC (Bradley 2007a), Blodgett's silverbush has been extirpated from at least 10 former sites within MDC. However, several sites relatively close to the proposed action area retain Blodgett's silverbush populations: Camp Owaissa Bauer, the Deering Estate (population potentially extirpated), Fuchs Hammock Addition, Richmond Pinelands (Larry and Penny Thompson Park and adjacent properties), Ned Glenn Pineland, and Owaissa Bauer Addition.

14.1.2. Status of Carter's Small-Flowered Flax

This section summarizes best available data about the biology and current condition of Carter's small-flowered flax (*Linum carteri* var. *carteri*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Carter's small-flowered flax as endangered on September 4, 2014 (79 FR 52567–52575).

14.1.2.1. Description of Carter's Small-Flowered Flax

Bradley and Gann (1999) described the species as follows:

> "Stems erect 23 to 36 cm tall, commonly branched near the base, puberulent; leaves slender, 18-26 mm long, 0.8 to 1.2 mm wide, entire, alternate, closely overlapping at the base of the plant, more distant above; stipules with paired dark glands; inflorescence an ascending or spreading cyme; pedicels 4.5 to 9 mm long in fruit; sepals lanceolate, short-awned, glandular toothed, 3-nerved; petals orange yellow, broadly obovate, 9 to 17 mm long, quickly deciduous; fruit straw-colored, ovoid, 4.1 to 4.6 mm long, 3.4 to 3.7 mm diameter, dehiscing into five two- seeded segments; seeds narrowly ovoid-elliptic, 2.3 to 2.8 mm long,1 to 1.3 mm wide (adapted from Rogers 1963 and 1968)."

In habit and flower, the plant closely resembles *Piriqueta caroliniana* (pitted stripeseed) in the Turneraceae.

14.1.2.2. Life History of Carter's Small-Flowered Flax

Carter's small-flowered flax is an annual or short-lived perennial herb that is endemic to MDC, where it grows in pine rocklands, particularly disturbed pine rocklands (Bradley and Gann 1999). The reproductive ecology and biology of this taxon is not well understood, but reproduction is sexual (Bradley and Gann 1999). The magnitude and frequency of seed production is unknown;

some fruits dehisce in a characteristic 5-parted star pattern, while others never dehisce (Fellows 2002b).

Carter's small-flowered flax has typical behavior for an early successional species (Maschinski 2006). Carter's small-flowered flax is found in pine rocklands, particularly those that are scarified or have undergone some sort of soil disturbance (*e.g.*, firebreaks, canal banks, edges of railway beds) (Bradley and Gann 1999). None of the known occurrences are from a completely undisturbed pine rockland (Bradley and Gann 1999). Bradley and Gann (1999) indicated that all documented occurrences are within scarified pine rocklands, in disturbed areas adjacent to or within pine rocklands, or in completely disturbed areas. This species does not tolerate shading or litter accumulation, and therefore may have been excluded from much of its former habitat by fire suppression (Bradley and Gann 1999).

14.1.2.3. Numbers, Reproduction, and Distribution of Carter's Small-Flowered Flax

Bradley and Gann (1999) estimated that the total population size was 101 to 1,000 plants (based on a log10 scale) and that the population may be declining. Based on the latest available data, the total population size is estimated to be between 318 to 2,615 individuals, although a better estimate of the upper range may be 2,215 if all populations on private lands have been extirpated. Maschinski *et al.* (2003 and 2004) noted that this short-lived perennial has widely fluctuating numbers of individuals. Development, exotic plants, mountain biking, modification to fire regime, mechanical disturbance, and herbicide use were cited as threats (Bradley and Gann 1999). Bradley and Gann (1999) stated that this taxon is in severe danger of extinction since most of the occurrences were not on conservation lands (at that time). Bradley and Gann (1999) also indicated that the conservation lands where this species occurs contained only a few dozen plants combined, one of which was damaged by maintenance crews. Since 1999, data from IRC and Fairchild Tropical Botanical Garden (FTBG) indicate that at least three additional occurrences (on private lands) have likely been extirpated since most of those sites were destroyed (Cocoplum Development, Old Dixie Pineland [=Keg South Pineland], and Ponce and Riviera Pineland) (Bradley 2007a; Possley 2012). However, populations at the Rockdale Pineland Preserve and the United States Department of Agriculture (USDA) Subtropical Horticulture Research Station were found to have more individuals than previously estimated (Bradley 2007a; Possley 2012), and a new occurrence was discovered (Montgomery Foundation) (Maschinski 2006).

Carter's small-flowered flax is currently found from R. Hardy Matheson Preserve (near Pinecrest) southwest to Naranja/Modello, with a distance of approximately 27.3 km (17 mi) between the farthest locations. The apparent reduction in its historical range (11.2 km [7.2 mi]; 30 percent) has occurred entirely in the northern portion, between Pinecrest and Coconut Grove, primarily due to urban development. Similarly, much of the habitat within the variety's current range has been destroyed (Gann *et al.* 2002). At least five known populations have been extirpated including: Brickell Hammock (site developed; last observation in 1911); Red Road/114 Terrace (site developed; last observation in 1969); Deering Estate at Cutler (not sighted since 1980s; unknown reason); Ponce and Riviera Pineland (site developed in 2004); and Cocoplum Development (site developed in 2005) (Bradley 2007a; Bradley and van der Heiden 2013). Bradley and Gann (1999) described nine known populations (only three of these

occurring on conservation lands) with an estimated total population of 100-1,000 individuals; its status was thought to be possibly declining. Maschinski *et al.* (2004) estimated the total population to be 10,300 plants across eight populations in 2003, with one population sustaining the vast majority (approximately 10,000 individuals). Carter's small-flowered flax was not found during a 2-year project intended to survey and map nonnative and rare plants along Florida Department of Transportation (FDOT) right-of-ways within MDC (Gordon *et al.* 2007).

Carter's small-flowered flax was recently found at seven locations containing approximately 1,313 individuals; populations ranged in size from a single plant to 700 plants, with a median of 18 plants (Bradley and van der Heiden 2013). Four of the populations occur near the north end of the variety's range (near R. Hardy Matheson Preserve) and three occur near the south end (near Camp Owaissa Bauer), with an approximately 16 km (10 mi) gap between the closest populations of these groups. This variety occurs on the Owaissa Bauer Addition (11-100 plants), R. Hardy Matheson (101-1,000 plants), and the Rockdale Pineland (101-1,000 plants) in MDC. R. Hardy Matheson and the Rockdale Pineland appear to contain two of the three largest occurrences of the subspecies

14.1.3. Status of Crenulate Lead-Plant

This section summarizes best available data about the biology and current condition of crenulate lead-plant (*Amorpha crenulata*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the crenulate lead-plant as endangered on July 18, 1985 (50 FR 29345–29349).

14.1.3.1. Description of Crenulate Lead-Plant

The crenulate lead-plant is a rhizomatous, perennial, deciduous shrub that inhabits marl prairies and wet pine rocklands in a small area of MDC. Also known as the Miami lead-plant, crenulate lead-plant grows to 1.5 m in height and is endemic to MDC, Florida (FDOT 1997).

14.1.3.2. Life History of Crenulate Lead-Plant

The crenulate lead-plant occurs in plant communities that were historically associated with seasonally hydrated soils and frequent burning, including wet pinelands, transverse glades, and hammock edges. It can be found growing in poorly-drained Opalocka sands within pine rocklands or in wet prairies with Opalocka-rock outcrop complex soils. It requires open sun to partial shade.

14.1.3.3. Numbers, Reproduction, and Distribution of Crenulate Lead-Plant

The crenulate lead-plant was known from a 20-mi^2 area from Coral Gables to Kendall, MDC (DERM 1993). Its historical range was only slightly greater, extending south to Cutler (based on an entry of *Amorpha caroliniana* on an unpublished plant list by John Kunkol Small of Addison Hammock), and north to the Little River in northeast MDC.

The current range of this species, limited to four natural sites and two introduced sites, is almost fully confined within MDC. The four natural sites include A.D. Barnes Park, Tropical Park, R. Hardy Matheson, and at Coral Pines Park. There were 208 plants documented at A.D. Barnes Park and 130 plants recorded in Tropical Park from 2012 surveys (Maschinski *et al.* 2012). R. Hardy Matheson contained one of the four natural populations, but the most recent survey in 2010 found no plants (Maschinski *et al.* 2012). The smallest natural populations of this species is at Coral Pines Park (Pinecrest) with five plants recorded in 2012; Maschinski *et al.* 2012) and approximately 5 mi northeast of the proposed Action Area. The Deering Estate has one documented introduced population (67 plants in 2011; Maschinski *et al.* 2012) and the other introduced population at Luis Martinez Army Reserve in the Richmond Pinelands (215 plants in 2012; Maschinski *et al.* 2012), immediately adjacent to the Action Area.

14.1.4. Status of Everglades Bully

This section summarizes best available data about the biology and current condition of Everglades bully (*Sideroxylon reclinatum* ssp. *austrofloridense*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the Everglades bully as threatened on October 6, 2017 (82 FR 46691–46715).

14.1.4.1. Description of Everglades Bully

Everglades bully is a decumbent or upright shrub, 3-6 ft (1-2 m) tall. The branches are smooth, slightly geniculate, and somewhat spiny. Leaves are thin, obovate or ovate, 0.8-2 in (2-5 cm) 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 2003).

14.1.4.2. Life History of Everglades Bully

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 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 in BCNP and reported finding the subspecies to have distribution within the study area.

14.1.4.3. Numbers, Reproduction, and Distribution of Everglades Bully

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. Everglades bully was long considered to be restricted to the tropical pinelands of MDC. 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.

Everglades bully is extant at 11 sites: Long Pine Key, Big Cypress National Preserve, 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 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 in BCNP and reported finding the subspecies to have distribution within the study area.

One occurrence is located at Larry and Penny Thompson Park in the Richmond Pinelands adjacent to the Metrozoo in MDC (Gann *et al.* 2002; Possley and McSweeney 2005). This plant occurs at the privately-owned Pine Ridge Sanctuary in MDC and possibly at a few non-protected pinelands, such as Grant Hammock (Gann *et al.* 2002). In 2007, Bradley (2007a) reported small occurrences in MDC at the following locations: Lucille Hammock, South Dade Wetlands, Natural Forest Community (NFC) #P-300, and NFC #P-310. More recently, Possley (Possley 2011a) found two plants at Quail Roost Pineland, an area that was formerly very overgrown, but was treated for manual hardwood reduction in 2007 and then burned in 2009.

Possley (2011b) reported populations from Navy Wells Pineland Preserve (four plants) and Sunny Palms Pinelands (two plants), both areas are MDC conservation lands. Everglades bully is extant at 11 sites in Monroe and Miami-Dade Counties (Bradley *et al.* 2013). This subspecies occurs within the Richmond Pinelands at Larry and Penny Thompson Park adjacent to the Metrozoo (73 plants; Gann *et al.* 2002; Possley and McSweeney 2005). Possley (2011a) found two plants at Quail Roost Pineland, an area that was formerly very overgrown, but was treated for manual hardwood reduction in 2007 and then burned in 2009. Possley (2011b) reported populations from Navy Wells Pineland Preserve (four plants) and Sunny Palms Pinelands (two plants); both areas are MDC conservation lands.

14.1.5. Status of Florida Brickell-Bush

This section summarizes best available data about the biology and current condition of Florida brickell-bush (*Brickellia mosieri*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Florida brickell-bush as endangered on August 17, 2015 (80 FR 49845–49886).

14.1.5.1. Description of Florida Brickell-Bush

Florida brickell-bush is a perennial herb 1–3.5 ft (0.3–1.1 m) tall, slender, erect, and branching (Chafin 2000). Leaves are 0.4–1.2 in (1–3 cm) long, alternate, narrow, linear, thick, usually spreading or curved downward, entire or slightly toothed, resin-dotted (Chafin 2000). The flower heads are in loose, open clusters at the ends of branches (Chafin 2000). Disk flowers are white in small, dense heads surrounded by hairy, slightly ribbed bracts; there are no ray flowers, although

long style branches (white, sometimes brown) may appear to be rays (Chafin 2000). Reproduction is sexual, pollinators and dispersers are unknown (Bradley and Gann 1999). Flowering takes place primarily in the fall (August–October), but individuals may be found in flower during most of the year (Bradley and Gann 1999).

14.1.5.2. Life History of Florida Brickell-Bush

Bradley and Gann (1999) stated that Florida brickell-bush is "found exclusively in pine rocklands." It tolerates only minor amounts of disturbance. The pine rockland habitat where it occurs in MDC requires periodic fires to maintain an open sunny understory with a minimum amount of hardwoods. It tends to occur in areas within open shrub canopy and exposed limestone with minimal organic litter (pine needles, leaves, and other organic materials). Some populations are found at relatively high elevations (3–4 m), one occurrence is in a low elevation pine rockland very close to a marl prairie (2–3 m). The pine rockland which contains this occurrence may have flooded periodically during the summer wet season. Periodic fires are extremely important in maintaining this ecosystem. The natural fire regime was probably 3–7 years, with most fires occurring at the beginning of the wet season in spring and early summer. Periodic fires keep the shrub canopy low and reduce litter accumulation.

14.1.5.3. Numbers, Reproduction, and Distribution of Florida Brickell-Bush

Bradley and Gann (1999) estimated populations using a logarithmic scale. On that scale, the total population of Florida brickell-bush was estimated at 1,001–10,000 plants, with the exact number probably between 5,000–7,000 plants (Bradley and Gann 1999). Based on the latest available data, the lower range may be closer to approximately 1,550 individuals. Bradley and Gann (1999) also stated the population was probably declining because "private sites where this plant occurs are either not being managed or are being developed. Populations on public lands are also being impacted."

Florida brickell-bush is "endemic to MDC on the Miami Rock Ridge. It was historically distributed from central and southern MDC from South Miami (latitude ca. 25º 42.5') to Florida City (latitude 25º 26.0'). This is a range of approximately 22.5 mi along the Miami Rock Ridge. Herbarium specimens have not been studied from the New York Botanical Garden, so the full extent of its historical range is unknown" (Bradley and Gann 1999). Bradley and Gann (1999) provided a list of herbarium specimens and other records for this plant that do not give precise or accurate location information. In these cases, the localities have almost certainly been destroyed because they were located in MDC. Bradley and Gann (1999) indicated this species was extirpated from two privately owned sites (Palms Woodlawn Cemetery, and Sunset Drive and 71 Court) in 1968 and 1992, due to development. Bradley (2007a) also confirmed the more recent extirpation of another population at a privately owned site (Turnpike Extension and 93rd Terrace) due to development.

The number of extant occurrences of this species is somewhat uncertain due to the lack of complete and recent survey information, which is primarily a function of the number of populations which occur on private lands, making them difficult to survey. In addition, Florida brickell-bush can be extremely difficult to identify when not in flower, making it difficult to

confidently determine when a population has been extirpated. The most complete survey which included the species was the 2004–2005 mapping by IRC of natural forest communities (NFCs; pinelands and hardwoods) in MDC outside of ENP. IRC mapped both public and private NFCs where the county government obtained landowner permission or determined it was not necessary. This survey found Florida brickell-bush on six privately owned parcels, including on the UM Richmond Campus (formerly the U.S. Naval Observatory). Surveys of populations on public lands, specifically those owned or managed by the County, occur more commonly and provide a more detailed assessment of the species' status on selected preserves. Florida brickell-bush was not found during a 2-year project intended to survey and map nonnative and rare plants along FDOT right-of-ways within MDC (Gordon *et al.* 2007).

Bradley and Gann (1999) estimated population size using a logarithmic scale. On that scale, the total population of the species in 1999 was estimated at 1,001–10,000 plants (with the exact number probably between 5,000 and 7,000 plants), and was thought to be declining (Bradley and Gann 1999). Since that time, the estimate for the largest population (Larry and Penny Thompson Park, 1,001–10,000 plants in 1999) has decreased to 101–1,000 plants, with adjacent areas (UM, Metrozoo, Martinez Pineland) estimated to hold another 112–1,100 plants combined (Possley 2013b, 2013c). Additional plants are suspected to occur on adjacent privately owned parcels in the Richmond Pineland Complex (Possley 2013a). The only other monitored population estimated to be composed of greater than 100 plants occurs on the Navy Wells Pineland Preserve, located approximately 20 km (12.5 mi) southwest at the southern end of species current range. Another large population was observed on a private parcel situated between Navy Wells Pineland Preserve and the Richmond Pinelands, however this property has not been surveyed since 2004. Smaller populations occur on pine rockland fragments spread across the landscape, most no more than approximately 3.2 km (2 mi) from their nearest neighboring population – the major exception to this is a 7.2-km (4.5-mi) gap between the populations on Quail Roost Pineland and Camp Owaissa Bauer. Based on the 17 populations considered to be extant, the current total population estimate is between 515 and 4,935 plants, although the actual number of individuals is probably closer to 2,150-3,700. Based on current estimates, the total population of Florida brickell-bush has apparently declined by approximately 50 percent since 1999.

14.1.6. Status of Florida Bristle Fern

This section summarizes best available data about the biology and current condition of Florida bristle fern (*Trichomanes punctatum* ssp. *floridanum*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list the Florida bristle fern as endangered on October 6, 2015 (80 FR 60439–60465).

14.1.6.1. Description of Florida Bristle Fern

It is a very small, mat-forming fern, superficially resembling some liverwort species. Wunderlin and Hansen (2000) described it as "Stem long- creeping, mat forming, the trichomes (hairlike or bristlelike outgrowth) brownish black, of 2 types, 2-celled glandular and elongate rhizoidlike ones; roots absent. Leaves separated, the petiole 0.1-2 cm long, usually shorter than the blade, pubescent above and below with trichomes like those of the stem but shorter, with stellate (star-shaped) trichomes few and distal on the winged upper part, the blade flabellate (fan-shaped),

round, narrowly oblanceolate to nearly linear, entire or irregularly lobed at the apex, 0.5-2 cm long, 0.2-1.1 cm wide, the midrib wanting or less than half the blade length, the apex rounded to obtuse, the base narrowly cuneate (wedge- shaped), the margin entire to irregularly and flabellately lobed, lobes oblong and blunt to obscurely deltoid, frequently resembling proliferous outgrowths distally, with marginal black stellate trichomes, with 2-celled glandular trichomes on the veins, false veins few, the true veins not enlarged at their apex. Involucres (a cup-shaped structure which houses the spore-bearing organs) 1.5-2 mm long, 1-6 at the blade apex, immersed for half or more of their length to fully so, the lips distinct from the blade tissue, inconspicuously dark-margined, the receptacle included or exserted to less than about half the involucre length."

14.1.6.2. Life History of Florida Bristle Fern

Florida bristle fern is always associated with shaded limestone outcrops. Plants usually grow on bare limestone, but are occasionally found on tree roots growing on limestone. In MDC, it has been found exclusively in oolitic (composed of minute rounded concretions resembling fish eggs) limestone solution holes and rocky outcrops in rockland hammocks. Solution holes are formed by dissolution of subsurface limestone followed by a collapse above (Snyder *et al.* 1990). Solution holes vary in size, from shallow holes less than 0.5 m (1.6 ft) deep to those that cover over 100 square meters (sq m) (1,076 square feet [sq ft]), and are several meters deep.

The bottoms of most solution holes are filled with deep organic soils. Deeper solution holes penetrate the water table and have (at least historically) standing water for part of the year. Humidity levels are higher in and around the solution holes because of standing water and moisture retained in the organic soils.

The canopy cover is typically very dense where Florida bristle fern occurs, and consists of a mix of temperate and tropical hardwood trees including lancewood (*Ocotea coriacea*), pigeon plum (*Coccoloba diversifolia*), live oak, paradise tree (*Simarouba glauca*), strangler fig (*Ficus aurea*), and mastic (*Sideroxylon foetidissimum*) (Bradley 2007b). Many tropical, epipetric plant species are associated with solution holes in rockland hammocks. Soils at the MDC sites are classified as Matecumbe Muck (http://www.fgdl.org/). In Sumter County, the plants occur in a mesic/hydric hammock on limestone boulders 1 - 2 m (3.3 - 6.6 ft) tall, under a canopy of live oak, cabbage palm, and American hornbeam (*Carpinus caroliniana*) (Werner 2007). Florida bristle fern grows on boulders with tall, horizontal faces with other rare fern species (*e.g.*, hemlock spleenwort [*Asplenium cristatum*], and widespread polypody [*Pecluma dispersa*]). The hammocks where it has been found are surrounded by a mosaic of wetlands. Soils at the Sumter County station are classified as Mabel Fine Sand, bouldery subsurface (http://www.fgdl.org/).

14.1.6.3. Numbers, Reproduction, and Distribution of Florida Bristle Fern

There are currently five, and possibly six, extant occurrences of Florida bristle fern (Gann *et al.* 2002), four in MDC and two in Sumter County. Within the action area for the FWC project in MDC, Florida bristle fern is known from Fuchs Hammock Preserve in three solutions holes (Possley 2008a). While no comprehensive status survey has been conducted, rockland hammocks in MDC with suitable habitat have been extensively explored, including sites where it

was formerly found. It is unlikely that additional surveys would reveal new occurrences in MDC. However, it is possible that Florida bristle fern occurs at some of the hammocks or hammock fragments that remain intact. It is possible that three or four hammocks may be sufficiently intact to support the species (Bradley 2009a).

The historical range of Florida bristle fern included southern (MDC) and central (Sumter County) Florida. In MDC it occurred historically in at least 12 hammocks (Castellow, Cox, Fuchs, Hattie Bauer, Meissner, Modello area, Nixon-Lewis, Ross, Royal Palm, Shields, Silver Palm, Snapper Creek area) (Gann *et al.* 2002). The range extended from Royal Palm Hammock (now in ENP) at its southern limit, north to at least Snapper Creek, and possibly further north into the Miami area (Gann *et al.* 2002). This is a range of at least 45 km (28 mi).

John Kunkel Small called attention to the demise of this taxon because of habitat destruction in 1938 (Small 1938). Sites that have been destroyed include a station (study location) near the City of Miami, the Snapper Creek area, a hammock near Modello (in southern MDC near the intersection of US 1 and S.W. 288 Street), Shields Hammock, and a hammock near Longview Camp (between Florida City and ENP). Some other hammocks still exist where the taxon formerly occurred. These include Cox Hammock (privately-owned Monkey Jungle tourist attraction) where it was last seen in 1989, Silver Palm Hammock (preserve owned by MDC) where it was last seen around 1980, Nixon-Lewis Hammock (privately-owned, disturbed, and mostly destroyed) where it was collected in 1915, and Royal Palm Hammock (in ENP) where it was last reported in 1917 or earlier (Gann *et al.* 2002). It has also been reported for the Deering Estate at Cutler and Matheson Hammock Park, both MDC Parks, but these reports were never confirmed (Gann *et al.* 2002).

14.1.7. Status of Florida Pineland Crabgrass

This section summarizes best available data about the biology and current condition of Florida pineland crabgrass (*Digitaria pauciflora*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Florida pineland crabgrass as threatened on October 6, 2017 (82 FR 46691–46715).

14.1.7.1. Description of Florida Pineland Crabgrass

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 cm 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 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 the upper floret becoming purple, acuminate to acute (Adapted from Webster and Hatch 1990; Bradley and Gann 1999).

14.1.7.2. Life History of Florida Pineland Crabgrass

The reproductive biology and ecology has not been studied, but reproduction is sexual (Bradley and Gann 1999). 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 do overlap somewhat into both of these ecosystems (Bradley and Gann 1999). The soil where it occurred at the Richmond Pine Rocklands has been classified as Biscayne marl, drained (USDA 1996). These habitats, particularly marl prairie, do flood for 1 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 to consist 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.

14.1.7.3. Numbers, Reproduction, and Distribution of Florida Pineland Crabgrass

The historical distribution included central and southern MDC 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 mi (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 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 had been documented many times in Long Pine Key. In 1995, a single plant was discovered in a small marl prairie on the grounds of the Luis Martinez U.S. Army Reserve Center in the Richmond Pine Rocklands in MDC; 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 hydroperiod (Bradley 2007a; IRC 2009). This species was extirpated from its historical range on the Miami Rock Ridge by drainage and development (FNAI 2007). Prior to its discovery in BCNP in 2003, the range of this species was thought to have contracted by approximately 29 mi (46.7 km) (Bradley and Gann 1999).

In 2003, Keith Bradley (2005) 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 FTBG have initiated surveys of the general area around Gum Slough, south of Loop Road (Bradley 2007a). Funding became available for a full survey in 2009, and a full survey within BCNP began in 2011 (Bradley 2009b). Until this study is complete, the most accurate rangewide estimate is 1,000-10,000 individuals at Long Pine Key (Gann *et al*. 2006) and >10,000 individuals within BCNP (Bradley 2007a).There is also some potential for the species to still occur on remaining unsurveyed pine rockland fragments within MDC.

Florida pineland crabgrass appears to have a much wider range than previously thought (Gann *et al.* 2006) and ongoing studies within the action area are expected to find additional populations.

14.1.8. Status of Florida Prairie Clover

This section summarizes best available data about the biology and current condition of Florida prairie-clover (*Dalea carthagenensis* var. *floridana*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Florida bristle fern as endangered on October 6, 2015 (82 FR 46691–46715).

14.1.8.1. Description of Florida prairie clover

Florida prairie-clover is a suffrutescent (having a stem that is woody only at the base; somewhat shrubby) shrub 3 to 6 ft (0.5 to 2 m) tall (Bradley and Gann 1999; Chafin 2000). Bradley and Gann (1999) describe it as follows, "Leaflets 15 to 23, ovate to elliptic, 5 to 14 mm long, glandular punctuate beneath; spikes subcaptitate to shortly oblong, 0.5 to 1.5 (-2) cm long, pubescent; peduncles opposite the leaves, terminal or appearing axillary, 1 to 3.5 cm long; bracts shorter than calyx; calyx 5 to 7 mm long, subequal and exceeding the tube, plumose; corolla subpapilionaceous, initially greenish white, turning maroon or dull purple, 4 to 5 mm long; stamens 9 to 10 (Adapted from Isely 1990)."

14.1.8.2. Life History of Florida prairie clover

This shrub is found in pine rocklands, edges of rockland hammocks, coastal uplands, and marl prairie (Chafin 2000). Bradley and Gann (1999) suggested fire is probably very important to the livelihood of this taxon. Plants probably do not tolerate shading by hardwoods in the absence of periodic fires. Two of the extirpated occurrences were reported from the Castellow and Cox rockland hammocks. Historically, this species likely occurred at the edges of rockland hammocks and was also known to occur in coastal uplands, at least within Palm Beach County.

In 1999, each of the five occurrences known at that time were located in slightly different habitat types: disturbed pine rockland, pine rockland and rockland hammock ecotone, pine rockland and rockland hammock ecotone along road edges, edge of roadside in marl prairie, and ecotone between rockland hammock and marl prairie and flatwoods (Bradley and Gann 1999). In 2007, Sadle (2007) characterized one occurrence in BCNP at an ecotone between pineland and hammock habitats. Florida prairie-clover occurs in association with South Florida slash pine, live oak (*Quercus virginiana*), gumbo-limbo (*Bursera simaruba*), poisonwood, willow bustic, white stopper (*Eugenia axillaris*), bluestem grasses, and paspalum grasses (*Paspalum* spp.) (Bradley and Gann 1999).

14.1.8.3. Numbers, Reproduction, and Distribution of Florida prairie clover

Florida prairie-clover was historically known from Miami-Dade, Collier, Monroe, and Palm Beach counties (Bradley and Gann 1999). Collections were made in Palm Beach County at an unknown location near Palm Beach by Curtiss in 1895 and south of Palm Beach by Small in

1918. In Monroe County it has been known historically from the Pinecrest region in the BCNP. It was discovered in Collier County portion of the BCNP in 1999 (Bradley and Gann 1999).

In MDC, this plant was reported from many locations, including Key Biscayne, Castellow Hammock, the Charles Deering Estate, R. Hardy Matheson Preserve, the edge of ENP, the Coral Gables area, pinelands south of the Miami River, and Cox Hammock (Bradley and Gann 1999). There have been no reports of this plant from Palm Beach County since 1918 (Bradley and Gann 1999). Gann *et al.* (2002) accounted for essentially every herbarium specimen and reliable sighting. Gann *et al.* (2006) did not find Florida prairie-clover in ENP and it is presumed to be extirpated at this location. Previous records (2) at this location may have represented waif populations established on road fill or disturbed soil (Gann *et al.* 2006).

Although Bradley and Gann (1999) estimated the total population (based on a $\log_{10}$ scale) to be 101–1,000 plants, they indicated that the total population size is probably closer to 200–300 individuals and that the population is probably declining since it has been extirpated on many sites where it once occurred. Updated information for the occurrences at MDC preserves was provided by Joyce Maschinski (2007) for 2007. Maschinski (2007) indicated that 10 woody plants and 4 seedlings occurred at the R. Hardy Matheson Preserve in 2007. Since 2003, the number of woody plants had declined dramatically at this preserve - from 31 to 1 (Possley and Maschinski 2009). Eleven seedlings were found in September 2008 (Possley and Maschinski 2009). Overall, the population at this site performed poorly, likely due to fire suppression for decades (Possley and Maschinski 2009). By 2008, only four plants remained, and only one was large enough to reproduce (Possley 2008b). Plants are failing to thrive for unknown reasons, and the population at this preserve is essentially extirpated leading some to speculate that the population would soon be extirpated (Possley 2008b). However, the population rebounded to 50 to 200 plants in 2010, apparently as a result of managers raking away pine straw and using a string trimmer (weed-eater) on competing plants in the immediate area (Possley 2011c).

14.1.9. Status of Garber's Spurge

This section summarizes best available data about the biology and current condition of Garber's spurge (*Chamaesyce garberi*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Garber's spurge as threatened on July 18, 1985 (50 FR 29345–29349).

14.1.9.1. Description of Garber's Spurge

Garber's spurge is a prostrate to erect herb with pubescent stems. The leaves are ovate in shape and 4 to 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 either are smooth or have transverse ridges, but are not wrinkled; this is not, however, a distinctive character for this species.

14.1.9.2. Life History of Garber's Spurge

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).

Garber's spurge is still found nearly throughout its historical range. It has been extirpated from Collier County and part of MDC. Within its historical range, many stations where it once occurred have been lost. On mainland Florida, Garber's spurge occurs in conservation lands like ENP. It probably occurs on less than half of the islands where it once occurred in the Florida Keys. Some populations are very small and are thus threatened with extirpation due to their small sizes. Examples include Cudjoe Key with 1 plant, Lower Matecumbe Key with 10 to 20 plants, Crocodile Lake National Wildlife Refuge on Key Largo with 10 to 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.

14.1.9.3. Numbers, Reproduction, and Distribution of Garber's Spurge

Garber's spurge is currently known from about 17 populations, including 2 within MDC: Long Pine Key and the Deering Estate at Cutler. At the Deering Estate, DERM (1993) reported a population size of 250-500 plants based on 4 days of searches specifically for this species.Herndon (2002) estimated a population size of 600-6,000 plants. In contrast, Possley (2007) estimated that only 100-200 plants were present in 2004. However, neither the Herndon nor Possley estimates were based on thorough surveys. The total rangewide population size has not yet been determined. Numbers of individuals in populations vary widely and some have fewer than 20 plants (*e.g.*, Crawl Key rock barren, Cudjoe Key, Key Largo, Lower Matecumbe Key).Two populations are extremely large. On Northwest Cape Sable (ENP), there may be over 1 million plants (Green *et al.* 2007b). On Long Pine Key (ENP), there may be over 100,000 plants (Green *et al.* 2007a).

14.1.10. Status of Sand Flax

This section summarizes best available data about the biology and current condition of sand flax (*Linum arenicola*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list sand flax as endangered on September 29, 2016 (81 FR 66842–66865).

14.1.10.1. Description of Sand Flax

Sand flax is a wiry, yellow-flowered herb (Bradley and Gann 1999; Bradley 2006). Bradley and Gann (1999) state sand flax "is a glabrous perennial herb; stems 1-several from the base, wiry,

35 to 53 cm tall; leaves mostly alternate, linear, 7 to 10 mm long, 0.6 to 1 mm wide, entire or with scattered marginal glands; stipules glandular, reddish; inflorescence a cyme of a few slender, spreading or ascending branches; pedicels 2 mm long or less; sepals lanceolate to ovate with a prominent midrib, 2.4 to 3.2 mm long; petals yellow, obovate, 4.5 to 5.5 mm long; fruit 2.1 to 2.5 mm long, 2 to 2.3 mm diameter, pyriform, dehiscing into ten segments; seeds ovate, 1.2 to 1.4 mm long, 0.7 to 0.8 mm wide. (Adapted from Rogers 1963a). The reproductive ecology and biology of this taxon has not been studied (Bradley and Gann 1999). No studies have been conducted on the ecology of the species (Bradley 2006).

14.1.10.2. Life History of Sand Flax

Sand flax is found in pine rockland, disturbed pine rockland, marl prairie, roadsides on rocky soils, and disturbed areas (Bradley and Gann 1999; Hodges and Bradley 2006). The pine rockland and marl prairie where this species occurs requires periodic wildfires in order to maintain an open, shrub free subcanopy and reduce litter levels (Bradley and Gann 1999). This taxon is currently rare in relatively undisturbed natural areas, with the exception of plants on Big Pine Key and the grounds of an office building on Old Cutler Road in Coral Gables (Bradley and Gann 1999; Hodges and Bradley 2006). Several occurrences are in scarified pine rockland fragments that are dominated by native pine rockland species, but have little or no canopy or subcanopy. One population in MDC occurs entirely on a levee composed of crushed oolitic limestone in the middle of a sawgrass marsh (Bradley and Gann 1999; Hodges and Bradley 2006).

More recently, Hodges and Bradley (2006) found in the Keys sand flax seems to only rarely occur within intact pine rockland, but more frequently adjacent to it. Its persistence on roadsides is not fully understood, but it is possible this species has evolved to occur in this habitat as fire regimes and natural areas were altered and destroyed over the last several hundred years (Hodges and Bradley 2006).

14.1.10.3. Numbers, Reproduction, and Distribution of Sand Flax

In MDC, Kernan and Bradley (1996) reported six mainland occurrences for sand flax. They estimated that approximately 1,000 plants occurred in MDC, with about 600 at Homestead Air Reserve Base. In 2008, Bradley (2008) estimated that hundreds of plants, possibly thousands, remained at this site, now owned by the MDC Homeless Trust. In 2009, Bradley (2009c) estimated that approximately 74,000 sand flax plants occur on the site, with densities ranging as high as 4.5 plants per 10.8 sq ft (per 1.0 sq m). This is the largest known population in Miami-Dade, but a portion of it is threatened by development; the U.S. Army Special Operations Command Center South (SOCSOUTH) seeks to locate permanent headquarters at this site (Department of Defense 2009). Project plans include avoidance of the majority of the population with accompanying protection and management of approximately 60,000 individuals (Service 2011b). In 2009, an assessment of rare plants and pine rockland habitat was conducted for the proposed SOCSOUTH headquarters at the site adjacent to the Homestead Air Reserve Base (Bradley 2009c). During a survey of the 90-ac (36.4-ha) tract, Small's milkpea and sand flax were found in 27 different locations covering 13.2 ac (5.3 ha) in disturbed pine rocklands (Bradley 2009c).

14.1.11. Status of Small's Milkpea

This section summarizes best available data about the biology and current condition of Small's milkpea (*Galactia smallii*) throughout its range that are relevant to formulating an opinion about the Action. The Service published its decision to list Small's milkpea as endangered on July 18, 1985 (50 FR 29345–29349).

14.1.11.1. Description of Small's Milkpea

Small's milkpea is a perennial herb with numerous trailing stems radiating from large woody taproots and with relatively large flowers (calyx 6 to 8 mm [0.2 to 0.3 in] long, standard and keel 1 to 1.5 cm [0.4 to 0.6 in] long) (Herndon 1981). This species has compound leaves, usually with 3 elliptic leaflets 1.5 to 3 cm (0.6 to 1.2 in) long. The stem pubescence is ascending or spreading-sericeous, and upper leaf surface is puberulent (hair 0.1 to 0.2 mm [0.004 to 0.008 inch] long; hairs on stem less than 0.5 mm (0.02 in) long) (Herndon 1981).

14.1.11.2. Life History of Small's Milkpea

There is limited knowledge about the demographic features and trends of this plant. Small's milkpea is a perennial legume and, therefore, probably experiences little annual variation in population size (Fisher 2000; Bradley and Possley 2002). This species does not experience seasonal dieback and is thought to be long-lived, as most of the plants used in a pollination study survived over a period of 5 years (Bradley and Possley 2002). Flowering occurs throughout the year but most abundantly during the dry season. Because most flowers do not produce fruit, it may be self-incompatible (Bradley and Possley 2002). Once pollinated, seeds take several months to mature and often germinate in response to fire. Annual variability in flowering, seed production, seed viability, and establishment requirements are unknown (Bradley and Possley 2002). Because of the small size of seeds, seed storage has been difficult (Maschinski 2005).

Small's milkpea prefers open sun and little shade and can be threatened by shading from hardwoods and displacement by invasive exotic species in the absence of periodic fires. Disturbance, such as prescribed fire, is a necessary management tool to maintain suitable habitat for the species. Habitat degradation on these sites continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding.

14.1.11.3. Numbers, Reproduction, and Distribution of Small's Milk Pea

When this species was listed, it was known from two sites near Homestead in MDC. In a study of distribution and habitat preference of two plant genera native to South Florida pine rocklands, Small's milkpea was found in the Redland region and a few sites at the southern end of the Biscayne region (O'Brien 1998). The distribution of this species is correlated with soil depth and color in Redland pine rocklands. Small's milkpea appears to prefer calcareous soils with less quartz sands, but not at low elevations, and does not occur in pine forests off of the limestone rock ridge (O'Brien 1998). As elevation decreases southward along the Miami Rock Ridge, so

does quartz sand (Bradley and Possley 2002). Preferred soils are mapped as Cardsound Rock outcrop complex and are porous and well-drained (Bradley and Possley 2002). The elevation where the plants occur generally ranges from 7 to 10 ft (2 to 3 m) with a smooth slope from 0 to 2 percent (Bradley and Possley 2002).

The distribution of this plant is fragmented. One study noted several sites had large numbers of plants distributed throughout each site with no well-defined population clusters (Fisher 2000). In 2002, this species occurred in less than 12 fragmented sites located along a 6.5-mi (10.5- km) portion of the ridge (Bradley and Possley 2002). The total population at that time was estimated to be less than 10,000 plants and ranged from 3 to 1,000 individuals per site, with only 2 sites that contained over 1,000 plants (Bradley and Possley 2002). Results of a project to map extant pine rockland habitat indicated that the plants remained on 7 public and 15 private sites (IRC 2006; Bradley 2010b). MDC owns six of the public sites, purchased for conservation purposes, and is working to restore and manage these lands through their Environmentally Endangered Lands (EEL) program. The remaining public site is owned by the County's Board of Education (Bradley 2010c) and is, therefore, subject to future development. However, the EEL program is currently attempting to acquire this site (Guerra 2010).

O'Brien (1998) located the species on 10 sites. In 2002, FTBG reported this species occurred on fewer than 12 sites located in a 6.5-mi (10.5-km) area (Bradley and Possley 2002). The total population at that time was estimated to be less than 10,000 plants and ranged from 3 to over 1,000 individuals per site, with only two sites that contained over 1,000 plants (Bradley and Possley 2002). The most recent comprehensive survey of pine rocklands documented the presence of Small's milkpea on five public sites but did not determine population sizes (IRC 2006). These sites have been purchased by MDC for conservation purposes.
The County is working to restore and manage these lands.

In 2009, a large population containing as many 100,000 individuals was documented on an additional public property (County owned) adjacent to the HARB (Bradley 2009c). Although HARB is seeking to develop these lands, they are also coordinating with the Service and IRC to retain and manage the plant at this site. Therefore, the most current assessment of NFCs in MDC recorded the species on eight public sites (IRC 2006; Bradley 2009c, 2010b). Also in 2009, an additional small population was discovered on the private Palms Woodlawn Cemetery along Old Dixie Highway in Homestead (Bradley 2010c). Because this species has no apparent mechanism for long-distance dispersal of seeds, it is presumed that these fragmented populations are relicts of larger populations prior to fragmentation (O'Brien 1998). Not much is known about how fragmentation has impacted the population dynamics of the species, but most likely populations have become isolated and more imperiled (O'Brien 2006).

Small's milkpea is found in the Redland region and a few sites at the southern end of the Biscayne region in MDC (O'Brien 1998). The most current assessment of NFCs in MDC recorded the species on 8 public sites and 15 private sites (IRC 2006; Bradley 2009c, 2010b). Within MDC, proximal to the project area, it is found on Navy Wells Pineland Preserve (data unavailable), Ingram Pineland (11-100 plants), Seminole Wayside Park (data unavailable), Palm Drive Pineland (11-100 plants), Sunny Palms Pineland (100-1,000 plants), and Rock Pit #39 (11-

100 plants). FNAI reported an occurrence of this species on August 14, 1991 within the Larry and Penny Thompson Park, also within the Richmond Area.

14.2. Conservation Needs of and Threats to the Other Listed Plants

Common threats to the other listed plant species that occur within the pine rockland plant include habitat loss, fragmentation, and degradation resulting from development, fire suppression, and competition from nonnative invasive plants. These threats are believed to be the primary drivers in the historical and recent declines for all of these species that occur within pine rocklands. Most of the remaining pine rockland habitat within MDC occurs in small, isolated stands in an urban landscape that are difficult to protect and manage. Many of the fragments are overgrown and in need of restoration. Today, natural fires are unlikely to occur or are likely to be suppressed in the remaining, highly fragmented pine rocklands habitat. The suppression of natural fires has reduced the size of the areas that burn, and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Without fire, successional climax from pine rocklands to rockland hammock is rapid, and displacement of native species by invasive, nonnative plants often occurs.

The Florida bristle fern shares these common threats of habitat loss, and in addition, threats of agricultural conversion, regional drainage, and canal installation, have impacted the range and abundance of Florida bristle fern. Secondary effects from hydrology and canopy changes have resulted in changes in humidity, temperature, and existing water levels; loss of natural vegetation; and habitat fragmentation. The modification and destruction of habitat where Florida bristle fern was once found has been extreme.

14.3. Environmental Baseline for the Other Listed Plants

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the following 11 species: Blodgett's silverbush, Carter's Small-Flowered Flax, crenulated lead-plant, Everglades bully, Florida brickell-bush, Florida bristle fern, Florida pineland crabgrass, Florida prairie clover, Garber's spurge, sand flax, and Small's milkpea, their habitat, and ecosystem within the Action Area. The environmental baseline is a "snapshot" of the species' health in the Action Area at the time of the consultation, and does not include the effects of the Action under review.

14.3.1. Action Area Numbers, Reproduction, and Distribution of Other Listed Plants

Botanical surveys of the proposed CRC property were conducted following the Service's guidelines for botanical inventory. Survey results are summarized in *Coral Reef Commons rare plant and floristic inventory* (Woodmansee 2014). The 11 listed plant species we address in section 14 were not documented within the Action Area through the last survey effort. Table 14-1 shows the local known distribution of these pine rockland dependent plant species, specifically, populations adjacent to the Action Area.

Table14-1. Local distribution of 11 pine rockland- and rockland hammock-associated plants in the Richmond Pine Rocklands.

Common Name	Known Local Distribution
Blodgett's silverbush	Species documented in Larry and Penny Thompson Park.
Carter's small-flowered flax	Closest natural population occurs 3 miles east of Richmond Area. CH present within CRC.
crenulate lead-plant	Plant was transplanted into Martinez Pineland. Closest natural population occurs 5 miles NE of the Richmond Area.
Everglades bully	Species previously documented within CRC in 2000 but is believed to have since been extirpated. Species documented in Larry and Penny Thompson Park.
Florida brickell-bush	Species documented in adjacent properties (Zoo Miami, Martinez Pineland, and Larry and Penny Thompson Park). CH present within CRC.
Florida bristle fern	FNAI lists the species as potentially occurring in the area.
Florida pineland crabgrass	Last known occurrence of species within Richmond Area consisted of a single plant documented in 1997. Species is believed to have since been extirpated from Richmond Area (Woodmansee 2014)
Florida prairie clover	Closest natural population is 4.5 miles ESE (Woodmansee 2014).
Garber's spurge	FNAI listed as potentially occurring in the area.
sand flax	Documented in two locations on adjacent properties (Martinez Pineland and Zoo Miami).
Small's milkpea	FNAI reported occurrence of species in Larry and Penny Thompson Park in 1991 but specimen not photographed. Suspected observation was misidentification given similarity in appearance to other species.

14.3.2. Action Area Conservation Needs of and Threats to Other Listed Plants

Habitat degradation within the Action Area is an ongoing threat. Fire suppression, invasive species, and habitat loss are contributing threats within the Action Area.

The 50.96-acre off-site Preserve, UM Richmond Campus, has a deed restriction which is limited to the listing of the deltoid spurge. The current agreement or proposed off-site Preserve plan does not include defined success criteria or botanical surveys for the management. Management has been limited to exotic vegetation removal (as outlined in Appendix K, (a consultant's report dated 2014). Although prescribed burning is not required through the deed restrictive covenants,

some fire has occurred within the units. The last prescribed burn was conducted in 2003 on about 1/3 of the property. Wildfires were recorded in August 2004 and in September 2006. The intensity and frequency of fire rotation do not meet the management conditions to support and maintain optimal pine rockland habitat for these covered species. Conservation needs include improving habitat within the Action Area and enhancing the current management of the off-site Preserve.

14.4. Effects of the Action on the Other Listed Plants

This section analyzes the direct and indirect effects of the Action on the Blodgett's silverbush, Carter's Small-Flowered Flax, crenulated lead-plant, Everglades bully, Florida brickell-bush, Florida bristle fern, Florida pineland crabgrass, Florida prairie clover, Garber's spurge, sand flax, and Small's milkpea. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

14.4.1. Effects of CRC Construction on the Other Listed Plants

The construction of the residential and commercial facilities and their associated infrastructure would result in the permanent loss of 33.30 acres characterized by pine rockland habitat and 20.78 acres of characterized as disturbed upland (exotic hardwood dominated, historically marl prairie, and scraped, dominated by turf species), for a total of 53.69 acres of habitat lost. The pine rockland habitat has the potential to support one or more of the 11 federal status plant species, if seeds are within the seed bank in the development footprint then the seeds would be destroyed by construction activities.

14.4.2. Effects of CRC Operations on the Other Listed Plants

With the exception of the Stepping Stones, the 11 federal status plant species are not expected to persist within any portion of the residential and commercial community after development. The Stepping Stones would be cleared during construction and then re-planted with pine rockland species (50 to 75 percent of composition) with a focus on plant species favorable for BSHB. There is a low likelihood that these other covered plant species would re-establish itself in a Stepping Stone from the seedbank. If established, the probability of dispersal into the developed areas following construction is unlikely because the developed areas would not contain suitable patches of open ground in a pine rockland matrix to recruit the species. The effects of managing the Stepping Stones are discussed in section 14.4.3.

14.4.3. Effects of the Preserves on the Other Listed Plants

We describe the proposed on-site Preserves, Stepping Stone, and off-site Preserve in sections 2.4.3, 2.4.4, and 2.4.5, respectively. The remainder of this section describes how the proposed management would cause changes to the Action Area and describes how the other listed plants are likely to respond upon exposure to these changes. Below we analyze each component of the

proposed management activities that is relevant to the other listed plants that may be exposed during Preserve management.

Invasive Exotic Plant Management

Herbicides are among the methods to reduce exotic plant species and adaptively manage the on-site Preserves to reach the success criteria. Herbicide treatment has the potential to adversely affect the 11 listed plant species, if the chemicals are applied directly to the plant and kill it. BMPs for the on-site Preserves (HCP section 6.2.4) include flagging all known populations listed plants to avoid their disturbance in general, and treatment with herbicides specifically. However, none of the 11 listed plant species were detected on the CRC Property.

Herbicides and mechanical measures to reduce exotic invasive plants on the off-site Preserve are on-going and are not part of the proposed Action. Therefore, the BMPs of HCP section 6.2.4 do not apply to the off-site Preserve.

Prescribed Fire

Prescribed fire would be anticipated to injure or "kill", to some degree, the other listed plant species that are within the on-site Preserves or off-site Preserve. Depending on the intensity of the fire at the location of the individual plant specimen, the fire could either: 1) completely consume/destroy the plant and eliminate its ability to regrow; 2) eliminate the above ground vegetation of the plant but leave the seed bank intact and able to germinate; 3) "top kill" the plant (killing all or most of the vegetative structure above ground) and leave the root mass or remaining limbs to re-sprout; or 4) minimally burn or scorch the vegetative structure of the plant and leave the remaining plant to continue to grow.

For both the on-site and off-site Preserve, prescribed burns would be conducted in a manner to promote a mosaic pattern. The Applicants would conducting fires with small burn units, and proposing fire techniques that would reduce the intensity of the fire and/or move it quickly through the landscape to reduce scorching. By using these techniques, the number of plants that would be completely consumed or destroyed would be minimized. Therefore, based on the proposed small burn units and the fire techniques that would be deployed to maintain a mosaic pattern within a burn, and the fact that each of these species are fire adapted, few if any of the individual plants would be expected to be completely lost (no ability to regrow from seed bank or root stock) as a result of the prescribed fires.

Because there is not a botanical monitoring program or success criteria associated with the off-site Preserve, if covered species establish from the seed bank within the burn units, the proposed measures that reduce the probability of harming plants, such as marking/flagging federally listed plants, GPS locations of plant species during monitoring or field inspections are not proposed for the off-site Preserve. Consequently, there would be a potential that newly established plants could be incidentally crushed, damaged or killed by equipment or an individual during implementation of prescribed fire.

Other listed plant species could also be damaged, crushed or trampled, and/or killed as a result of equipment, vehicles, and people moving in and out of burn units within the off-site Preserve. The off-site Burn Plan does include best management practices to minimize the effects of equipment by prohibiting roller-chopping and using hand removal when feasible.

14.5. Conclusion for the Other Listed Plants

In this section, we summarize and interpret the findings of the previous sections for the Blodgett's silverbush, Carter's Small-Flowered Flax, crenulated lead-plant, Everglades bully, Florida brickell-bush, Florida bristle fern, Florida pineland crabgrass, Florida prairie clover, Garber's spurge, sand flax, and Small's milkpea (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

- jeopardize the continued existence of species listed as endangered or threatened; or
- result in the destruction or adverse modification of designated CH.

"Jeopardize the continued existence" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR §402.02).

Status

Ten of the 11 other listed plants occur in pine rockland habitat that requires periodic fires to maintain an open sunny understory with a minimum amount of hardwoods. The exception is the Florida bristle fern, which occurs on the limestone outcrops within hammocks. Pine rocklands occur in areas within open shrub canopy and exposed limestone with minimal organic litter (pine needles, leaves, and other organic materials) and very close to marl prairies.

These listed plants are share common threats that include habitat loss, fragmentation, and degradation resulting from development, fire suppression, and competition from nonnative invasive plants. These threats are believed to be the primary drivers in the historical and recent declines for all of these species that occur within pine rocklands.

Baseline

The 11 listed plant species addressed in this section of the BO/CO were not documented within the Action Area through the last survey effort. Based on their historical range and potential persistence within the seedbank, we anticipate that the plants may occur within the Action Area

The Action Area is comprised of two disjunct properties: the CRC property, which contains the development and the on-site Preserves, and the UM property, which contains the off-site Preserve. Fire has been generally suppressed on the CRC property, and the most recent fire on the UM property was in 2002.

Effects

Ten of the 11 other listed plant species (not the bristle fern) are adapted to a fire ecosystem; therefore, the proposed implementation of prescribed fire on the Preserves is expected to be beneficial for each of these. Regularly occurring fire would maintain an open understory that promotes plant species diversity. In addition, many fire dependent plant species respond positively to fire. These responses could include increased flower, fruit and seed production as well as improved germination and seedling establishment. Herbicide treatment within the on-site and off-site mitigations areas has the potential to adversely affect the 11 other listed plants if the chemicals are applied directly to the plant.

The commitment to manage the on-site Preserves and the restoration success criteria listed in section 7.2.4 and 7.7 of the HCP suggests that the Action would improve habitat conditions and possibly support either growth of the 10 pine rockland plants from a dormant seedbank or colonization by other dispersal methods. The off-site Preserve does not have restoration success criteria, however; there is an anticipated increase in the other listed plant populations resulting from habitat enhancement substantially exceeds the decrease resulting from habitat loss. Success criteria would validate this assumption.

Opinion

The other listed plants are not known to currently occupy property proposed for the development of CRC or the Preserves; however, the potential exists for individuals to re-establish within the Preserves as the habitat is managed and prescribed fire is reintroduced into the ecosystem. This potential could increase over time as the Preserves lands are managed and the habitat quality is anticipated to improve. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect these species (cumulative effects; see section 3.4).

After reviewing the current status of the species, the environmental baseline for the Action Area, the effects of the Action and the cumulative effects, it is the Service's biological opinion that the Action is not likely to jeopardize the continued existence of the Blodgett's silverbush, Carter's small-flowered flax, crenulated lead-plant, Everglades bully, Florida brickell-bush, Florida bristle fern, Florida pineland crabgrass, Florida prairie clover, Garber's spurge, sand flax, and Small's milkpea.

15. CRITICAL HABITAT FOR CARTER'S SMALL-FLOWERED FLAX AND FLORIDA BRICKELL-BUSH

15.1. Status of CSFF and FB-B Critical Habitat

This section summarizes best available data about the current condition of all designated units of CHfor that are relevant to formulating an opinion about the Action. The Service published its decision to designate CH for Carter's small-flowered flax (*Linum carteri var. careri)* (CSFF) and Florida brickell-bush (*Brickellia mosieri*) (FB-B) on August 17, 2015 (80 FR 49846–49886). We combine the analyses for both species' CH in this section, because the two designations identify

a common suite of PBFs that are essential to the conservation of both species. Sharing identical PBFs allows us to apply a common analytical framework for evaluating potential PBF responses to the Action. Under this framework, our analyses identify designation-specific findings to support independent conclusions about the effects of the Action on the CH for each species.

15.1.1. Description of CSFF and FB-B Critical Habitat

Geographic Extent

CH for CSFF is comprised of 2,624 acres in seven separate units located in Miami-Dade and Monroe Counties, Florida. Table 15-1 lists these units and identifies the acreage of each that is under Federal, State, County, or private ownership.

CH for FB-B is comprised of 2,649 acres in seven separate units located in Miami-Dade and Monroe Counties, Florida. Table 15-1 lists these units and identifies the acreage of each that is under Federal, State, County, or private ownership.

The seven CH units designated for the CSFF overlap substantially with the seven units designated for the FB-B.

Physical and Biological Features

CH designation for the CSFF and FB-B used the term "primary constituent elements" (PCEs) to identify the key components of CH that are essential to its conservation and may require special management considerations or protection. Revisions to the CH regulations in 2016 (81 FR 7214–7440; 50 CFR §424) discontinued the Services' use of the term PCEs. We now rely exclusively on the term PBFs to refer to these key components, because it is the term used in the statute. This shift in terminology does not change how the Service conducts a "destruction or adverse modification" analysis. In this BO, we use the term PBFs to label the key components of CH that provide for the conservation of the CSFF and FB-B that we labeled as PCEs in the 2015 critical habitat designation rule.

Our final rule designating CH for the CSFF and FB-B identified three PBFs (80 FR 47180–47220):

(1) Areas of pine rockland habitat that contain:
   (a) Open canopy, semi-open subcanopy, and understory;
   (b) Substrate of oolitic limestone rock; and
   (c) A plant community of predominately native vegetation that may include, but is not limited to:
      (i) Canopy vegetation dominated by *Pinus elliottii* var. *densa* (South Florida slash pine);
      (ii) Subcanopy vegetation that may include, but is not limited to, *Serenoa repens* (saw palmetto), *Sabal palmetto* (cabbage palm), *Coccothrinax argentata* (silver palm), *Myrica cerifera* (wax myrtle), *Myrsine floridana* (myrsine), *Metopium toxiferum* (poisonwood), *Byrsonima lucida* (locustberry), *Tetrazygia bicolor* (tetrazygia),

Guettarda scabra (rough velvetseed), *Ardisia escallonioides* (marlberry), *Psidium longipes* (mangroveberry), *Sideroxylon salicifolium* (willow bustic), and *Rhus copallinum* (winged sumac);

(iii) Short-statured shrubs that may include, but are not limited to, *Quercus pumila* (running oak), *Randia aculeata* (white indigoberry), *Crossopetalum ilicifolium* (Christmas berry), *Morinda royoc* (redgal), and *Chiococca alba* (snowberry); and

(iv) Understory vegetation that may include, but is not limited to: *Andropogon* spp.; *Schizachyrium gracile*, *S. rhizomatum*, and *S. sanguineum* (bluestems); *Aristida purpurascens* (arrowfeather threeawn); *Sorghastrum secundum* (lopsided Indiangrass); *Muhlenbergia capillaris* (hairawn muhly); *Rhynchospora floridensis* (Florida white-top sedge); *Tragia saxicola* (pineland noseburn); *Echites umbellata* (devil's potato); *Croton linearis* (pineland croton); *Chamaesyce* spp. (sandmats); *Chamaecrista deeringiana* (partridge pea); *Zamia integrifolia* (coontie); and *Anemia adiantifolia* (maidenhair pineland fern).

(2) A disturbance regime that naturally or artificially duplicates natural ecological processes (*e.g.*, fire, hurricanes, or other weather events) and that maintains the pine rockland habitat as described in (1) above.

(3) Habitats that are connected and of sufficient area to sustain viable populations of *Brickellia mosieri* and *Linum carteri* var. *carteri* in the pine rockland habitat as described in (1) above.

CH for the CSFF and FB-B does not include manmade structures (such as buildings, aqueducts, runways, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on September 16, 2015.

The Service determined that designating unoccupied units was essential the conservation of both the CSFF and the FB-B. The CSFF occurs in three areas, and the FB-B occurs in five areas, which renders both highly vulnerable to extinction by a natural disaster (*e.g.*, a major hurricane) or other catastrophic event.

15.1.2. Conservation Value of CSFF and FB-B Critical Habitat

The PBFs of CH listed in section 15.1.1 above address the various aspects of a pine rockland habitat that supports CSFF and FB-B. We discussed in section 3.1 how fire serves as the primary disturbance that maintains pine rockland plant communities and prevents a successional change to rockland hardwood hammock. In combination with fire suppression, exotic invasive species accelerate this successional change. A lighting-ignited fire frequency of 3–7 years, in combination with periodic hurricanes, maintained plant community structure and composition in pine rocklands prior to development.

Data about the current condition of each PBF in every designated unit (*e.g.*, invasive species, disturbance regime, native vegetation) is not available. However, the fire regime within a CH unit strongly influences the condition of the other PBFs and fire return intervals and scope are inconsistent. We characterize in general terms the status of the CH units in the following paragraphs.

Table 15-1. Designated CH units for the Carter's small-flowered flax (CSFF) and Florida brickell-bush (FB-B) (source: 80 FR 49846-49886; Tables 1 and 2) (note: totals displayed for all ownerships does not equal the sum of unit-specific ownerships displayed due to rounding).

Unit Name (Unit #)	Ownership	CSFF Acres	FB-B Acres	Unit Occupied by CSFF	Unit Occupied by FB
Trinity Pineland and Surrounding Areas (LCC1/BM1)	State	10	10	No	No
	County	18	14		
	Private	19	19		
Nixon Smiley Pineland Preserve and Surrounding Areas (LCC2/BM2)	State	131	121	Yes	Yes
	County	147	146		
	Private	<1	<1		
USDA Subtropical Hortiultural Research Station (LCC3/BM3)	Federal	145	145	Yes	No
	State	112	112		
	County	38	38		
	Private	21	19		
Richmond Pinelands and Surrounding Area (LCC4/BM4)	Federal	185	185	No	Yes
	County	592	590		
	Private	175	200		
Quail Roost Pineland and Surrounding Area (LCC5/BM5)	State	97	97	No	Yes
	County	44	37		
	Private	101	104		
Camp Owaissa Bauer and Surrounding Areas (LCC6/BM6)	State	51	50	Yes	Yes
	County	156	156		
	Private	109	70		
Navy Wells Pineland Preserve and Surrounding Area (LCC7/BM7)	State	132	132	No	Yes
	County	309	309		
	Private	56	68		
Total All Owerships		2,649	2,624		

Trinity Pineland and the Surrounding Areas (Units LCC1 and BM1) is comprised of State, County, and privately owned lands. Broken into several subunits, this unit has the only remaining pine rockland habitat in the northern portion of the Miami Rock Ridge. This unit was not occupied by FB-B or CSFF at the time of listing, but is essential to the conservation the species because it serves to protect habitat needed to recover the species, reestablish wild population within the historical ranges of the species, and maintain populations through the historical distribution. This unit faces the challenges of managing with prescribed fire within the urban setting; there has been some restoration with hardwood reduction.

The Nixon Smiley Pineland Preserve and Surrounding Areas (Units LCC1 and BM2), has seven subunits comprising primarily conservation lands that are under state or county ownership. This

unit had both occupied and unoccupied habitat for FB-B (52 acres) and CSFF (39 acres) at the time of listing.

Camp Owaissa Baurer (Units LCC6 and BM6), has 12 subunits and is comprised of state, county lands and private conservation area. It is also occupied by both species FB, (67 acres) and CSFF (23 acres), and the other subuntits were designated as unoccupied for recovery of the species. The occupied habitat has some of the PBFs for the plants including pine rockland habitat, oolitic limestone substrate, suitable vegetation composition and structure, natural or artificial disturbance regimes, and habitat connectivity of sufficient size and suitability.

The USDA Subtropical Horticultural Research Station (Units LCC3, BM3), has nine subunits and is comprised of Federal, State, County, and private ownership. One of the subunits is occupied by CSFF, about 153 acres, and designated unoccupied habitat within the units for FB-B and CSFF.

The remaining units are occupied by FB-B and unoccupied by CSFF: Richmond Pinelands and Surrounding Area (Units LLC4, BM4), Quail Roost Pineland and Surrounding Areas (Units LLC4, BM4) and the Navy Wells Pineland (Units LCC7, BM7). The Navy Wells Pineland and Richmond Pinelands, are one of the largest remaining areas of pine rockland habitats outside of ENP and contains all of the PBFs. The Navy Wells Pineland had one occurrence of FB, approximately 330 acres, at the time of listing.

15.1.3. Conservation Needs for CSFF and FB-B Critical Habitat

The PBFs may require special management considerations to address habitat fragmentation, inadequate fire management, completion with nonnative, invasive plants, and sea level rise. In some cases, like the Navy Wells Pineland Preserve unit, these threats are being addressed in coordination with cooperating agencies and landowners to implement needed actions.

Areas of pine rockland habitat that now support one or both of these plants may not support the plants in the future, as inadequate fire management results in the degradation of suitable habitat. Conversely, suitable habitat conditions may return or increase in areas following natural or prescribed fires, allowing opportunities for the plants to expand or colonize these areas in the future.

15.2. Environmental Baseline for CSFF and FB-B Critical Habitat

This section is an analysis of the effects of past and ongoing human and natural factors leading to the current status of designated CH for CSFF and FB-B within the Action Area. The environmental baseline is a “snapshot” of the condition of PBFs that are essential to the conservation of the species within designated critical of the Action Area at the time of the consultation, and does not include the effects of the Action under review.

15.2.1. Action Area Conservation Value of CSFF and FB-B Critical Habitat

The Action Area is within the Richmond and Surrounding Area CH Units (LCC4/MB4). The

pine rocklands of the Action Area are in various conditions, *e.g.*, scraped, fire suppressed, dominated by Burma reed, with or without a pine canopy, *etc*. CH within the CRC property also includes some smaller areas classified as rockland hammock, developed (cleared and sodded), and disturbed upland (historically marl prairie, exotic dominated) (HCP Figures 2-2, and 3-2). The Action Area also includes the off-site Preserve, and the Applicants describe the off-site Preserve on the UM property as entirely pine rockland, but do not classify it into finer categories.

Conditions relative to the PBFs of CH in the off-site Preserve are not specifically described in the HCP. This property is pine rockland habitat under management to conserve the deltoid spurge, primarily via mechanical and chemical control of invasive exotic plant species, and relatively infrequent prescribed fire. There has been some fire within the property; however, the intensity and frequency is not the optimal to meet the disturbance regime described in PBF #2. We expect that there are some of the PBFs on site because of the targeted invasive removal, such as a semi-open subcanopy and understory.

These data suggest that the PBFs of designated CH within the Action Area provide a moderate level of conservation value to the Richmond Pine Rocklands Unit, with much potential for enhancement through management through prescribed fire, or by mechanical means that artificially duplicates natural ecological processes.

15.2.2. Action Area Conservation Needs for CSFF and FB-B Critical Habitat

As stated in section 15.1.1, the action area has exotics and various conditions pine rocklands. A disturbance regime that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat is needed within the unit.

15.3. Effects of the Action on CSFF and FB-B Critical Habitat

This section analyzes the direct and indirect effects of the Action on CH for Carter's small flowered flax and Florida brickell-bush. Direct effects are caused by the Action and occur at the same time and place. Indirect effects are caused by the Action, but are later in time and reasonably certain to occur. Our analyses are organized according to the description of the Action in section 2 of this BO.

15.3.1. Effects of CRC Construction on CSFF and FB-B Critical Habitat

CRC construction would eliminate CH PBFs from 52.85 acres within the CRC development footprint. This reduces the available CH hat support the PBFs within the Richmond Unit to about 899 acres for CSFF and 922 acres for FB-B. This reduction in acres represents a loss of PBFs in CSFF by 5.6 percent, and by 5.4 percent in FB-B4. It would reduce the acreage that can support PBFs throughout all designated units for the CSFF and FB-B by about 2 percent.

15.3.2. Effects of CRC Operations on CSFF and FB-B Critical Habitat

CRC construction would eliminate CH PBFs from 52.85 acres within the CRC development

footprint (see section 15.3.1). PBFs remaining on the CRC property following construction would occur only within the areas the Applicants propose as on-site Preserves. Therefore, any additional effects of CRC operations on PBFs are limited to activities that cause stressors that extend into the adjacent Preserves. CRC operations, *i.e.*, residential and commercial use of the development, may affect PBF #2, which relates to the disturbance regime. However, we believe the Applicants' proposed measures for a firewise community (see section 2.3.2) would inform residents and lessees about the fire management activities. The Applicate proposes to require all lessees, property owners, and/or tenants to sign documentation acknowledging that fire management activities would occur on the CRC property and on adjacent properties in the Richmond Area. Therefore, we believe that CRC operations are unlikely to adversely affect PBF #2 within the proposed Preserves.

The other two PBFs relate to pine rockland habitat condition and connectivity, which CRC operations would not affect.

15.3.3. Effects of the Preserve Management on CSFF and FB-B Critical Habitat

The proposed Preserves include 55.78 acres of CH (50.73 acres of the on-site Preserves and all 50.96 acres of the off-site Preserve) (Service 2017). Our analyses in section 14.3.3 of the effects of the proposed invasive exotic plant management and prescribed fire on habitat conditions for 11 listed plants, including CSFF and FB-B, apply to the PBFs of CSFF and FB-B CH. However, our analysis of the proposed pine rockland plantings in the narrow strip of existing sod along the southern boundary of the CRC property does not apply, as this area is outside the boundaries of designated CH.

As we discussed in section 14.3.3, we expect the proposed Preserves management to enhance habitat conditions for the CSFF and BF. Relative to CH for both these species, we believe the proposed management will:

a) maintain open-canopy pine rockland habitat with a predominantly native plant species community (PBF #1a and 1c);
b) restore a disturbance (natural or artificial) regime that maintains pine rockland habitat (PBF #2); and
c) connect habitats of sufficient area within the Preserves to sustain viable populations (PBF #3).

On-site Preserves

The Applicants' functional habitat assessment (see section 3.3) estimates the degree of habitat enhancement that management to achieve the "Level 3" success criteria of the on-site Preserves would accomplish. The assessment predicts a 66 percent increase from 26.35 habitat value units (HVUs) to 43.82 HVUs. The success criteria used in the assessment that relate to CH PBFs included canopy cover, fire frequency, and percent cover of pine rockland herbaceous species. As we discussed in section 3.3, this degree of enhancement is predicated on full success, *e.g.*, increasing fire frequency to a 3–7 year return interval, on each pine rockland parcel within the on-site Preserves.

Off-site Preserve

The Applicants did not evaluate the potential enhancement of the off-site Preserve. The off-site Preserve is already under management to control invasive exotic plant species, but does not receive fire on the 3–7 year return interval that is most effective at maintaining pine rockland habitats relative to PBF #2. Although success criteria are not included besides a 3–7 year burn frequency, the management plan for the off-site Preserve (HCP Appendix J1) proposes to enhance the habitat, and we expect the results to be similar to the on-site Preserves. Because invasive plant control is ongoing, the off-site Preserve provides a greater conservation value to CH than the on-site Preserves. Therefore, we expect less than the 66 percent increase in functional habitat value that the Applicants estimated for the on-site Preserves (see section 3.3).

We describe in section 3.3 the functional gain we expect from the burn plan for the off-site Preserve in terms of Habitat Value Units (HVUs) estimated for the on-site Preserves. We assume that burning would provide about half of the per-acre functional gain estimated for the on-site Preserves, but this gain would add to a better baseline condition. A gain of 0.34 ÷ 2 = 0.17 HVU per acre applied to 45.60–48.65 acres of the off-site Preserve (the portion that would receive burning) would result in a total gain of 7.75–8.27 HVUs. We compare this rough estimate with the results for the other portions of the Action Area in section 15.3.4 below.

15.3.4 Summary of the Effects of the Action on CSFF and FB-B Critical Habitat

The proposed CRC development would collectively occupy 86.49 acres, including 52.85 acres of plant CH (Service 2017). This development would reduce the acreage that can support plant PBFs in LCC3 by 5.6 percent, and by 5.4 percent in FB4. It would reduce the acreage that can support plant PBFs throughout all designated units for the CSFF and FB-B about 2 percent.

We consider the Applicants' functional habitat assessment a reasonable surrogate measure of CH conservation value, because the parameters of the assessment are comparable to several of the plant PBFs. The Applicants estimate that the CRC development would cause a loss of 14.37 Habitat Value Units (Table 3-1), which we conservatively attribute entirely to a loss of PBFs in CH.

We believe the proposed firewise community conservation measures for CRC operations would facilitate the use of prescribed fire in the on-site Preserves. The off-site Preserve is presently in better condition as for plants than the on-site Preserves, due to ongoing invasive exotic plant management, but the burning is not frequent enough to maintain open herbaceous understory. The Applicants did not apply the functional habitat assessment to the off-site Preserve. To facilitate an estimation of habitat value change for the entire Action Area, we assume that the off-site Preserve would receive about half of the "habitat lift," from a higher baseline condition, that the on-site Preserves would receive. We expect that the proposed management of the on-site and off-site Preserves would enhance the conservation value of plant CH to a comparable functional level in both areas. We attribute all of the loss of conservation value resulting from the CRC development to CH located within the development footprint. Combining these inferences results in the following overall characterization of the change in CH conservation value.

Area	Change in HVUs
CRC Development	-14.37
On-site Preserves	+17.47
Off-site Preserve	+8.05
Net change	+11.15

15.4. Conclusion for CSFF and FB-B Critical Habitat

In this section, we summarize and interpret the findings of the previous sections for CSFF and BF-F CH (status, baseline, effects, and cumulative effects) relative to the purpose of a BO under §7(a)(2) of the ESA, which is to determine whether a Federal action is likely to:

a) jeopardize the continued existence of species listed as endangered or threatened; or
b) result in the destruction or adverse modification of designated CH.

"*Destruction or adverse modification*" means a direct or indirect alteration that appreciably diminishes the value of designated CH for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the PBFs essential to the conservation of a species or that preclude or significantly delay development of such features (50 CFR §402.02).

Status

CH for CSSFF is comprised of 2,624 acres in seven separate units located in Miami-Dade and Monroe Counties, Florida. CH for FB-B is comprised of 2,649 acres in seven separate units located in Miami-Dade and Monroe Counties, Florida. The CH units overlap substantially with the seven units designated for FB-B. The two CH designations share a common set of three PBFs: (1) pine rockland habitat comprised of native species with an open canopy and understory; (2) disturbance regime that maintains this species composition and structure; and (3) habitat connectivity and size sufficient to sustain viable populations. Managing the CH units with prescribed fire is the primary conservation need.

Baseline

PBFs of designated CH within the Action Area provide a moderate level of conservation value to the Richmond Pinelands and Surrounding Area Units (LCC5/BM5), with much potential for enhancement through management through prescribed fire or mechanical means that artificially duplicates natural ecological processes.

Effects

The proposed CRC development would collectively occupy 86.49 acres, including 52.85 acres of plant CH (Service 2017). This development would reduce the acreage that can support plant PBFs in LCC3 by 5.6 percent, and by 5.4 percent in FB4. It would reduce the acreage that can support plant PBFs throughout all designated units for the CSFF and FB-B by about 2 percent.

We believe the proposed firewise community conservation measures for CRC operations would facilitate the use of prescribed fire in the on-site Preserves.

We consider the Applicants' functional habitat assessment a reasonable surrogate measure of CH conservation value, because the parameters of the assessment are comparable to several of the PBFs. We believe the action would cause a net increase in conservation value, because the habitat improvements in the Preserves exceed the losses in the CRC development area.

Opinion

Although the Action would reduce the acreage that can support the PBFs of CSFF and FB-B CH by about 2 percent, we believe the action would cause a net increase in CH conservation value, because the habitat improvements in the Preserves exceed the losses in the CRC development area. We are unaware of other non-federal actions in the Action Area that are reasonably certain to occur and that may affect the 11 listed plants considered in this section (cumulative effects; see section 3.4).

After reviewing the current status of the CH, the environmental baseline for the Action Area, the effects of the Action, and the cumulative effects, it is the Service's biological opinion that the Action is not likely to destroy or adversely modify designated CH for CSFF and FB-B.

16. INCIDENTAL TAKE STATEMENT

ESA §9(a)(1) and regulations issued under §4(d) prohibit the take of endangered and threatened fish and wildlife species without special exemption. The term "take" in the ESA means "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (ESA §3). In regulations at 50 CFR §17.3, the Service further defines:

- "harass" as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering;"
- "harm" as "an act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering;" and
- "incidental take" as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity."

Under the terms of ESA §7(b)(4) and §7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered prohibited, provided that such taking is in compliance with the terms and conditions of an incidental take statement (ITS).

The proposed Coral Reef Commons Habitat Conservation Plan (CRC HCP) and its associated documents clearly identify anticipated impacts to affected species likely to result from the proposed taking and the measures that are necessary and appropriate to minimize those impacts. All conservation measures described in the proposed HCP, together with the terms and conditions of any section 10(a)(1)(B) permit or permits issued with respect to the proposed HCP, are incorporated herein by reference as reasonable and prudent measures and terms and

conditions within this incidental take statement as stated in 50 CFR 402.14(i). Such terms and conditions are non-discretionary. The amount or extent of incidental take anticipated under the proposed CRC HCP, associated reporting requirements, and provisions for disposition of dead or injured animals are as described in the HCP and its accompanying section 10(a)(1)B) permit(s). This concludes the ITS.

17. CONSERVATION RECOMMENDATIONS

ESA §7(a)(1) directs Federal agencies to use their authorities to further the purposes of the ESA by conducting conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary activities that an action agency may undertake to avoid or minimize the adverse effects of a proposed action, implement recovery plans, or develop information that is useful for the conservation of listed species. The NFESO offers the following recommendations that are relevant to the listed species and designated CH addressed in this BO and that we believe are consistent with the authorities of the Service's RO through its permit decision for the CRC HCP.

1. Identify success critieria for the off-site Preserve that are consistent with those applicable to the on-site Preserves.
2. Move any remaining listed plants from the development area into adjacent on-site Preserves, or allow their collection by a botanical institution for conservation purposes.
3. Conduct FBB roost surveys within the on- and off-site Preserves every 2–5 years to determine whether new roosts are established.
4. Allow for outplantings of the covered plant species to occur within the Preserves.
5. Allow for re-introductions of leafwing to occur within the Preserves.
6. Promote (fund and allow) research on the Covered Species to occur within the Preserves.
7. Promote (fund and allow) collection of MTB larvae from within the construction footprint, and studies that examine the effectiveness of this recovery tool.

18. REINITIATION NOTICE

Formal consultation for the Action considered in this BO/CO is concluded. Reinitiating consultation is required if the Service's Regional Office retains discretionary involvement or control over the Action (or is authorized by law) when:

a. the amount or extent of incidental take is exceeded;
b. new information reveals that the Action may affect listed species or designated CH in a manner or to an extent not considered in this opinion;
c. the Action is modified in a manner that causes effects to listed species or designated CH not considered in this opinion; or
d. a new species is listed or CH designated that the Action may affect.

In instances where the amount or extent of incidental take is exceeded, the Service's Regional Office is required to immediately request a reinitiation of formal consultation.

19. LITERATURE CITED

Alexander, T.R. 1967. A tropical hammock on the Miami (Florida) limestone—a twenty-five-year study. Ecology 48(5):863-867.

Allen, G.M. 1932. A Pleistocene bat from Florida. Journal of Mammalogy 13(3):256-259.

Anderson, C. 2010. Personal communication. Email to Paula Halupa (comments on Bartram's hairstreak species assessment). U.S. Fish and Wildlife Service, Florida Keys National Wildlife Refuge Complex. Big Pine Key, Florida. February 10, 2010.

Anderson, C. 2014. Presentation Record. Presentation at the Imperiled Butterfly Working Group Meeting. U.S. Fish and Wildlife Service, Florida Keys National Wildlife Refuge Complex. Big Pine Key, Florida. January 23, 2014.

Anderson, C., and E. Henry. 2015. Synthesis of Research, Monitoring, Management of the Bartram's Hairstreak in the National Key Deer Refuge 2009-2014. Final Report. U.S. Fish and Wildlife Service, Florida Keys National Wildlife Refuge Complex. Big Pine Key, Florida.

Arlettaz, R., C. Ruchet, J. Aeschimann, E. Brun, M. Genoud, and P. Vogel. 2000. Physiological traits affecting the distribution and wintering strategy of the bat *Tadarida teniotis*. Ecology 81(4):1004-1014.

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

Ashton R.E. and P.S. Ashton. 2008. The natural history and management of the gopher tortoise *Gopherus polyphemus* (Daudin). Krieger Publishing Company, Malabar, Florida.

Auffenberg, W. and J.B. Iverson. 1979. Demography of terrestrial turtles. Pages 541–569 in M. Harless and H. Morlock (eds.). Turtles: Perspectives and Research. Wiley, New York, New York.

Auffenberg, W. and R. Franz. 1982. The status and distribution of the gopher tortoise (*Gopherus polyphemus*). Pages 95–126 in R. B. Bury, editor. North American Tortoises: Conservation and Ecology. U.S. Fish and Wildlife Service, Wildlife Research Report 12.

Avery, G. N. 1983. *Digitaria pauciflora* -a very particular grass. Fairchild Tropical Garden Bulletin 38 (3):30-31.

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.

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 and Wildlife Service, Jacksonville, Florida.

Belwood, J.J. 1981. Wagner's mastiff bat, *Eumops glaucinus floridanus* (Molossidae) in southwestern Florida. Journal of Mammalogy 62(2):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.

Best, T.L., W.M. Kiser, and J.C. Rainey. 1997. *Eumops glaucinus*. Mammalian Species 551:1-6.

Birkhead R.D., C. Guyer, S.M. Hermann, and W.K. Michener. 2005. Patterns of folivory and seed ingestion by gopher tortoises (*Gopherus polyphemus*) in a southeastern pine savanna. American Midland Naturalist 154(1):143–151.

Boglioli, M.D., W.K. Michener, and C. Guyer. 2000. Habitat selection and modification of the gopher tortoise (*Gopher polyphemus*) in Georgia longleaf pine forest. Chelonian Conservation and Biology 3(4):699–703.

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

Bradley, K.A. 2006. Distribution and population size for three pine rockland endemic candidate plant taxa on Big Pine Key, Florida. The Institute for Regional Conservation. Report submitted to U.S. Fish and Wildlife Service, Vero Beach, Florida.

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

Bradley, K.A. 2007b. Personal communication. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. September 12, 2007.

Bradley, K.A. 2008. Personal communication. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. November 17, 2008.

Bradley, K. A. 2009a. Personal communication. Email to Paula Halupa. The Institute for Regional Conservation. Miami, Florida. May 20, 2009.

Bradley, K.A. 2009b. Status survey of Everglades bully and Florida pineland crabgrass in the Big Cypress National Preserve, Florida. Proposal submitted to the South Florida Ecological Services Office.Institute for Regional Conservation. Miami, Florida. July 31, 2009.

Bradley, K.A. 2009c. Assessment of rare plant species and pine rockland habitat at proposed U.S. Army Special Operations Command South Headquarters adjacent to the U.S. Air Reserve Base, Homestead, Florida. Contract No. W91278-09-P-0278. The Institute for Regional Conservation. Report submitted to Ralph Etheridge, U.S. Army Corps of Engineers, Mobile District, Mobile, Alabama.

Bradley, K. A. 2010a. Personal communication. Email to Mark Salvato. Subject: Re deltoid spurge. Institute for Regional Conservation. Miami, Florida. March 18, 2010.

Bradley, K. A. 2010b. Personal communication. Email to Mark Salvato. Subject: G. smalli. Institute for Regional Conservation. Miami, Florida. March 29, 2010.

Bradley, K. A. 2010c. Personal communication. Email to Mark Salvato. Assistant Director. Institute for Regional Conservation. Miami, Florida. March 30, 2010.

Bradley, K.A., and C. van der Heiden. 2013. Status survey of *Linum arenicola* and *Linum carteri var. carteri* in South Florida . The Institute for Regional Conservation. Draft report submitted to the U.S. Fish and Wildlife Service, Vero Beach, Florida.

Bradley, K.A, and G.D. Gann. 1995. Endangered species status survey: *Polygala smallii* Smith & Ward, tiny polygala. Unpublished report prepared by The Institute for Regional Conservation for U.S. Fish and Wildlife Service, Jacksonville, Florida.

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

Bradley, K.A. and G.D. Gann. 2008. Restoration of Privately Owned Pine Rockland Habitat in Miami- Dade County. Final report submitted to the U.S. Fish and Wildlife Service, Vero Beach, Florida. The Institute of Regional Conservation, Miami, Florida. March 4, 2008. 30 pp.

Bradley, K.A., G.D. Gann, and C. Heiden. 2013. Status survey of Everglades bully and Florida pineland crabgrass in the Big Cypress National Preserve, Florida. Draft report submitted to the South Florida Ecological Services Office. Institute for Regional Conservation. Miami, Florida. March 4, 2013.

Bradley, K. A., and J. Possley. 2002. Conservation Action Plan for *Galactia smallii*. In Maschinski, J., M.Q.N. Fellows, J. Fisher, C. Lane, M. Fidelibus, S. Wright, P. Anderson, G. Guala, J. Pipoly, and J. Possley. 2002. Conservation of South Florida endangered and threatened flora: Final Report to the Endangered Plant Advisory Council, FDACS Contract #006466. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida.

Bradley, K. A., S. Woodmansee, and G. Gann. 1999. Rare plants of Florida scrub in Martin, St. Lucie, and Indian River Counties, Florida. Unpublished report prepared by The Institute for Regional Conservation for U.S. Fish and Wildlife Service, Vero Beach, Florida.

Braun de Torrez, E.C. 2016. Presentation given at Florida bonneted bat working group meeting at Avon Park Air Force Range. University of Florida, Department of Wildlife Ecology and Conservation. Gainesville, Florida. May 25, 2016.

Breaux, D. 2015. Personal communication. Email to Multiple regarding the Intra-Service Section & form for burning on NKDR. U.S. Fish and Wildlife Service, Florida Keys National Wildlife Refuge Complex. Big Pine Key, Florida. September 23, 2015.

Breininger, D.R., 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.

Breininger, D.R., P. Schmalzer, and C. Hinkle. 1994. Gopher tortoise (Gopherus polyphemus) Densities in coastal scrub and slash pine flatwoods in Florida. Journal of Herpetology 28:60–65.

Brzoska, D., C.B. Knisley, and J. Slotten. 2011. Rediscovery of *Cicindela scabrosa floridana* Cartwright (Coleoptera: Cicindelidae) and its elevation to species level. Insecta Mundi 0162:1-7.

Calhoun, J.V., J.R. Slotten, and M.H. Salvato. 2000. The rise and fall of tropical blues in Florida: *Cyclargus ammon* and *Cyclargus thomasi bethunebakeri* (Lepidoptera:Lycaenidae). Holarctic Lepidoptera 7(1):13-20.

Campbell, H. W. and P. E. Moler. 1992. Rim Rock crowned snake, *Tantilla oolitica* Telford. Pages 158– 161 in P. E. Moler, editor. Rare and endangered biota of Florida. Volume III. Amphibians and Reptiles. University Press of Florida, Gainesville, Florida, USA.

Carlson, P.C., G.W. Tanner, J.M. Wood, and S.R. Humphrey. 1993. Fires in Key deer habitat improves browse, prevents succession, and preserves endemic herbs. Journal of Wildlife Management 57: 914-928.

Carr, A.E. Jr. 1940. A contribution to the herpetology of Florida. University of Florida Publications, Biological Science Series: Volume III, No. 1.

Ceilley, D.W., J.E. Herman, S. B. Jackson, D. Dickinson, C.F. Houston, J. Webb, and E.M. Everham III. 2014. Final Report: Effects of Land Conversion Projects on the Eastern Indigo Snake (*Drymarchon couperi*) in South Florida. C-44 Reservoir Site and Adjacent Lands in Allapattah Flats. Service Agreement No: F11AP00168.

Chafin, L.G. 2000. Field guide to the rare plants of Florida. Florida Natural Areas Inventory. Tallahassee, Florida.

Collins, C. S. 1998. The influence of hardwood midstory and pine species on pine bole arthropod communities in eastern Texas. M.Sc. thesis, Stephen F. Austin State University, Nacogdoches, TX.

Cook, F.A. 1954. Snakes of Mississippi. Mississippi Game and Fish Commission; Jackson, Mississippi. Crother, B.I. (ed.). 2000. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding (p. 82).

Dickson, J.D. 1955. An ecological study of the Key deer. Florida Game and Freshwater Fish Commission. Pittmann-Robertson Project Technical Bulletin 3.

Diemer, J.E. 1992. Home range and movement of the tortoise (*Gopherus polyphemus*) in northern Florida. Journal of Herpetology 26:158–165.

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.

Dodd Jr., C.K. and W.J. Barichivich. 2007. Movements of Large Snakes (*Drymarchon Masticophis*) in North Central Florida. Florida Science. 70(1): 83-94.

Duellman, W. E., and A. Schwartz. 1958. Amphibians and reptiles of southern Florida. Bulletin of the Florida State Museum, Biological Sciences 3:181–324.

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 *Chamaesyc*e (Euphorbiaceae), with special reference to bees. American Midland Naturalist 101:87-98.

Eisenbeis, G., and F. Hassel. 2000. Zur Anziehung nachaktiver Insekten durch Strassenlanternen -eine Studie kommunaler Beleuchtungseinrichtungen in der Agrarlandschaft Rheinhessens [Attraction of nocturnal insects to street lights – a study of municipal lighting systems in rural area of Rheinhessin]. Nat Landsch 75:145–156.

Elliott, M., J. Jensen, and L. Smith. 2013. Estimating Gopher Tortoise Populations in Georgia. 35th Annual Meeting of the Gopher Tortoise Council, Ponte Vedra, FL.

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.

Enge, K.M., M.S. Robson, and K.L. Krysko. 2004. Reptile Surveys of Pine Rockland Habitat in Six Miami-Dade County Parks. Florida Scientist. Vol 67(3). Pp 194-204.

Enge, K. M., B. A. Millsap, T. J. Doonan, J. A. Gore, N. J. Douglass, and G. L. Sprandel. 2003.Conservation plans for biotic regions in Florida containing multiple rare or declining wildlife taxa.

Ernst, C. H. and E. M. Ernst. 2003. Snakes of the United States and Canada. Smithsonian Books, Washington, D.C., USA. 668 pp.

Eubanks, J.O., J.W. Hollister, C. Guyer, and W.K. Michener. 2002. Reserve area requirements for gopher tortoises (*Gopherus polyphemus*). Chelonian Conservation and Biology 4(2): 464–471.

Fellows, M. 2002a. Appendix C5: Smoke treatment of *Polygala smallii* seeds. In: Conservation of South Florida endangered and threatened flora. Final report to the Endangered Plant Advisory Council, Florida Department of Agriculture and Consumer Services FDACS contract #006466. December 2002. Fairchild Tropical Garden.

Fellows, M. 2002b. Demography of *Linum carteri var. carteri*. In: Conservation of South Florida endangered and threatened flora. Final report to the Endangered Plant Advisory Council, Florida Department of Agriculture and Consumer Services FDACS Contract #006466. December 2002.

Findley, J.S., E.H. Studier, and D.E. Wilson. 1972. Morphologic properties of bat wings. Journal of Mammalogy 53(3): 429-444.

Fisher, J.B. 2000. Demography of pine rockland endangered plant taxa in Miami-Dade County. Final report for contract # 4743 to the Florida Plant Conservation Program, Florida Department of Agriculture and Consumer Services, Gainesville, Florida.

Florida Bat Conservancy (FBC). 2005. Florida bonneted bat (*Eumops floridanus*). Bay Pines, Florida http://www.floridabats.org/Species_EUFL.htm

Florida Department of Transportation (FDOT). 1997. Technical memorandum: endangered and threatened species assessment for State Road 90/Tamiami Trail/ S.W. 8 Street from S.R. 826/Palmetto Expressway to S.W. 27 Avenue, Miami-Dade County, Florida. Florida Department of Transportation District Six; Miami, Florida.

Florida Fish and Wildlife Conservation Commission (FWC) 2011. Rim rock crowned snake biological status review report. March 31, 2011. Tallahassee, FL. Florida Fish and Wildlife Conservation Commission, Bureau of Wildlife Diversity Conservation Final Report, Tallahassee, Florida, USA. 146pp.

Florida Fish and Wildlife Conservation Commission (FWC). 2012. Gopher Tortoise Management Plan. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida.

Florida Fish and Wildlife Conservation Commission (FWC) 2013. A species action plan for the rim rock crowned snake (*Tantilla oolitica*). November 1, 2013. Tallahassee, FL.

Florida Natural Areas Inventory (FNAI). 2001. Field guide to the rare animals of Florida. http://www.fnai.org/FieldGuide/pdf/Tantilla_oolitica.PDF

Florida Natural Areas Inventory (FNAI). 2007. Florida Natural Areas Inventory. Element occurrence records. *Digitaria pauciflora*. Tallahassee, Florida.

Florida Natural Areas Inventory (FNAI). 2010. Element occurrence records for *Polygala smallii*. Florida Natural Areas Inventory. Tallahassee, Florida.

Florida Natural Areas Inventory (FNAI). 2015. Element occurrence records for *Polygala smallii*. Florida Natural Areas Inventory. Tallahassee, Florida.

Frank, K.D. 1988. Impact of outdoor lighting on moths: an assessment. Journal of the Lepidopterists' Society 42(2):63-93.

Freeman, P.W. 1981. A multivariate study of the family Molossidae (Mammalia, Chiroptera): morphology, ecology, evolution. Mammalogy Papers: University of Nebraska State Museum. Paper 26. http://digitalcommons.unl.edu/museummammalogy/26

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: May 5, 2011]

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.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 to Everglades National Park, Homestead, Florida.

Garner, J.A. and J.L. Landers. 1981. Foods and habitat of the gopher tortoise in southwestern Georgia.

Gillies, K. 2012. Comments on proposed endangered species status for Florida bonneted bat (Document # FWS-R4-ES-2012-0078-0026). Bat Conservation International. Austin, Texas. November 29, 2012.

Gordon, D.R., G.D. Gann, S.E. Green, K.A. Bradley, A.M. Jenkins, and S. Travis. 2007. Mapping of invasive exotic plants and rare native plants on Florida Department of Transportation District 6 right- of-way in Miami-Dade and Monroe Counties, Florida. Final report prepared for the Florida Department of Transportation District 6. Financial Management Number: 404278-1-32-07. University of Florida. Gainesville, Florida.

Gore, J., C. Marks, and H. Ober. 2010. Biological status review information findings - Florida bonneted bat (*Eumops floridanus*). In: Florida bonneted bat biological status review report. March 31, 2011. Florida Fish and Wildlife Conservation Commission. Tallahassee, Florida.

Green, S.E., K.A. Bradley, and S.W. Woodmansee. 2007a. Status survey of the Federally threatened Chanzaesyce garberi in South Florida . Quarterly Report 2. The Institute for Regional Conservation, Miami, Florida. Submitted 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 Clzamaesj~ceg arberi in South Florida . Quarterly Report 3. The Institute for Regional Conservation, Miami, Florida. Submitted to U.S. Fish and Wildlife Service, Vero Beach, Florida.

Groves, F. 1960. The eggs and young of *Drymarchon corais couperi*. Copeia 1960 (1):51-53.

Guerra, C. 2010. Personal communication. Email to Mark Salvato. Program Director. Endangered Environmental Lands Program. Miami, Florida. April 1, 2010.

Guyer, C., S. Glenos, S.M. Hermann, and J. Stober. 2011. The status of gopher tortoises (*Gopherus polyphemus*) in Alabama, with special reference to three important public properties. Unpubl. report by the Alabama Division of Wildlife and Freshwater Fisheries. 28 pp.

Haltom, W.L. 1931. Alabama reptiles. Alabama geological Survey and Natural History Museum, Paper No. 11:1-145.

Halupa, P. 2017. Personal communication. Email Halupa to Blackford, U.S. Fish and Wildlife Service biologists. November 13, 2017.

Harvey, M.J., J.S. Altenbach, and T.L. Best. 1999. Bats of the United States. Published by the Arkansas Game and Fish Commission. In cooperation with the Asheville Field Office, U.S. Fish and Wildlife Service.

Hennessey, M.K. and D.H. Habeck. 1991. Effects of mosquito adulticiding on populations of non-target, terrestrial arthropods in the Florida Keys. Final report of research results. Submitted on February 1, 1991 to U.S. Fish and Wildlife Service and University of Florida Cooperative Wildlife Research Unit. United States Department of Agriculture - Agricultural Research Service; Miami, Florida.

Henry and Haddad, 2013. Using mechanical disturbance to restore Bartram's scrub-hairstreak habitat. Research proposal to the Service. North Carolina State University. Raleigh, North Carolina. 8 pp.

Herndon, A. 1981. *Galactia smallii*: A new name for Galactia prostrata Small. Rhodora 83:471-472.

Herndon, A. 1998. Life history studies of plants endemic to South Florida. Final report to the National Park Service under cooperative agreement number CA5280-5-9019. September 1998. 146 pp.

Herndon, A. 2002. Monitoring protocol development and seed germination requirements in endemic plants of the Miami Rock Ridge Pinelands. Cooperative Agreement 1448-0004-96-9198 for the U.S. Fish and Wildlife Service. April 2002.

Hines, K. N. 2011. Status and Distribution of the Rim Rock Crowned Snake, *Tantilla oolitica*. Herpetological Review 42(3), 352-356.

Hines, K. N. and K. A. Bradley. 2009. Assessment of the Status and Distribution of the Endemic Rim Rock Crowned Snake (*Tantilla oolitica*) in Miami-Dade and Monroe Counties, Florida. Final Report Grant Agreement #401817G006. July, 10, 2009. Submitted by: The Institute for Regional Conservation, Miami, Florida.

Hoffman, M. 2017. Personal communication. Email to Anthony Daly-Crews. Central Florida Zoo's Orianne Center for Indigo Conservation. Sanford, Florida. June 20, 2017.

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. Miami, Florida.

Holbrook, J.E. 1842. North American Herpetology; or, A Description of the Reptiles Inhabiting the United States. Vol. III. J.Dobson. Philadelphia. 122 pp. (Coluber couperi, pp. 75–77 & Plate 16).

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

Hyslop, N. L. 2007. Movements, habitat use, and survival of the threatened eastern indigo snake (*Drymarchon couperi*) in Georgia (Doctoral dissertation, University of Georgia).

Hyslop, N. L., Stevenson, D. J., Macey, J. N., Carlile, L. D., Jenkins, C. L., Hostetler, J. A., and M.K. Oli. 2012. Survival and population growth of a long-lived threatened snake species, *Drymarchon couperi* (Eastern Indigo Snake). Population ecology, 54(1), 145-156.

Institute for Regional Conservation (IRC). 2006. Plant lists of Natural Forest Communities in Miami-Dade County, exclusive of Everglades National Park. Prepared in cooperation with U.S. Fish and Wildlife Service, Vero Beach, Florida. Project funded under a Memorandum of Agreement between Miami- Dade County and the U.S. Fish and Wildlife Service.

Institute for Regional Conservation (IRC). 2009. The Institute for Regional Conservation Florida Inventory of South Florida Database Online. Digitaria pauciflora. http://regionalconservation.org/ircs/database/plants/PlantPage.asp?TXCODE=Digipauc. March 16, 2009.

Intergovernmental Panel on Climate Change (IPCC). 2013. Summary for Policymakers. In Stocker, T.F., D. Qin, G.K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (pp. 3-29). Cambridge, United Kingdom: Cambridge University Press.

Isely, D. 1990. Vascular flora of the southeastern United States. Vol. 3, part 2: Leguminosae (Fabaceae). University of North Carolina Press, Chapel Hill. xvii, 258 p.

James, F. C., C. A. Hess, and D. Kufrin. 1997. Species-centered environmental analysis: indirect effects of fire history on red-cockaded woodpeckers. Ecological Applications 7:118-129.

Jennings, W.L. 1958. The ecological distribution of bats in Florida. A dissertation presented to the Graduate Council of the University of Florida in partial fulfillment of the requirements for the degree of Doctor of Philosophy. University of Florida, Gainesville, Florida.

Kehl, M.J., R.B. Smith, and D.R. Breininger 1991. Radiotelemetry studies of eastern indigo snakes (*Drymarchon corias corias*) 71st Annual Meeting Supplement to American Society of Ichthyologists and Herpetologists.

Kennedy, S. 1998. The seed bank and seedling dynamics of *Polygala smallii*, the tiny polygala. M.S. Thesis. Florida International University. Miami, Florida. Kennedy, S. 2003a. Status Survey for *Dicerandra thinicola* Miller, Titusville Mint, in Brevard County, Florida. Unpublished report prepared by Brevard County Board of County Commissioners Natural Resources Management Office for U.S. Fish and Wildlife Service, Jacksonville, Florida.

Kennedy, S. 2006. Peer review comments to U.S. Fish and Wildlife Service. November 21.

Kernan, C. and K. A. 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.

Kimball, C. P. 1965. The Lepidoptera of Florida, an annotated checklist. Arthropods of Florida and Neighboring Land Areas. Vol. 1. Gainesville: Div. Plant Indus., Fla. Dept. Agric. 363 pp, 26 pl.

Knisley, C B. 2009. Assessing the accuracy of index counts for determining the population size of the Northeastern Beach Tiger Beetle, Cicindela d. dorsalis. Final Report to Virginia Department of Agriculture and Consumer Affairs, Richmond, VA.

Knisley, C.B. 2011a. Taxonomy, biology, and conservation the Florida tiger beetle. Final Report to South Florida Ecological Services Office. February 20, 2011.

Knisley, C.B. 2011b. Anthropogenic disturbances and rare tiger beetle habitats: benefits, risks and implications for conservation. Terrestrial Arthropod Reviews 4:41-61.

Knisley, C.B. 2013. Biological studies of the Florida tiger beetle, 2011-2013. Final Report. April 13, 2013.

Knisely, C.B. 2014. Personal communication. Email Knisley, Professor Randolph-Macon College, to E. Bauer, U.S. Fish and Wildlife Service, biologist. Subject, survey data west of Zoo Miami Rd. July 25, 2014.

Knisley, C.B. 2015a. Species Assessment of the Miami Tiger Beetle, *Cicindelidia floridana*. Draft Report. April 15, 2015.

Knisley, C.B. 2015b. Species assessment of the Highlands tiger beetle, *Cicindelidia highlandensis*, 2014. Final Report. April 11, 2015.

Knisley, C.B. and J.M. Hill. 1992. Status survey of the rare Florida scrub tiger beetle, *Cicindela highlandensis*. Manuscript report prepared for U. S. Fish and Wildlife Service, Jacksonville, Florida.

Knisley, C.B. and J.M. Hill. 1996. The Florida Highlands tiger beetle, Cicindela highlandensis: habitat requirements, remaining range, life history, and management. Final report, Florida nongame wildlife program grant (NG91-012). Submitted to Florida Game and Fresh Water Fish Commission, Bureau of Nongame Wildlife, Richmond, Virginia.

Knisley, C.B. and J.M. Hill. 2013. The Highlands Tiger Beetle, *Cicindelidia highlandensis* (Choate): distribution, abundance, biology and conservation. Cicindela 45:17-47.

Knisley, C.B. and T.D. Schultz. 1997. The Biology of Tiger Beetles and a Guide to the Species of the South Atlantic States. Virginia Museum of Natural History, Martinsville. 210 pp.

Kolligs, D. 2000. Ökologische Auswirkungen künstlicher Lichtquellen auf nachtaktive Insekten, insbesondere Schmetterlinge (Lepidoptera) [Ecological effects of artificial light sources on nocturnally active insects, in particular on moths (Lepidoptera)]. Faunistisch-Ökologische Mitteilungen Suppl 28: 1–136.

Koptur, S., C. Kernan, and S. Kennedy. 1998. Final Report for the Project: Feasibility of relocating tiny polygala. State Study No. 0745, WPI # 0510745, State Job No. 99700-3308-010, Contract No. B- 9919.

Krysko, K.L., J.P. 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 3028:1-64.

Lacki, M.J., D.R. Cox, L.E. Dodd, and M.B. Dickinson. 2009. Response of northern bats (*Myotis septentrionalis*) to prescribed fires in eastern Kentucky forests. Journal of Mammalogy 90(5):1165-1175.

Landers J.L. 1980. Recent research on the gopher tortoise and its implications. Pages 8–14 in R. Franz and R.J. Bryant (Eds). The dilemma of the gopher tortoise – is there a solution? Proceedings of the first annual meeting, Gopher Tortoise Council, Florida State Museum.

Landers, J.L. and D.W. Speake. 1980. Management needs of sandhill reptiles in southern Georgia.

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

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.

Lazell, J. D. 1989. Wildlife of the Florida Keys: a natural history.

Lindenmayer, B. and J. Franklin. 2002. Conserving Forest Biodiversity: A Comprehensive Multiscaled Approach. Island Press, Washington DC. 352 pp

Legare, M and D. Breininger. 2002. Determining the impact of land management practices, current status and distribution of Eastern Indigo Snakes (*Drymarchon corais couperi*) on Avon Park Air Force Range. Quarterly Report (May 1, 2002 – July 31, 2002) and Second Annual Report (August 1, 2001 – July 31, 2002).

Loding, H.P. 1922. A preliminary catalog of Alabama reptiles and amphibians. Alabama Geological Survey and Natural History Museum, Paper No. 5:1-59.

Lohoenfener, R. and R. Altig. 1983. Mississippi herpetology. Mississippi State University Research Center Bulletin 1, National Space Technology Laboratory Station, Mississippi. 21 pp.

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

Longcore, T. and C. Rich. 2004. Ecological light pollution. Frontiers in Ecology and the Environment 2(4):191-198.

Loope, L.L., and V.L. Dunevitz. 1981. Impact of fire exclusion and invasion of *Schinus terebinthifolius* on limestone rockland pine forests of southeastern Florida. South Florida Resource Center. Report T-645, National Park Service. Everglades National Park, Homestead, Florida.

Ludlow, M.E. 2012. Comments on proposed endangered species status for Florida bonneted bat (Document # FWS-R4-ES-2012-0078-0029). Florida Department of Environmental Protection, Florida Park Service. November 30, 2012.

Macdonald, L.A. and H.R. Mushinsky. 1988. Foraging ecology of the gopher tortoise, *Gopherus polyphemus* in sandhill habitat. Herpetologica 44(3):345–353.

Maguire, J. 2006. Peer review comments on 5-year review of deltoid spurge to U.S. Fish and Wildlife Service, Vero Beach, Florida. October 31.

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

Marks, C. 2013. Preliminary dietary analysis report for the Florida bonneted bat (Eumops floridanus). Draft copy. Florida Bat Conservancy. Bay Pines, Florida.

Marks, G.E. and C.S. Marks. 2008a. Status of the Florida bonneted bat (Eumops floridanus). Submitted by George E. Marks and Cynthia S. Marks of the Florida Bat Conservancy for the U.S. Fish and Wildlife Service under grant agreement number 401815G192. January 31, 2008. 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. 2012. Status of the Florida bonneted bat (Eumops floridanus). Submitted by George E. Marks and Cynthia S. Marks of the Florida Bat Conservancy for the U.S. Fish and Wildlife Service under grant agreement number 40181AG121. May 4, 2012. Florida Bat Conservancy. Bay Pines, Florida.

Martin, R.A. 1977. Late Pleistocene Eumops from Florida. Bulletin of the New Jersey Academy of Science 22:18--19.

Maschinski, J. 2005. Personal communication. Letter from Joyce Maschinski, Fairchild Tropical Botanic Garden to Cindy Schulz, U.S. Fish and Wildlife Service, Vero Beach, Florida. Status updates for *Galactia smallii, Chamaesyce deltoidea* ssp. *deltoidea, Polygala smallii, Amorpha crenulata,* and *Jacquemontia reclinata.*

Maschinski, J. 2006. Demography of Linum carteri var. carteri growing in disturbed and undisturbed sites. In: Maschinski, J., K.S. Wendelberger, S.J. Wright, J. Possley, D. Walters, J. Roncal, and J. Fisher. 2006. Conservation of South Florida endangered and threatened Flora: 2005 program at Fairchild Tropical Garden. Final report contract #009706. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida. June 2006.

Maschinski, J. 2007. Personal communication. Email to Paula Halupa. Fairchild Tropical Botanic Garden. Coral Gables, Florida. March 12, 2007.

Maschinski, J. 2010. Personal communication. Email to Mark Salvato, Fairchild Tropical Botanical Garden, Miami, Florida. April 26, 2010.

Maschinski, J., K.S. Wendelberger, S.J. Wright, H. Thornton, A. Frances, J. Possley and J. Fisher. 2004. Conservation of South Florida endangered and threatened flora: 2004 Program at Fairchild Tropical Garden. Final report contract #007997. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida. June 2004.

Maschinski, J., M.Q.N. Fellows, J. Fisher, C. Lane, M. Fidelibus, S. Wright, P. Anderson, G. Guala, J. Pipoly, and J. Possley. 2002. Conservation of South Florida endangered and threatened flora. Final Report to Florida Department of Agriculture and Consumer Services FDACS Contract #006466., Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida.

Maschinski, J., S. Hodges, E.B. Magnaghi, and J. Possley. 2013. Survey and Mapping of the Distribution of Pineland Croton (Croton linearis) in Pine Rocklands in Miami-Dade County. Final Report. Fairchild Tropical Botanic Garden, Coral Gables, Florida.

Maschinski, J., S.J. Wright, J. Possley, D. Powell, and V. Pence. 2012. Conservation of South Florida Endangered and Threatened Flora: 2011-2012 Program at Fairchild Tropical Garden. Final Report Contract #017162. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida.

Maschinski, J., S.J. Wright, J. Possley, J. Goodsman, J. Roncal, V. Pence, D. Walters, S. Lewis, and N. Spencer. 2008. Conservation of South Florida endangered and threatened flora: 2007-2008. Program at Fairchild Tropical Garden. Final Report to Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida. Contract #012863 to Fairchild Tropical Botanic Garden.

Maschinski, J., S.J. Wright, K. Wendelberger, and A. Muir (ed.) 2003. Conservation of South Florida endangered and threatened flora. Contract #007182. Final report to Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida. October 2003.

Mays, J.D. and D.G. Cook. 2015. Field note summary of Miami tiger beetle surveys, Cicindela (Cicindelidia) floridana, 14-16 September 2015. Florida Fish and Wildlife Conservation Commission, Tallahassee, Florida. 23 pp.

Mays, J.D. and K.M. Enge. 2016. Survey of state-listed reptiles in the Florida Keys: Final Report. Florida Fish and Wildlife Commission. October 31, 2016. Reptile and Amphibian Subsection, Fish and Wildlife Research Institute, Gainesville, FL,USA. 41pp.

McRae, W.A., J. Landers, and J. Garner. 1981. Movement patterns and home range of the gopher tortoise. The American Midland Naturalist 106(1):165–179.

Miami-Dade County Department of Environmental Resources Management (DERM). 1993. Endangered Plants of Dade County's Pine Rocklands. Dade County Department of Environmental Resources Management, Technical Report 93-5. Miami, FL.

Minno, M. C. and M. Minno. 2009. A plan to conserve rare butterflies in the Florida Keys. Final report to the Florida Keys Mosquito Control District. 1993 pp.

Minno, M.C. and T.C. Emmel. 1994. Schaus swallowtail – Papilio aristodemus ponceanus Schaus. Species of Special Concern. Family Papilionidae. Pages 668-671 in M. Deyrup and R. Franz, editors. Rare and Endangered Biota of Florida, Vol. IV, Invertebrates. University Press; Gainesville, Florida.

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

Minno, M. C., J. F. Butler, and D. W. Hall. 2005. Florida Butterfly Caterpillars and Their Hostplants. University Press of Florida, 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 Fresh Water Fish Commission; Tallahassee, Florida.

Moler, P. E. 1992. Eastern indigo snake. Rare and endangered biota of Florida, 3, 181-186.

Morgan, G.S. 1985. Fossil bats (Mammalia: Chiroptera) from the Late Pleistocene and Holocene Vero Fauna, Indian River County, Florida. Brimleyana 11:97--117.

Morgan, G.S. 1991. Neotropical Chiroptera from the Pliocene and Pleistocene of Florida. Pages 176–213 in T.A. Griffiths and D. Klingener (eds.), Contributions to Mammalogy in Honor of Karl F. Koopman. Bulletin of the American Museum of Natural History 206:1–432.

Morgan, G. S. 2002. Late Rancholabrean mammals from southernmost Florida, and the neotropical influence in Florida Pleistocene faunas. Smithsonian Contributions to Paleobiology 93:15-38.

Mushinsky, H. R., E. D. McCoy, J. E. Berish, R. E. Ashton, Jr., and D. S. Wilson. 2006. *Gopherus polyphemus,* Gopher Tortoise. In P. A. Meylan, (ed). Biology and conservation of Florida's turtles. Chelonian Research Monographs, Lunenburg, Massachusetts.

National Park Service (NPS). 2014. Everglades National Park Fire Management Plan, Environmental Assessment. National Park Service, Everglades National Park. Homestead, Florida.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. http://www.natureserve.org/explorer [accessed March 23, 2011].

National Climate Assessment (NCA). 2014. Climate Change Impacts in the United State: The Third National Climate Assessment. U.S. Global Change Research Program. Washington, D.C.

New, K. C., and J. L. Hanula. 1998. Effect of time elapsed after prescribed burning in longleaf pine stands on potential prey of the red-cockaded woodpecker. Southern Journal of Applied forestry 22:175-183.

National Oceanic and Atmospheric Administration (NOAA). 2017. Global and Regional Sea Level Rise Scenarios for the United States. NOAA Technical Report NOS CO-OPS 083. Silver Spring, MD.

Norberg, U.M. and J.M.V. Rayner. 1987. Ecological morphology and flight in bats (Mammalia; Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences 316 (1179):335-427.

O'Brien, J.J. 1998. The distribution and habitat preferences of rare Galactia species (Fabaceae) and *Chamaesyce deltoidea* subspecies (Euphorbiaceae) native to southern Florida pine rockland. Natural Areas Journal 18:208-222.

O'Brien, J.J. 2006. Peer review comments on 5-year review of Small's milkpea to U.S. Fish and Wildlife Service, Vero Beach, Florida. December 5.

Ober, H. 2012. Comments on proposed endangered species status for Florida bonneted bat (Document # FWS-R4-ES-2012-0078-0033). University of Florida, Department of Wildlife Ecology and Conservation, North Florida Research and Education Center. Quincy, Florida. November 20, 2012.

Ober, H. 2015. Annual report to Service for calendar year 2015. Permit number TE23583B-1. University of Florida, Department of Wildlife Ecology and Conservation, North Florida Research and Education Center. Quincy, Florida.

Ober, H. K., E. C. Braun de Torrez, J. A. Gore, A. M. Bailey, J. K. Myers, K. N. Smith and R. A. McCleery. 2016. Social organization of an endangered subtropical species, Eumops floridanus, the Florida bonneted bat. Mammalia

Ober, H. 2016. Annual report to Service for calendar year 2016. Permit Number TE23583B-1. University of Florida, Department of Wildlife Ecology and Conservation, North Florida Research and Education Center. Quincy, Florida.

Ober, H., and B. McCleery. 2012. Scope of work: closing data gaps for the Florida bonneted bat (*Eumops floridanus*). University of Florida, Department of Wildlife Ecology and Conservation, North Florida Research and Education Center. Quincy, Florida.

Olson, M.S., and W.J. Platt. 1995. Effects of habitat and growing season fires on resprouting of shrubs in longleaf pine savannas. Vegetation 119:101-118.

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.

Owre, O.T. 1978. Status undetermined, Florida mastiff bat, *Eumops glaucinus floridanus*. Pages 43–44 in J.N. Layne (ed.), Rare and Endangered Biota of Florida. Volume 1. Mammals. University Presses of Florida, Gainesville, Florida.

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

Porras, L., and L.D. Wilson. 1979. New distributional records for *Tantilla oolotica* Telford (Reptilia, Serpentes, Colubridae) from the Florida Keys. Journal of Herpetology 13: 218-220.

Possley, J. 2007. Personal communication. Email to Keith A. Bradley. The Institute for Regional Conservation, Miami, Florida. April 24, 2007.

Possley, J. 2008a. Personal communication. Email to Paula Halupa. Fairchild Tropical Botanic Garden. Coral Gables, Florida. October 10, 2008.

Possley, J. 2008b. Personal communication. Email to Paula Halupa. Fairchild Tropical Botanic Garden. Coral Gables, Florida. August 1, 2008.

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. 2011c. Personal communication. Email to Paula Halupa. Fairchild Tropical Botanic Garden. Coral Gables, Florida. January 11, 2011.

Possley, J. 2012. Personal communication. Email to Heather Tipton. Fairchild Tropical Botanic Garden. October 15, 2012.

Possley, J. 2013a. Personal communication. Email to Heather Tipton. Fairchild Tropical Botanic Garden. Miami, Florida. February 7, 2013.

Possley, J. 2013b. Personal communication. Email to Heather Tipton. Fairchild Tropical Botanic Garden. Miami, Florida. February 14, 2013.

Possley, J. 2013c. Personal communication. Email to Heather Tipton. Fairchild Tropical Botanic Garden. Miami, Florida. February 14, 2013.

Possley, J. 2015. Priceless Pieces: even disturbed pine rockland fragments are valuable pieces of one of the world's most unique ecosystems. The Topical Garden 70(1):17-19.

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

Possley, J., and J. Maschinski. 2009. Year 6 report: biological monitoring for plant conservation in Miami-Dade County natural areas. Miami-Dade County Resolution #R-808-07 Proceedings of the annual conference of the southeast association of fish and wildlife agencies. 35:120–134.

Possley J., S. Hodges, E. Magnaghi, and J. Maschinski. 2016 Distribution of *Croton linearis* in Miami-Dade County Preserves with Potential for Supporting the Federally Endangered Butterflies *Strymon acis bartrami* and *Anaea troglodyte floridalis*. Natural Areas Journal. 36: 81-87.

Provencher, L., A.R. Litt, K.E. M. Galley, D.R. Gordon, G.W. Tanner, L.A. Brennan, N.M. Gobris, S.J. McAdoo, J.P. McAdoo, and B.J. Herring. 2001. Restoration of fire-suppressed longleaf pine sandhills at Eglin Air Force Base, Florida. Final report to the Natural Resources Management Division, Eglin Air Force Base, Niceville, Florida. Science Division, The Nature Conservancy, Gainesville, FL.

Provencher, L., K.E. M. Galley, B. Herring, J. Sheehan, N.M. Gobris, D.L. Gordon, G.W. Tanner, J.L. Hardesty, H.L. Rodgers, J.P. McAdoo, M.N. Northrup, S.J. McAdoo, and L.A. Brennan. 1998. Post-treatment analysis of restoration effects on soils, plants, arthropods, and birds in sandhill systems at Eglin Air Force Base, Florida. Annual report to Natural Resources Division, Eglin Air Force Base, Niceville, Florida. Public Lands Program, The Nature Conservancy, Gainesville, FL.

Ray, C. E. 1958. Additions to the Pleistocene mammalian fauna from Melbourne, Florida. Bulletin of the Museum of Comparative Zoology 119:421-449.

Ridgley, F., D. Smith, and K. Milk. 2014. Acoustic survey of Eumops *floridanus* in three Miami-Dade County Parks within the Richmond Tract Miami, Florida. Zoo Miami, Miami-Dade County Parks, Recreation and Open Spaces. Miami, Florida.

Roberts, M. 2012. Personal communication. Email to Mark Salvato. Monroe County Growth Management. Marathon, Florida. November 27, 2012.

Robertson, W.B., Jr. 1955. An analysis of the breeding bird populations of tropical Florida in relation to the vegetation. Ph.D. dissertation, University of Illinois; Urbana, Illinois.

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

Rogers, C. M. 1963a. Yellow flowered species of *Linum* in eastern North America. Brittonia 15: 97-122.

Rogers, C. M. 1963b. Yellow-flowered species of *Linum* in Central America and western North America. Brittonia 20:107-135.

Rogers, C. M. 1968. A reassessment of *Linum rigidum* and *L. carteri* (Linaceae) in Florida. Brittonia 4: 209-210.

Sadle, J. 2007. Personal communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. November 29, 2007.

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

Sadle, J. 2011. Personal communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. January 31, 2011.

Sadle, J. 2017. Personal communication. Email to Mark Salvato. Everglades National Park. Homestead, Florida. August 10, 2017.

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.H. 2001. Influence of mosquito control chemicals on butterflies (Nymphalidae, Lycaenidae, Hesperiidae) of the lower Florida Keys. Journal of the Lepidopterists' Society 55(1):8-14.

Salvato, M.H. 2003. 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 10(1-2):53-57.

Salvato, M.H. 2015. Observation record. U.S. Fish and Wildlife Service, South Florida Ecological Services Office. Vero Beach, Florida. 2015.

Salvato, M. H. 2017. Observation record. U.S. Fish and Wildlife Service, South Florida Ecological Services Office. Vero Beach, Florida. January 2017

Salvato, M.H. and M. K. Hennessey. 2004. Notes on the status, natural history and fire-related ecology of *Strymon acis bartrami* (Lycaenidae). J. Lepid. Soc. 58: 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 *Strymon acis bartrami* in Everglades National Park. Journal of the Lepidopterists' Society. 64:154-160.

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

Salvato, M.H., and H.L. Salvato. 2017. Parasitism of the Florida leafwing, Bartram's scrub-hairstreak and Three-spotted skipper butterfly immature stages. Comprehensive Annual Report to Everglades National Park.

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

Schwarz, K.A., R.A. Worth, and T.C. Emmel. 1996. Conservation of two threatened south Florida butterflies and their host plant (Lepidoptera: Lycaenidae, Nymphalidae). Holarctic Lepidoptera 3:59-61.

Scott, C. 2004. Endangered and Threatened Animals of Florida and their Habitats. University of Texas Press, Austin, TX.

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

Simmons, J.A., M.B. Fenton, and M.J. O'Farrell. 1979. Echolocation and pursuit of prey by bats. Science 203(4375):16-21.

Slocum, M.G., W.J. Platt, and H.C. Cooley. 2003. Effects of differences in prescribed fire regimes on patchiness and intensity of fires in subtropical savannas of Everglades National Park, Florida. Restoration Ecology 11:91-102.

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

Small, J.K. 1938. Ferns of the Southeastern States. The Science Press, Lancaster, Pennsylvania.

Smith, C.R. 1987. Ecology of Juvenile and Gravid Eastern Indigo Snakes in North Florida. MS 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.B., D. Breininger, and V. Larson. 1997. Home range characteristics of radio–tagged gopher tortoises on Kennedy Space Center, Florida. Chelonian Conservation and Biology 2(3):358–362.

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. 2012. Personal Communication. Email to Paula Halupa. Everglades National Park. Homestead, Florida. January 3, 2012.

Snyder, J.R., A. Herndon, and W.B. Robertson, Jr. 1990. South Florida rockland. Pages 230–278 in R.L. Myers and J J. Ewel, editors. 1990. Ecosystems of Florida. University of Central Florida Press, Orlando, Florida.

Snyder, J.R., M.S. Ross, S. Koptur, and J.P. Sah. 2005. Developing ecological criteria for prescribed fire in South Florida pine rockland ecosystems. USGS Open File Report OF 2006-1062.

Speake, D.W., J.A. McGlincy and T.R. Colvin. 1978. Ecology and Management of The Eastern Indigos Snake in Georgia: A Progress Report. Proceedings of the Rare and Endangered Wildlife Symposium. August 3-4 1978, Athens, GA.

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 SFRC-83-01, Everglades National Park; Homestead, Florida.

Timm, R.M. 2012. Comments on proposed endangered species status for Florida bonneted bat (Document # FWS-R4-ES-2012-0078-0025). University of Kansas, Kansas University Natural History Museum. Lawrence, Kansas. November 27, 2012.

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 2011. IUCN Red List of Threatened Species. Version 2011.2. <http://www.iucnredlist.org/>. Downloaded on 11 April 2012.

Todd, B. D., J. D. Willson, C. T. Winne, R. D. Semlitsch, and J. W. Gibbons. 2008. Ecology of the southeastern crowned snake, Tantilla coronata. Copeia 2008:388–394.

Trokey, S. 2006a. Personal communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. July 7, 2006.

Trokey, S. 2006b. Personal communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. July 17, 2006.

Trokey, S. 2008a. Personal communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. February 5, 2008.

Trokey, S. 2008b. Personal communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. October 18, 2008.

Trokey, S. 2012. Personal communication. Email to Paula Halupa. U.S. Fish and Wildlife Service. Ding Darling National Wildlife Refuge. Sanibel, Florida. January 10, 2012.

Tuma, M.W. 1996. Life history and population structure of the gopher tortoise (*Gopherus polyphemus*) on Camp Shelby, Mississippi. Annual report for Gopher Tortoise Legacy Research. U.S. Department of Agriculture. 1996. Soil survey of Dade County Area, Florida [cited in Bradley and Gann 1999].

U.S. Fish and Wildlife Service (Service). 1999. South Florida multi-species recovery plan. Fish and Wildlife Service; Atlanta, Georgia.

U.S. Fish and Wildlife Service (Service). 2006. Deltoid spurge (*Chamaesysce deltoidea* ssp. *deltoidea*). 5-year review: summary and evaluation. U.S. Fish and Wildlife Service, 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. 33pp.

U.S. Fish and Wildlife Service (Service). 2011a. 12-month finding on a petition to list the gopher Tortoise as threatened in the eastern portion of its range. Federal Register 76:14445130-45162.

U.S. Fish and Wildlife Service (Service). 2011b. Biological opinion on the proposed construction of the Special Operations Command Center (SOCSOUTH) in Homestead, Florida. U.S. Fish and Wildlife Service, Vero Beach, Florida.

U.S. Fish and Wildlife Service (Service). 2013. Standard Protection Measures for the Eastern Indigo Snake. South Florida Ecological Services Office; Vero Beach, Florida

U.S. Fish and Wildlife Service. (Service) 2014a. Recovery Outline for Bartram's scrub-hairstreak butterfly (*Strymon acis bartrami*). October 2014, South Florida Ecological Services Office, Vero Beach, Florida.

U.S. Fish and Wildlife Service. (Service) 2014b. Recovery Outline for Florida leafwing butterfly (*Anaea troglodyta floridalis*). October 2014, South Florida Ecological Services Office, Vero Beach, Florida.

U.S. Fish and Wildlife Service. (Service). 2016. Species Assessment and Listing Priority Form. May 25, 2016. https://ecos.fws.gov/docs/candidate/assessments/2016/r4/C044_V02.pdf

U.S. Fish and Wildlife Service. (Service) 2017. Environmental Assessment for the Coral Reef Commons Project Incidental Take Permit Application. March 2017. South Florida Ecological Services Office, Vero Beach, Florida.

URS Corporation Southern. 2007. Miami-Dade County Environmentally Endangered Lands Program Management Plan: Part II – Management of Specific Habitat Types, Ch. 1 – The Pine Rockland Habitat. Prepared for Miami Dade County, EEL program. Miami, Florida.

Van Lear, D. H., Carroll, W. D., Kapeluck, P. R., and R. Johnson. 2005. History and restoration of the longleaf pine-grassland ecosystem: Implications for species at risk. Forest Ecologyand Management, 211, 150-165.

Vasquez, C. 2017. Personal communication. Email Chalmers Vasquez, Miami-Dade County Mosquito Control to A. Blackford, U.S. Fish and Wildlife Service. RE: Follow-up to mosquito control conversation today. October 16, 2017.

Vaughan, T.A. 1959. Functional morphology of three bats: Eumops, Myotis, Macrotus. University of Kansas Publishing, Museum of Natural History 12: 1-153.

Vaughan, T.A. 1966. Morphology and flight characteristics of molossid bats. Journal of Mammalogy 47(2):249-260.

Wade, D., J. Ewel, and R. Hofstetter. 1980. Fire in South Florida ecosystems. General Technical Report SE-17. U.S. Department of Agriculture, Forest Service, Southeast Rorest Experiment Station, Asheville, North Carolina. 125 p.

Walesky, R.E. 2005. Letter from Palm Beach County Department of Environmental Resources Management to James Slack, U.S. Fish and Wildlife Service, Vero Beach, Florida.

Watts, K. 2017. Personal communication. Email Watts to Salvato, U.S. Fish and Wildlife Service Biologists. Observations of Bartram's scrub-hair streak herbivory on Big Pine Key. Subject: CRI Bartram's SH. August 7, 2017.

Wear, D.N., and J.G. Greis. 2002. Southern forest resource assessment – technical report. General technical report SRS-53. U.S. Department of Agriculture, Forest Service, Southern Research Station, Asheville, North Carolina. http://www.srs.fs.usda.gov/sustain/report/index.htm

Wear, D.N., and J.G. Greis. 2011. The Southern Forest Futures Project: summary report. Draft report. U.S. Department of Agriculture, Forest Service, Southern Research Station. Research Triangle Park, North Carolina. http://www.srs.fs.usda.gov/futures/

Webster, R.D. and S.L. Hatch. 1990. Taxonomy of Digitaria section Aequiglumae (Poaceae: Paniceae).

Webster, R.L. 1967. Genera of Euphorbiaceae. Journal of the Arnold Arboretum. 48.

Wendelberger, K., and A. Frances. 2004. Updated Conservation Action Plan for *Polygala smallii* from M. Fellows, J. Possley, H. Thornton, K. Wendelberger, and A. Frances, Pages 95-102 in Maschinski, J., S.J. Wright, K.S. Wendelberger, J. Possley, and J. Fisher. 2005. Conservation of South Florida endangered and threatened flora: 2004-2005 Program at Fairchild Tropical Botanic Garden. Final Report Contract #009064. Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, Florida.

Wendelberger, K., 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 Botanic Garden.

Werner, C. 2007. Personal communication. Email from Withlacoochee State Forest to Keith Bradley, Institute for Regional Conservation, Miami, Florida.

Wilkinson, G.S., and J.M. South. 2002. Life history, ecology and longevity in bats. Aging Cell 1:124-133.

Willis, H. L. 1967. Bionomics and zoogeography of tiger beetles of saline habitats in the central United States (Coleoptera: Cicindelidae). University of Kansas Science Bulletin 47:145-313.

Wilson, L.D. 1982. Catalogue of American Amphibians and Reptiles. Society for the Study of Amphibians and Reptiles, NY.

Wipff. J. K. 2004. Digitaria, in Flora of North America, grass manual online. http://herbarium.usu.edu/grassmanual/. Accessed June 6, 2004.

Wirth, C. 2015. Once altered = gone forever? Blog. Online [https://cicindela.wordpress.com/category/insects/beetles/] [Accessed: April 30, 2015].

Woodmansee, S.W. 2014. Coral Reef Commons rare plant and floristic inventory and assessment. Pro Native Consulting. Miami, FL.

Woodmansee, S.W., M.J. Barry, K.A. Bradley, S. Green, and J.M. Mahoney. 2007. Post-hurricane Field Assessments of six federally endangered and candidate plant species. Final Report to the Service, Vero Beach, Florida. Contract #401815G156 to the Institute for Regional Conservation.

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.

Wright, J.S. 1982. Distribution and population biology of the gopher tortoise, *Gopherus polyphemus*, in South Carolina. Clemson University. Master Thesis. 74 pp.

Wunderlin, R.P. and B.F. Hansen. 2000. Flora of Florida, Volume 1: Pteridophytes and Gymnosperms.University Press of Florida, Gainesville, Florida.

Wunderlin, R.P. and B.F. Hansen. 2003. Guide to the vascular plants of Florida, second edition.

Wunderlin, R.P. and B.F. Hansen. 2004. Digitaria pauciflora in Atlas of Florida vascular plants. http://www.plantatlas.usf.edu/main.asp?plantID=1108 Accessed June 6, 2004.

Yirka, M.A., J.N. Flowers, M.D. Martin, K.R. Messenger, and N.A. Shepard. 2010. Geographic distribution: *Tantilla oolitica* (rim rock crowned snake). Herpetological Review 41:382.

Zhong, H., L.J. Hribar, J.C. Daniels, M.A. Feken, C. Brock, and M.D. Trager. 2010. Aerial ultra-low-volume application of naled: impact on non-target imperiled butterfly larvae (*Cyclargus thomasi bethunebakeri*) and efficacy against adult mosquitoes (*Aedes taeniorhynchus*). Environmental Entomology 39(6):1961-1972.

Zwick, P.D., and M.H. Carr. 2006. Florida 2060. A population distribution scenario for the State of Florida. A research project prepared for 1000 Friends of Florida. Prepared by the Geoplan Center at the University of Florida, Gainesville, Florida. 29 pp. (pag 28)